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East Africa's Infrastructure

A Continental Perspective

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Abstract

Sound infrastructure is critical for growth in East Africa. During 1995–2005, improvements in infrastructure boosted growth by one percentage point per year, due largely to wider access to information and communication technologies (ICTs). Although power infrastructure sapped growth in other regions of Africa, it contributed 0.2 percentage points per year growth in East Africa. If East Africa's infrastructure could be improved to the level of the strongest performing country in Africa (Mauritius), regional growth performance would be boosted by some six percentage points, with power making the strongest contribution.

East Africa's infrastructure ranks behind that of southern and western Africa across a range of indicators, though in terms of access to improved sources of water and sanitation and Internet density, it is comparable with or superior to the subcontinent's leader, southern Africa. By contrast, density of fixed-line telephones, power generation capacity, and access to electricity remain extremely low, though utility performance is improving through regional power trades.

The road network is relatively good, although with some lengths of poor-quality or unpaved roads. Surface transport is challenged by border crossings, port delays, slow travel, limited railways, and trade logistics, but the region has a relatively mature and competitive trucking industry. Air transport benefits from a strong hub-and-spoke structure but has made little progress toward market liberalization.

Of the seven countries in the region, four are landlocked, two have populations of fewer than 10 million people, and two have an annual gross domestic product of less than $10 billion. The difficult economic geography of East Africa makes a regional approach to infrastructure development necessary to achieve further improvement.

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East Africa's Infrastructure: A Regional Perspective

Rupa Ranganathan and Vivien Foster

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Synopsis

Sound infrastructure is a critical determinant of growth in East Africa. Over the period 1995–2005, improvements in infrastructure boosted growth in East Africa by one percentage point per year, an effect attributable largely to the revolution in information and communication technologies (ICTs). Unlike other regions of Africa, in which power infrastructure eroded growth, in East Africa, power infrastructure contributed 0.2 percentage points per year. If East Africa's infrastructure could be improved to the level of the strongest performing country in Africa (Mauritius), regional growth performance would be boosted by some six percentage points, with power making the strongest contribution.

East Africa's infrastructure ranks consistently behind that of southern and western Africa across a range of indicators. In areas such as access to improved sources of water and sanitation and Internet density, however, East Africa's performance is comparable with or superior to that of the regional leader—southern Africa. Nevertheless, density of fixed-line telephones, power generation capacity, and access to electricity in East Africa are extremely low even by African standards.

The difficult economic geography of East Africa makes it particularly important to take a regional approach to infrastructure development. East Africa is characterized by small-scale economies, many of which are physically cut off from key resources. The small size of these economies prevents the capture of scale economies, making it difficult for governments to afford the high fixed costs associated with infrastructure development. Of the seven countries in the region, four are landlocked, two have populations of less than 10 million people, and two have a gross domestic product (GDP) of less than $10 billion. The Nile is the major transnational river that runs through the region, and most of the countries in the region are riparian.

East Africa's road network is in relatively good condition, with prominent patches of poor-quality roads along some corridors and significant stretches of unpaved road. There are three main corridors in the region. The northern corridor—which connects Kenya, Uganda, Rwanda, and Burundi, with a branch heading north to Sudan—is the main trading corridor. The central corridor competes directly with the northern corridor. It connects Tanzania, Burundi, Rwanda, and Uganda and extends into the northeastern part of the Democratic Republic of Congo. The third corridor connects Addis Ababa to Djibouti in the northern part of East Africa.

Surface transport in East Africa is challenged by border crossings and trade logistics but faces fewer obstacles from the trucking industry which is comparatively mature and more competitive than in some other subregions. In East Africa, road transport tariffs are on the order of $0.07 per tonne-kilometer, compared with $0.05 per tonne-kilometer in southern Africa and $0.04 per tonne-kilometer in much of the rest of the developing world. Nevertheless, in East Africa, trucking industry prices are determined by market forces rather than restrictive regulations. Recent surveys based on transporter perceptions (World Bank 2010b) indicate that logistics in East Africa are the worst in Africa, with bottlenecks exceeding those in West Africa. The primary reason for the challenges appears to be a steep increase in traffic and trade flows across borders without a corresponding improvement in infrastructure and in the policy environment and institutions associated with cross-border trade.

Surface transport in East Africa is very slow when viewed against that of southern Africa and against global standards. Widespread delays occur in ports, at border crossings, and in other processes. The average effective velocity of road freight in East Africa is around 8 miles per hour, slower than the 11 miles per hour found in southern Africa. In both cases, freight is moving no faster than a horse and buggy. This slow speed of freight movement has something to do with road infrastructure but even more to do with the extensive delays suffered in ports, in administrative procedures such as border crossings and customs clearance, and at informal checkpoints and roadblocks that keep trucks stationary for extended periods of time.

The overall cost of moving a tonne of freight along East Africa's key trade routes is on the order of $200–300 and takes between 200 and 600 hours. The extensive dwell times in ports and in customs clearance account for about 80 percent of the time. Shortening those delays could greatly reduce the time needed to move imports from ports to landlocked capitals. The high costs of moving freight along East African corridors correspond well with observed traffic patterns on roads and in ports. Reducing delays at ports alone could shave off between $70 and $100 from the cost of moving a tonne of imports.

Except for Tazara, there is no real regional rail network within the East Africa, and the existing rail networks are very lightly used, which complicates further regional integration. The national rail networks of East African member states are mostly independent from each other, again with the exception of Tazara, which is linked into the southern African network. This situation poses a stark contrast to southern Africa, where interconnected national railway systems form a regional railway network that spans half a dozen countries. Further integration of East Africa's rail systems is complicated by the use of various gauges in the region. The meter gauge is prevalent in most of East Africa, but in Tanzania, for example, two railways lines operating in the same area use two different gauges. Only three East African railway lines span more than one country. Poor operational performance, with the exception of Tazara and TRC, and light use of existing rail networks, makes the economic case for integration even less clear. The more pressing priority is to improve the performance of national systems to allow them to compete more effectively with road transport.

In the ports sector, East Africa has two maritime hubs that anchor the regional transshipment network but need significant improvements in performance across the board. The performance of East African ports compares unfavorably with ports in southern Africa ports and lags far behind global best practice in their costliness and timeliness. The services provided by East African ports cost nearly twice as much as those in other global ports. Ports in East Africa also suffer from serious issues of overcapacity and congestion. The international standard for dwell time is seven days or less, but in East Africa, containers routinely spend more than a week in the terminal. The result is terminal congestion and port inefficiencies.

With respect to air transport, East Africa has a strong hub-and-spoke structure that centers on two regional hubs, but the region has made little progress toward market liberalization. Even if bilateral connectivity is not strong among East Africa countries, connectivity with Nairobi or Addis Ababa, the two regional hubs, ensures good connectivity across the region. In terms of market liberalization, according to a recent study, the East African Community (EAC) has earned a middling score in its implementation of the Yamoussoukro Decision. The rating is based on the percentage of flights in the region that are flown under so-called fifth-freedom arrangements. Owing to the presence of two strong

regional carriers and a clear hub system, such flights are not as common in EAC as in Central or West Africa, because the dominant carriers are able to work out bilateral agreements that preempt regional cooperation (or make it more difficult). On the other hand, most countries in East Africa have made good progress toward achieving international standards in air safety, and regional collaboration in this area is already well underway. Ethiopia is the only country in all of Africa, other than South Africa, that has complied with all international standards in air safety.

The power situation in East Africa is grave compared with other regions of Africa. East Africa's overall generation capacity is the smallest after Central Africa, but per capita generation is the smallest. Access to power is also the lowest in Africa. On the other hand, utility performance in EAC is encouraging. Systems losses and hidden costs are less serious than in other regions of the continent, and the region's cost-recovery record is the highest in Africa. In terms of pricing for power, the average historic costs of power in the region are high—almost $0.20 per kilowatt-hour. With demand for power expected to increase by 70 percent, expanding power infrastructure is critical to the region's economic infrastructure.

East Africa already practices regional power trade, albeit much less actively than western and southern Africa; greater trade could bring substantial benefits. The potential to develop trade is great, because many countries in the region would be better off by importing a sizable share of their power needs. Realizing the benefits of trade depends, however, on the ability of Ethiopia and Sudan (as well as Uganda and Rwanda, to a lesser extent) to develop their hydropower capacity. Ethiopia and Sudan would have to build more than 6,700 MW and 3,100 MW of additional hydropower capacity to deliver the full benefits of trade, and the members of the East African Power Pool would have to build more than 27,700 MW of interconnectors. If these targets could be met, the region's cost of energy would be reduced by $1 billion annually. Several countries would save significantly on their national power development and a number of smaller countries could substantially reduce their long-run marginal cost of power. In addition, regional trade would allow a shift to cleaner energy that would reduce regional carbon emissions by more than 20 million tonnes annually, the second-largest savings of any subregion (after those of the Southern African Power Pool). Overall, the returns on investments in regional interconnection would yield an average rate of return of 20 percent.

Compared with the continent's other regional economic communities, EAC has performed poorly in terms of ICT access and, in 2007, faced relatively high prices for critical ICT services. But with access to submarine cable in several countries, ICT prices have dropped significantly, and access has improved. East Africa pioneered the "borderless roaming arrangements" across several countries, with free incoming calls and billing based on local tariffs. All countries except Ethiopia have opened their telecommunications market to some level of foreign investment. While there are several large mobile groups that operate in multiple countries in the region, no single operator dominates the region. Countries with submarine cable have seen a dramatic decline in prices for basic ICT services. The landlocked countries are also expected to see a drop in prices as soon as their overland connection to the undersea cable becomes available. As of 2007, however, East Africa needed to complete over 3,500 kilometers of terrestrial fiber optic network. Only a fraction of the needed cable has been accomplished in the course of connecting to the submarine cable.

1 Introduction

The Africa Infrastructure Country Diagnostic (AICD) has conducted extensive data collection and analysis of the infrastructure situation in Africa, including East Africa. The results have been presented in a variety of continental reports covering different areas of infrastructure— information and communication technology (ICT), irrigation, power, transport, water, and sanitation—and in different policy areas—including investment needs, fiscal costs, and sector performance.

The purpose of this regional report is to pull together in one place the key AICD findings relevant for East Africa. The main value in doing so is that it makes it possible to benchmark the infrastructure situation in the region against that of other African peers, to identify the main gaps in the regional infrastructure backbones, and to quantify the costs and benefits of regional integration, as well as their distribution across member states.

A number of methodological issues should be borne in mind.

First, due to the cross-country nature of the data collection, there is inevitably a time lag in the data. The period covered by AICD runs from 2001 to 2006. Most technical data presented are for 2006 (or the most recent year available), while financial data are typically averaged over the available period to smooth out the effect of short-term fluctuations. Given the fast pace of regional integration, the snapshot presented here does not necessarily correspond to today's situation but rather represents the 2006 baseline against which subsequent progress can be measured.

Second, given the need to make comparisons across countries, indicators and analysis had to be standardized and made consistent. That means that some of the indicators may be slightly different from those routinely reported and discussed at the country level.

Third, the database on which the analysis is based was designed to give a national and continental picture of infrastructure, as opposed to an explicitly regional picture. But national infrastructure provides the basic building blocks for regional integration, and hence can be used to build up a picture of the regional situation. Nevertheless, some specifically regional issues—particularly of the regulatory and institutional variety—may not have been explicitly addressed in the national data collection effort.

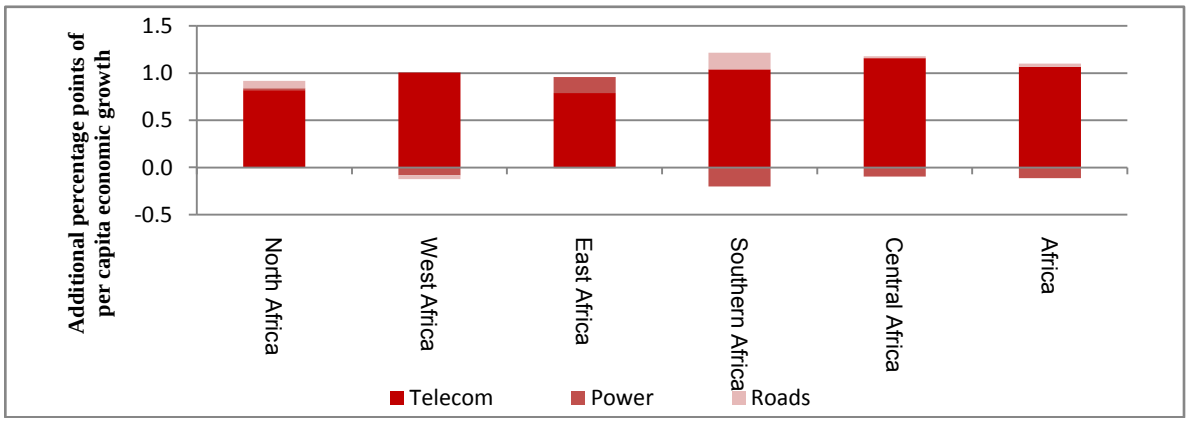
Fourth, for the purposes of this review, an extended East Africa is discussed. This includes the East African Community (Burundi, Kenya, Rwanda, Tanzania, and Uganda), as well as Sudan and Ethiopia. This group of seven countries is referred to in this report as East Africa.

Fifth, while water resource management is an important aspect of regional integration in Africa, this report does not explore water resource issues. The reason is that the AICD project did not cover water resources per se, but rather the specific water resource needs associated with the power, irrigation, and water supply sectors.

Why infrastructure matters

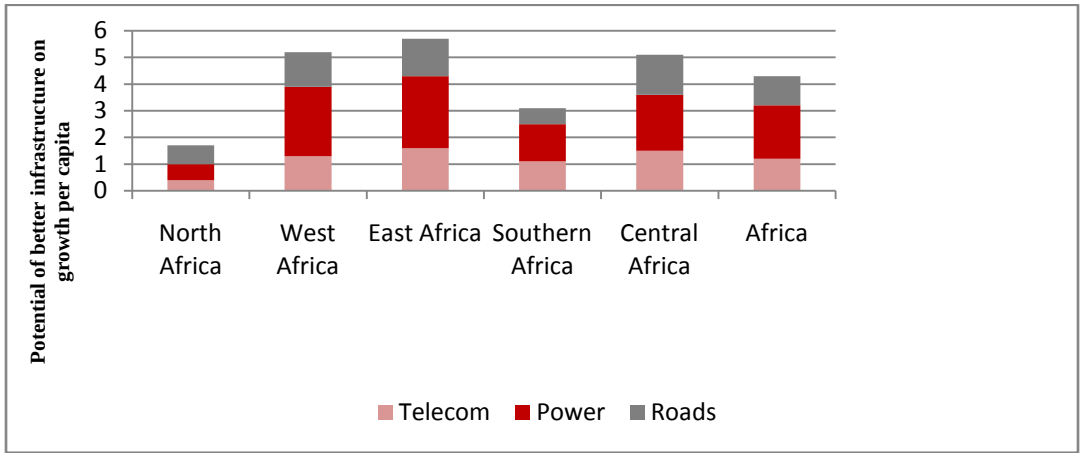
For the period 2003–08, all East African countries experienced economic growth, albeit at different rates. On average, East African countries grew at an annual rate of 5 percent, and EAC countries at 4 percent, from 2003 to the onset of the global financial crisis. During this period, infrastructure contributed one percentage point to growth among East African countries. As in other regions of Africa, most of that growth can be traced to the introduction and spread of mobile telephony (figure 1.1a). Yet unlike other regions where power infrastructure has constrained growth, in East Africa power infrastructure has contributed around 0.2 percentage points per capita to growth per year.

Figure 1.1a. Infrastructure's historic contribution to economic growth, 1995-05



Source: Calderon 2008.

Figure 1.1b. Infrastructure's potential future contribution to economic growth (% GDP per capita per year)



Source: Calderon, 2008.

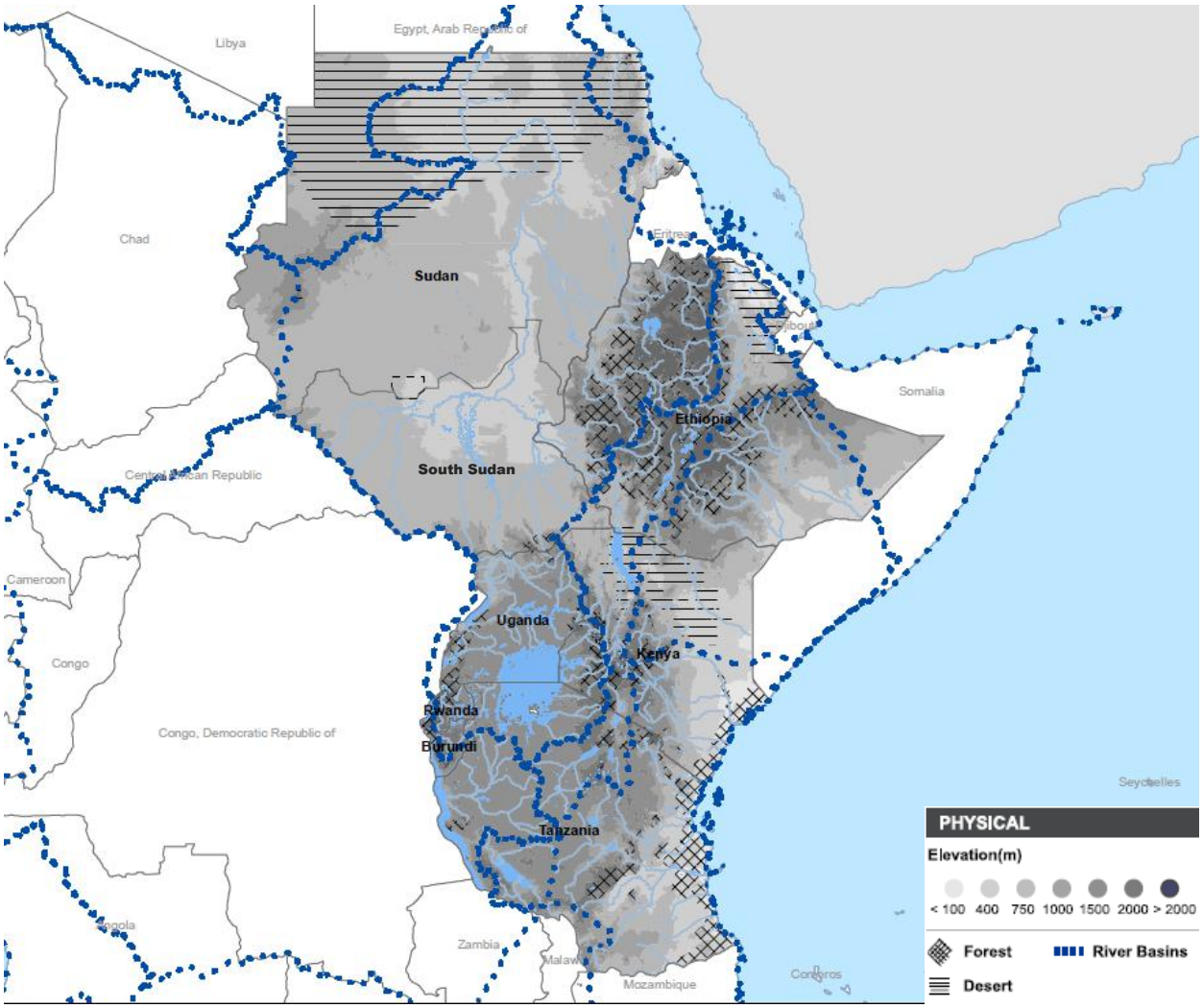
Infrastructure could potentially contribute much more to economic growth than it has in the past (figure 1.1b). Simulations suggest that if East Africa's growth infrastructure were upgraded to the level of the best-performing country in Africa (Mauritius), per capita growth would increase by almost 6 percentage points. Interestingly, improvements in infrastructure make a greater contribution to per capita growth in East Africa than in the other regions of Africa. While all areas of infrastructure—ICT, power,

and transport—need to be upgraded, improvements in power would have the largest impact on growth, raising it by up to 2.7 percentage points.

Why regional integration matters

Unlike some of the other regions of Africa, where one large country dominates the regional picture, East Africa comprises a number of medium-sized economies. Of the seven countries in the region, four are landlocked, two have populations below 10 million people, and two have GDPs of less than $10 billion. The Nile is the major transnational river that runs through the region, and most of the countries in the region are riparian (figure 1.2a).

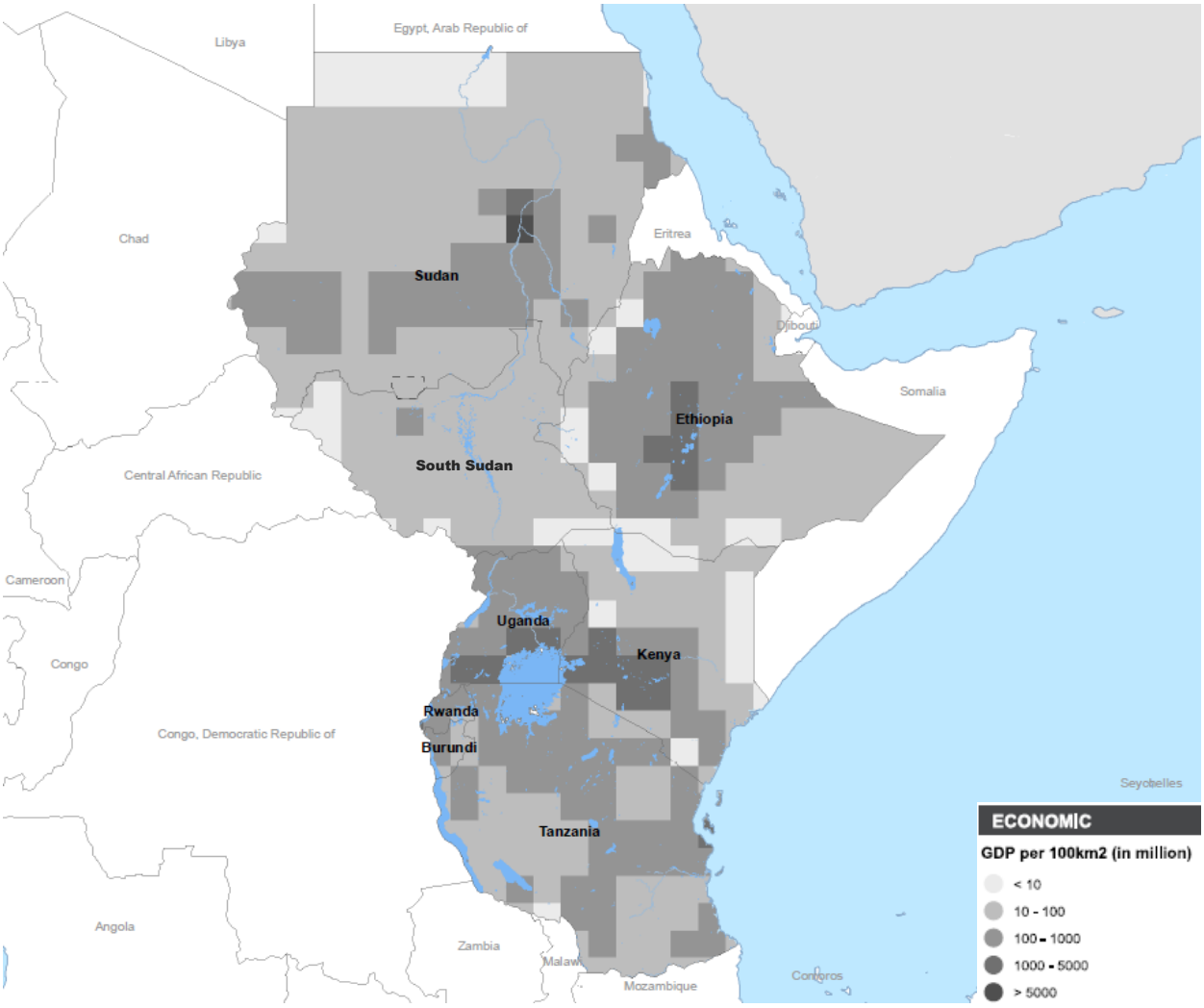
Figure 1.2a. Topographical profile of East Africa



East Africa is also different from some other parts of Africa in that its economic activity is located away from the coast and concentrated in pockets. An agglomeration of economic activity forms a circle around Lake Victoria and reaches down toward Mombasa and Dar Es Salaam on the coast. Economic density in this region ranges from $1 billion to $5 billion per 100 square kilometers. Further north, there

are pockets of economic concentration around Addis Ababa and Khartoum, but these are relatively isolated geographically. A strip of central Sudan has an economic density ranging from $1 billion to $5 billion per 100 square kilometers, peaking at more than $5 billion per 100 square kilometers around Khartoum. Another pocket of activity around Addis Ababa has an economic density ranging from $1 billion to $5 billion per 100 square kilometers, tapering off to less than $1 million per 100 square kilometers away from the center and toward the coast (figure 1.2b).

Figure 1.2b. Spatial distribution of economic activity within East Africa



Regional integration is probably the only way to overcome these handicaps and allow East Africa to participate in the global economy. Integrating physical infrastructure is both a precursor to and enabler of deeper economic integration, because it allows countries to gain scale economies, harness regional public goods, and overcome the disadvantages of adverse location. Joint provision increases the scale of infrastructure construction, operation, and maintenance. 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 neighbors share their benefits. Connecting countries electronically through

undersea cables or satellite communications requires large up-front investments that demand a regional approach.

The state of East Africa's infrastructure

East Africa performs below the Southern African Development Community (SADC) and the Economic Community of West African States (ECOWAS) on most aggregate infrastructure indicators (table 1.1). In areas such as access to improved sources of water and sanitation and Internet density, however, East Africa has performance comparable with or superior to the regional leader—southern Africa. The density of fixed-line telephones is staggeringly low—less than half the density of Central Africa and one-twelfth that of southern Africa. Power generation capacity and electricity access are also extremely low, even by African standards. Southern Africa generates 11 times more electricity than East Africa; West Africa, twice as much. Household access to power is three times higher in West Africa and four times higher in southern Africa than it is in East Africa. The aggregates for East Africa as a whole inevitably mask substantial country variations within the region.

Table 1.1 Benchmarking EAC with other economic communities

	Western	Eastern	Southern	Central
Paved road density	38	**29**	92	4
Fixed-line telephone density	28	**6**	80	13
Mobile telephone density	72	**46**	133	84
Internet density	2	**2**	4	1
Generation capacity	31	**16**	176	47
Electricity coverage	18	**6**	24	21
Improved water	63	**71**	68	53
Improved sanitation	35	**42**	46	28

Source: AICD.

The following sections of the report review the main achievements, challenges, and future benefits of regional integration for each type of network infrastructures. Table 1.2 summarizes the main findings of this sectoral review. The final section of the paper explores the overall financial costs and affordability of implementing the regional integration agenda in East Africa.

Table 1.2. Progress and challenges for regional integration in East Africa

Sector	Achievements	Challenges	Promise of regional integration
Road transport	Several major gateways in East Africa that facilitate intraregional trade. The northern corridor is by far the most important corridor and has roads of good quality. The trucking industry is deregulated and performs relatively well.	Extremely problematic trade logistics systems. Trade logistics perception rankings for East Africa are the lowest in the world as of 2010. Lengthy delays and inadequate infrastructure at borders..	Reducing costs and delays associated with surface transport of goods within the region
Railways	Three binational railways offer tremendous potential for regional integration	Low levels of passenger and freight traffic. Poor operational performance of most railways. Stiff intermodal competition	
Ports	Burgeoning container and general cargo traffic. Some ports in East Africa perform at global good-practice standards on some parameters such as container dwell time.	The two major ports in East Africa—Dar es Salaam and Mombasa—face major capacity constraints that could damage trade.	
Air transport	Good regional connectivity. Nairobi and Addis Ababa are strong regional hubs and provide good intraregional connectivity. Air traffic has grown steadily. Most countries are making progress toward global safety standards. Significant fleet modernization	Relatively small share of flights flown under fifth=freedom arrangements.	
Power	Performance of power utilities is encouraging, particularly on cost recovery. Principle of regional trade already well-established.	Generation capacity relatively low. Per capita generation capacity and access to electricity are worst in Africa.	Deepening regional integration would save the East African Power Pool (EAPP) $1billion (or 10 percent) in annual energy costs, and annual savings in carbon emissions of some 20 million tonnes of carbon. Long-run marginal cost of power in the EAPP would fall by less than $0.01 per kilowatt-hour. Overall rate of return on regional integration investments is 20 percent.
ICT	Recent initiatives to connect East Africa to submarine cables have pushed prices down. Plans to connect all countries to the cable underway.	Low access to ICT services and high prices. Relatively high GSM coverage. Lags other Africa regions on intraregional roaming arrangements.	Achieving regional integration of ICT will cost only $96 million in total and bring benefits of $53 million annually. Overall rate of return on regional integration investments that fill in gaps is 57 percent.

2 Transport

Figure 2.1a . Condition of East Africa's regional road network

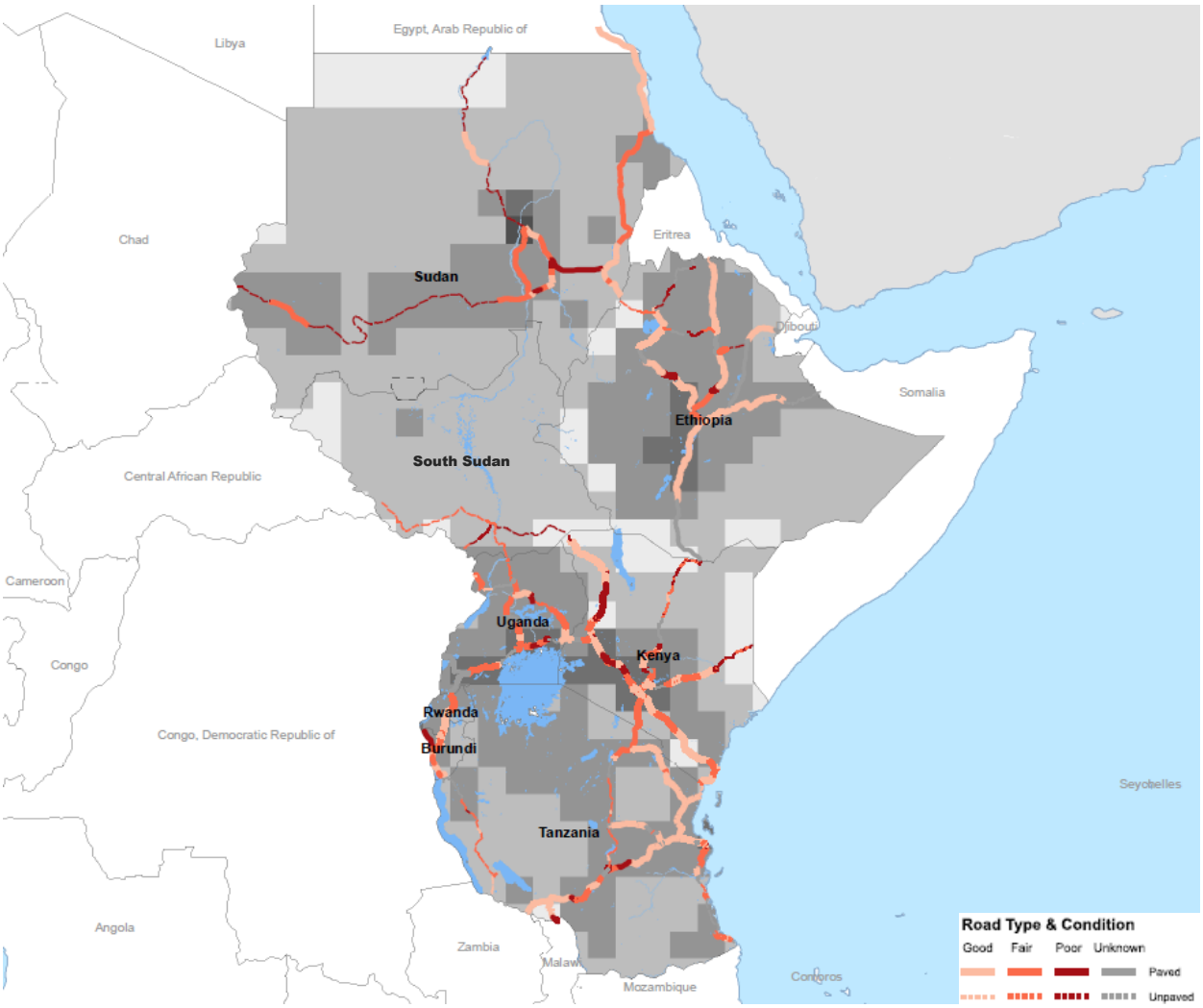


Figure 2.1b . Traffic volumes on East Africa's regional roads

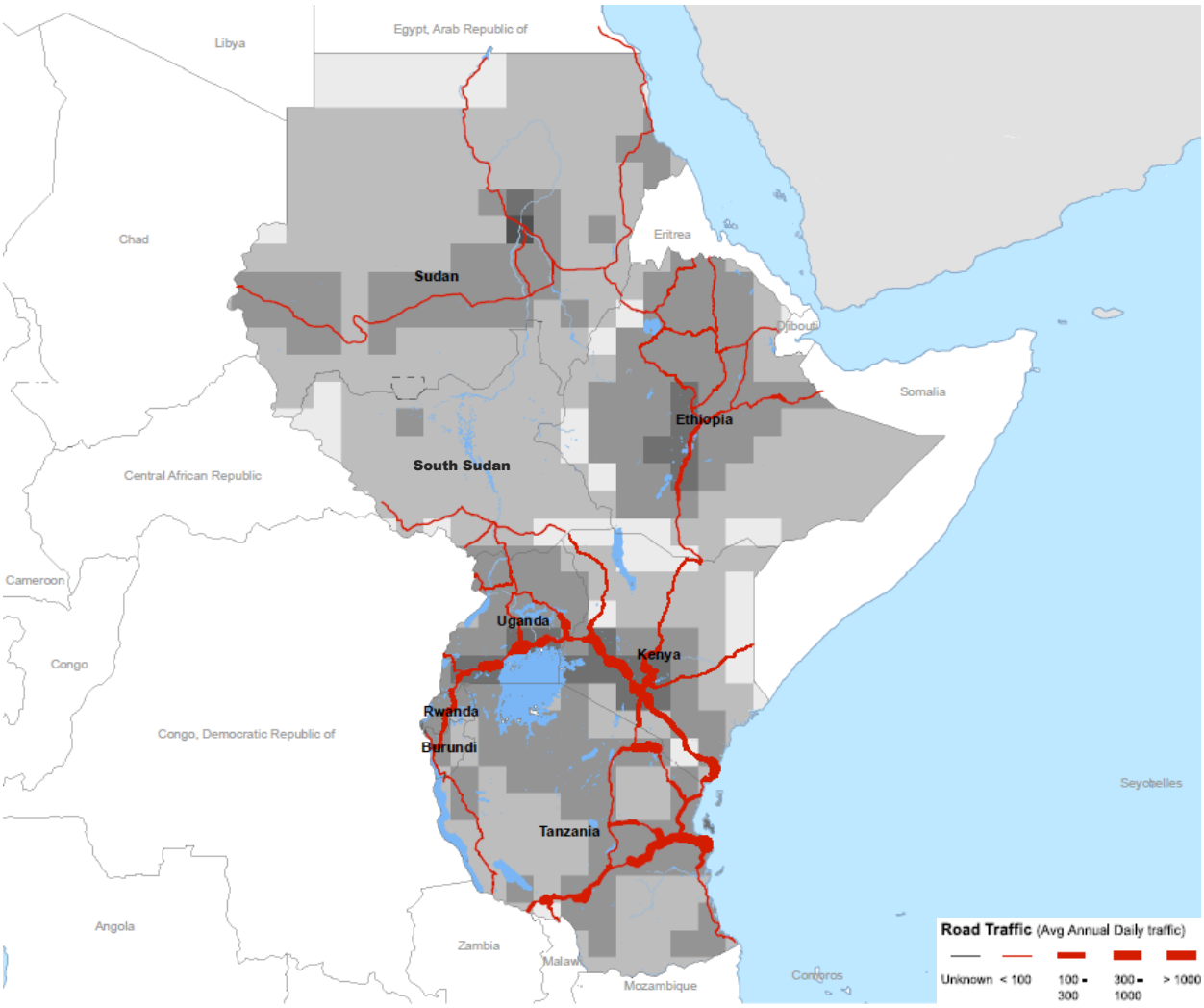
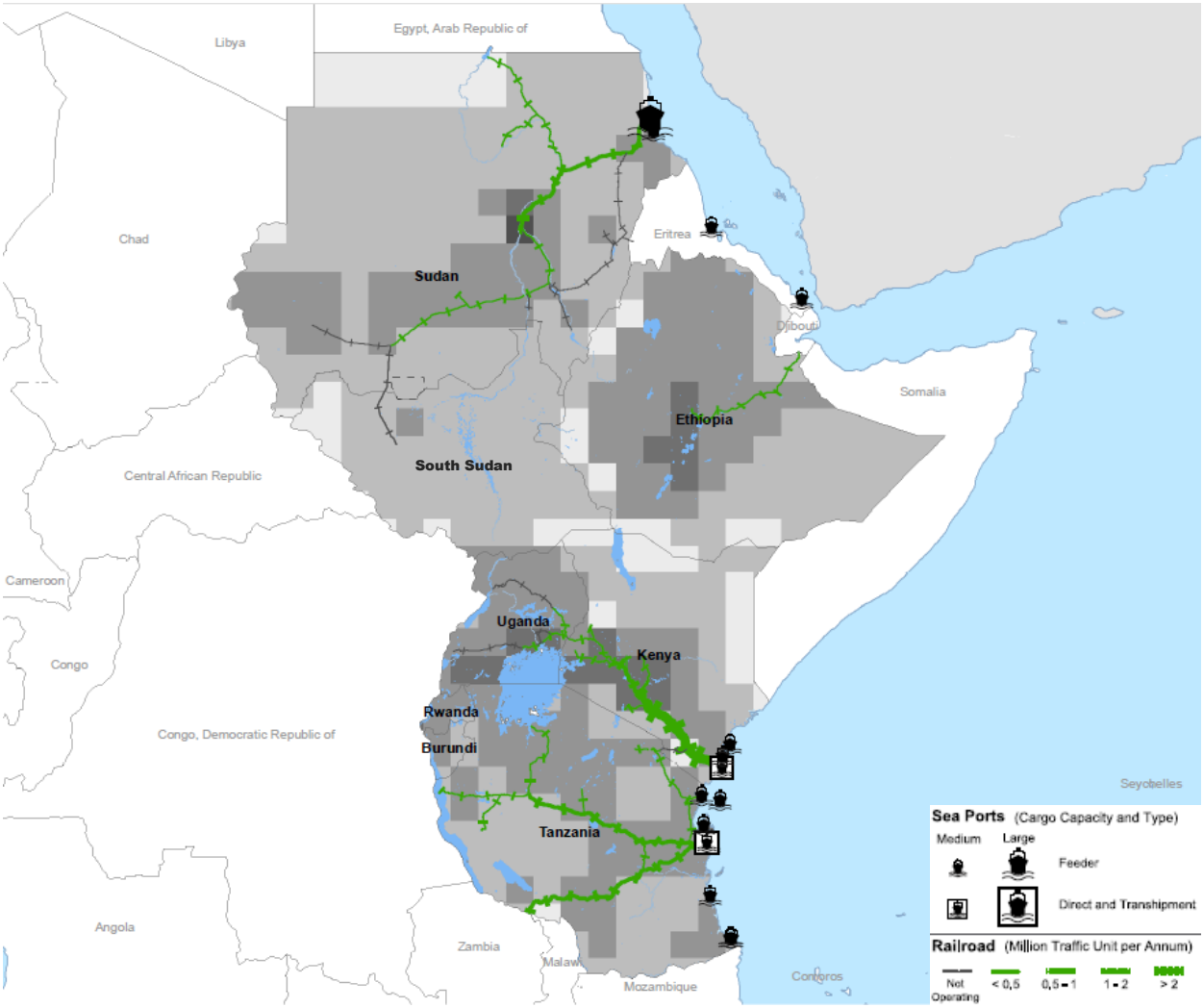


Figure 2.1c . East Africa's regional railways and ports



Surface transport

Surface transport of goods in Africa is much slower and costlier than elsewhere in the developing world. Across the developing world, freight can typically be moved at rates of between $0.01 and $0.04 per tonne-kilometer. A recent study of road transport costs and prices across Africa found rates of between $0.05 and $0.13 per tonne-kilometer, well above the global benchmark. In addition, despite the relatively good condition of the road corridors, freight movements are astonishingly slow when all delays are taken into account: effective velocity is between 6 and 12 kilometers per hour, which is not much faster than a horse and buggy (table 2.1).

Transit corridors in East Africa are in the middle of the pack relative to the other regions. Of the 2,845 kilometers of road, 82 percent are in good condition. Road quality is second only to southern Africa, where all roads are in good condition. Goods travel at an effective velocity of 8.1 kilometers per hour when all delays are taken into account. This is slightly faster than in western and central Africa, but

still somewhat slower than southern Africa. The trade density (in US$ per km) is less than one-fifth of the density in southern Africa. Road freight tariffs average $0.07 per tonne-kilometer, in the middle of the range for African regions but still exceedingly high relative to global standards (Teravaninthorn and Raballand 2009).

Table 2.1. Relative performance of transport corridors in Africa

Corridor	Length (kms)	Road in good condition (%)	Trade density (US$ millions per km)	Implicit velocity (km per hour)	Freight tariff (US$ per ton-km)
Western	2,050	72	8.2	6.0	0.08
Central	3,280	49	4.2	6.1	0.13
Eastern	**2,845**	**82**	**5.7**	**8.1**	**0.07**
Southern	5,000	100	27.9	11.6	0.05

Note: Implicit velocity is the total distance divided by the total time taken to make the trip, including time spent stationary at ports, border crossings, and other stops

Source: Teravaninthorn and Raballand 2009.

According to the 2010 International Logistics Performance Index (LPI), [1] the costs associated with logistics in East Africa are higher than in any other region in world, including West Africa. This is a major change from a few years ago when the LPI in West Africa was considered the worst. In recent years, however, East Africa has been constrained by inadequate infrastructure and customs performance, as well as difficulty in clearing borders (World Bank 2010b). Overall traffic and trade flows in East Africa have also increased without a corresponding improvement in the policy environment. At the country level, Uganda's LPI ranked at 66 out of 155 countries, a significant improvement since the previous LPI ranking. The low ranking of Rwanda suggests that the country is constrained by logistics (World Bank 2010a).

The domestic LPI suggests that average lead times for exports and imports in East Africa are the highest and second-highest in the developing world, respectively. This is also a change from previous estimates. Freight from landlocked countries in East Africa that must cross borders suffers economic and time penalties when compared with coastal countries. Among countries in East Africa, clearance times for landlocked countries are around five times higher than for those with port access. Among logistics operators surveyed as part of the LPI study, 60 to 75 percent of the respondents from East Africa indicate that the port, airport, and road transport rates are exorbitant, while 45 percent of respondents from the rest of the world indicate that the rates are high or very high.

In comparison to West and central Africa, the trucking industry in East Africa is more competitive and mature. Freight transportation rates are determined by market forces rather than government regulations. In Rwanda, deregulation of the trucking industry illustrates the close correlation between high transport prices and cartelization (box 2.1). The largest professionalized trucking companies claim 20 percent of the market share, a rate comparable to Europe and North America. There are 20 large companies that operate over 100 trucks each. The largest Kenyan company owns a fleet of 600 trucks.

[1] LPI is an annual survey of international freight forwarders conducted in 155 countries. The survey aggregates the responses of survey participants concerning several factors—among them transport, warehousing, and border clearance—into an index that is used to rank and rate global logistics for trade.

These large companies obtain loads from long-term direct contracting and reach a much higher mileage than companies in other parts of Africa (Teravaninthorn and Raballand 2009).

Box 2.1. Deregulation of the trucking industry in Rwanda

The only deregulation experience in the African region so far took place in Rwanda in 1994, and it had a huge effect on transport prices, confirming the impact that cartels have had elsewhere in Africa. After deregulation of international transport, prices declined by more than 30 percent in nominal terms and by almost 75 percent in real terms when taking into account the continued increase in input prices. The impact of deregulation in Rwanda was probably stronger than in most other countries because previously the country's freight services were a monopoly of a parastatal trucking company (STIR) that was able to set high prices without any restraint. Furthermore, 1994 was also the bloodiest period of the Rwandan civil war, during which, for all practical purposes, a road freight fleet had ceased to exist.

Deregulation led to growth in the Rwandan fleet. This result was in contrast with common fears that deregulation, which liberalizes market entry, leads to eradication of the fleet owned by truckers from landlocked countries. In the case of Rwanda, the fear was even stronger, given the disappearance of its trucking fleet at the height of the civil war in 1994. In fact, deregulation aided in a rapid recovery of the domestically owned fleet. A distinctive feature of the business strategy followed by Rwandan truckers has been their specialization in specific goods to capture niche and profitable markets, such as petroleum products. This largely explains why the current fleet is as large as it was prior to deregulation of international transport.

Source: Teravaninthorn and Raballand 2009.

The comparatively slow effective velocity of freight in East Africa can be explained by lengthy customs clearance processes, administrative delays at ports, and delays at the border. The situation seems to have worsened since 2009. According to the LPI survey, customs clearance time in the region is up to seven times less predictable than in other parts of the world. Associated border delays are also lengthy (World Bank 2010b). Based on estimates from 2008, East African trucking companies have indicated that their trucks have to wait between one and two days at Malaba (the border post between Kenya and Uganda). Congestion at the posts due to limited parking availability, limited space in customs yards, poor cargo documentation, and duplication of administrative processes in Uganda and Kenya have also contributed to the delays. Ugandan and Kenyan authorities are now working on an initiative that would oblige trucks to pass through only one stop instead of two. Once fully launched this effort should significantly reduce delays (Teravaninthorn and Raballand 2009).

Recent reports indicate that roadblocks and weigh stations significantly increase transport costs. A 2008 survey of the East African Business Council found that random police checks that impose costs and delay trucks are pervasive. Similar problems have been documented in West Africa. Truckers traveling west from Mombasa or Dar es Salaam report an average of 19 roadblocks and 4.4 weigh stations per trip, resulting in 12 hours spent on diversions. Truckers traveling between Kigali and Mombasa experienced a combined total of 47 roadblocks and weigh stations. Although the value of the individual bribes sought at roadblocks and weigh stations is not large, their cumulative total is daunting—around $8 million per year in the East African Community alone (USAID 2009).

East Africa has four landlocked countries, which use Dar es Salaam and Mombasa as their gateways to the sea. Ethiopia uses Djibouti as its gateway, and Sudan has access to Port Sudan. Rwanda and Burundi have the option of using either Mombasa or Dar es Salaam, which creates the possibility of competition along corridors and between ports. For example, Burundi's most direct route to the coast is

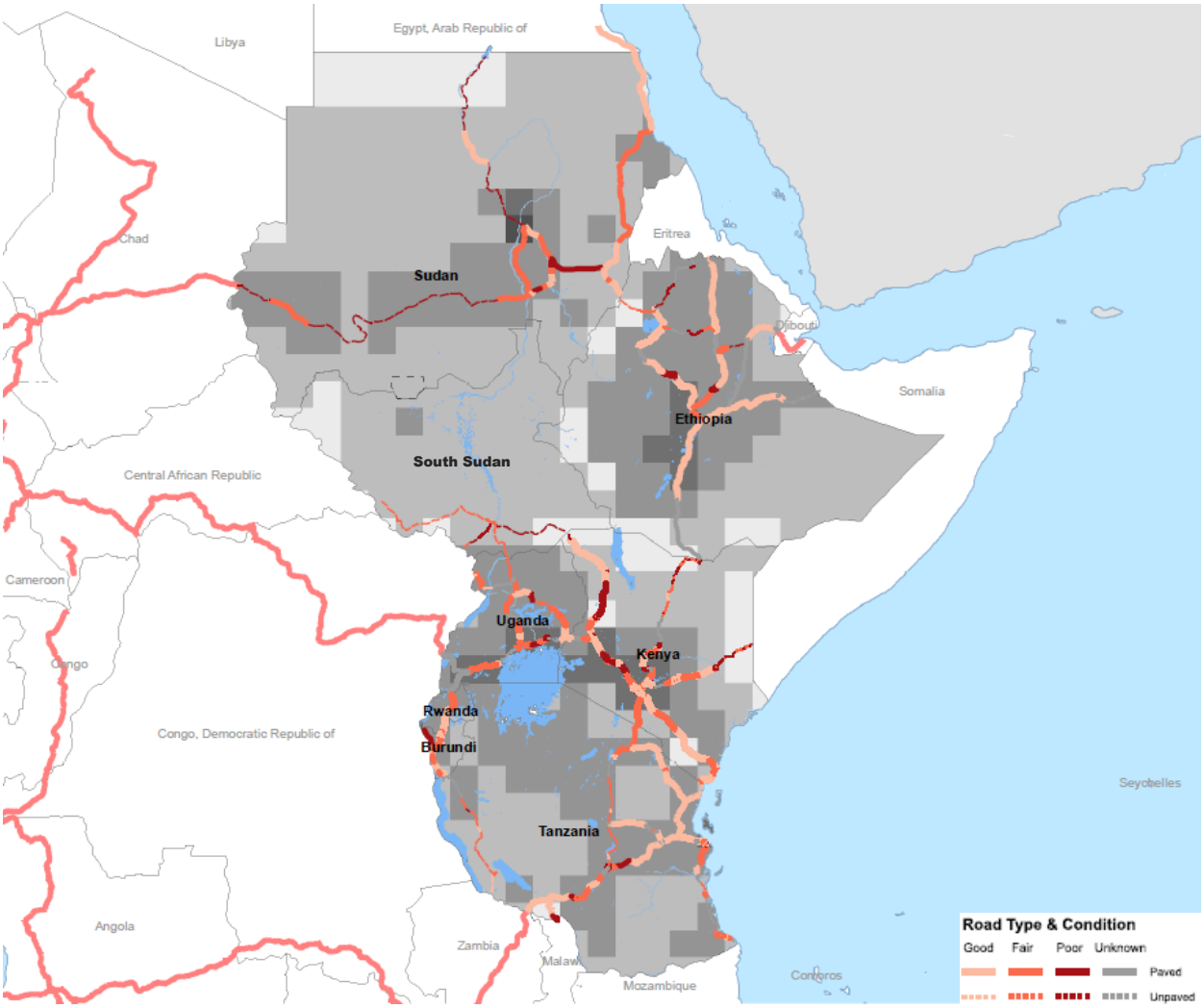
through neighboring Tanzania. Yet infrastructure along that route has traditionally been poor, which diverts Burundian transit to the route through Rwanda and Uganda into Kenya, which is 600 kilometers longer.

The northern corridor that runs inland from Mombasa is by far the most significant trading corridor in the region, greater even than the southern corridor through Tanzania (the central corridor). Further north, a corridor connects Addis Ababa with Djibouti, and another connects Addis Ababa with Sudan. Strikingly, no major road routes link Ethiopia and Sudan with the EAC.

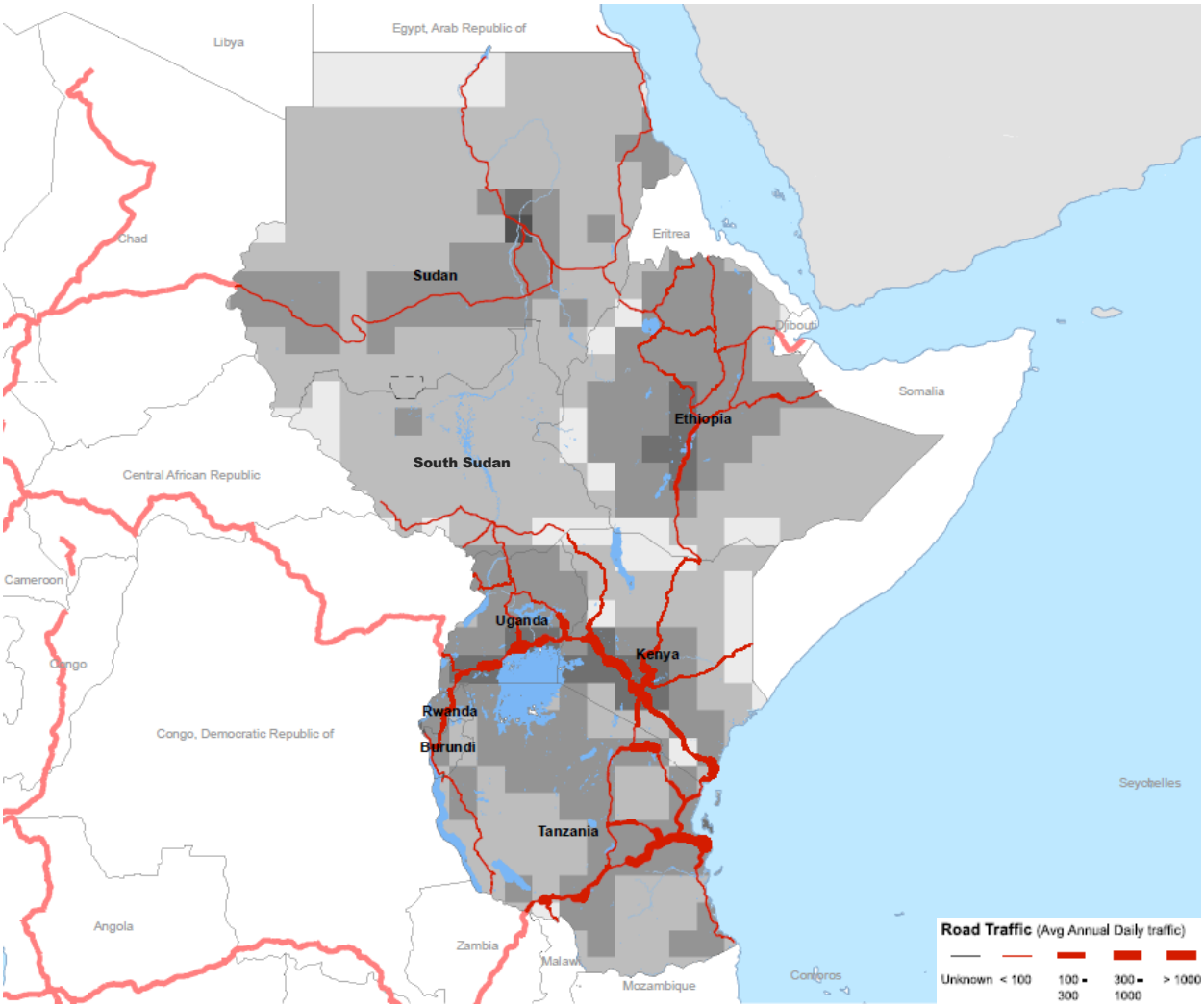
Regional corridors in EAC are typically paved and in reasonable condition (figure 2.2). Around 80 percent of most regional roads are in good or fair condition. There are, however, prominent patches of poor-quality roads along the regional networks, and there are significant unpaved stretches, particularly in some countries (table 2.2).

Figure 2.2. EAC's main regional road corridors

a. Road condition



b. Traffic volumes



Note: Background shows GDP per 100 square kilometers on grey scale.

The northern corridor, the most strategic trading route in the region, starts out in Kenya as a paved corridor that was generally in good or fair condition in 2008. However, the Ugandan portions of the corridor are only about three-quarters paved, with a marked decline in the condition of the road infrastructure. The corridor then bifurcates toward Kigali (Rwanda) and Juba (Southern Sudan). The Rwandan portions are paved and reasonably maintained, while the Sudanese portions remain unpaved but in reasonable condition. Along the southern side of Lake Victoria, the route from Bujumbura to Dar es Salaam starts out in Burundi as a paved road in quite good condition, while the Tanzanian section is only partially paved but is reasonably maintained. Further north in Ethiopia and Sudan, there is a marked absence of paving even along routes that appear to be of strategic significance. There have been significant efforts in East Africa (particularly in Uganda and Ethiopia) to improve road quality. Preliminary evidence from recent studies on the route between Djibouti and Addis Ababa indicates that both Ethiopia and Djibouti have planned investments to improve the roads, although none of the projects is fully complete (Nathan 2010).

Table 2.2. Road condition along major transit corridors in East Africa

	Condition				Type			Traffic bands (vehicles per day)			
Corridors	Good	Fair	Poor	Unknown	Paved	Unpaved	Unknown	>300	300-1000	>1000	Unknown
Mombasa to Nairobi to Kampala to Kigali to Bujumbura (northern corridor)	***43.8***	***34.7***	***9.9***	***11.6***	***94.6***	***0***	***5.4***	***1.2***	***10.3***	***80.2***	***8.3***
Rwanda	66.5	33.5	0	0	100	0	0	14.5	0	85.5	0
Uganda	6.9	34.6	10.1	48	77.5	0	22.5	*0*	21.8	78.2	0
Kenya	54.3	34.3	11.4	0	100	0	0	*0*	3.9	83.3	12.7
Burundi	45.2	4.2	0	0	100	0	0	0	70.3	25.6	4.2
*Mombasa to Nairobi to Kampala to Juba ***	***43.7***	***47.5***	***8.7***	***0***	***84.1***	***15.9***	***0***	***18.7***	***7.9***	***64.2***	***9.2***
Ethiopia	0	100	0	0	0	100	0	*100*	0	0	0
Uganda	21.7	75.4	2.2	1	58.7	41.3	0	*55.5*	25.7	18.8	0
Kenya	54.3	34.3	11.4	0	100	0	0	*0*	3.9	83.3	12.7
Dar Es Salaam to Bujumbura (central corridor)	***45.3***	***36.2***	***5.9***	***13***	***57.3***	***42.7***	***0***	***42.3***	***17.6***	***39***	***1***
Burundi	58.4	27.4	2.5	12	88.3	11.7	0	*2.9*	85.4	0	11.7
Tanzania	44	37	6.2	13	54.3	45.7	0	*46.1*	11.1	42.8	0
*Addis Ababa to Djibouti**	***37.4***	***16.5***	***16.3***	***30***	***23.1***	***65.8***	***11.2***	***11.2***	***65.8***	***0***	***23.1***
Ethiopia	48.6	21.5	21.2	9	0	85.5	14.5	*14.5*	85.5	0	0
Djibouti	0	0	0	100	100	0	0	*0*	0	0	100
*Nairobi to Addis**	***36.2***	***31.1***	***17.1***	***16***	***63***	***37***	***0***	***47.9***	***0.2***	***41.8***	***10.2***
Kenya	24.9	48.4	26.6	0	42.4	57.6	0	*57.7*	0.2	33.7	8.4
Ethiopia	56.4	0	0	44	100	0	0	*30.3*	0	56.4	13.4
Chad border to Djibouti	***9.4***	***23***	***53.1***	***15***	***43.4***	***56.6***	***0***	***61.3***	***24.5***	***7.4***	***6.9***
Sudan	8.9	18.8	72.3	0	41.1	58.9	0	*74*	15.4	10.6	0
Ethiopia	13.9	42.2	11.1	33	33.6	66.4	0	*41.1*	58.9	0	0
Djibouti	0	0	0	100	100	0	0	*0*	0	0	100

Source: AICD calculations.

* Denotes portions of the TransAfrica Highway in EAC.

** No data for Sudan available for this route.

Data from 2006 illustrate the significant variation in traffic across key regional corridors. There is heavy traffic around the northern corridor that connects Kigali, Kampala, Nairobi, and Mombasa. This corridor routinely carries more than 1,000 vehicles per day. The central corridor between Bujumbura Dar es Salaam, and the corridor connecting Addis Ababa to Djibouti, see moderate traffic of 300–600 trucks per day. Traffic across the corridor from the Chad-Sudan border through Ethiopia is very low—no more than 300 vehicles a day, which is the traffic threshold required to make paving economically viable. None of the corridors exceeds the threshold of 10,000 vehicles per day needed to make toll road concessions viable.

The competitiveness of each corridor can be gauged by aggregating the time and costs associated with transport, administrative processes (customs), ports, and long waits incurred along the route. The cost of moving imports (or exports) along each of these key arteries and the times taken for this movement are key elements of competitiveness for both international and intraregional trade.

These times can be broken down into four components: the travel times of moving goods, determined by time of travel based on effective velocity along each corridor; administrative time spent importing goods to a country; port time, based on the time taken to clear goods at ports; and border time, the delays incurred in crossing borders. Transport costs are based on unit costs of moving freight along specific corridors, whereas administrative costs are based on costs involved in transporting imports into a country. Port delays and border delays were quantified into costs based on the assumption that delays cost $5 per day per tonne of imports.

Comparing the rail and road options for transport along corridors where a parallel railway exists presents a mixed story. Two railways in East Africa connect landlocked countries to the sea: the Kenya-Uganda railway connects Mombasa with Kampala, and CDE connects Addis Ababa to Djibouti. A comparison of these parallel road and rail corridors suggests that in the case of importing goods from Djibouti to Addis, the CDE railway tariff (0.13 cents per tonne-kilometer) is slightly more expensive than the road tariff (between 0.10 and 0.11 cents per tonne-kilometer). On the other hand, freight tariffs on the northern corridor are between 0.07 and 0.09 cents per tonne-kilometer, slightly more than the Kenya-Uganda railway tariff (0.05 cents per tonne-kilometer) assuming that the railway does not encounter additional delays due to disrepair or service disruptions.

Recent studies on the rail network between Djibouti and Addis have found that the axle load of the railway line is rather limited. In addition, several of the bridges need rehabilitation, which is already underway. In the case of the Kenya-Uganda railway, whose tariffs are competitive with road freight tariffs, a concession has been upgrading the railway line, which had been in a state of serious disrepair. The railway line is operational, but traffic utilization is extremely poor (5 percent of corridor traffic). If the railway line were fully operational, it would help decongest the port at Mombasa and reduce time spent in port (Nathan 2010).

Importing goods to landlocked countries along East Africa's major corridors is an expensive and a lengthy process due to inefficient ports, high transport costs, and delays at borders. Dwell times at ports add between 200 and 800 hours to the total travel times.

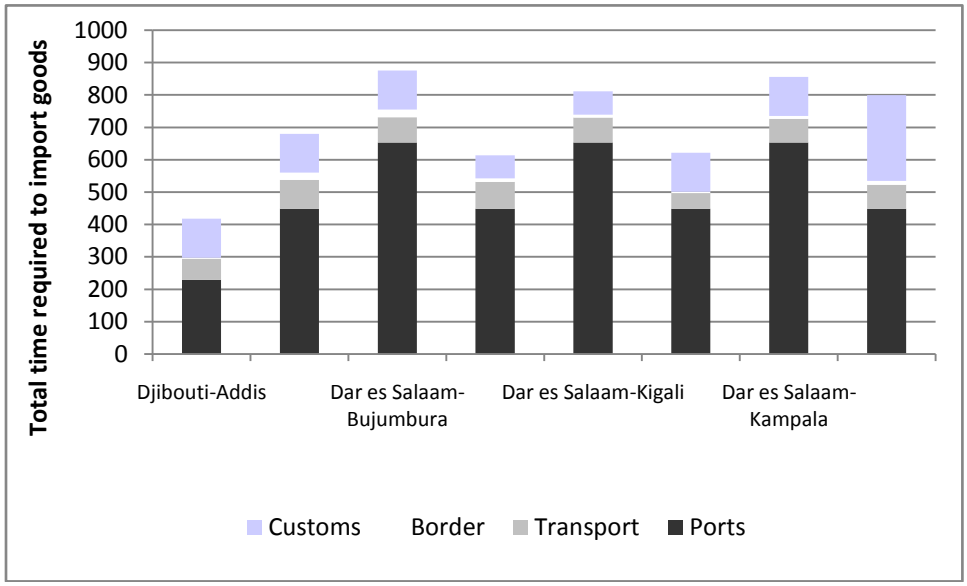
It is striking that it takes more time to travel to Bujumbura from Dar es Salaam than it does from Mombasa, even though Dar es Salaam is closer. The extensive delays at the border (on the order of entire day), long port times, and slow travel owing at least partly to the poor condition of the route, add to the total time.

Port times make up 50 to 80 percent of the time required to move imports to landlocked countries (figure 2.3). Reducing congestion at the ports by reducing dwell times and time spent waiting for a berth can have a dramatic impact on speeding imports across borders in East Africa.

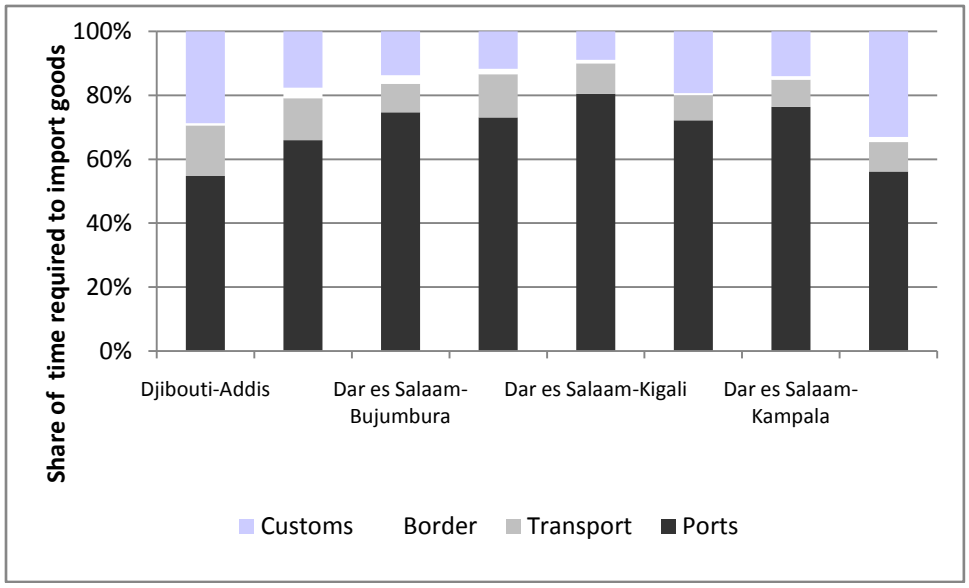
Among road corridors serving landlocked countries, there are significant cost differences. Based on the three main intraregional arteries in East Africa, the cost of importing goods from a landlocked country lies in the range of $170 to $370 per tonne-kilometer. Overall, travel to landlocked Burundi, Rwanda, and Uganda is cheaper via the northern corridor than the central corridor. For Burundi, the northern corridor has a competitive edge over the central corridor. This is striking because Bujumbura is closer to Dar es Salaam than to Mombasa.

Figure 2.3. Time required to import goods by road through alternative gateways

a. In hours



b. By step (% of total time)

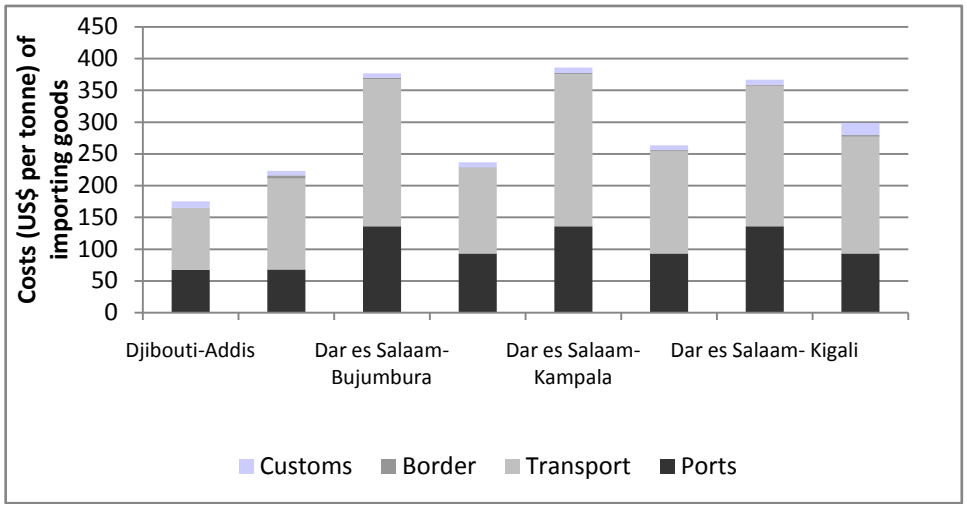


Source: Source: Data collected from "Trading Across Borders"; Nathan Associates 2010; and AICD ports database.

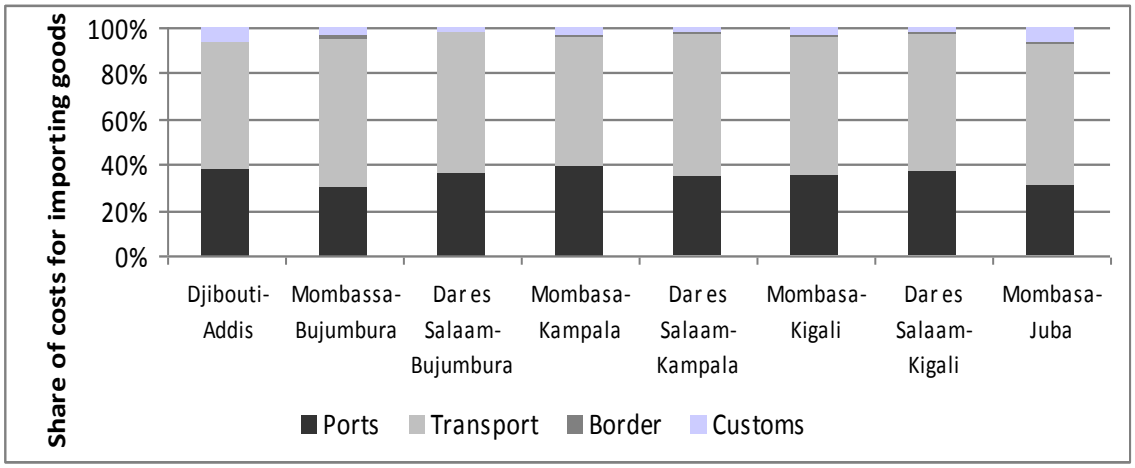
Even though both Dar es Salaam and Mombasa have significantly exceeded their handling thresholds, Mombasa is slightly cheaper and more efficient than Dar es Salaam, making it the preferred port of entry for goods destined for landlocked Burundi. Costs incurred at ports and high transport costs make up more than 90 percent of the total cost of importing goods (figure 2.4).

Figure 2.4. Cost of importing goods by road through alternative gateways

a. In U.S. dollars



b. By step (% of total time)



Source: Data collected from "Trading Across Borders"; Nathan Associates 2010; and AICD ports database.

In order to understand overall corridor performance, it is helpful to examine the national performance of the various modal components. The performance of the corridor can be only as good as the performance of the national transport systems that comprise it. To this end, the performance of the national road, rail, and ports sectors is briefly reviewed in the remainder of the section, with a view to identifying national weaknesses that may have serious repercussions at the regional level.

Roads

Data from 2008 reveal that around 73 percent of roads in EAC are paved. A much lower 57 percent of the regional road network in East Africa is paved (table 2.3). This section takes a national perspective on the regional road network. For this purpose, the regional road network is defined as the network needed to connect all national capitals with one another and with the major deep sea ports. In EAC (and East

Africa), a smaller percentage of roads are already paved than in southern and western Africa. Nevertheless, the regional aggregates mask variation at the country level.

Some East African countries have already made the investments necessary to pave the portions of the regional network that fall within their national jurisdictions. All of the regional roads in Rwanda, almost all of the regional roads in Burundi, and 80 percent of the regional roads in Kenya are paved. In Ethiopia, Tanzania, and Uganda the share of the regional road network that is already paved is much lower, at 60 to 70 percent. The extreme case is Sudan, where only around 12 percent of the regional road network is paved.

East African countries vary substantially in their track record on maintenance of the regional road network. Overall, 77 percent of the regional network in EAC is in good or fair condition, compared with 56 percent for East Africa as a whole (table 2.3). As a general rule, all EAC members except Uganda are succeeding in maintaining their portions of the regional network in good or fair condition. In Uganda, only 61 percent of the regional road network is in good or fair condition.

Further north, the quality of roads in Ethiopia and Sudan is also very poor. Only around half the regional roads in Ethiopia and around 15 percent of the regional roads in Sudan are in good or fair condition. The large share of poorly maintained roads may be symptomatic of wider deficiencies in the funding and implementation of road maintenance works in these countries, or it may point to the low priority given to regional routes in national road plans. Significant resources are being allocated to Ethiopia and Uganda by the respective governments to improve the regional road network. More recent data will reflect this change.

Table 2.3. Condition of East Africa's regional road network by member country, based on 2008 data

Percent	Condition				Type		
	Good	Fair	Poor	Unknown	Paved	Unpaved	Unknown
Burundi	42.4	27.9	24.2	5.6	94.4	5.6	0.0
Kenya	40.5	38.4	21.1	0.0	79.5	20.5	0.0
Rwanda	66.7	33.3	0.0	0.0	100.0	0.0	0.0
Tanzania	44.9	35.7	3.7	15.7	60.0	40.0	0.0
Uganda	13.5	47.4	4.3	34.8	69.9	21.9	8.2
EAC	**38.0**	**38.7**	**13.2**	**10.2**	**73.3**	**25.3**	**1.3**
Ethiopia	43.5	10.9	11.3	34.4	69.9	30.1	0.0
Sudan	0.0	15.3	9.1	75.6	11.6	21.4	67.0
East Africa	**29.8**	**26.5**	**11.7**	**32.0**	**57.2**	**25.4**	**17.4**

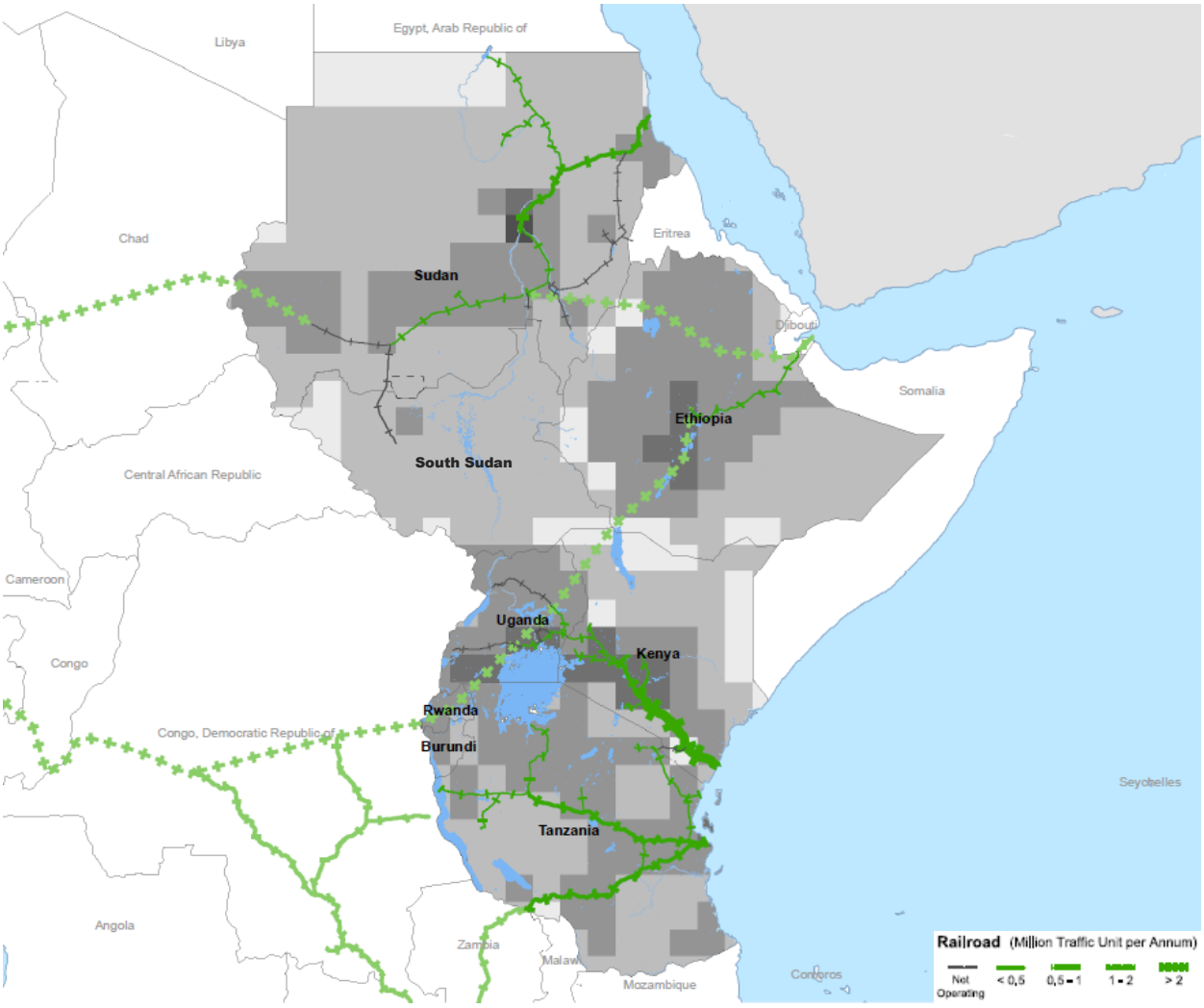
Source: AICD various sources.

Railways

The national railways in East Africa do not constitute a true regional network (figure 2.5), and the demand for rail services is relatively low. The exception is Tanzania, which is linked into the railway network of southern Africa via the Tazara railway. The economic insignificance of railways in East Africa stands in contrast to southern Africa, where interconnected national railway systems form a railway network that spans half a dozen countries and extends from southern Democratic Republic of

Congo all the way to Durban in South Africa. Further integration of East Africa's rail systems is complicated by the coexistence of multiple rail gauges in the region. The meter gauge is prevalent in most of East Africa, but in Tanzania two railways operate with two different gauges in the same area. East Africa has just three railway lines that span more than one country. There is a railway network that connects Kenya and Uganda, a second that connects Tanzania and Zambia, and a third that links Ethiopia and Djibouti.

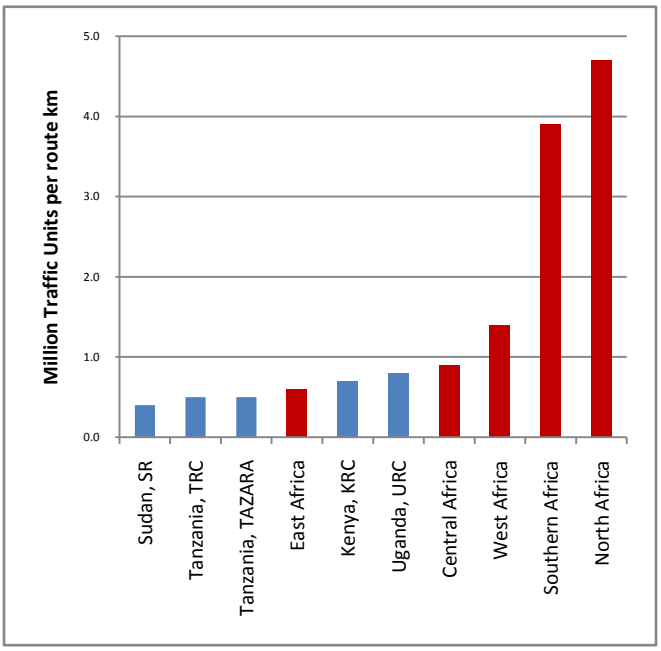
Figure 2.5. East Africa's railway network



The case for further regional integration of railway networks is at present constrained by the relatively limited usage of existing lines. Rail traffic density in East Africa is the lowest on the continent and only a fraction of that found in southern Africa and North Africa (figure 2.6). None of the East African railways has a traffic density of more than one million traffic units per route kilometer. By global standards, these traffic volumes are little more than what might be carried by a moderately busy branch line. Moreover, such low traffic volumes do not generate the revenue needed to finance track rehabilitation and upgrading.

Under these market conditions, and given the technical incompatibilities of the various gauges, the case for further integration of railway networks is quite limited. Although the average haul of African networks is long relative to their size, it is comparable to the average haul for road transport. Tanzania Railway Corporation and Tazara both haul freight an average distance of 1,000 kilometers, and some smaller railways in East Africa—such as Uganda Railway—act as feeders to other systems that carry traffic a few hundred kilometers further.

Figure 2.6. Traffic density on African railways



Source: Bullock 2009.

Note: Density is normally expressed as traffic units per route-km. The traffic units carried by a railway are the sum of the passenger-km and the net tonne-km.

Before contemplating further extensions to the rail network, a turnaround in the performance of existing railways is sorely needed to regain competitiveness with road transport. The poor quality of service provided by East Africa's railways makes it increasingly difficult for them to compete with road freight services. Most railways in East Africa operate at the standard at which they were originally constructed and now face major problems with competing modes. The rails can accommodate only relatively light and slow-moving trains. Poor maintenance over extended periods has many sections of track to deteriorate beyond repair and resulted in a loss of competitiveness and rolling-stock productivity. While such inefficiencies can be tolerated on low-volume feeder lines (and may be necessary for some lines to be viably operated), they are a major handicap when competing against the modern roads being built in major corridors.

Competition from road transport is often cited as one the of the reasons for declining railway traffic. Yet Tanzanian railways (Tazara and TRC) both record relatively high volumes of passenger traffic, but only because the competing road network is in poor condition or does not exist. Tazara is one of the few railway networks that records cross-border flows of passenger traffic.

East Africa has several binational railway systems. The rail lines serving landlocked Uganda, Zambia, and Ethiopia via Kenya, Tanzania, and Djibouti respectively have been developed as integrated operations—the Kenya-Uganda railway, Tazara, and CDE—that link the landlocked capitals to coastal ports (except for CDE). This configuration smoothes the passage of goods across national borders and avoids the lengthy delays otherwise associated with switching of locomotives as freight is shifted from one national network to another.

The overall operational efficiency of most East African railways is very poor, with the exception of TRC and Tazara, which demonstrate reasonably good operational efficiency. There have been two

concession arrangements in East Africa, the first for TRC and the second for the for Kenya-Uganda railway. The concession arrangements have helped to boost operational efficiency for TRC in particular, and its performance is now substantially better than the region's major publicly owned railways based on measures of labor and rolling stock productivity (table 2.4).

Table 2.4 . Performance of East African railways, 2005

	Labor productivity	Carriage productivity	Locomotive productivity	Wagon productivity	Freight yield	Passenger yield
Djibouti, CDE					12.5	3.1
Ethiopia/Djibouti, CDE	71	3,037	11	156		
Kenya, KRC (RVRC)	203	1,159	24	218	3.8	0.6
Sudan, Sudan	77	329	9	225		
Tanzania, TRC	259	3,264	25	583	4	1.6
Tanzania, TAZARA	352	2,770	13	551	3	1.1
Uganda, URC (RVRC)	156		9	144		
Rail concessions	350	2,945	23	491	5	2

Legend: Labor productivity = '000s traffic units per employee; Locomotive productivity = millions of traffic units per locomotive; carriage productivity = '000s passenger-kilometers per carriage; wagon productivity = '000s net tonne-kilometers per wagon.
Source: AICD railways database.

According to the 2010 LPI, the quality of East Africa's rail infrastructure is remarkably low compared with that of the other parts of Africa. This highlights the need for facilitation services to further develop and promote the use of railways (World Bank 2010b).

Ports

East African ports (figure 2.7) substantially increased their container and general cargo traffic between 1995 and 2005. The average annual rate of growth of container traffic and general cargo traffic through East African ports is 10.7 percent and 10.8 percent per year, respectively (table 2.5). Though not as high as the growth of container traffic in West Africa or of general cargo traffic in southern Africa, this expansion is nonetheless substantial. The overall growth in traffic was propelled by rapid economic growth in Sub-Saharan Africa, a rising tide of global trade, the privatization of ports, and the advent of modern container vessels.

Owing to the rapid expansion of traffic, a few of the region's ports are beginning to experience capacity constraints (figure 2.8). This is most notable in the case of Mombasa (Kenya) and Dar es Salaam (Tanzania), where the volume of general cargo and container traffic significantly exceeds design capacity. Port Sudan (Sudan) is also experiencing capacity constraints with respect to container traffic. All three of these ports are also reaching their limits with respect to dry-bulk cargo. There is some scope for easing capacity constraints by improving the efficiency of port performance, although ultimately new investments will be required.

The ports of Mombasa and Tanzania have traditionally been the most important players in the container sector on the east coast of Africa. Double-digit growth in this sector has now pushed both ports to their limit, however, and new capacity is essential.

Figure 2.7. East Africa's port network

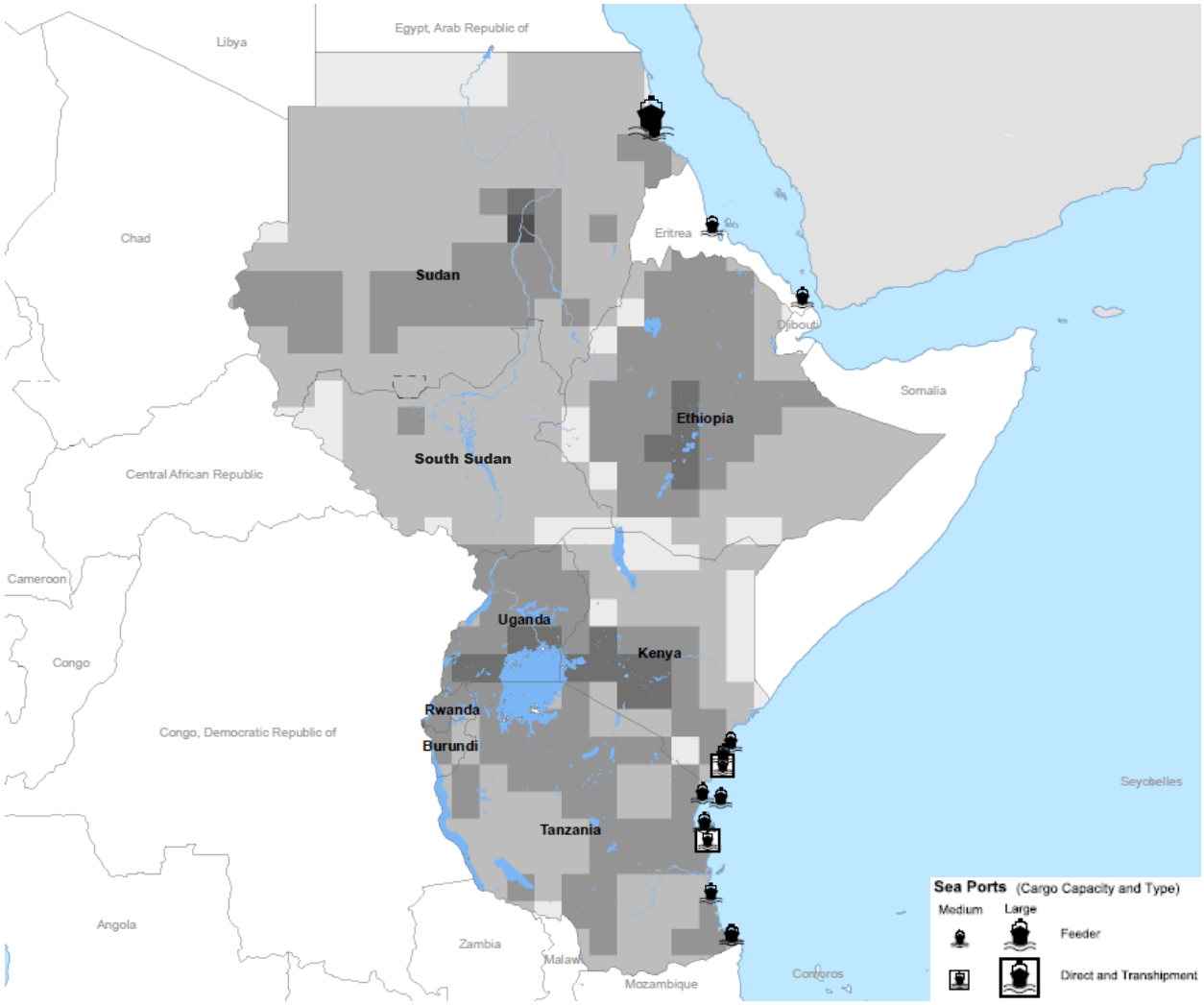
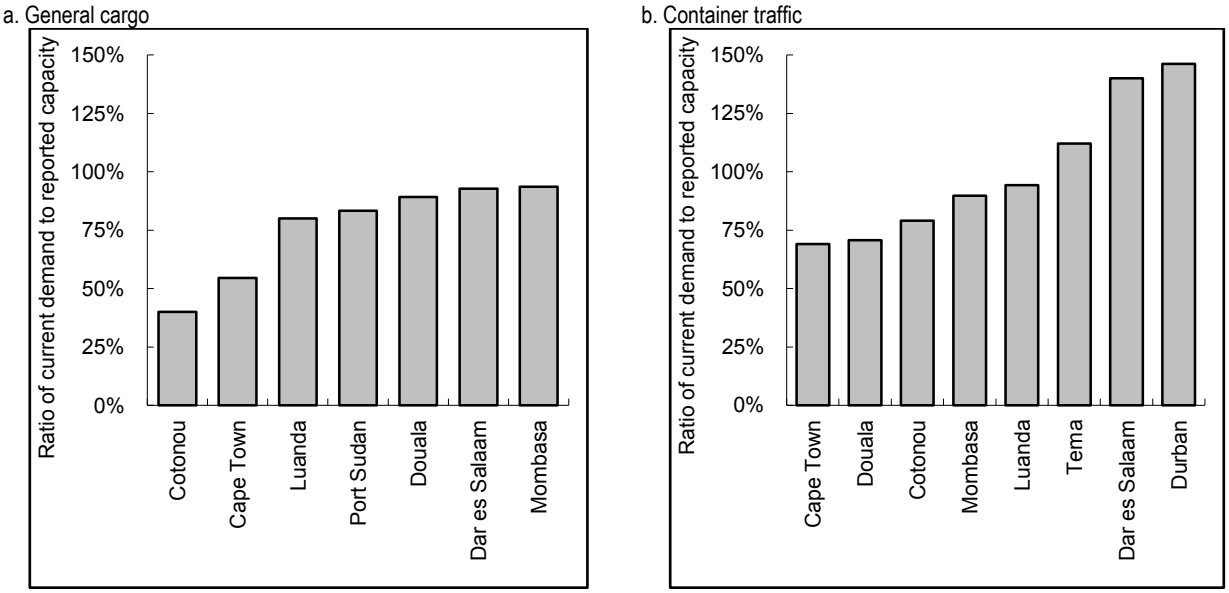


Table 2.5. Growth in containerized and general cargo traffic between 1995 and 2005

	CONTAINER TRAFFIC				GENERAL CARGO TRAFFIC			
	TEUs		Percentage		'000s tonnes		Percentage	
	1995	2005	Overall growth	Average annual growth	1995	2005	Overall growth	Average annual growth
East Africa	505.1	1,395.0	+276	+10.7	13.8	38.4	+278	+10.8
North Africa	1,637.3	5,267.9	+322	+12.4	12.3	16.5	+134	+3.0
Southern Africa	1,356.0	3,091.8	+228	+8.6	2.7	14.5	+532	+18.2
West Africa	1,035.4	4,082.0	+394	+14.7	23.1	61.2	+265	+10.2
Total	4,533.8	13,836.7	+305	+11.8	52.0	130.7	+251	+9.7

Source: Ocean Shipping Consultants Limited 2010.

Figure 2.8. Ratio of current demand to reported capacity



Source: AICD ports database, 2008.

East African ports do not compare favorably with those of southern Africa, and even less so with global best practice, in terms of performance and charges (table 2.6). Compared with global best practice, Africa's ports are expensive to use and subject to extensive delays, though those of southern Africa tend to perform somewhat better than those in other African regions across a range of parameters. The services provided by East African ports cost nearly twice as much as those in other global ports. Crane productivity in East African ports, in terms of containers or weight, is about half the international benchmark. Global best practice for truck cycle time is 1 hour, but trucks spend between 4 and 24 hours in East African ports. The international standard for port dwell time is seven days or less, but in East Africa, containers routinely spend more than a week in the terminal. The result is terminal congestion and port inefficiency. Incentives for speedier pickups might include a daily storage charge after a given number of free days and specific rules to prevent the dumping of empty containers at the terminal. Unlike in East Africa, most terminals in southern Africa offer a given number of free days' storage—typically up to seven days—and thereafter apply a daily storage charge, which sometimes increases on a sliding scale the longer the container remains in the terminal.

Table 2.6. Comparative port performance across African regions

	East Africa	Southern Africa	West Africa	Global best practice
Performance				
Container Dwell Time (days)	**5–28**	4–8	11–30	<7
Truck Processing Time (hours)	**4–24**	2–12	6–24	1
Crane Productivity (containers per hour)	**8–20**	8–22	7–20	20–30
Crane Productivity (tonnes per hour)	**8–25**	10–25	7–15	>30
Charges				
Container handling (US$ per TEU)	**135–275**	110–243	100–320	80–150
General cargo handling charge (US$ per tonne)	**6–15**	11–15	8–15	7–9

Source: AICD ports database.

Table 2.7. Comparative performance across East African ports

	Djibouti	Mombasa	Port Sudan	Dar es Salaam
Container dwell time (days)	8	5	28	7
Truck processing time (hours)	12	5	24	5
Container crane productivity (container per hour)	17	10	8	20
Charges				
Container cargo handling charge (US$ per TEU)	135	68	150	275
General cargo handling charge (US$ per tonne)	8	7	10	14

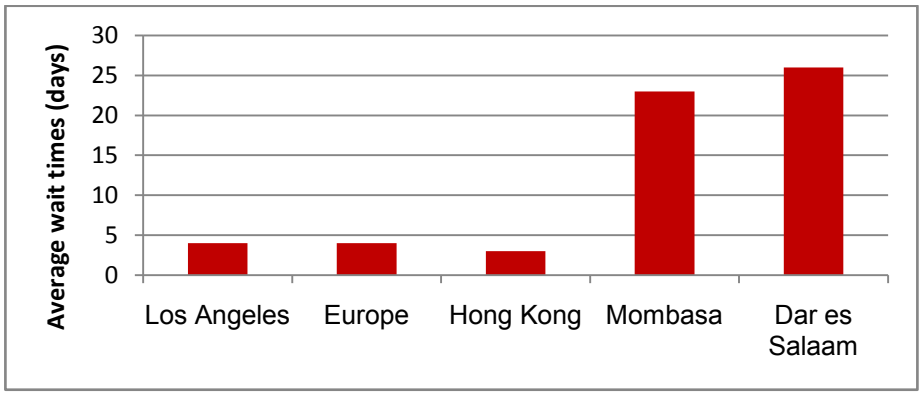
Source: AICD ports database.

Performance of individual ports in East Africa varies (table 2.7). Mombasa (Kenya) and Dar es Salaam (Tanzania) exhibit generally good performance that is within global best practices on some indicators. On the other hand, Port Sudan (Sudan) and Djibouti (Djibouti) exhibit much lower port efficiency levels. Container dwell times in Mombasa and Dar es Salaam are within global best practice benchmarks, but the dwell times in other ports are significantly longer, particularly in Port Sudan. Truck processing time at Port Sudan is almost five times that at Mombasa or Dar es Salaam. Crane productivity (in terms of containers handled per hour) in Dar es Salaam is twice that of Mombasa. Dar es Salaam, which performs slightly better than Mombasa in terms of productivity, levies higher port charge —four times more than Mombasa (the cheapest port in the region) for container handling. The prices for Mombasa are consistent with global best practice benchmarks.

Mombasa and Dar es Salaam are natural transshipment points on the East African coastline. While both ports have pursued transshipment, both now face severe challenges to increase their national cargo flows over the short term (box 2.2), and their limited capacity is likely to curtail their transshipment activities. Djibouti, on the other hand, may soon provide a new solution to transshipment along the East African coast. DP World is scheduled to bring a new container-terminal facility on stream at Djibouti, one intended specifically to offer significant transshipment capacity for East Africa and the Indian Ocean.

The capacity constraints faced at the ports of Mombasa and Dar es Salaam, coupled with extremely lengthy import and export procedures, adds considerable time to the clearing of goods from ports (figure 2.9). The long detention of goods in port has become a major obstacle to distribution. Detailed studies on importing goods along the northern corridor indicate that waiting times at ports account for a significant portion of the total time associated with transporting goods along the corridor. This problem is particularly acute for railways. At the port of Mombasa, for example, cargo is often detained because of the serious shortage of railway capacity, exacerbated by poor port infrastructure, such as inadequate berths and yard and delays in customs processes (JICA 2010).

Figure 2.9. Average wait times in East Africa compared with ports worldwide



Source: JICA 2010.

Box 2.2. Impact of port capacity constraints: Mombasa's story

Port Mombasa is the largest port in East Africa and a vital gateway for imports to Kenya and neighboring countries. Imports into Mombasa rose sharply between 2005 and 2009. In 2009, imports accounted for 87 percent of the total weight of goods handled by the port. Around 72 percent of imports were destined for Kenya. The remainder was transit cargo headed to neighboring landlocked countries, with the largest transit directed to Uganda. Of the goods that exited the Port of Mombasa, 12 percent originated in Uganda and 85 percent in Kenya. The growth of imports and exports is expected to continue.

Maersk Shipping Line indicates that Mombasa is operating at maximum capacity with respect to its ability to service container ships (at a time of the year when container traffic is typically 30 percent lower than the second half of the year). In the short term, this situation causes very serious capacity problems in the form of vessel and cargo delays, port congestion surcharges, slower throughput of the port, and higher costs to customers. Exporters subject to tight deadlines cannot count on meeting them. Port performance is further affected in the following ways:

Inability to service ships at berth. In 2009, the average ship waiting time was 2.3 days, and the average number of port days for containerized vessels was 3.1 days. The ratio of the waiting time to time at berth (the waiting ratio) reaches 74 percent for container vessels at Mombasa. Full container ships do not tolerate a waiting ratio of more than 10 percent. They charge demurrage fees or impose a freight surcharge. The waiting ratio is a huge deterrent to shipping lines as it implies uncertainty in port call time.

Yard capacity. Previous evidence had suggested that dockside congestion had been reduced and dwell time had been lowered. However, recent findings suggest that older evidence was distorted. Goods destined for the Kenyan market are quickly transferred to Container Freight Services (an inland, privately operated container depot), but transit cargo waits at the dockside.

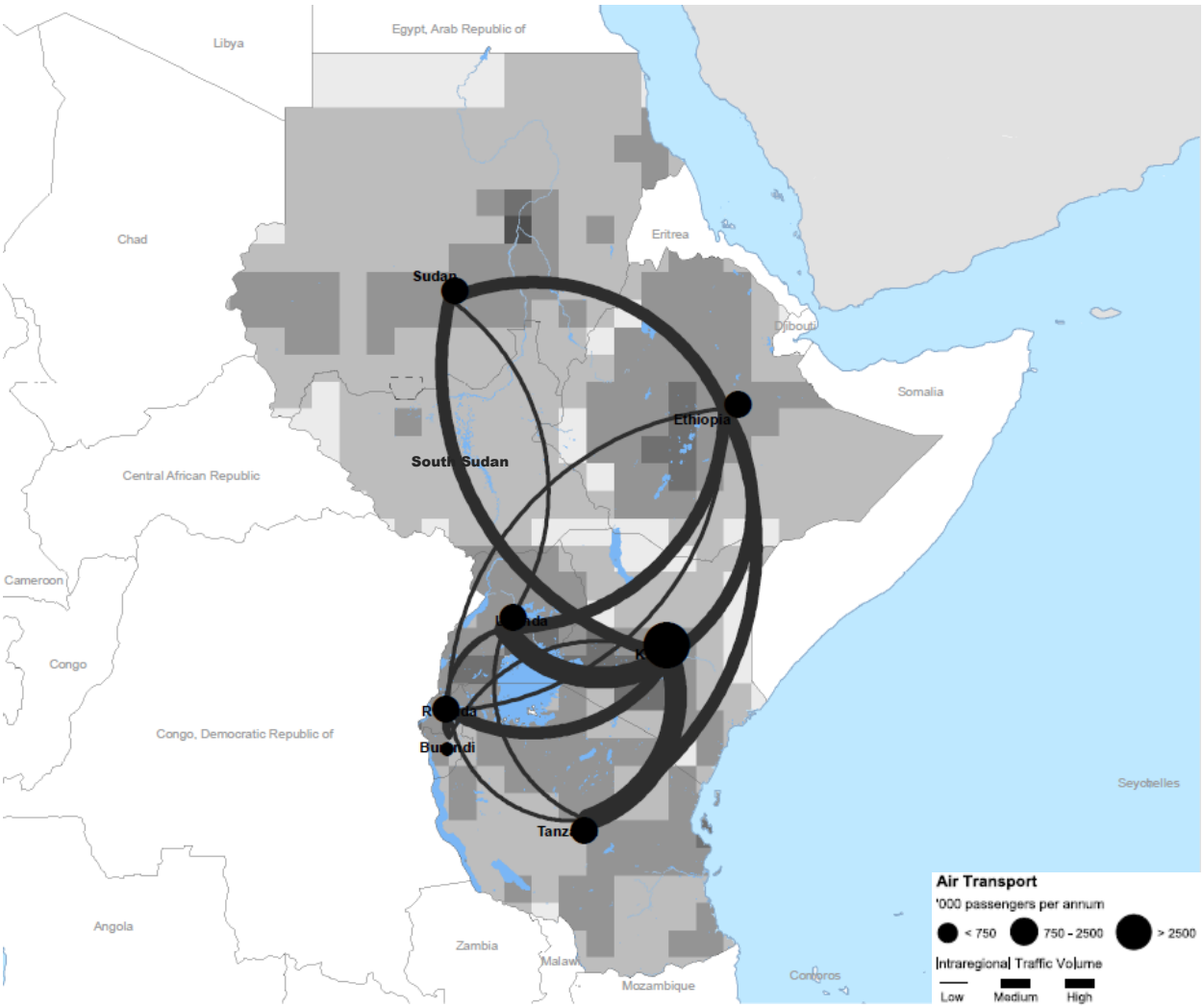
Clearance and transfer. The complexity of clearance processes, which involve a mix of government processes, logistics, and transport infrastructure, adds to the delays in clearing and forwarding freight. Increased imports have placed land transport systems under stress, highlighting the need for efficient intermodal connections. The lack of integrated rail and road links implies that Mombasa is unable to efficiently handle goods. The failure of the railway system has resulted in new truck movements in and around the port, which increase congestion and cause parking problems. Rail transport that previously carried 80 percent of transiting goods in Mombasa in the early 1970s now carries 5 percent of Mombasa's freight. There is no alternative today to heavy trucks, which move through an increasingly crowded town center.

Overall, the port contributes 58 percent of the total transportation time for cargo destined to Kampala and 50 percent of the time for cargo heading to Kigali. For low-value bulk commodities, which constitute the highest proportion of cargo entering Mombasa, port costs account for over 15 percent of the delivered market value (excluding the costs of doing business in countries beyond Kenya).

Source: World Bank 2010c.

Air transport

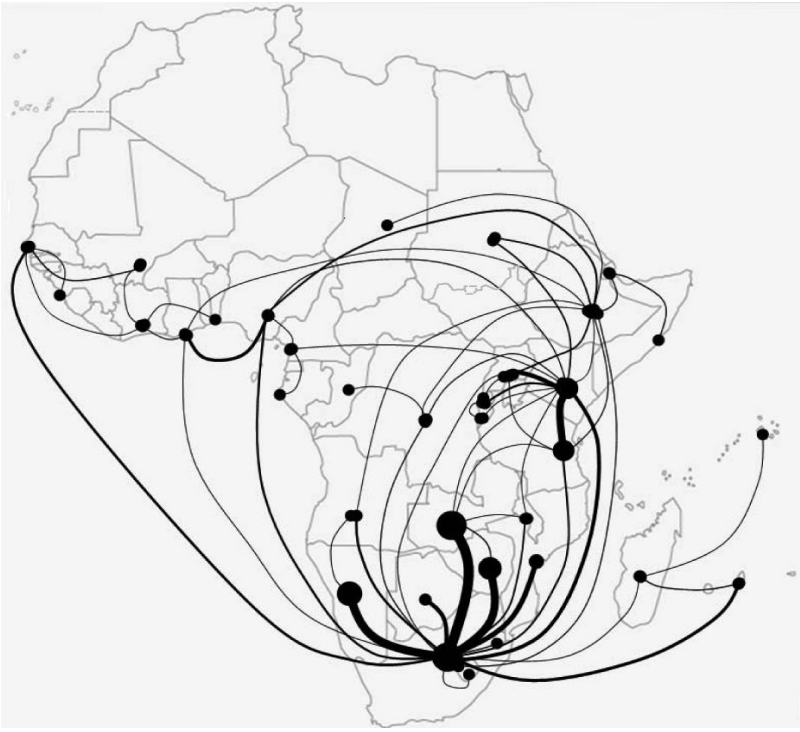
Figure 2.10. East Africa's regional airports and air traffic flows



Viewed from a continental perspective, there is strong regional air connectivity in East Africa, with clear transportation hubs. The map of the top 60 intracontinental routes in Africa highlights the main traffic patterns across the continent, and East Africa figures quite prominently in these routes (figure 2.11). While none of Africa's Sub-Saharan airports (with the possible exception of Johannesburg) moves enough traffic to be considered a global air transport hub, a number of regional air transport hubs have emerged during the last decade. On the eastern and southern side of the continent, a strong hub-and-spoke structure centered on Johannesburg—and to a lesser extent on Nairobi and Addis Ababa—is apparent. All East African countries are connected to Nairobi and most to Addis Ababa. Almost all of the countries in the region also have bilateral connectivity with each other.

East Africa has a vibrant internal air transport market—the second-largest in Africa after that of the SADC. Relative to other regions, EAC lags behind both the Southern African Development Community (SADC) and the Economic Community of West African States (ECOWAS) in terms of domestic seats flown but has the highest number of seats flown within Africa. The market has been growing, although it is consistently dominated by Kenya Airways, which now has 60 percent of the market share of international travel within the community. An average of 13 pairs of domestic cities and 29 international city-pairs are served within the community. The number of international pairs served is the highest in the continent (table 2.8).

Figure 2.11. International routes within Sub-Saharan Africa in 2007



Source: Bofinger 2009.

Table 2.8. Benchmarking air transport in EAC and other regional economic communities

	ECOWAS	CEMAC	**EAC**	SADC
Annual seats, domestic ('000s)	2,034	235	**1,345**	3,076
Annual seats, international within SSA ('000s)	362	187	**1,196**	964
Domestic city pairs served (number)	8	4	**13**	17
International city pairs (number)	20	15	**29**	26
Seat-km in old aircraft (of total)	43	30	**33**	29
Seat-km in recent aircraft (of total)	57	70	**67**	71
Domestic market Herfindahl Index	0.84	0.83	**0.64**	0.73
International market Herfindahl Index	0.19	0.24	**0.25**	0.34
Market Herfindahl Index (domestic and international)	0.21	0.30	**0.27**	0.42

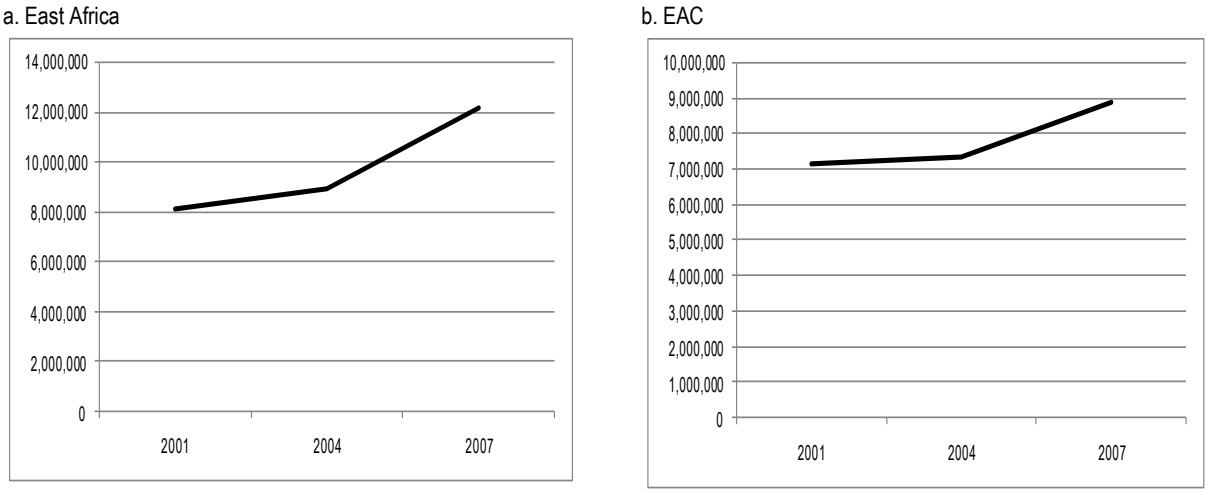
Source: AICD database.

Note: ECOWAS = Economic Community of West African States; CEMAC = Economic and Monetary Community of Central Africa; EAC = East African Community; SADC = Southern African Development Community.

Air transport capacity within the East African countries increased markedly during the last decade. A similar, although less pronounced, trend is visible for the EAC group (figure 2.12). In East Africa, the number of seats grew 50 percent from 8 million in 2001 to 12 million in 2007, and in EAC the number of seats increased from 7.1 million in 2001 to 8.9 million in 2007 (a 24 percent increase) .

In per capita terms, East Africa had the second-most aircraft seats in all of Africa in 2007 after SADC. This is striking for a region that has one of the lowest per capita incomes in Africa. Two of the three strongest carriers in Sub-Saharan Africa—Kenya Airways and Ethiopian Airlines—are very active in the market. The routes between Kenya and Tanzania are frequently traveled, reflecting tourist travel for the game parks and Mount Kilimanjaro, as are the routes between Kenya and landlocked Uganda

Figure 2.12. Seats for intraregional travel within East Africa



Source: Bofinger 2009.

Air transport connectivity for countries within East Africa is rather mixed. All countries except Burundi and Rwanda have relatively good international connectivity. Burundi is connected through five international city pairs, and Rwanda through seven. The other countries have a much higher number of international city pairs and are well connected with the regional hub in Kenya. It is because of its hub status—both in East Africa and beyond—that Kenya has exceptionally high international connectivity. Domestic connectivity within Ethiopia is the highest in the region. Kenya, on the other hand, has low domestic connectivity, which reflects the limited purchasing power of its domestic market. Burundi and Rwanda have no domestic connectivity (table 2.9).

Table 2.9. International and domestic connectivity for 2007 (number of city pairs served)

	Domestic city pairs	International city pairs
Burundi	0	5
Ethiopia	45	52
Kenya	15	77
Rwanda	0	7
Sudan	13	32
Tanzania	19	38
Uganda	4	19

Source: Derived from Bofinger 2009.

Not all countries within EAC and the broader East Africa region are connected with one another. They do, however, have direct flights to either Kenya or Ethiopia, which then have frequent direct flights to all of the EAC and East African countries (table 2.10). Most countries in the region have at least seven flights per week to one of the main regional hubs. The route between Tanzania and Kenya is the most frequently travelled, followed by the route between Kenya and Uganda.

Table 2.10. All flights from one week in November 2007 for EAC and East Africa

a. East Africa

Origin \ Destination	Burundi	***Ethiopia***	***Kenya***	Rwanda	Sudan	Tanzania	Uganda
Burundi		*7*	*8*	20			7
Ethiopia	*7*		*11*	*7*	*15*	*21*	*14*
Kenya	*7*	*11*		*15*	*34*	*87*	*39*
Rwanda	20	*7*	*14*			1	11
Sudan		*12*	*17*				4
Tanzania		*7*	*48*				6
Uganda	*7*	*14*	*39*	11	12	16	

b. EAC

Origin \ Destination	Burundi	***Kenya***	Rwanda	Tanzania	Uganda
Burundi		*8*	20		7
Kenya	*7*		*15*	*87*	*39*
Rwanda	20	*14*		1	11
Tanzania		*48*			6
Uganda	*7*	*39*	11	16	

Beyond basic connectivity, it is also important to evaluate the convenience and speed of air travel. For most countries, most flights that originate from within the country are direct. About 70 percent of flights originating in all countries except Tanzania are direct. Many flights that originate in Nairobi or Addis are direct, reflecting the status of those cities as hubs for air transport in East Africa. Of the 61 flights that originate in Tanzania, however, only 36 are direct (table 2.11a). The travel times for flights from Rwanda to Uganda and Burundi are longer than for flights in other parts of the regional economic community, which is largely due to waiting time at airports (table 2.11b).

According to a recent study, EAC has been rated as having an overall implementation score of three out of five for the Yamoussoukro Decision. The rating is based on the percentage of flights in the region that are flown under so-called fifth-freedom arrangements. Owing to the presence of two strong regional carriers and a clear hub system, such flights are not as common in EAC as in central or West Africa. The EAC council issued a directive to amend bilateral agreements among EAC states to conform to the Yamoussoukro Decision. The amendments remain pending, however, and air services have not been liberalized. Despite having some of the larger and more dominant airlines in Africa (Kenya and Ethiopia), East Africa has a poor liberalization record, which can be attributed to the presence of power airlines that are able to negotiate bilateral contracts individually to their own best interest rather than following regional initiatives.

The evolution of the regional market structure since 2001 has been in the direction of consolidating the position of the two dominant carriers, while at the same time providing space for newcomers to emerge (table 2.12). As of 2007, Kenya Airlines still maintained a large share of the market, and Ethiopian Airlines remained the second-most significant player in the market. Kenyan airlines controlled around 42 percent of the market in 2001 and now controls 47 percent. Ethiopian Airlines now controls 19 percent of the market, up from 11 percent in 2007. These two airlines remain the dominant carriers in the region. Nevertheless, some of the smaller players are gaining a larger share of the market. For example, Africa Start Airways and Rwandair Express, both of which had no market share in 2001, controlled around 8 percent and 11 percent of the market, respectively, in 2007.

Table 2.11. Proportion of direct flights and speed of air service in East Africa

a. Directness of service

	All flights	Direct flights
Burundi	42	31
Ethiopia	75	54
Kenya	193	168
Rwanda	53	49
Sudan	33	24
Tanzania	61	36
Uganda	99	78

b. Speed of service

		Destination						
		Burundi	Ethiopia	Kenya	Rwanda	Sudan	Tanzania	Uganda
Origin	Burundi		460	410	296			512
	Ethiopia	460		582	620	497	557	610
	Kenya	350	582		363	298	275	436
	Rwanda	***16***	620	305			590	***73***
	Sudan		572	330				513
	Tanzania		662	***193***				661
	Uganda	256	610	440	***176***	332	307	

Source: Bofinger 2009.

Ethiopian Airlines and Kenya Airways have been gaining a larger share outside of East Africa in markets in West and Central Africa (table 2.13). They are using fifth-freedom provisions to take over routes discontinued following the collapse of major carriers in West Africa. One effect of the two carriers' expansion is a slow rise in east-west traffic.

Table 2.12. Grading of the level of the implementation of the Yamoussoukro Decision

Community	General status of YD implementation	Status of air services liberalization	Overall implementation score
AMU	No implementation.	No liberalization within the AMU initiated, but need is recognized.	1
Banjul Accord Group	Principles of the YD agreed upon in a multilateral air services agreement.	Up to fifth freedom granted, tariffs are free, and capacity/frequency is open.	4
Economic and Monetary Community of Central Africa	Principles of the YD agreed upon in an air transport program. Some minor restrictions remain.	Up to fifth freedom granted, tariffs are free, and capacity/frequency is open. Maximum two carriers per state may take part.	5
Common Market for Eastern and Southern Afric	Full liberalization agreed upon ("legal Notice No. 2"), but application and implementation remain pending until a joint competition authority is established.	Pending. Operators will be able to serve any destination (all freedoms), and tariffs and capacity/frequency will be free.	3
East African Community	EAC council issued a directive to amend bilaterals among the EAC states to conform with the YD.	Air services are not liberalized, as the amendments of bilaterals remain pending.	3
Southern African Development Community	No steps taken toward implementation, although the civil aviation policy includes gradual liberalization of air services within the SADC.	No liberalization has been initiated.	2
West African Economic and Monetary Union	The YD is fully implemented.	All freedoms, including cabotage, granted. Tariffs have been liberalized.	5

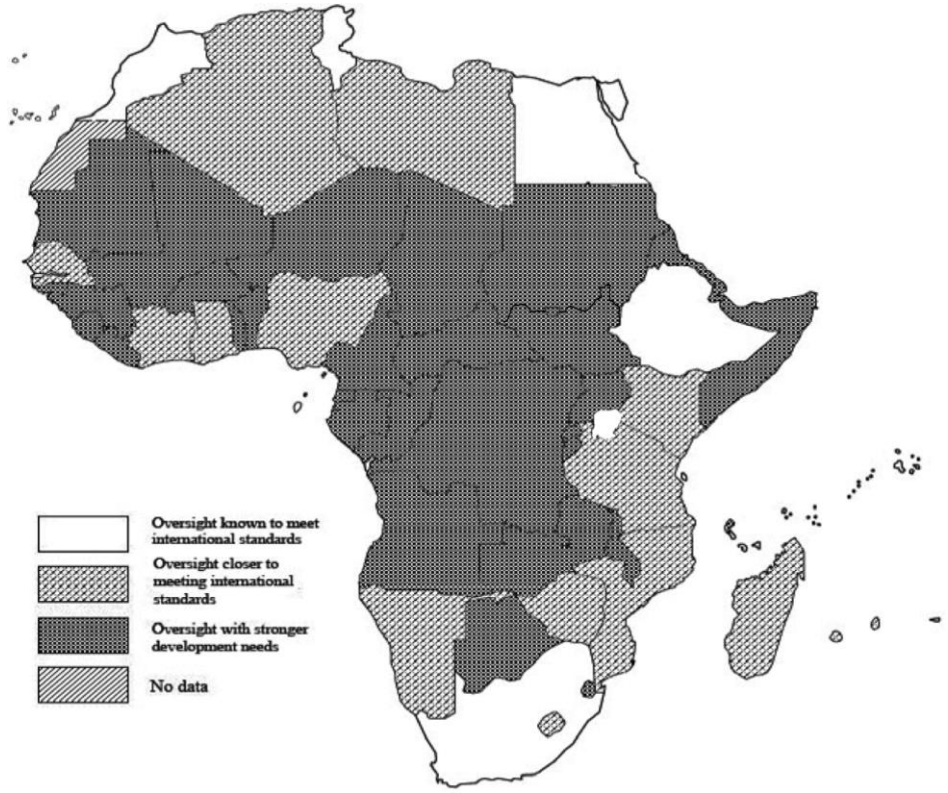
Most countries in EAC have made good progress toward achieving international standards in air safety, and regional collaboration in this area is already well underway (figure 2.13). Ethiopia is the only country in all of Africa, other than South Africa, that has complied with all international standards in air safety. Ethiopia is one of the few countries in Africa that carry the U.S. FAA category 1 rating for good safety oversight; that rating entitles it to fly directly into the United States. Kenya and Tanzania are in the process of improving their oversight agencies. In addition, the EAC countries are pooling resources to bolster their newly formed regional safety oversight organization—the East African Civil Aviation Authority—with support from the U.S. Department of Transportation's Safe Skies for Africa program. Though not yet fully operational, this organization is now collocated with the EAC headquarters in Arusha, Tanzania. Countries still facing hurdles in their oversight include Uganda and Rwanda, which have had difficulties in modernizing their standards for awarding air carrier certificates; and Burundi, owing to its legacy of conflict.

Table 2.13. Changes in air transport market in East Africa, 2001–07

Market share (%)	2001	2004	2007
Kenya Airways	42	51	47
Ethiopian Airlines Enterprise	11	17	19
Rwandair Express		8	11
African Star Airways Ltd.			8
Precision Air Services Ltd.	<1	3	4
Emirates	5	3	3
Air Tanzania Company Ltd.	6	9	1
East African Safari Air		5	
East African Airlines Limited	12		
FlyGlobeSpan	6		
British Airways P.L.C.	5		

Source: Bofinger 2009.

Figure 2.13. Status of African safety oversight, using several criteria



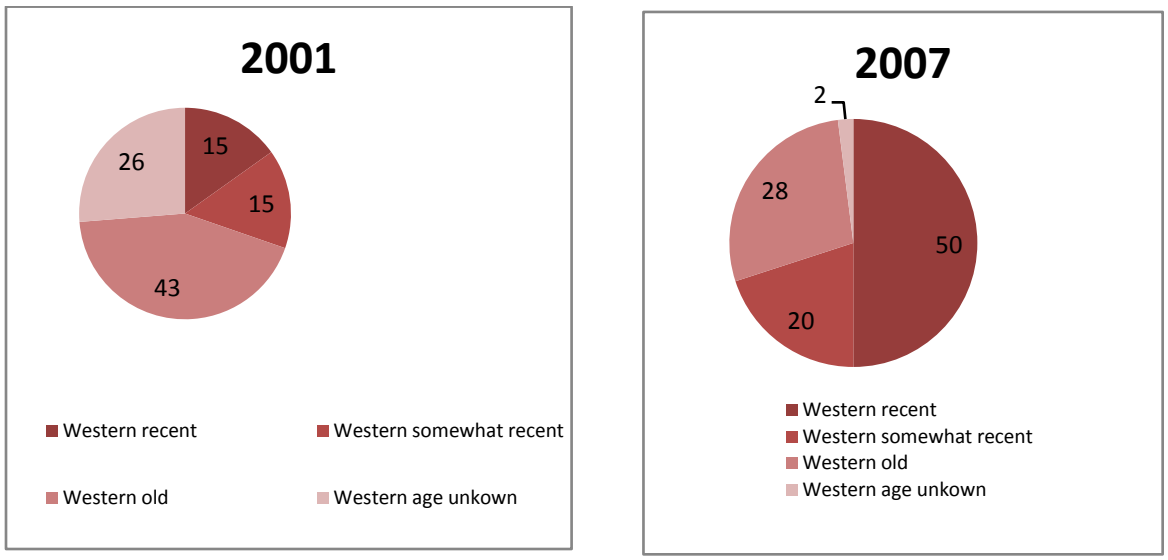
Source: Bofinger 2009.

Several airports in East Africa—including Kenya, Tanzania, Rwanda, and Uganda—are equipped with air traffic surveillance systems of some sort. Kenya is an exception in the region, with over 90 percent radar coverage. Ethiopia, although it is an important hub, had no radar coverage as of 2008. Rwanda's radar is primarily for military use, and Uganda and Tanzania have systems covering the approaches to their main airports in Entebbe and Dar es Salaam.

The air fleet in East Africa underwent a dramatic modernization in 2007. Across Africa, there has been substantial investment in new aircraft, leading to an overall renewal in the aircraft fleet. This trend is dramatically different from that observed in West Africa. The share of aircraft rated "western recent" and "western somewhat recent" in use in East Africa increased by 30 percent between 2001 and 2007 (figure 2.14).

The air cargo of Africa, the Middle East, and Latin America constitutes around 11 percent of global air cargo traffic. The bulk of Africa's air cargo traffic is handled by three countries: South Africa (20 percent), Kenya (15 percent), and Egypt (14 percent). Several other East African countries handle smaller volumes of Africa's air cargo traffic, namely Sudan (13 percent), Ethiopia (3 percent), and Uganda (3 percent). Europe is the primary destination for African air cargo, accounting for two-thirds of African air cargo. Air cargo traffic from Africa to Europe is expected to grow at a rate of more than 5 percent between 2005 and 2025. Primary exports are counter-seasonal flowers and perishables, with relatively little return cargo. Kenya is a large exporter of flowers to the Netherlands, Nairobi is one of the three main airports in Africa that handles air cargo traffic. In addition to exporting cut flowers, it handles strong domestic demand for imports shipped via air. The airport has become one of Africa's largest air cargo gateways (box 2.3).

Figure 2.14. Age distribution of airline fleet in East Africa



Source: Derived from Bofinger 2009.

Two East African airlines—Kenya Airways and Ethiopian Airlines—in addition to South African Airways provide high quality air cargo services in collaboration with other major international operators. The small volume of air cargo originating from Africa has often placed constraints on air cargo handling

operations. Recently, however, governments in Africa have given exclusive rights to third parties for services such as ground handling and ramp and warehouse services. A growing number of international operators are handling air cargo. These operators not only provide specialized skills but also provide business connection services with carriers and forwarders. They have provided standard quality air cargo handling and have adapted to the complex regulatory environments that are prevalent among African countries. One such company is Swissport Cargo, which offers services in 20 Latin American countries and 8 African countries, making use of joint ventures in which it holds a majority stake in Brazil, Philippines, South Africa, Kenya, and Tanzania.

The freight rates for air cargo from Europe to East Africa are surprisingly lower than for several other regions of the world (table 2.14). The pricing of cargo is determined by market conditions, and discriminatory pricing is used to improve price margins based on level of service. Prices are increasingly differentiated according to guaranteed delivery time. Freight rates computed per kilometer taper off with distance, in part because the block costs per kilometer decline and in part because the costs for cargo handling are fixed.

Table 2.14. Air cargo freight rates

Trade routes	$/kg
South China–Western Europe	4.39
South China–West Coast United States	4.62
South China–Middle East	6.54
West Europe–Middle East	2.01
East Coast United States–Middle East	2.00
West Europe–East Africa	**3.45**
West Europe–West Africa	6.44
China–Central Europe	8.85

Source: World Bank 2009b.
Note: Excludes fuel surcharge which average $1.05 in May 2008.

Box 2.3. The importance of air freight in East Africa

Air freight is an essential mode of transport for time-sensitive goods and for expansion into more distant markets as globalization continues.

Kenya. Horticulture is the third-largest and fastest-growing sector in the Kenyan economy. In 2003, Kenyan exports of fruits and vegetable totaled $260 million (around 15 percent of all exports). Kenya is the largest single supplier in the European flower market, with a 31 percent market share. Around 70 percent of exports are shipped to wholesale markets in the Netherlands. The average value of Kenyan cut flowers varies but stood at around $4 per kilogram as of 2009. Demand for Kenyan flowers is increasing, which has encouraged new entrants to the market, including Rwanda and Uganda. Uganda not only has an environment conducive to growth but also utilizes passenger and freight services (DAS Cargo) that provide sufficient cargo capacity.

Around 90 percent of fresh horticultural products are air freighted, which makes securing air cargo space a priority. Large exporters have some control through joint ventures with freight forwarders. As much as 90 percent of the shipments are carried as belly cargo on Kenyan Airways. Air cargo carriers such as Lufthansa Cargo and Cargolux provide dedicated cargo space from Nairobi to Frankfurt or Maastricht.

Around 70 percent of the flowers are grown northwest of Nairobi at the rim of Lake Naivasha. Good-quality roads between this area and Nairobi's Jomo Kenyatta International Airport are therefore imperative. Bad roads along this route can compromise the growth of the industry.

Tanzania. Seafood comprises the bulk of Tanzania's exports to the European Union. Around two-thirds of the West Nile perch catch are shipped fresh by air. Tanzania exports about 22,000 tons of fresh and frozen fillets that are worth some $77 million. Around 80 percent is sold in Europe, the rest in Asia.

The fish are caught by fisherman as well as commercial fishing operations and then transferred via air to Mwanza or Nairobi. The cargo is driven from factories and loaded at night for morning delivery. For cargo to Mwanza, chartered aircraft are used. These are costly because the short runways restrict operations to smaller, older aircraft. Shipments through Kenyatta International Airport incur a higher land transport cost, but the airfreight costs are lower. There is competition for space on passenger aircraft for flowers and vegetables during the peak season. These are sent on scheduled airfreight services to Brussels, Liege, and Ostend but require transshipment in Spain, Italy, and Germany. There are relatively few shipments that are large enough to justify chartering a larger air freighter. The overall cost of transport to the market is estimated to be about $1 per kilogram.

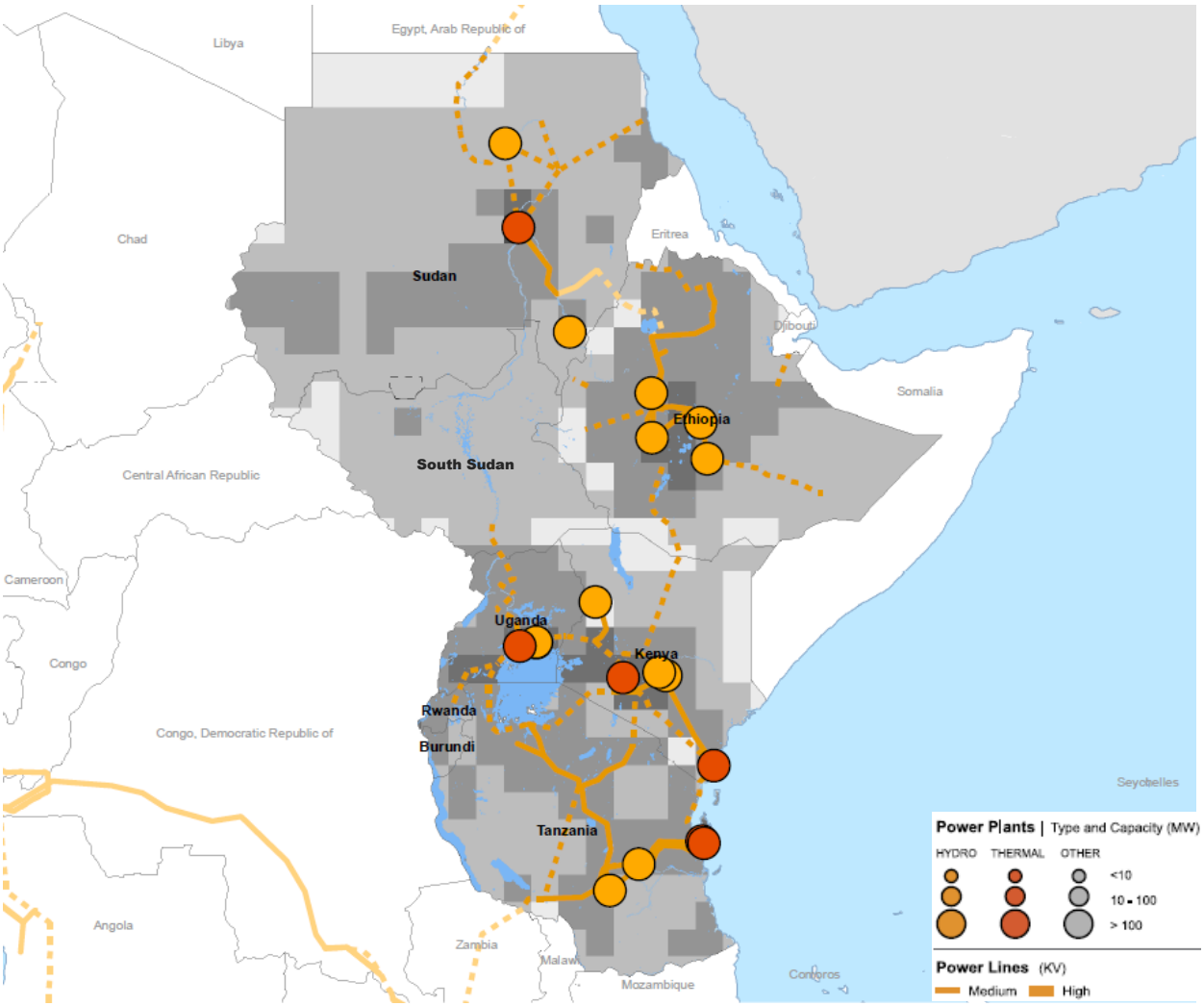
To maintain the cold chains required for seafood, air shipments need to be delivered close to the time of departure. Where the seafood is carried on a passenger aircraft, there is the additional problem of ensuring that the flight is not delayed in taking off. If the route involves a change in the aircraft, as it often does in the case of Tanzania, or significant wait on the ground, the cold chain could be compromised. To minimize this problem, airlines offer "tail to tail" service where cargo is moved directly from one plane to the other. This reduces handling costs and transit times.

Air freight will continue to be an essential mode of transport for time-sensitive goods and will play a growing role in developing exports for landlocked countries. To facilitate its use, landlocked countries will need to improve operations at their airports and liberalize access for foreign airlines. It is unlikely that scheduled air cargo operators will have significant operations in landlocked countries unless they become major suppliers themselves. Instead most air cargo will move as belly cargo on passenger airlines, with complementary use of chartered air freighters. It is necessary to expand access to foreign passenger airlines.

Source: World Bank 2009b.

3 Power

Figure 3.1. East Africa's regional power network and infrastructure



Relative to the other regional economic communities of Sub-Saharan Africa, the power situation in the East African Community is rather grave. EAC has the smallest generation capacity after the Economic and Monetary Community of Central Africa (CEMAC). Generation capacity in the Southern African Development Community (SADC) is 13 times greater than that of EAC, and that of the Economic Community of West African States (ECOWAS) is 5 times greater. Per capita generation is the worst in Africa, even lower than in CEMAC. Although annual power outages in the region are lower than in ECOWAS and CEMAC, they cause greater economic losses to firms, possibly because of the nature of industry in East Africa. Overall access to power is also the lowest in Africa. Nevertheless, utility performance in EAC is relatively encouraging. System losses are the lowest after southern Africa, and hidden costs, at 69 percent, are also second to southern Africa. EAC's power utilities have the best cost-

recovery record of any of the regional communities, with power tariffs covering 94 percent of the full capital costs of providing service

Table 3.1. Benchmarking power infrastructure and capacity, access, and utility performance

	ECOWAS	CEMAC	COMESA	EAC	SADC	Low-income countries	Middle-income countries
Installed generation capacity (MW)	3,912	583	1,085	774	9,855	2,110	36,971
Net generation per capita, annual (kWh/capita/year)	171	147	114	82	1214	165	4,479
Outages, number, annually (number/year)	165	152	119	132	91	134	71
Outages, value lost, annually (% of sales)	7	5	7	8	2	5	2
Firms with own generator (% of firms)	54	51	43	56	19	33	18
Access (urban, % of population)	50	31	34	23	35	43	50
Growth in access of population to electricity, annual (%)	2	1	1	1	1	3	2
System losses (% of generation)	29	31	32	23	12		10
Cost recovery ratio, historical (%)	79	45	73	69	68	100	87
Total hidden costs (% of revenue)	159	107	102	65	4	544	0
Collection rate reported by utility, electricity (% of billing)	71	93	93	94	89		91
	WAPP		CAPP		EAPP		SAPP
Average historic cost (US$/kWh)	0.21		0.49		0.19		0.14—
Long-run marginal cost (US$/kWh)	0.18		0.09		0.12		0.07—

Source: Eberhard and others 2009.

Note: CEMAC = Economic and Monetary Community of Central Africa; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECOWAS = Economic Community of West African States; SADC = Southern African Development Community.

The remainder of this section will focus on the East African Power Pool/Nile Basin (EAPP/NB) countries. Owing to the central role of the Nile Basin in determining hydropower potential, it is difficult to think about the region's long-term energy prospects without including Ethiopia, Sudan, and Egypt, which is potentially a large and creditworthy off-taker for hydropower generated further upstream. The benchmarks will be the other regional power pools—the Central Africa Power Pool (CAPP), the West African Power Pool (WAPP), and the Southern African Power Pool (SAPP).

The baseline total net demand for power in EAPP/NB was 100.6 terawatt-hours in 2005, making it the second-largest power market in Sub-Saharan Africa behind SAPP. Power outages suppress demand at the country level, albeit at varying rates. In Burundi, for example, 13 percent of net demand was suppressed in 2005. In a second group of countries that includes Djibouti and Kenya, between 6 and 8 percent of the effective power demand was suppressed. In the remaining countries, 95 percent of the effective demand was being met (in other words, just 5 percent of demand was suppressed).

Power demand in the EAPP area is expected to increase by 69 percent over the next decade. It is estimated that power demand could reach 169 terawatt hours by 2015. This total takes into account the need to fully satisfy existing demand for power; the anticipated expansion in market demand driven by economic growth in commerce and industry; and the need to provide additional power to support the planned expansion in electrification from 35 percent to 60 percent of households in the region. Meeting this demand will require the development of 26,000 megawatts of new generation capacity, which essentially calls for a doubling of existing capacity (table 3.2). These projections are based on economic

growth forecasts prior to the onset of the global financial crisis of 2008. On the assumption that the economic crisis could halve anticipated economic growth rates over this region, the estimate of demand for 2015 would fall by 2,101 megawatt-hours

Table 3.2. Demand and suppressed demand in the East Africa Power Pool–Nile Basin countries

All figures are in TWh unless noted otherwise

	Total net demand in 2005	% suppressed demand as a share of net demand (2005)	Market demand 2015	Social demand with national targets 2015	Total net demand 2015
Burundi	0.2	13	0.3	0.5	0.7
Djibouti	0.2	6	0.3	0.1	0.4
Egypt	84.4	0	119.9	3.4	123.3
Ethiopia	2.1	5	3.4	7.4	10.7
Kenya	4.6	8	6.8	5.2	12
Rwanda	0.1	5	0.2	0.3	0.5
Sudan	3.2	5	5.2	3.9	9.2
Tanzania	4.2	5	6.2	1.7	7.9
Uganda	1.6	5	2.5	1.7	4.2
EAPP	**100.6**	**1**	**144.8**	**24.2**	**169**
SAPP	258.8	1	383	14	396.9
WAPP	31.3	30	69.6	24.8	94.3
CAPP	10.7	9	17.1	3.1	20.2
Island States	1.1	5	1.6	1.5	3

Source: Rosnes and Vennemo 2009.

Note: The East African Power Pool is expanded to include key Nile Basin trading partners Egypt, Ethiopia, and Sudan. CAPP = Central Africa Power Pool; SAPP = Southern African Power Pool; WAPP = West African Power Pool.

Future power demand can either be met by expanding national production or by expanding cross-border power trade within EAPP. Two alternative scenarios will be considered in this report. The *trade stagnation* scenario assumes that no additional cross-border interconnectors will be built. In this scenario, trade is constrained at the levels observed today, and countries are thus obliged to meet incremental power demands solely through the development of their own domestic power sectors. For many EAPP countries that lack significant energy resources of their own, this entails increased reliance on thermal generation fueled by oil imports.

Alternatively, under the *trade expansion* scenario, future regional power demand is met by the most cost-effective energy resources available to the region as a whole, and additional cross-border transmission capacity is added wherever required to allow power to flow from production to consumption locations. Essentially, this scenario takes regional power trade to its fullest economic potential, assuming that there are no restrictions to cross-border exchange and that the necessary infrastructure can be built wherever it is required. Reality is likely to lie somewhere in between the trade stagnation and trade expansion scenarios, and in this sense the two scenarios serve to frame the range of possible outcomes.

Deepening regional integration would save the EAPP/NB area $1 billion in annual energy costs. Table 3.3 compares the cost of meeting growing regional power demand over the next decade in the trade stagnation and trade expansion scenarios. Overall, under trade expansion, the total annual cost of producing and distributing power decreases from $16 billion to $15 billion, saving the region $1 billion each year. Under the trade expansion scenario, countries would have to make larger investments of $1.8 billion per year in capital-intensive hydropower generation as well as investments of $100 million per year in the development of cross-border transmission capacity. These higher investments of $1.9 billion per year are more than compensated by reduced variables costs of $2.9 billion per year, which is essentially the annual reduction in the fuel bill associated with reduced reliance on thermal generation. The net savings are therefore $1 billion per year.

Table 3.3. Annualized costs of system expansion in EAPP, 2015

		Trade stagnation	
US$ billions	Trade expansion	Base growth	Low growth
New Investment			
Generation	4.4	2.6	4.2
Interconnectors	0.1	0	0.1
Distribution	1.1	1.1	1
Refurbishment	0.5	0.5	0.5
Variable cost	6.8	9.7	5.6
Total cost	**15**	**16**	**13.5**

Source: Rosnes and Vennemo 2009.

To make trade expansion possible, significant additional investments would be required. Ethiopia and Sudan—and to a lesser extent Rwanda, Tanzania, and Uganda—would have to make sizeable investments to develop their hydropower potential. Ethiopia, in particular, would need to develop more than 6,700 megawatts of additional hydropower capacity to supply export markets in neighboring countries. Sudan would have to develop 3,100 megawatts of additional hydropower capacity. All countries in the EAPP region would need to invest significantly in developing a total of 27,755 megawatts of new cross-border interconnectors to allow power to flow more readily around the region (table 3.4). The heaviest transmission investments would need to be made in Egypt, Ethiopia, and Sudan, which would need to develop a combined 26,488 megawatts of interconnector capacity—95 percent of the total required for the region. Egypt and Sudan would need to develop 10,000 and 13,941 megawatts of interconnection capacity, respectively.

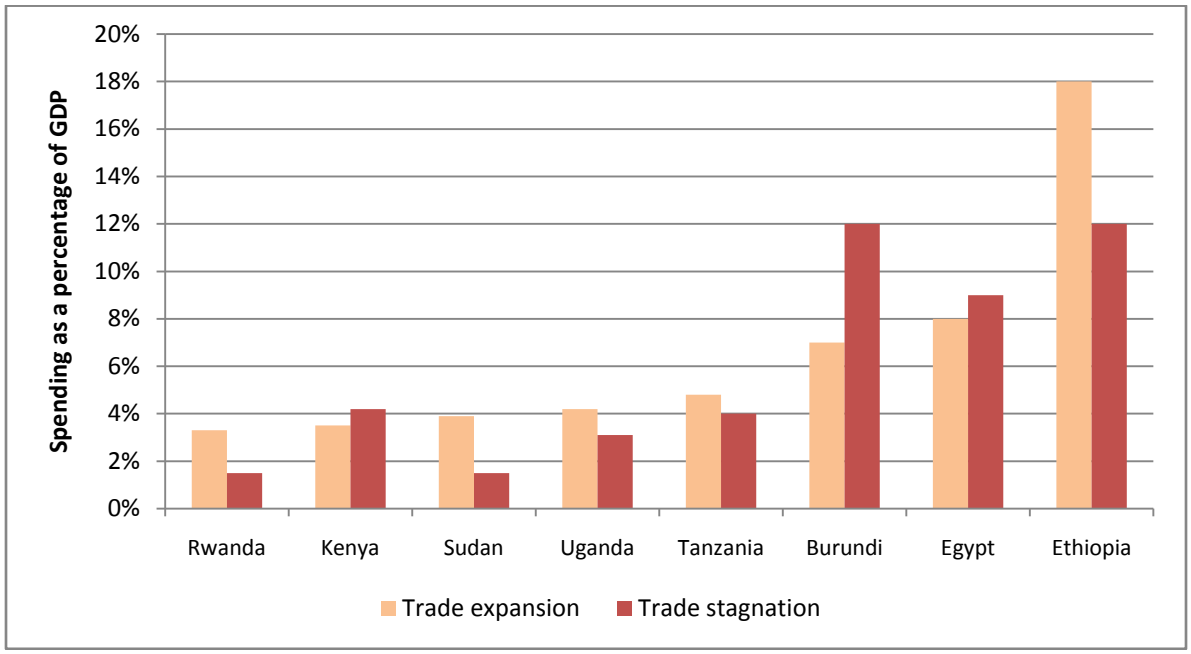
Table 3.4. Additional infrastructure requirements for trade expansion (MW)

MW	Interconnectors	Additional hydropower
EAPP/NBI	**27,755**	**10,968**
Burundi	78	0
Egypt	10,000	0
Ethiopia	2,997	6,766
Kenya	266	0
Rwanda	120	236
Sudan	13,491	3,136
Tanzania	266	279
Uganda	537	551

The EAPP region would have to spend a sizable portion of its gross domestic product (GDP) to meet its power needs. For individual countries, the impact of adopting trade can substantially influence the burden of power sector development on their national economies. Under trade stagnation, three EAPP countries (Burundi, Egypt, and Ethiopia) would need to spend between 7 and 12 percent of GDP per year for 10 years to meet their power sector needs, an extremely tall order. Kenya, Tanzania, and Uganda would all have to spend close to 5 percent of their GDP to meet their power sector needs—also a rather high share of GDP.

Under trade expansion, the pattern of spending shifts. Kenya, Burundi, and Egypt would need to spend less than they do under trade stagnation to meet the regional power infrastructure needs. Ethiopia, Sudan, Tanzania, and Uganda would have to spend more under trade expansion to meet their infrastructure needs. In the extreme case, Ethiopia would have to spend as much as 6 percent more of its GDP under trade expansion than under trade stagnation. This reflects the important role that Ethiopia would assume as an exporter of hydropower for the region under trade expansion.

Figure 3.2. Regional spending needs as a percentage of GDP



Source: Derived from Rosnes and Vennemo 2009.

In 2005, power trade flows in the EAPP were just 0.28 terawatt-hours of imports and 0.18 terawatt-hours of exports, about 2.1 percent of the electricity generated. Although EAPP is the third-most active regional power pool in Africa, after SAPP and WAPP, the volumes of power involved are very small. The main flows involve Egypt importing power, and Uganda exporting small amounts of power to Rwanda and Tanzania (figure 3.3a).

Under trade stagnation, future trade volumes would be 12 terawatt-hours per year up to 2015, and the pattern of trade would shift somewhat. Most notably, under trade stagnation, gas-fired power capacity and production would rise in Egypt and Kenya, and less hydropower would be developed in Ethiopia, Sudan, Uganda, and Rwanda. Because the existing transmission network remains in the trade stagnation scenario, there would be very little trade (figures 3.3b, 3.4b).

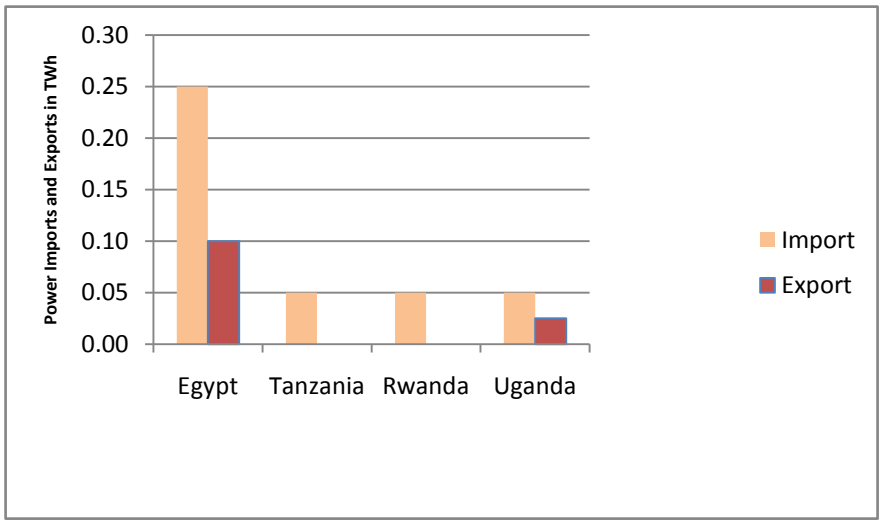
Under trade expansion, the volume of power traded in EAPP could increase substantially to 162 terawatt-hours by 2015. The key change under trade expansion is that Ethiopia and Sudan would fully develop their hydropower potential and become the major power exporters of the region, sending power into neighboring countries, particularly Egypt. Under this scenario, Ethiopia could export as much as 200 percent of its domestic consumption and Sudan more than 100 percent of its domestic consumption. Rwanda and Uganda would also become power exporters. While the volume of their exports would be

lower than Ethiopia's and Sudan's, these countries would be able to export a sizable share of their domestic consumption (figure 3.3b, 3.4a). As a result, Egypt would decrease its power production substantially. Burundi and Kenya, which currently import minimal amounts of power, would become significant power importers.

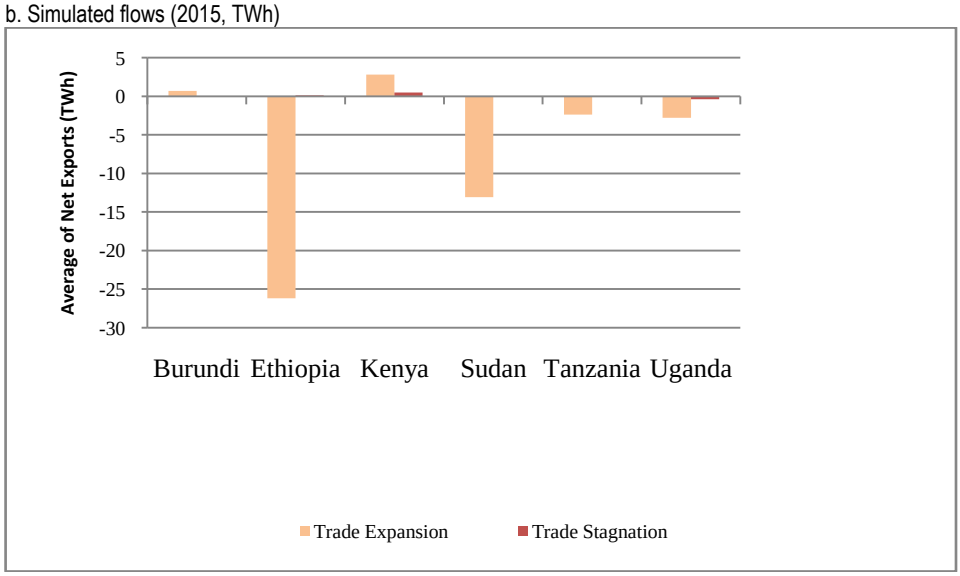
Under the trade expansion scenario, several countries in EAPP would be able to rely heavily on power trade by importing a large share of their domestic power needs. Figure 3.5 presents the absolute trade flows between countries under the trade stagnation and trade expansion scenarios. Under trade expansion, power exporters would export as little as 22 percent (in the case of Tanzania) and as much as 200 percent of their domestic consumption. Egypt, Kenya, and Burundi would import power. Egypt and Kenya would import significant volumes of power—between 20 and 30 percent of their domestic consumption. Burundi would import almost all of its power needs under trade expansion, making it fully dependent on traded power.

Figure 3.3. Existing and simulated patterns of future power trade in EAPP, 2015 (TWh)

a. Existing flows (2005, TWh)



b. Simulated flows (2015, TWh)



Source: Derived from Eberhard and others 2009.

The possibility of accelerating regional power trade in EAPP depends critically on the ability of Ethiopia and Sudan to deliver the massive investments in hydropower that would be needed. A host of technical, financial, and political challenges will make this difficult. First, from a technical perspective, the envisaged scale-up is around 10 times the installed generation capacity of Ethiopia and 1.5 times the generation capacity of Sudan. Increasing installed capacity to such an extent would be a huge technical

challenge for Ethiopia. Second, the cost of developing these hydropower schemes would be around $1 billion annually for a decade in each of these countries, an amount equivalent to around 8 percent of Ethiopia's GDP and 4 percent of Sudan's GDP annually. For a low-income country like Ethiopia, investing that amount each year would be financially complicated and would require massive capital contributions from the countries that would ultimately import the power. Third, because Sudan is a fragile state that has suffered from ongoing conflicts, it is not necessarily the most attractive destination for investments of this magnitude. If Ethiopia were able to fully harness its hydropower potential as a power exporter, it could export as much as 26.3 terawatt-hours per year, accruing revenues of $263 million (or 2 percent of GDP per year).

Figure 3.4. Trade flows in EAPP in 2015 (TWh)

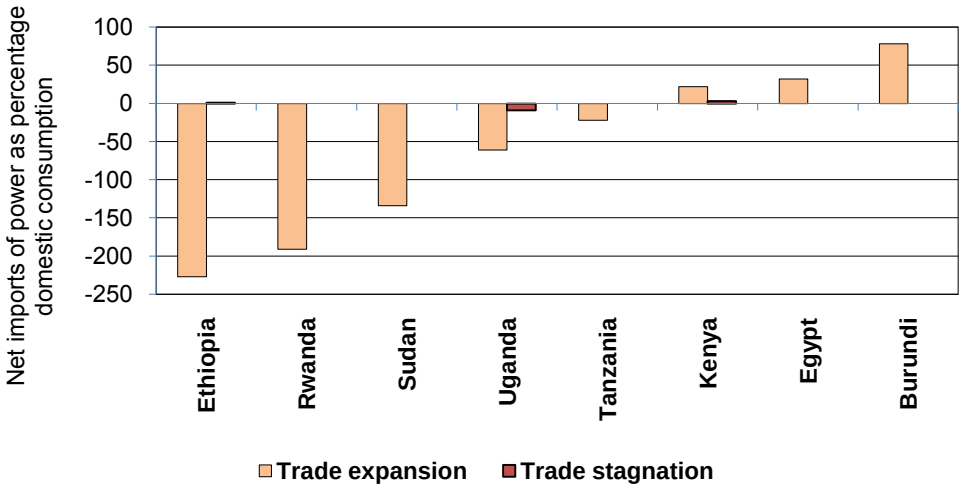
a. Trade expansion

b. Trade stagnation

Source: Rosnes and Vennemo 2009.

By increasing the share of hydropower in the regional generation portfolio, the trade expansion scenario would lead to annual savings in carbon emissions of some 20 million tonnes of carbon. The main impact of trade expansion would be to make possible a shift away from gas-fired generation and relatively dispersed small-scale hydropower toward larger and more cost-effective hydropower resources. Overall, the weight of hydropower in the regional generation portfolio would increase substantially from 28 to 48 percent, displacing gas-fired (and to a lesser extent diesel) generation (figure 3.6). Under trade stagnation, gas-fired power capacity and production would become much higher in Egypt and Kenya, and less hydropower would be developed in Ethiopia, Sudan, Uganda, and Rwanda. Under trade expansion, an additional 2.4 terawatt-hours of hydropower would generated, thereby reducing carbon emissions by 20.4 million tons (table 3.5). The savings in carbon emissions would be quite significant, second only to the savings achievable in the SAPP.

Figure 3.5. Net imports as a share of domestic demand (percentage)



Source: Derived from Rosnes and Vennemo 2009.

It is important to consider the implications for EAPP if hydropower were affected by climate change. There is some evidence that climate change will produce unstable and unpredictable weather patterns, including droughts, storms, heavy rainfall, and floods. Several sources argue that East Africa is likely to experience decreased water flow, while water flow will increase in southern Africa. The possible impact of climate change throughout Africa ranges from a 15 percent decrease to a 5 percent increase in water flows by 2050 compared to the 1961–90 baseline.

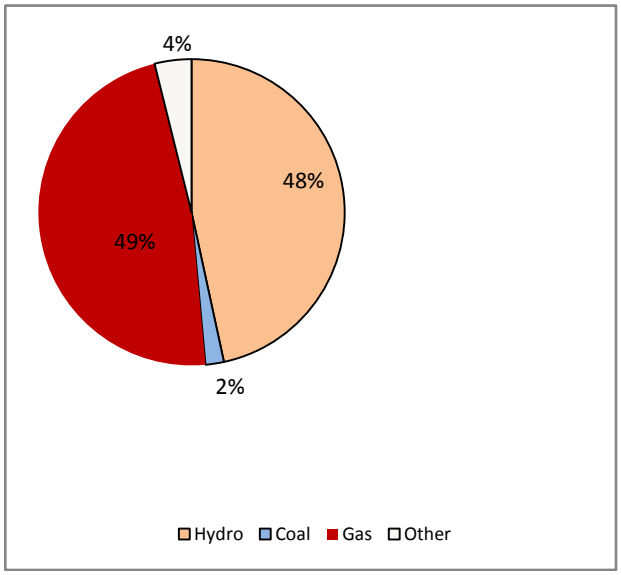
AICD simulated a scenario in which climate change reduced by 5 to 25 percent so-called firm hydropower production from both existing and new capacity . The results indicated that investments in natural-gas-fired power plants in Egypt and Tanzania would replace investments in the less-reliable hydropower in EAPP. Because natural-gas-fired power plants produce more energy (in gigawatt-hours) per megawatt installed, the *total* investment would be reduced from that of the non-climate-change scenario. But because the gas resources of Egypt and Tanzania are almost fully exploited, geothermal power from Djibouti would become a more profitable option. In rural areas, diesel-fired power plants would become an alternative to small-dam hydropower.

Lower capacity investment and a shift away from hydropower under the climate-change scenario would reduce total overnight (short-term) investment costs. Additionally, the lower investment in hydropower would reduce the need for transmission lines, since thermal power plants can be built in the vicinity of load centers. On the other hand, as hydropower resources are increasingly constrained, substitutes become increasingly expensive. Ultimately, *overnight* investment costs are only slightly reduced.

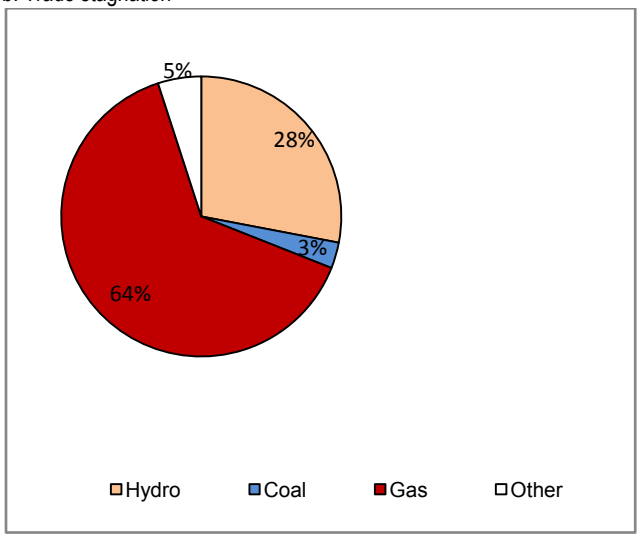
On the other hand, when taking into account the higher operating costs and shorter economic lifetime of gas-fired power plants, *annualized* costs increase steadily as hydropower investments are replaced by other technologies. Results indicate that annualized costs increase 9 percent when hydropower availability is reduced 25 percent.

Figure 3.6. Power generation mix

a. Trade expansion



b. Trade stagnation



Source: Derived from Rosnes and Vennemo 2009.

Table 3.5. Differences in electricity production and CO2 emissions in trade expansion and stagnation

	WAPP	SAPP	EAPP	CAPP	Total	WAPP	SAPP	EAPP	CAPP	Total
	Production difference (TWh)					*Emissions savings (M ton)*				
Coal		–41.5	0.7		–40.8		–37.8	0.6		–37.2
Diesel	–0.8	–0.3	0.3		–0.8	–0.6	–0.2	0.2		–0.6
Gas	–9.2	–5.3	–42.4		–56.8	–4.7	–2.7	–21.5		–28.9
HFO	0.2		0.4	–4.9	–4.3	0.1		0.3	–3.6	–3.2
Hydro	11.5	47.5	43.4	5.1	107					0
Total	**1.6**	**0.5**	**2.4**	**0.3**	**4.7**	**–5.2**	**–40.7**	**–20.4**	**–3.6**	**–69.9**

Source: Derived from Rosnes and Vennemo 2009.

Note: The East African Power Pool is expanded to include key Nile Basin trading partners Egypt, Ethiopia, and Sudan. CAPP = Central Africa Power Pool; SAPP = Southern African Power Pool; WAPP = West African Power Pool.

Ultimately, power trade expansion in EAPP would save less than $0.01 per kilowatt-hour, less than for all other power pools. In addition to the financial savings, however, the deepening of regional power trade would benefit the region by reducing the long-run marginal cost of power. Given that power is a key production input to the economy, any reduction in power costs will improve productivity and competitiveness.

The magnitude of power cost savings varies across individual countries in the EAPP (table 3.6). Small countries that have traditionally relied on gas-fired generation have the most to gain from switching to imported hydropower. In particular, Burundi stands to gain $0.04 per kilowatt-hour, the highest savings in the region. Kenya and Uganda would gain $0.01 per kilowatt-hour. Even in countries where per unit savings are more modest—$0.01 per kilowatt-hour or less—the aggregate value of the savings can be quite significant. Ethiopia, which would become a major power exporter under trade expansion, would

face an increase in long-run marginal costs owing to the need to develop a much larger amount of power from larger schemes that are more expensive than those that would be built to meet domestic demands alone.

Hydropower is more expensive in EAPP/NB than in SAPP, where the Democratic Republic of Congo can provide inexpensive hydropower. As a result, the difference in long-run marginal costs under trade expansion and trade stagnation is narrower in EAPP/NB than in SAPP. Even with trade stagnation, in which no interconnectors are built, generation costs in Ethiopia (the cheapest source of hydropower in EAPP/NB) are four times higher than in the Democratic Republic of Congo (the cheapest source of hydropower in SAPP).

Indeed, under either trading scenario the long-run marginal cost of power in the EAPP/NB area, at $0.12 per kilowatt-hour, is substantially higher than the cost of $0.06 to $0.09 per kilowatt-hour in SAPP and CAPP. Thus, from a competitiveness perspective, East Africa will never be able to compete as effectively in energy-intensive industry as central and southern Africa, both of which have access to lower-cost hydropower resources.

Table 3.6. Long-run marginal costs of power in EAPP

(US cents/kWh)	Trade expansion	Trade stagnation	Difference
CAPP	7	9	–2
EAPP/NB	**12**	**12**	**0**
SAPP	6	7	–1
WAPP	18	19	–1
Burundi	11	15	–4
Egypt	9	9	<1
Ethiopia	19	16	3
Kenya	12	13	–1
Rwanda	12	12	<1
Sudan	13	13	<1
Tanzania	10	8	–2
Uganda	12	11	–1

Source: Derived from Rosnes and Vennemo 2009

Note: The East African Power Pool is expanded to include key Nile Basin trading partners Egypt, Ethiopia, and Sudan. CAPP = Central Africa Power Pool; SAPP = Southern African Power Pool; WAPP = West African Power Pool.

For EAPP, regional power trade could result in gains of more than 20 percent annually accruing to the power pool members. However, individual countries stand to earn higher returns. For power importers, the trading decision can be thought of as an investment in cross-border interconnection that yields an annual return in terms of access to lower-cost power. On this basis, it is possible to calculate returns to trade for individual importers. Limited evidence suggests that importers stand to gain significantly from trade because they obtain cheaper power for a nominal investment in interconnectors. For example, one-time investments of $10 million and $30 million in interconnectors by Burundi and Kenya, respectively, would yield returns of more than 200 percent for Burundi and more than 400 percent for Kenya. Power exporters also stand to make significant returns on the investment, ranging from 12 percent to 43 percent per year. Sudan, which would bear the heaviest burden of spending for regional trade, stands to earn a return of 12 percent per year for a one-time investment of $1 billion in regional power infrastructure. Ethiopia, with the second-largest burden of spending for regional power, would enjoy a rate of return of 22 percent from a one-time investment of $1 billion.

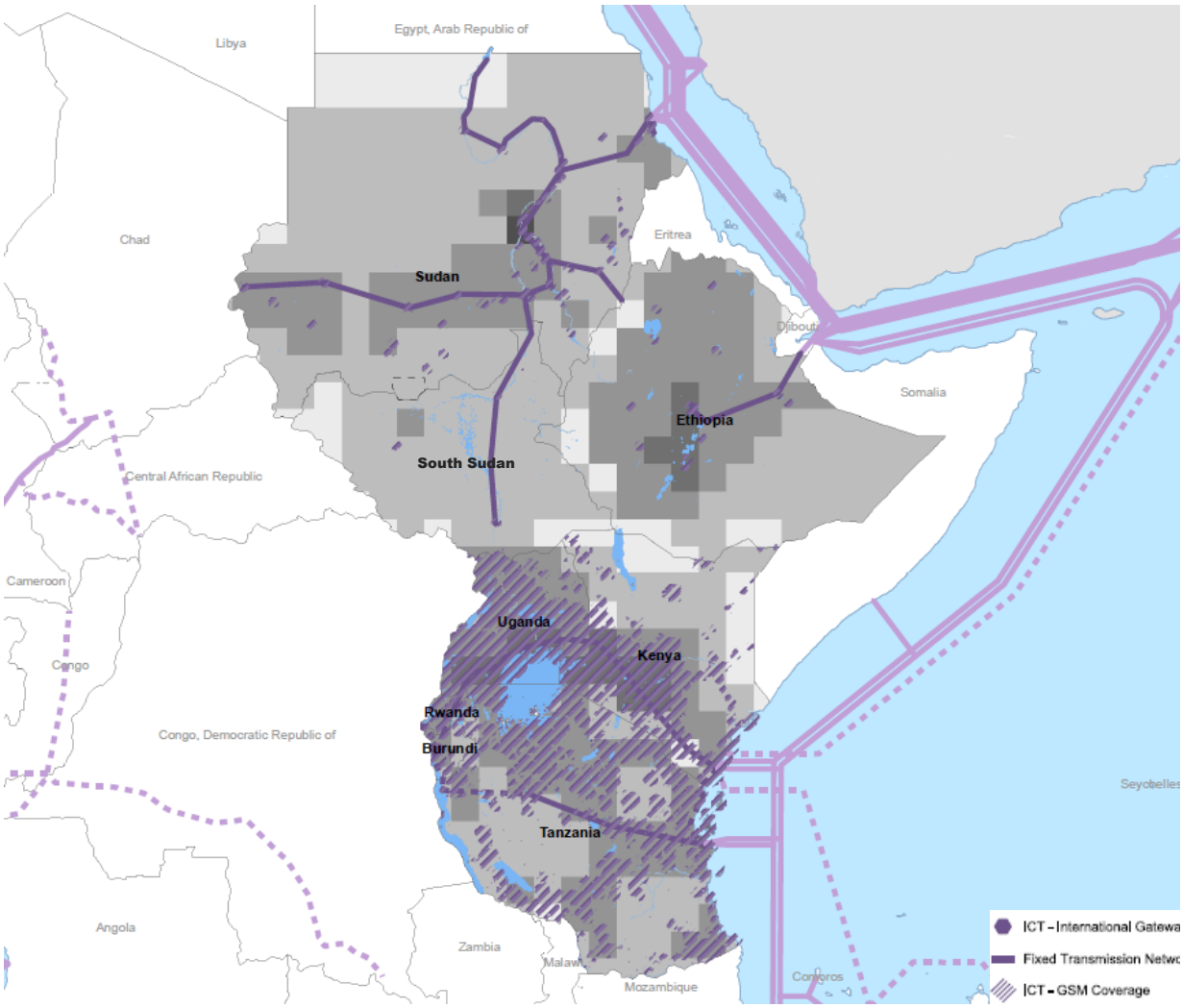
Table 3.7. Rate of return to power trade at country level

	Unit benefit (US$/kWh)	Net power trade (TWh)	Annual benefits (US$ millions per year)	One-time investment (US$ millions)	Rate of return (%)
Exporters					
Ethiopia	0.19	26.2	2169	1,001	22
Rwanda	0.12	1	72	59	12
Sudan	0.13	13	1258	1,032	12
Tanzania	0.1	2.4	187	44	43
Uganda	0.12	2.8	235	145	16
Importers					
Burundi	0.03	1	210	10	210
Djibouti	<.01	<1		0	
Kenya	0.01	12	1,200	30	400
Egypt	<.01	123	6,165		

Source: AICD calculations.

4 Information and communication technologies

Figure 4.1. East Africa's ICT backbone infrastructure



Within the East African Community (EAC), one finds strong GSM coverage around Lake Victoria—spanning Burundi, Rwanda, Uganda, and Kenya. Coverage in Tanzania is not as extensive. In the broader East Africa, mobile signal coverage is high in Sudan but much more limited in Ethiopia. Figure 4.1 captures the situation in East Africa as of the mid-2000s. Since then, however, the situation in Sudan—particularly with regard to GSM coverage—has improved significantly and is now on par with the rest of the EAC countries, but this is not reflected in the figure.

As of 2007, EAC stood out relative to other regions in terms of the very high costs and low penetration of Internet services. At $95 per month, the cost of an Internet subscription in EAC was substantially higher than in other parts of Africa. Hence, it is no surprise that Internet penetration (both dial-up and broadband) was the lowest in Africa and about a tenth of the levels observed in the Southern

African Development Community (SADC) (table 4.1). This finding reflects the complete absence of submarine cables on the eastern side of Africa at that time.

Regional indicators of information and communication technologies (ICTs) mask significant variations across countries (table 4.2). Mobile (GSM) signal coverage ranged between 60 to 90 percent of the population in most countries but was as low as 10 percent in Ethiopia. Notwithstanding high signal coverage, only a handful of countries (Kenya, Sudan, Tanzania, Uganda) had achieved mobile penetration of around 20 percent or more. Initial uptake of mobile telephony in Sudan was slow, with less than 4 percent of the population owning a mobile phone in 2003. The slow uptake is partially attributable to a lack of coverage, poor availability of prepaid services, and the price incurred by customers receiving calls. Yet as these impediments have eased, penetration has increased, growing by 500 percent since 2005.

Prices vary widely among countries. Most recent estimates for mobile prices range from less than $3 per month for a standard basket of services in Ethiopia and Sudan to almost $10 per month in Kenya. The median price for a standard basket of services in the region is around $9. The price of dial-up service (based on 2007 estimates) reveals wide variation—by a factor of 10—across countries, ranging from $15 per month in Ethiopia to $150 per month in Tanzania.

Table 4.1. Benchmarking ICT infrastructure across Africa's regional communities

	ECOWAS	CEMAC	COMESA	EAC	SADC
Broadband subscribers (per 100 inhabitants)	0.03	0.01	0.04	**0.02**	0.36
International Internet bandwidth (per capita)	16	11	9	**11**	19
Internet subscribers (per 100 inhabitants	0.24	0.06	0.09	**0.05**	0.53
Main telephone lines outside largest city (per 100 inhabitants)	0.39	0.20	0.53	**0.24**	1.89
Mobile telephone subscribers (per 100 inhabitants)	25	22	12	**21**	31
Prepaid mobile phone basket (US$ per month)	14.04	15.11	9.09	**12.18**	11.32
Price of three-minute call to United States (US$)	0.83	5.68	2.20	**1.37**	1.50
Price of 20-hour Internet basket (US$ per month)	79.98	67.97	50.91	**95.70**	75.60
Price of fixed-line phone basket (US$ per month)	9.35	12.59	6.85	**13.33**	13.27

Source: Ampah and others 2009.

Note: CEMAC = Economic and Monetary Community of Central Africa; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECOWAS = Economic Community of West African States; SADC = Southern African Development Community.

In Burundi, Rwanda, Ethiopia, and Sudan, it costs about as much to call within EAC as it does to call the United States. In Kenya, Tanzania, and Uganda, it is *much cheaper* to place a one-minute call to the United States than to call within the community—by as much as 14 cents per minute in Kenya and 19 cents in Tanzania.

Given that fixed-line services have largely been overtaken by mobile services in East Africa, the regional availability of roaming arrangements on mobile tariffs is in many ways a much more relevant measure of the costs of internal communications than the level of international fixed-line tariffs. East Africa pioneered "borderless mobile roaming" with free incoming calls and local tariffs. The scheme was introduced by Zain as a part of its "One" network linking Kenya, Tanzania, and Uganda, all primarily Zain networks. To compete, other mobile operators have also allowed regional roaming networks among

these three countries. Subscribers who belong to one of these networks can use their mobile handset in the others. When in one of these countries, users do not pay for incoming calls and are charged local rates for outgoing calls. In Burundi, none of the operators allows international roaming, partly because Burundi does not share any strategic investors with Kenya, Tanzania, or Uganda. Burundi, however, offers one-way roaming, which allows users from other countries to use their phones in Burundi. MTN in Rwanda has preferential roaming with MTN in Uganda. Ethiopia, on the other hand, has relatively few roaming arrangements.

Table 4.2. Benchmarking ICT in EAC member states

	Burundi	Kenya	Rwanda	Tanzania	Uganda	Ethiopia	Sudan
ACCESS							
Coverage of mobile network (% of population)	60	92	81	69	97	10	80
Mobile telephone subscribers (per 100 inhabitants)*	5.3	48.5	12.7	32.7	23.3	2	24.1
Internet subscribers (per 100 inhabitants)	0.01	0.04	0.03	0.09	0.03	0.03	0.11
Broadband subscribers (per 100 inhabitants)	0.0	0.05	0.03	0.00	0.01	0.00	0.11
International Internet bandwidth (Mbps)	4	885	31	200	344	245	705
Landline penetration	0.4	0.7	0.2	0.4	0.5	1.2	1.6
PRICES							
Prepaid mobile monthly price basket (US$)*	NA	7.36	6.16	9.5	9.32	2.9	2.9
Price of fixed telephone monthly price basket (US$)	2.5	19.4	7.8	11.3	13.0	1.7	4.5
Price of a three-minute call to United States (US$)	2.4	1.8	1.3	0.7	1.4	3.3	1.3
Price of 20-hour Internet basket (US$)	52	82	85	148	58	15	29

Source: Ampah and others 2009.
* Denotes data from 2008/09. All other data are from 2006/07.

Table 4.3. GSM roaming in East Africa

	Burundi	Kenya	Rwanda	Tanzania	Uganda	Ethiopia	Sudan
Burundi							
Kenya	X		X	P	P	X	X
Rwanda	X	X		X	P		
Tanzania	X	P	X		P	X	X
Uganda	X	P	P	P		X	X
Ethiopia	X	X	X	X	X		X
Sudan							

Note: P = preferential (cheaper tariffs and free incoming calls when using same group network—such as Zain in Kenya, Tanzania, and Uganda, and MTN in Rwanda and Uganda—and typically available for prepaid subscribers). X = available but with regulator roaming charges and typically limited to postpaid subscribers.
Source: Derived from Ampah 2009 and others.

The East African Regulatory Post and Telecommunications Organization (EARPTO),[2] an EAC regulatory body, appears to be less active than similar subregional organizations, but it has made some progress. Although the agency led the drafting of an EAC interconnection policy, agreements on border frequencies and common standards still tend to be bilateral, and there do not appear to be any model laws or regulations. Even for approvals of equipment types there does not seem to be any regional agreement.

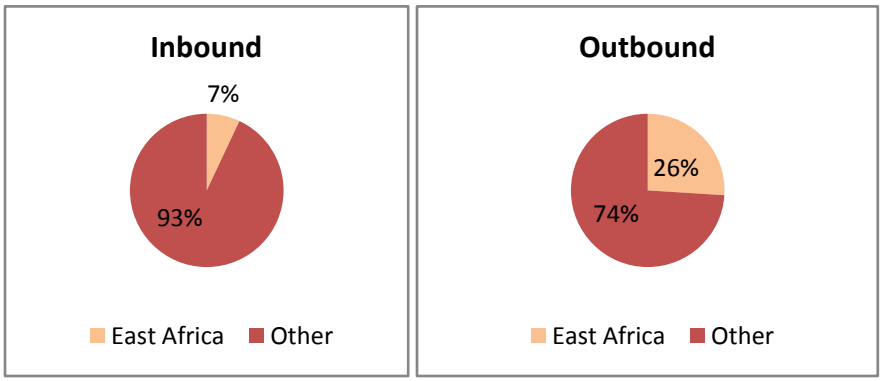
[2] http://www.cck.go.ke/earpto_issues/

For example, Uganda accepts equipment that has been approved in other jurisdictions—such as North America or Europe—but not the EAC.[3] Not all countries are represented by EARPRO. Burundi is a member of the Association des Régulateurs de Télécommunications de l'Afrique Centrale (ARTAC), and Sudan's regulator is a member of the Arab Regulators Network.[4]

Box 4.1. Regional telephone traffic in Tanzania

Only Tanzania publishes data on its telephone traffic with the rest of East Africa. Around a quarter of Tanzania's outgoing international voice traffic is to other East African countries, but only 7 percent of the incoming traffic is from East Africa. This discrepancy suggests that Tanzania has relatively low interregional tariffs. It is cheaper to call from Tanzania than it is to call into Tanzania because interregional telephone tariffs in Tanzania have the lowest average in the region, at $0.44.

Inbound and outbound East Africa traffic as a share of Tanzania's international traffic in 2007



Source: TCRA.

Several large mobile groups operate in multiple countries in the region, but no single operator dominates the region. With the exception of Ethiopia, all countries in East Africa allow foreign investment in telecommunications services. Burundi, Sudan, Tanzania, and Uganda do not have a limit on the amount of foreign investment, and each has at least one overseas operator that fully owns its investment. The main strategic investors in the region (in terms of the number of East African countries in which they operate) are MTN of South Africa (three countries) and Zain of Kuwait (four countries). France Telecom and Millicom, both European investors, are each involved in two countries. The Libyan African Portfolio (LAP) owns integrated (fixed and mobile) incumbent operators in Rwanda and Uganda. Practically all of the region's GSM mobile operators have some degree of foreign investment.

Incumbent operators have been partly privatized in five countries of East Africa. Privatizations in Rwanda, Tanzania, and Uganda have not performed as expected. Problems include renationalization and subsequent resale in Rwanda,[5] strategic investor changes in Uganda,[6] and management issues in Tanzania.[7] Sudan is unique in having released on regional stock markets shares in its incumbent, Sudatel,

[3] http://www.ucc.co.ug/typeApprovalFAQ.php

[4] Tanzania is a member of EARPTO and the Communications Regulators' Association of Southern Africa (CRASA), the telecommunications regulators group for SADC.

[5] http://www.rwandainvest.com.cn/DetailA.asp?ID=225&intMaxID=9

[6] http://www.ihsglobalinsight.com/SDA/SDADetail8574.htm

[7] http://allafrica.com/stories/200909070804.html

over a number of years. Safaricom, a mobile operator in Kenya, offered some of its shares on the Nairobi Stock Exchange in 2008, the largest initial public offering in East Africa.[8]

Foreign investment has contributed to connectivity and service enhancement, particularly when the same investor is involved in different countries. For example, Zain offers attractive mobile roaming prices for its subscribers roaming between Kenya, Tanzania, and Uganda. Collaboration over mobile roaming and fiber optic connectivity between Rwandatel and Uganda Telecom has been facilitated by common ownership. These multi-country networks have provided the basis for the regional roaming arrangements detailed in table 4.4 and box 4.2.

Table 4.4. Foreign investors in the East Africa's telecom sector

	Econet (Zimbabwe)	ESSAR (India)	France Telecom	Libyan African Portfolio	Orascom (Egypt)	Millicom (Luxembourg)	MTN (South Africa)	Vodacom (South Africa)	Vodafone (UK)	VTEL (100%)	Zain	TOTAL
Burundi	100%				100%					100%		3
Kenya	36%	34%	51%						40%			5
Rwanda				80%		88%	55%				80%	4
Tanzania						100%		65%			60%	2
Uganda			53%	51%			95%				100%	4
EAC	2	1	2	2		2	2	1	1	1	3	
Ethiopia												0
Sudan							85%				100%	2
East Africa	0		0	0		0	1				1	
TOTAL	2	1	2	2		2	3	1	1	1	4	

Source: Derived from Ampah and others 2009.

Ethiopia and Sudan have for some time enjoyed access to international fiber optic systems. In the case of Sudan, the 333 km SAS-1 submarine cable system links Port Sudan to Jeddah. Ethiopia has a fiber optic link between Addis Ababa and Djibouti, which provides access to submarine cables landing in Djibouti. There is also a fiber optic cable linking Metema in the country's north into Sudan, which allows Ethiopia to access other cables landing in Sudan.

[8] http://www.bloomberg.com/apps/news?pid=20601116&sid=aqOUSqNggEf4&refer=africa#

Box 4.2. Mobile sharing arrangements in Uganda

As of 2009, Uganda's telecommunications market had five mobile operators and several ISPs. MTN and UTL are the two national wireline operators and are also significant mobile operators. Both companies also have operations in Rwanda and thus have a common interest in establishing a communications link across the border from Uganda to Rwanda. In 2007, MTN constructed a fiber-optic cable from Kigali, Rwanda, to the border with Uganda. The company also recently announced a deal with its competitor UTL to jointly develop the fiber optic network on the Uganda side—a good example of competing operators forming a cooperative arrangement to lower the costs of developing fiber optic networks outside major urban areas. However, such an arrangement raises concerns for the market in Rwanda since the only fiber optic connection to the country will be jointly controlled by the only two network operators in Rwanda. Such concerns may ease as more licenses are issued in Rwanda and competition grows.

Source: Information and Communications for Development 2009.

For years, EAC suffered from a shortage of international connectivity traceable to its lack of undersea fiber optic cables. Since 2009, this situation has changed with the advent of three new cable systems. SEACOM (South Africa–East Africa–South Asia–Fiber Optic Cable)[9] was the first of the new East African cables, arriving in July 2009. It has landing stations in Kenya and Tanzania; Uganda and Rwanda can access the cable through connections via Kenya. The East African Submarine Cable System (EASSy)[10] is scheduled for deployment in mid-2010); its landing stations will include Kenya, Sudan, and Tanzania with access via terrestrial backhaul for Burundi, Ethiopia, Rwanda, and Uganda. The TEAMS cable will link the United Arab Emirates and Kenya.

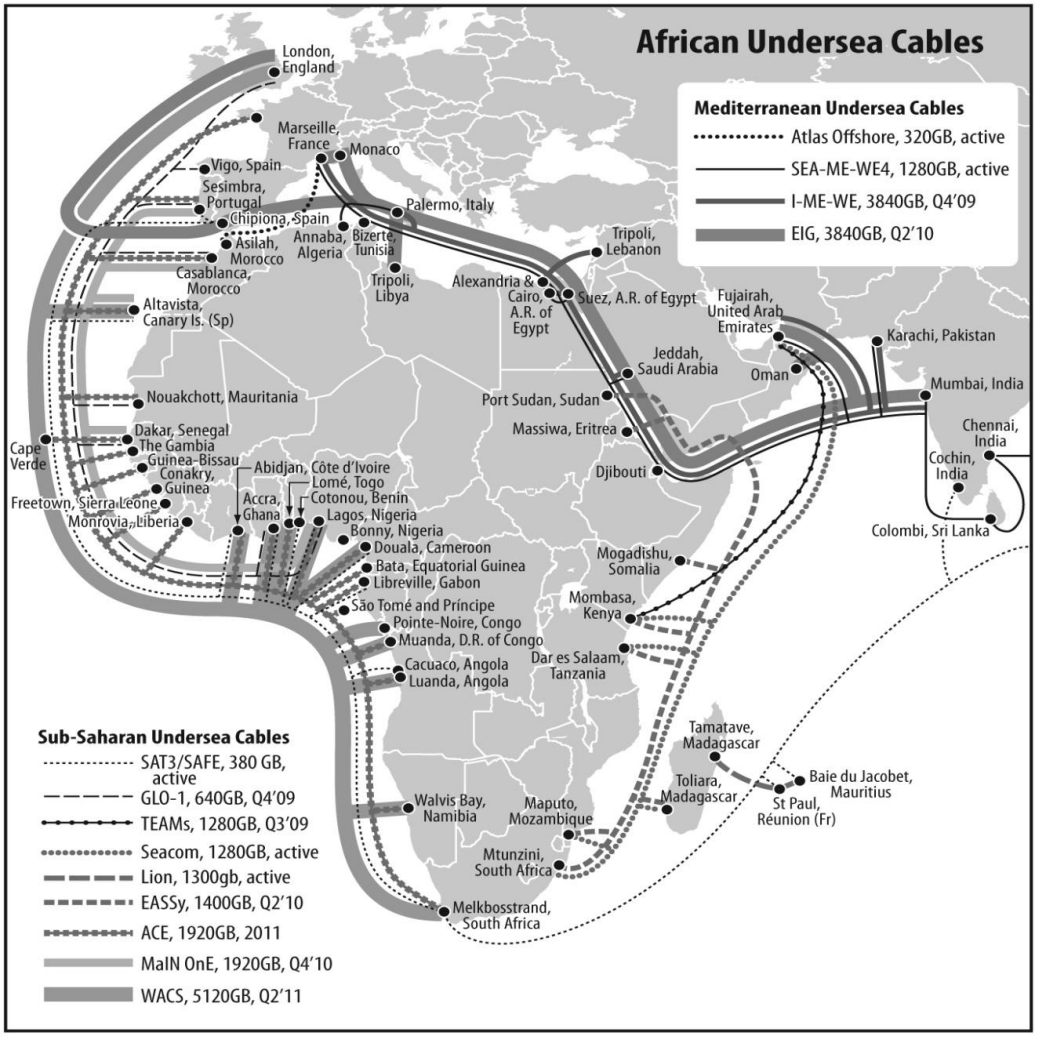
Connectivity to the landing stations of these new undersea cable systems has spurred upgrading and expansion of domestic backbones and cross-border agreements for onward transmission throughout the region. Burundi is building a national backbone assistance that will have two international exits via Rwanda and Tanzania.[11] Rwanda has around 230 kilometers of fiber optic cable in its national backbone, which is expanding to complete a 400-kilometer link from the capital to Gatuna on the border with Uganda. From there it connects to Ugandan fiber optic links, which run to the Kenyan border and on to the landing station in Mombasa. Rwanda has connectivity to the new SEACOM cable and will also have access to EASSy (figure 4.2).

[9] http://www.seacom.mu

[10] http://www.eassy.org

[11] http://web.worldbank.org/external/projects/main?pagePK=64312881&piPK=64302848&theSitePK=40941&Projectid=P094103

Figure 4.2. Proposed fiber optic connectivity in East Africa



Source: Mayer and others 2009.

Countries with access to the submarine cable benefitted from lower prices for ICT services; those with competitive access benefitted even more so (table 4.5). As of 2007, no countries in EAC were connected to the submarine cable. However, Sudan and Ethiopia had some international connectivity through SAS-1. The general expectation was that the impending connectivity to both EASSy and SEACOM would bring down prices in East Africa. Indeed, with connection to the submarine cables, prices have fallen dramatically in several countries (table 4.6). In Kenya, prices of the monthly mobile basket declined from more $14 in 2005 to

Table 4.5. Prices of Internet and phone calls in Sub-Saharan Africa, with and without access to submarine cables

	Price per minute for a call within Sub-Saharan (US$)	Price per minute for a call to United States (US$)	Price for 20 hours of dial-up Internet access per month ($)
No access to submarine cable	1.34	0.86	67.95
Access to submarine cable	0.57	0.48	47.28
Monopoly international gateway	0.7	0.72	37.36
Competitive international gateway	0.48	0.23	36.62

Source: AICD calculations.

$7.36 in 2009. In 2009, the price of ADSL in Kenya declined to one-sixth of its 2005 value, from around $220 to $37 per month. Tanzania has also experienced a decline in prices, albeit on a less dramatic scale than Kenya. ADSL prices in Uganda and Rwanda remained high in 2009 and 2010 but are expected to decline once service providers connect to the submarine cable over land.

In addition to connecting to the submarine cable, Kenya has taken additional steps to open up the region's telecommunications market. It has led the way in East Africa in establishing gateways with licenses for multiple mobile operators—Kenya now has over 10 international gateways in an open market, and international call tariffs are cheaper as a result (World Economic Forum 2007).

As evident in East Africa, prices for Internet services were lower than in the rest of the community thanks to connections with the international cables. Prices for long distance (interregional and international) were among the highest in the region, however, because monopolies control several international long-distance services. Even though Ethiopia has a monopoly in access to the international data gateways, government subsidies have reduced the price for access to the Internet. Prices for telephone services in the rest of EAC are governed by the levels of competition in long-distance services. Internet prices generally remain high due to lack of access to the submarine cable.

Table 4.6. ICT pricing trends for EAC countries, 2005–10 (US$)

	2005	2006	2009	2010
Monthly prepaid mobile basket				
Burundi	11.51	…	…	…
Kenya	14.60	15.93	7.36	7.36
Rwanda	11.64	11.31	6.16	5.39
Tanzania	13.46	10.40	9.32	9.28
Uganda	8.08	9.60	8.32	8.32
Monthly postpaid fixed basket				
Burundi	…	2.63	…	…
Kenya	10.42	14.23	…	…
Rwanda	4.84	7.69	…	…
Tanzania	12.43	10.82	…	9.65
Uganda	12.96	12.49	…	10.25
ADSL monthly service charge				
Burundi	…	…	…	…
Kenya	…	220.44	37.51	37.51
Rwanda	…	…	86.38	86.38
Tanzania	…	38.87	29.74	29.74
Uganda	…	300.00	300.00	300.00

Source: AICD.

Box 4.3. A shared model for backbone infrastructure development in East Africa

A challenge faced by most incumbent operators in Africa has been the sheer difficulty of building and operating networks that meet the needs of the market. A partnership between the public and private sectors has been formed to develop a stronger backbone infrastructure in East Africa. Under this approach, existing private operators have formed a consortium and built and operated networks in underserved areas. Governments have also provided financing to ensure that cost-oriented wholesale prices are offered and to ensure regulatory protection.

This shared model of ICT infrastructure development has been used in the Eastern Africa Submarine Cable System (EASSy), an undersea cable project established by 20 telecommunications operators, mostly from East and Southern Africa, and partially financed by a few international financial institutions.

The system has been designed to minimize the problems associated with the lack of competition and regulation in the region. This is done through a special purpose vehicle that makes it possible to sell network capacity in any market in the region on an open-access, nondiscriminatory basis, enabling other members of the consortium to compete. The agreements that established the special purpose vehicle require members to pass through to customers any cost savings arising from increased traffic volumes. These mechanisms for competition and pass-through of cost reductions are intended to lower prices and increase access.

Source: Information and Communications for Development 2009.

To attain full intraregional connectivity based on information from 2007, EAC member countries will have to add around 3,500 kilometers of new fiber optic links. Achieving the minimum levels of regional connectivity will require investments in several countries. The levels of investment required in each case are very modest in absolute terms (table 4.7).

Table 4.7. Gaps in intraregional connectivity and total investment required to attain minimum levels of regional connectivity

	Gap (km)	Investment (US$ millions)
EAC +	3,565	96
EAC	2,487	66
Burundi	90	**2**
Kenya	894	24
Rwanda	198	5
Tanzania	1,220	33
Uganda	85	2
Ethiopia	408	11
Sudan	670	18

EAC+ = EAC (Burundi, Kenya, Rwanda, Tanzania, and Uganda) + Ethiopia and Sudan.

In addition to the interregional connectivity within East Africa, the cost of completing the submarine infrastructure is estimated at $260 million, all of which will be undertaken by the private sector (table 4.8).

The benefits of completing regional integration of ICT networks would be substantial relative to the modest costs. Experience from other African countries suggests that connecting a country to a submarine cable via a competitive arrangement for landing stations can bring down the costs of broadband Internet by as much as 75 percent. Not only would this bring substantial savings to existing users of broadband, but the substantial price reduction could be expected to induce additional uptake of broadband service. Based on regional experience, each 10 percent reduction in broadband prices could be expected to bring about a significant increase in broadband penetration.

On this basis, the overall benefits of completing the regional integration agenda can be estimated to be $53 million per year for East Africa, against a one-time cost of $96 million to complete the backbone connectivity. This works out to a 57 percent annual rate of return. In EAC, the benefits are $26 million per year for a one-time investment of $64 million, equivalent to a 40 percent annual rate of return (table 4.9). The bulk of the benefits derive from the addition of new broadband users since the revenue lost from existing customers is more than compensated by that gained from new customers. Regional integration is therefore a positive business prospect for broadband service providers.

Table 4.8. Intercontinental and intraregional spending needs for East Africa for 10 years

	Intercontinental connectivity	
	Projects	Required annual investment (US$ millions)
East Africa	EASSy, TEAMS	260
Southern Africa	Infraco, SRII	510
Central Africa	Infinity, GLO-1, WAFS	1010
West Africa		
Total, Sub-Saharan Africa		1780

Source: Mayer and others 2009.

The rate of return for individual countries ranges from 22 to 304 percent (table 4.9). In Uganda, filling in the missing link of 85 kilomters of cable to complete the required backbone infrastructure will cost only about $2 million. Completing this investment would produce a rate of return of more than 300 percent. In Tanzania, which has the largest regional infrastructure gap (approximately 1,220 km), completing the backbone infrastructure will cost $33 million. This one-time investment would produce an annual rate of return of 22 percent.

Table 4.9. Summary of cost-benefit analysis of regional integration

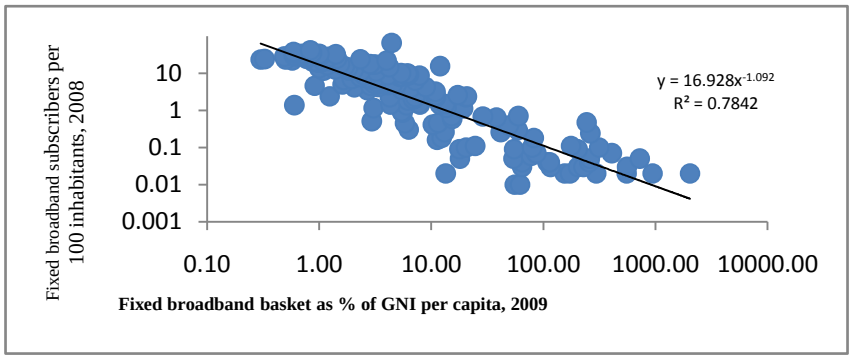
	Broadband price (US$/mo.)		Broadband subscriptions ('000s)		Benefits (US$ millions per year)	Costs (US$ millions)	Rate of return (%)
	Baseline 2008	Induced	Baseline 2008	Induced			
Burundi			0.2			2	
Ethiopia	486.50	304.1	0.4	5.5	6	11	59
Kenya	39.82	24.9	3.3	120.9	11	24	46
Rwanda	88.02	55	4.2	6.5	2	5	42
Sudan	23.25	14.5	44.6	354.3	21	18	116
Tanzania	63.56	39.7	6.4	43.5	7	33	22
Uganda	194.37	121.5	4.8	9.1	6	2	304

Source: AICD calculations.

Box 4.4. Methodology for calculating benefits of ICT

Affordability significantly affects access to telecommunications services. As the price of broadband service rises, the number of fixed broadband subscribers per 100 inhabitants drops (see figure).

Relation between broadband penetration and broadband affordability, world



The cost of Internet access largely depends on the wholesale price paid for international Internet connectivity. Presently, African countries rely heavily on satellite connections for Internet access. But fiber optic cable can lower the cost of Internet access provided countries allow Internet service providers (ISPs) open access to the cable. For example, in Kenya, connectivity to the fiber optic cable produced a 75 percent drop in international bandwidth prices.

Assuming Kenya's wholesale cost reduction were applicable to other countries and that international wholesale prices account for half of the ISPs' cost structure, the reduction in retail prices is assumed to be 37.5 percent. The potential savings for consumers in African countries, once they have open access to undersea fiber optic networks, can then be estimated. The revised broadband tariff is used to estimate the number of new broadband subscriptions based on the equation shown in the figure. Based on these assumptions, it is estimated that a 37.5 percent reduction in retail broadband prices would result in a *consumer* savings of $159 million for existing subscribers. The lower broadband prices would trigger new subscriptions estimated at around 2.7 million (compared with 833,000 in 2008). These new subscriptions would generate an additional $800 million of new revenue.

Certain assumptions in the model should be noted. The model assumes a standard broadband tariff, even though several packages are typically available, priced according to their speed. The model assumes a scenario similar to Kenya's in terms of the degree of the price reduction, and that half of the wholesale price reduction will be passed through to retail prices. It also assumes that there is a lone relationship between broadband pricing and take-up, even though other variables such as education and infrastructure availability will also have an impact. Finally, the model shows the one-off effect of a 37.5 percent reduction in retail tariffs. The timing of the full reduction is likely to spread over several years in some countries.

Source: AICD.

5 Regional infrastructure funding

The preceding sections identified key physical gaps in East Africa's regional infrastructure backbone. Filling those gaps and meeting the region's connectivity targets would entail annual spending of almost $2.9 billion dollars over a period of 10 years (table 5.1). That level of spending would buy a basic regional package that included the infrastructure required for full regional power trade, a complete regional road network, and fiber optic links connecting all countries to submarine cables. The level of spending required to meet the same targets in the EAC countries alone would be much smaller—around $513 million annually.

To put this in perspective, the total amount of infrastructure spending needed in the broader East Africa region to fulfill both regional and national infrastructure demands is $4.3 billion a year. The regional portion therefore represents 12 percent of the region's overall requirement. However, in the East Africa area (excluding Sudan),[12] the total amount needed for infrastructure is $6.1 billion per year, of which the regional component accounts for only 28 percent.

Spending requirements vary greatly across countries and sectors. The power sector has the largest requirements in terms of investments, operations, and maintenance—$2.5 billion annually for East Africa and a far less daunting $365 million for EAC. Transport spending needs are significantly smaller, amounting to $304 million for East Africa and $141 million for EAC. ICT investments pale in comparison to the other sectors, totaling $10 million per year for East Africa and $7 million for EAC.

The countries that would bear the heaviest spending burden in absolute terms are Ethiopia and Sudan. To meet regional targets, both would need to spend $1.2 billion annually on regional infrastructure, mainly in the power sector. Within EAC, Tanzania has the largest spending burden ($212 million), chiefly for power-related interconnectors.

Table 5.1. Annual regional spending requirements by sector over 10 years

	Transport		Power		ICT		Total		
US$ millions	Investment	O&M	Investment	O&M	Investment	O&M	Investment	O&M	Total needs
Burundi	1	3	1	0	1		3	3	7
Kenya	17	27	3		2	0	22	27	49
Rwanda	1	2	59		1	0	60	2	62
Tanzania	29	32	44	104	3	0	76	136	212
Uganda	14	16	145	9	0	0	159	25	183
EAC	**61**	**80**	**252**	**113**	**7**	**0**	**320**	**193**	**513**
Ethiopia	23	34	1,008	98	1	0	1,032	132	1,164
Sudan	65	42	1,032	52	2	0	1,099	94	1,192
East Africa	**149**	**155**	**2,292**	**263**	**10**	**0**	**2,451**	**418**	**2,870**

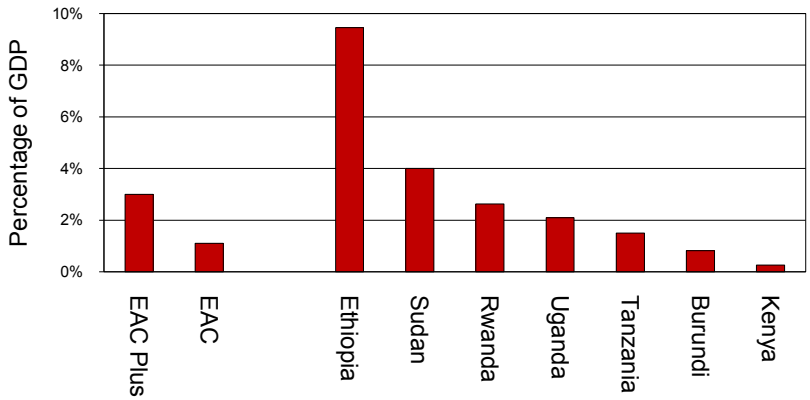
Source: AICD calculations.

[12] Sudan was not included in this calculation due to data limitations.

Maintaining East Africa's regional backbones, once complete, would cost a significant $418 million a year. The corresponding total for EAC is $193 million. Although the bulk of regional infrastructure spending needs relate to new investment, there is also a significant ongoing need for maintenance. Most of the associated maintenance costs are in the power sector—$263 million a year for East Africa and $113 million for EAC.

Completing the regional backbone would cost around 3 percent of East Africa's collective gross domestic product (GDP), but only around 1 percent of EAC's GDP. Overall, then, the cost of completing regional infrastructure backbones looks quite challenging for East Africa as a whole but much more manageable for EAC alone.

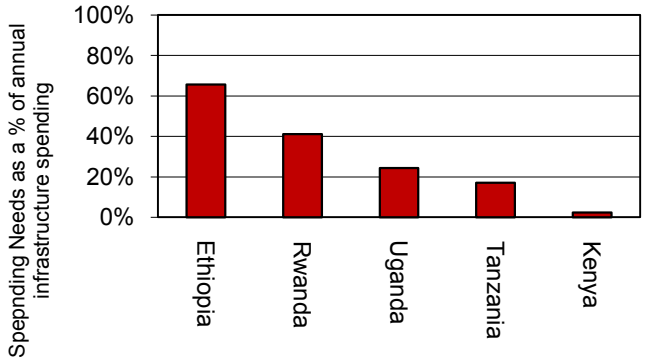
Figure 5.1. Spending for regional infrastructure as a share of GDP



Source: AICD calculations.

However, the burden of regional spending as a percentage of GDP varies enormously across countries and is quite daunting in some cases (figure 5.1). For example, although Ethiopia's and Sudan's spending needs are roughly the same—approximately $1.2 billion a year—this total represents only 4 percent of Sudan's GDP compared with 9 percent for Ethiopia. Most of the other EAC countries would need to spend around 2 percent of their GDP to achieve regional spending targets, which is still quite challenging. Kenya is the only country in the region for which regional infrastructure spending requirements appear modest in relation to the size of the national economy.

Figure 5.2. Spending for regional infrastructure as a percentage of national infrastructure spending



Source: AICD calculations.

Most countries would have to devote a significant share of their existing infrastructure budgets to regional projects to meet the regional requirements. Figure 5.2 expresses each country's regional spending requirement as a percentage of existing infrastructure spending (information on existing spending is available for only a subset of countries.) Kenya would need to spend 2.4 percent of its existing infrastructure budget to meet regional targets. For the other countries, reaching regional targets based on historical infrastructure spending patterns would be more challenging. Tanzania and Uganda would need to spend between 17 and 24 percent of their existing infrastructure spending on regional programs to address regional infrastructure issues. For Rwanda and Ethiopia, spending for regional infrastructure would appear unachievable relative to historic infrastructure spending: these two countries would have to spend between 40 to 60 percent of their existing infrastructure spending on regional backbone infrastructure to meet the goals laid out in this report.

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This country report draws upon a wide range of papers, databases, models, and maps that were created as part of the Africa Infrastructure Country Diagnostic. All of these can be downloaded from the project Web site: www.infrastructureafrica.org. For papers go to the document page (http://www.infrastructureafrica.org/aicd/documents), for databases to the data page (http://www.infrastructureafrica.org/aicd/tools/data), for models to the models page (http://www.infrastructureafrica.org/aicd/tools/models), and for maps to the map page (http://www.infrastructureafrica.org/aicd/tools/maps). The references for the papers that were used to compile this country report are provided in the table below.

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AICD
AFRICA INFRASTRUCTURE
COUNTRY DIAGNOSTIC

About AICD

This study is a product of the Africa Infrastructure Country Diagnostic (AICD), a project designed to expand the world's knowledge of physical infrastructure in Africa. AICD provides a baseline against which future improvements in infrastructure services can be measured, making it possible to monitor the results achieved from donor support. It also offers a solid empirical foundation for prioritizing investments and designing policy reforms in Africa's infrastructure sectors.

The AICD is based on an unprecedented effort to collect detailed economic and technical data on African infrastructure. The project has produced a series of original reports on public expenditure, spending needs, and sector performance in each of the main infrastructure sectors, including energy, information and communication technologies, irrigation, transport, and water and sanitation. *Africa's Infrastructure—A Time for Transformation*, published by the World Bank and the Agence Française de Développement in November 2009, synthesized the most significant findings of those reports.

Reports on Africa's for major regional economic communities (RECs) provide a snapshot of the state of integration of infrastructure networks at the regional level. The focus of these reports is on benchmarking infrastructure performance within and between RECs, gauging the benefits of regional integration, identifying missing links, and quantifying the main financing gaps and their distribution across countries. These reports are particularly relevant to national and regional policy makers and development partners working on regional integration programs.

The AICD was commissioned by the Infrastructure Consortium for Africa following the 2005 G8 (Group of Eight) summit at Gleneagles, Scotland, which flagged the importance of scaling up donor finance for infrastructure in support of Africa's development.

The AICD's first phase focused on 24 countries that together account for 85 percent of the gross domestic product, population, and infrastructure aid flows of Sub-Saharan Africa. The countries are: Benin, Burkina Faso, Cape Verde, Cameroon, Chad, Côte d'Ivoire, the Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Uganda, and Zambia. Under a second phase of the project, coverage was expanded to include as many as possible of the remaining African countries.

Consistent with the genesis of the project, the main focus is on the 48 countries south of the Sahara that face the most severe infrastructure challenges. Some components of the study also cover North African countries so as to provide a broader point of reference. Unless otherwise stated, therefore, the term "Africa" is used throughout this report as a shorthand for "Sub-Saharan Africa."

The World Bank has implemented the AICD with the guidance of a steering committee that represents the African Union, the New Partnership for Africa's Development (NEPAD), Africa's regional economic communities, the African Development Bank, the Development Bank of Southern Africa, and major infrastructure donors.

Financing for the AICD is provided by a multidonor trust fund to which the main contributors are the United Kingdom's Department for International Development, the Public Private Infrastructure Advisory Facility, Agence Française de Développement, the European Commission, and Germany's KfW Entwicklungsbank. The Sub-Saharan Africa Transport Policy Program and the Water and Sanitation Program provided technical support on data collection and analysis pertaining to their respective sectors. A group of distinguished peer reviewers from policy-making and academic circles in Africa and beyond reviewed all of the major outputs of the study to ensure the technical quality of the work.

The data underlying the AICD's reports, as well as the reports themselves, are available to the public through an interactive Web site, www.infrastructureafrica.org, that allows users to download customized data reports and perform various simulations. Many AICD outputs will appear in the World Bank's Policy Research Working Papers series.

Inquiries concerning the availability of data sets should be directed to the volume editors at the World Bank in Washington, DC.