AICD
AFRICA INFRASTRUCTURE
COUNTRY DIAGNOSTIC

COUNTRY REPORT

South Sudan’s Infrastructure: A Continental Perspective

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Africa’s Infrastructure | A Time for Transformation

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About AICD and its country reports

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.

The focus of the AICD country reports is on benchmarking sector performance and quantifying the main financing and efficiency gaps at the country level. These reports are particularly relevant to national policy makers and development partners working on specific countries.

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 of the remaining African countries as possible.

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 (AfDB), the Development Bank of Southern Africa (DBSA), 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 (DFID), the Public Private Infrastructure Advisory Facility (PPIAF), Agence Française de Développement (AFD), the European Commission, and Germany's Entwicklungsbank (KfW). 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 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.

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.

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Acknowledgments

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Dominguez on water, Michael Minges and Mark Williams on information and communication technologies, Nataliya Pushak on public expenditure, and Alvaro Federico Barra on spatial analysis. The paper benefitted from comments and guidance from Vivien Foster.

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Synopsis

The results of South Sudan's referendum were finalized in February 2011. Over 98 percent of the votes favored secession from the all parts of Sudan. Going forward, South Sudan faces the major hurdle of overcoming policy and capacity challenges and determining the priorities of its overall development agenda. Since 2005 the government of South Sudan (GOSS) has generated over $6 billion in oil reserves, more than half during the 2008 oil spike, yet social and infrastructure spending has not been remotely proportional to this accruing oil wealth. On the contrary, public spending and the actual provision of services supporting infrastructure and social needs have lagged what was accomplished in other parts of Sudan before the split.

During the six-year interim period, 2005–10, defined in the Comprehensive Peace Agreement (CPA), South Sudan benefited from the strong support of donors. In the transport sector the priority was to reestablish regional and interstate links and access to seaports, and to rehabilitate the only rail line, as well as river ports and airstrips. Meanwhile, South Sudan saw notable improvements in the information and communication technology (ICT) sector as it became increasingly liberalized. Recent efforts have been concentrated on strengthening institutions and creating the basic capacity needed to implement projects and maintain and administer infrastructure.

Nonetheless, the state of South Sudan's infrastructure is in complete disarray, making it difficult to pin down the single most pressing infrastructure challenge. Existing infrastructure problems (whether related to assets, capacity, or institutions) are daunting; it is simply not realistic to expect—even in the most optimistic scenario—that the south will catch up with neighboring countries, even those in a similar income bracket, in a period of 10 years or even more. Estimates based on very modest illustrative targets indicate spending needs on the order of $1.4 billion per year over a decade—more than three times as much as the country has been spending in recent years, even under the CPA. Capital expenditure would account for 80 percent of this spending requirement. The transport sector accounts for half of the spending needs, and the water and sanitation sector for a further quarter of the total.

In terms of the size of its economy, South Sudan's infrastructure spending needs are huge relative to the country's gross domestic product (GDP) (around 23 percent of GDP annually) but small relative to the average estimated needs for other African fragile states—likely because of oil's large contribution to the economy. The resource influx due to oil exports obviously plays in favor of South Sudan's potential to afford the long term massive interventions in infrastructure. Other countries have proven that it is, in fact, possible to reach such high levels of spending. China, for example, invested 15 percent of its GDP per year in infrastructure over 15 years. during the mid-2000s. The estimate for South Sudan's infrastructure capital investment alone is 18 percent—larger, yet within the ranges observed in China. but not unimaginable. But the daunting conditions faced in South Sudan across the board make the possibility that existing spending will be boosted to the level required—not to speak of maintaining this level over a decade—highly unlikely for the country.

Given that such levels of spending are beyond reach in the medium term, only by using an incremental but sustained approach to infrastructure improvements will the challenge of turning around

South Sudan's infrastructure situation become manageable. This makes it absolutely critical to adopt sound principles for the prioritization of many competing infrastructure needs.

South Sudan already spends approximately $450 million per year on infrastructure, equivalent to about 7.5 percent of GDP. A further $36 million a year l is wasted due to inefficiencies. This makes that the country's annual infrastructure funding gap amounts to $879 million per year, or roughly 15 percent of GDP. The largest funding gap—equivalent to 40 percent of South Sudan's needs—is in the water and sanitation sector. Transport comes a close second, with its needs representing 35 percent of the total. Power is in third place, but has significant requirements. South Sudan can build on potential inflows of financing from China and the private sector, particularly in the power sector, to close these gaps. But the ongoing instability in the country may deter investors. Meanwhile, adopting lower-cost technologies can help the country develop a strong infrastructure backbone and pave the way for growth and productivity in the near future. Finally, if all else fails, it may be necessary to realistically extend the time horizon for meeting the infrastructure targets beyond the illustrative period of 10 years considered here. In the case of South Sudan, the total amount of the cost of inefficiencies is low relative to the economy, since the actual provision of services is almost nonexistent. Addressing inefficiencies will not only result in modest gains in the short run but will be vital to creating solid institutions for attracting new investors and getting the biggest bang for their buck in coming years.

The continental perspective

The Africa Infrastructure Country Diagnostic (AICD) has gathered and analyzed extensive data on infrastructure in more than 40 Sub-Saharan countries, including all parts of Sudan. The results have been presented in reports covering different areas of infrastructure—ICT, irrigation, power, transport, and water and sanitation—and different policy areas, including investment needs, fiscal costs, and sector performance.

This report presents the key AICD findings for South Sudan, allowing the country's infrastructure situation to be benchmarked against that of its African peers. South Sudan is a newly independent country, affected by conflict, endowed with oil, but poor in terms of infrastructure and economic development. Because of these factors, both low-income, fragile states and resource-rich benchmarks will be used to evaluate its performance. Detailed comparisons will also be made with immediate regional neighbors in the East African Community (EAC).

Several methodological issues should be borne in mind. First, because of the cross-country nature of the data collection, a time lag is inevitable. The period covered by the AICD runs from 2001 to 2006. Most technical data presented are for 2006–07 (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. Second, to make comparisons across countries, the indicators and analysis were standardized so that everything was done on a consistent basis. This means that some of the indicators presented here may be slightly different from those that are routinely reported and discussed at the country level. Third, in terms of nomenclature, *all parts of Sudan* refers to Sudan prior to the split of the country, *Sudan* refers to the northern part of Sudan, and *South Sudan* refers to the newly independent country. Fourth, data for Sudan and South Sudan were originally collected and processed for the country as a whole, that is, *all parts of Sudan*. But given recent geopolitical events, including the secession of South Sudan from the rest of the country, and the vast differences between Sudan and South Sudan in terms of topography, infrastructure, and financial resources, this report presents analyses and results that reflect the situation in South Sudan as much as possible. In a few cases this involves relying on imperfect data and using proxy variables to attribute otherwise global estimates.

Why infrastructure matters

The results of South Sudan's referendum were finalized in February 2011. Over 98 percent of the votes favored secession from all parts of Sudan. Political negotiations over major macroeconomic issues such as debt, oil, and currency are ongoing. The GOSS is preparing for a transition from an autonomous subnational government to a sovereign state. Going forward, it faces the major hurdle of overcoming policy and capacity challenges and determining the prioritization of its overall development agenda.

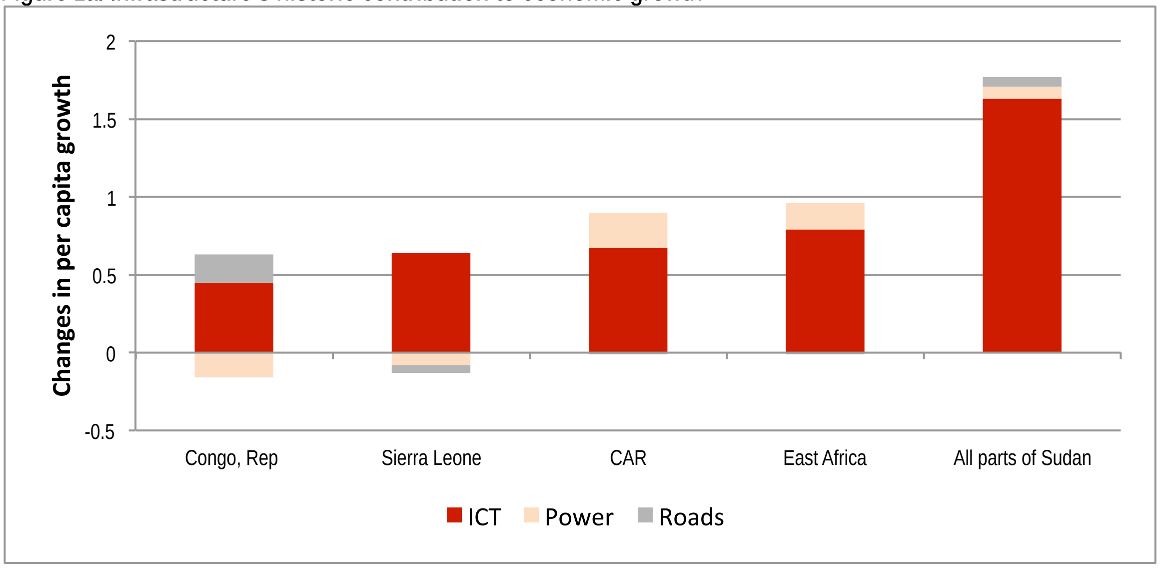
South Sudan presents the stark divide between economic reality and unrealized potential. South Sudan has around 25 percent of all parts of Sudan's land area. The area contains a majority of the oil reserves and has the best-quality agricultural land. Since 2005 the GOSS has generated over $6 billion in oil reserves—more than half during the 2008 oil spike—yet social and infrastructure spending has not been remotely proportional to this accruing oil wealth. On the contrary, public spending and the actual provision of services supporting infrastructure and social needs have lagged behind what was previously achieved in all parts of Sudan.

Adequate infrastructure is the key to economic growth. Empirical evidence suggests that infrastructure has made positive contributions to per capita growth in Sub-Saharan Africa, but to varying degrees. Between 2001–05, infrastructure contributed as little as 0.14 percent (Togo) and as much as 1.7 percent (Mauritius) to per capita growth across African countries. For all parts of Sudan the contribution of infrastructure was similar to that of Mauritius.

Estimates of infrastructure's contribution to growth in South Sudan are unavailable. But the Central African Republic and Sierra Leone (by virtue of being landlocked or fragile states) and the Republic of Congo (because of its natural resource endowments) provide a rough point of reference. Consistently in these countries, infrastructure's contribution to growth has been between 0.5 and 1 percentage point of per capita growth. In most cases, ICT and roads led the contribution.

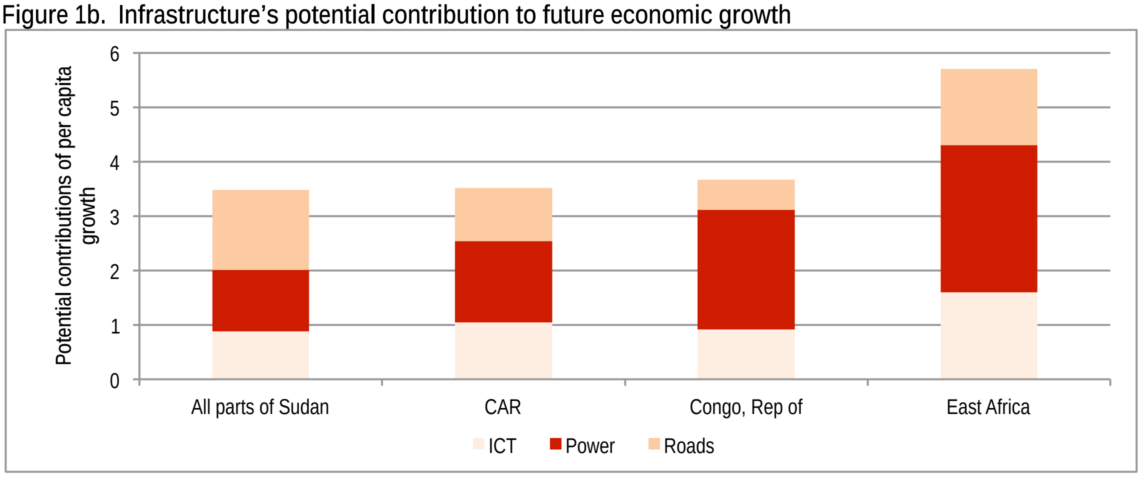
Looking forward, infrastructure could potentially contribute much more to per capita growth than it has in the past (figure 1b). Based on simulations done in the suggested country comparators, the impact of improved infrastructure might be expected to boost per capita growth by 3.5 percentage points. While all areas of infrastructure—including ICT, power, and transport—need to be upgraded, improvements in power can impact growth the most. The contributions from infrastructure vary depending on how much the productive sectors of the economy are supported.

Figure 1a. Infrastructure's historic contribution to economic growth



Source: Calderón 2009.
Note: ICT = information communication and technology; CAR = Central African Republic.

Figure 1b. Infrastructure's potential contribution to future economic growth



Source: Calderón 2009.
Note: ICT = information communication and technology; CAR = Central African Republic.

Specific data for South Sudan indicate its predicament. Inadequate infrastructure belittles the productivity of firms. In the state of Central Equatoria, power outages force 100 percent of firms to own backup generators to self-generate power. At least 50 percent of firms (particularly large firms) and almost 70 percent of small firms report that electricity is a major constraint on doing business (World Bank 2009a). Further, high costs associated with ports, transport, and trade logistics impact the business environment and compound the productivity challenges faced in South Sudan.

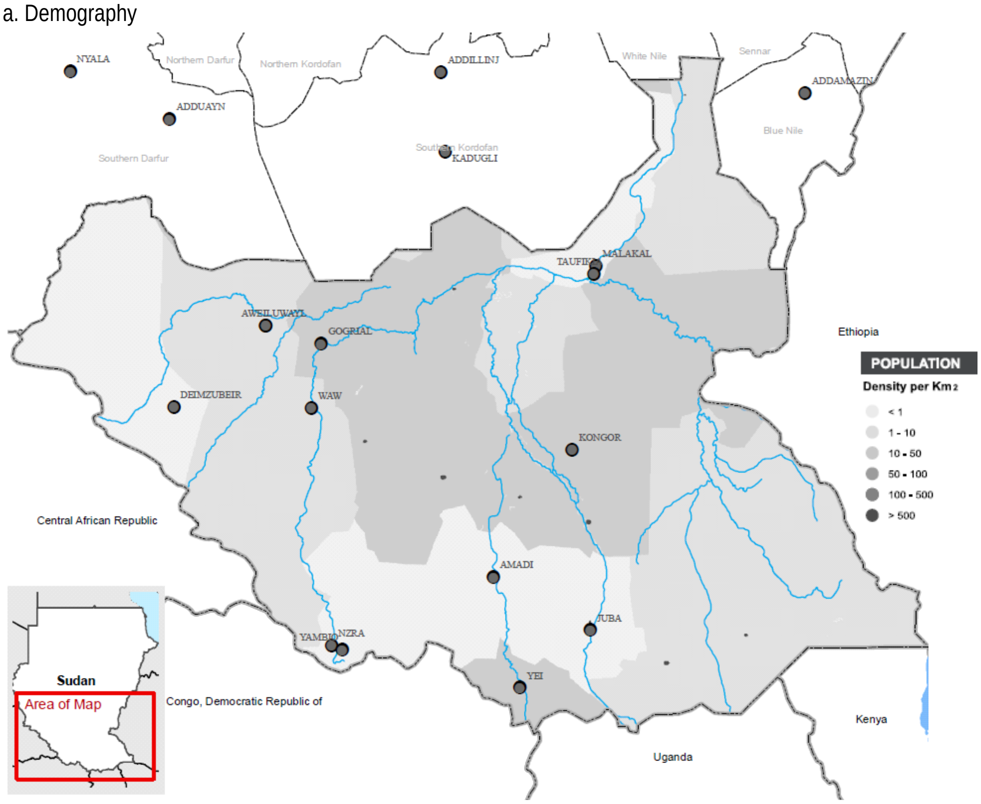
The state of South Sudan's infrastructure

South Sudan is sparsely populated, with small pockets of economic activity centered on two main urban centers, Juba and Malakal (figure 2a). The Nile spans much of all parts of Sudan's territory; in South Sudan, the vast wetlands of the upper Nile region are among the largest in the world. The tributaries of the Nile—the White Nile and Blue Nile—meet in Khartoum in the north. The White Nile crosses South Sudan from the Ugandan border while the Blue Nile flows through east and central Sudan and irrigates a large part of the Sudanese land confluence to form the River Nile (figure 2b). South Sudan is endowed with significant natural resource wealth in the form of minerals, metals, and oil (figure 2c).

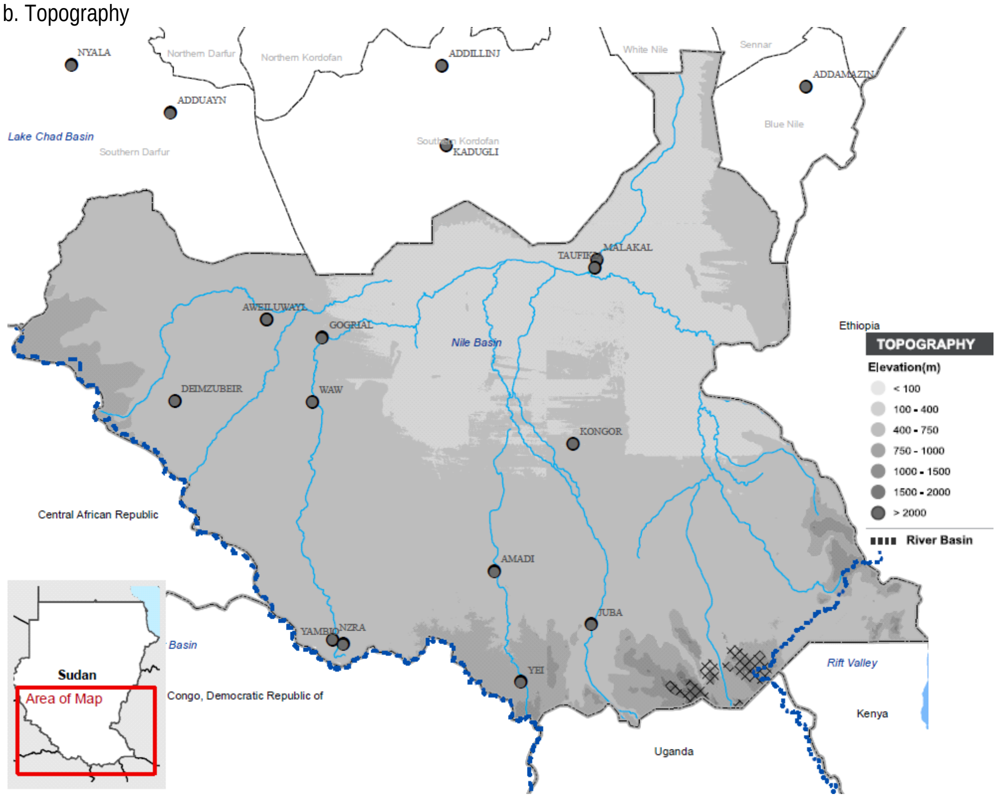
The area's infrastructure backbone has until now received scant attention, but the urgent need for its development has put it on top of the policy agenda. South Sudan is an emerging landlocked country dependent on its neighbors to the north and south for access to the sea, including connectivity with an undersea fiber-optic cable. Meanwhile, the development of water resources is critically linked to international water agreements that are yet to be defined. All the riparian rights of the Nile will need to be revised in the region's new geopolitical context.

Figure 2. South Sudan's demography, topography, and natural resources

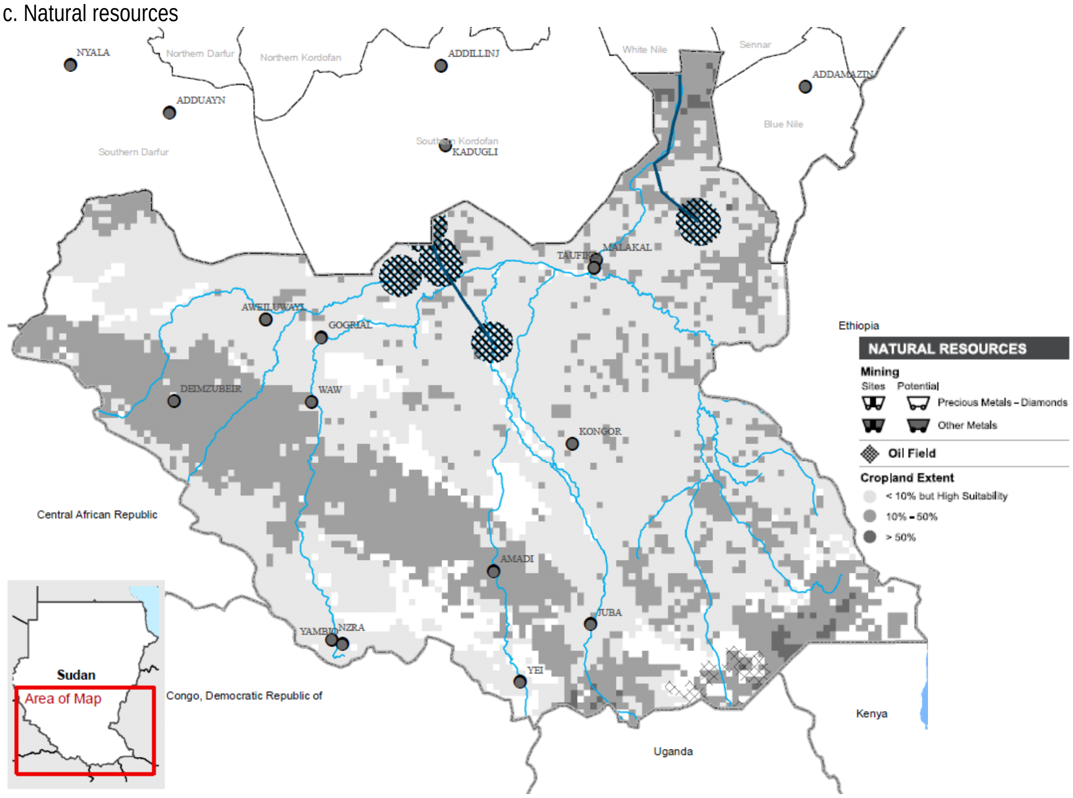
a. Demography



b. Topography



c. Natural resources



Source: AICD.

Road density in South Sudan is among the lowest in Africa; connections with neighbors are limited, especially in the north. Connectivity to Sudan is via river or air. On the limited roads, most traffic is between Juba and Uganda (and the northern corridor), which in turn links South Sudan with the rest of East Africa (figure 3a). Elsewhere on the network, traffic is sparse and road conditions are patchy at best. The distant port at Mombasa, Kenya, provides connectivity to the sea.

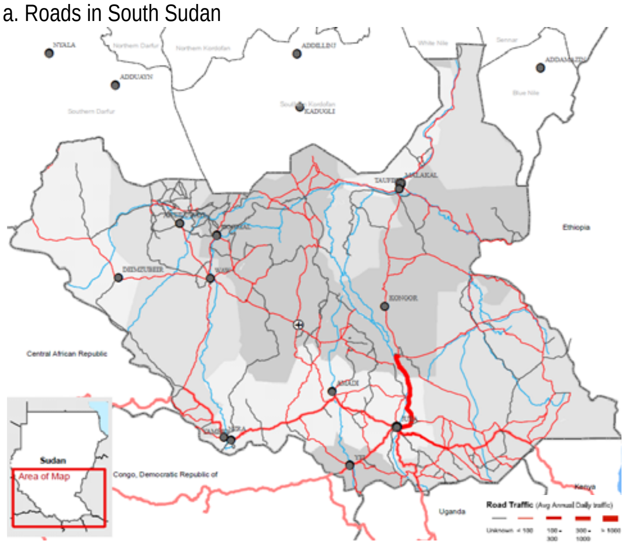
Similar to the other infrastructure sectors, the power generation and transmission networks are in an embryonic state. There is only a very small distribution network in Juba; in the rest of the country, power networks are nonexistent and power provision is limited to small-scale thermal generation (figure 3b).

South Sudan is naturally endowed with water, as the Nile feeds large irrigated areas. But even though over 50 percent of the land is suitable for cultivation, less than 4 percent of the total land is currently cultivated, and agricultural production is primarily for subsistence (figure 3c).

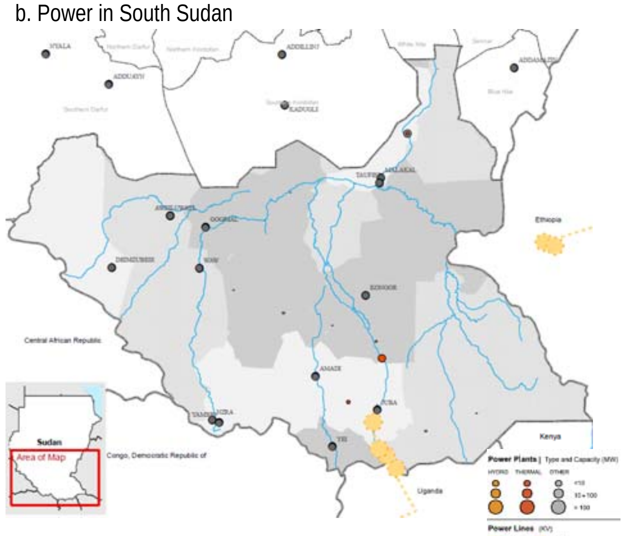
South Sudan's ICT market is still underdeveloped: even the semblance of an ICT backbone has not yet been put in place. The country would do well to take advantage of Sudan's and Uganda's connections to a submarine cable. In sum, significant improvements are needed to improve South Sudan's connectivity (figure 3d).

Figure 3. South Sudan is yet to develop infrastructure backbones

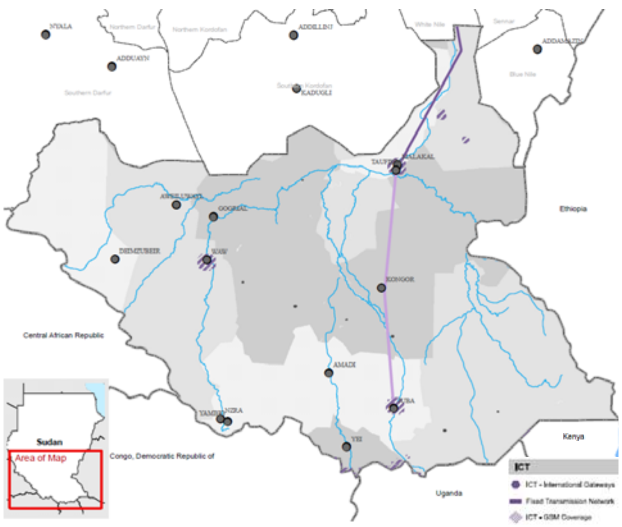
a. Roads in South Sudan



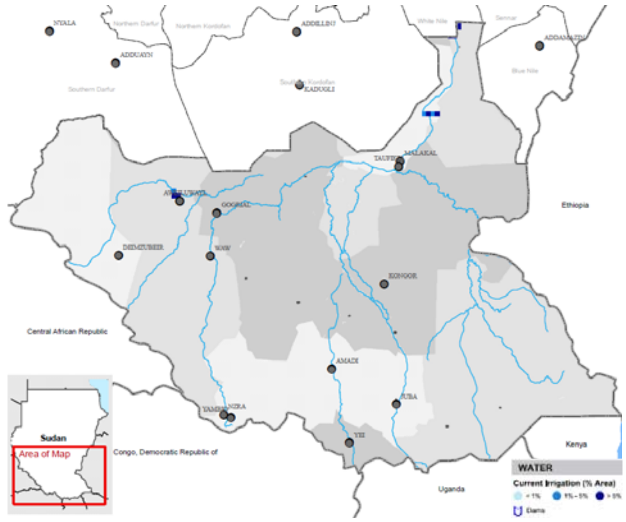
b. Power in South Sudan



c. ICT in Sudan and South Sudan



d. Water in Sudan and South Sudan



Source: AICD.

This report begins by reviewing the main achievements and challenges in each of South Sudan's major infrastructure sectors (table 1). Thereafter, attention will turn to the problem of how to finance outstanding infrastructure needs.

Table 1. Achievements and challenges in South Sudan's infrastructure sectors

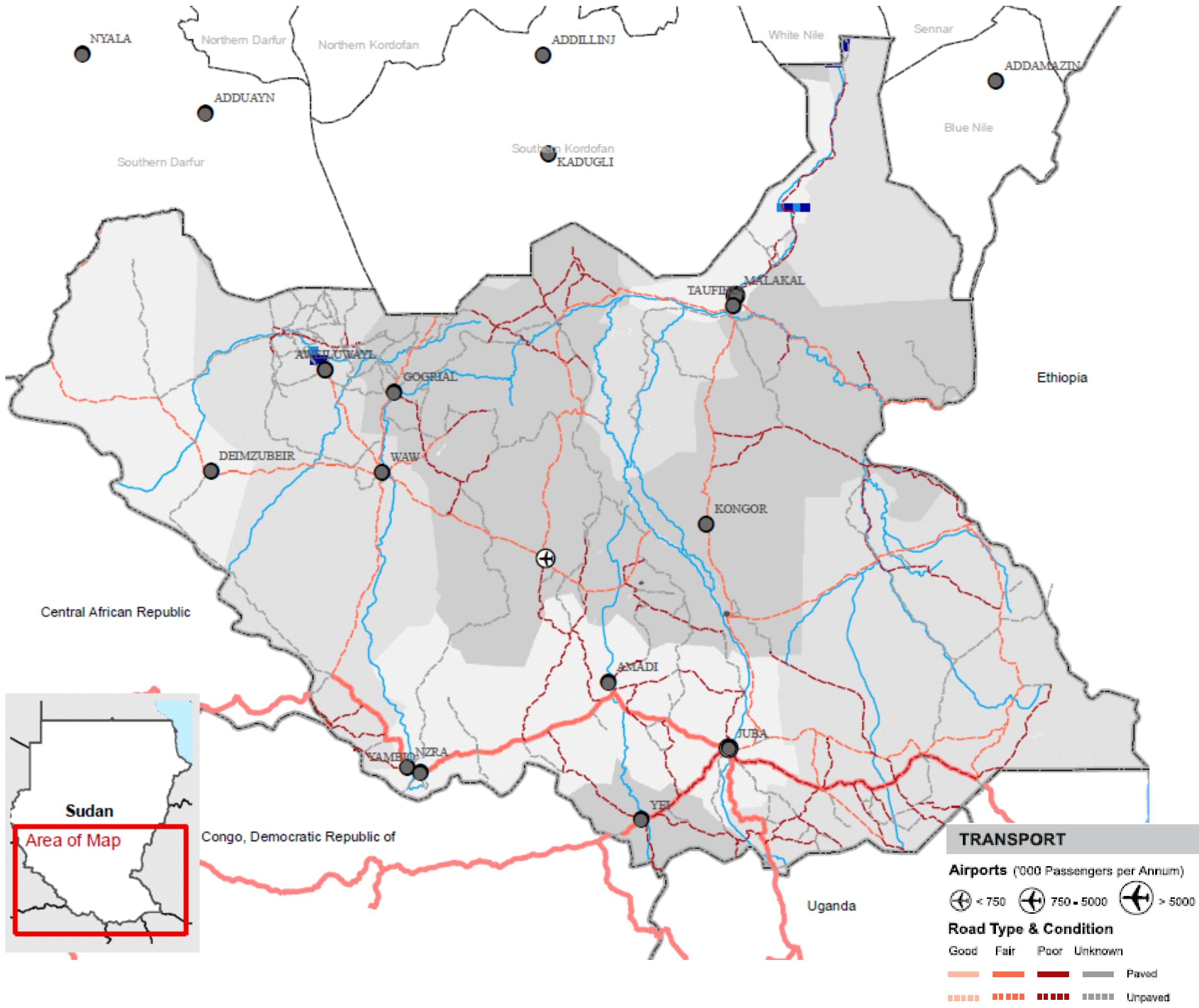
Sector	Achievements	Challenges
Roads	Reestablishing regional and interstate links and access to sea ports.	Maintaining existing assets; developing institutions; achieving better and all-season connectivity; reducing freight costs by improving road quality and balancing trading patterns; overcoming the enormous construction costs; overcoming implementation capacity constraints; increasing rural connectivity.
Air transport	Growing the air transport market. Increasing connectivity with East Africa.	Rebuilding and improving airport quality; introducing safety oversight and attaining safety standards.
Water and sanitation	Creating a very basic institutional framework and initiating essential sector strategic assessments and feasibility studies to rehabilitate the sector. Bringing together all water-related functions under the Ministry of Water Resources and Irrigation. Implementing projects to invest in the water and sanitation sector.	Increasing access to improved water and sanitation services; improving the efficiency of the water utility; overcoming enormous construction costs; overcoming implementation capacity constraints; maintaining existing assets.
Energy	Initiating a feasibility analysis of hydropower plants.	Introducing some type of pragmatic and cost-effective means of lighting via off-grid electrification schemes; redressing the massive system losses and tackling a pervasive culture of noncollection of bills; overcoming large operational inefficiencies of the power utility; tapping into Eastern Africa Power Pool's (EAPP's) energy market; creating conditions to harness massive hydropower capacity.

Sector	Achievements	Challenges
Information and communication technology (ICT)	Signing a memorandum of understanding for the ICT sector. Increasing competition from several mobile operators and thus reducing prices.	Increasing telecommunications coverage; reducing costs of Internet services while increasing access; establishing overland connectivity to fiber-optic cable.

Source: Summary based on analysis presented in this report.

Transport

Figure 4. National and regional transport networks in South Sudan

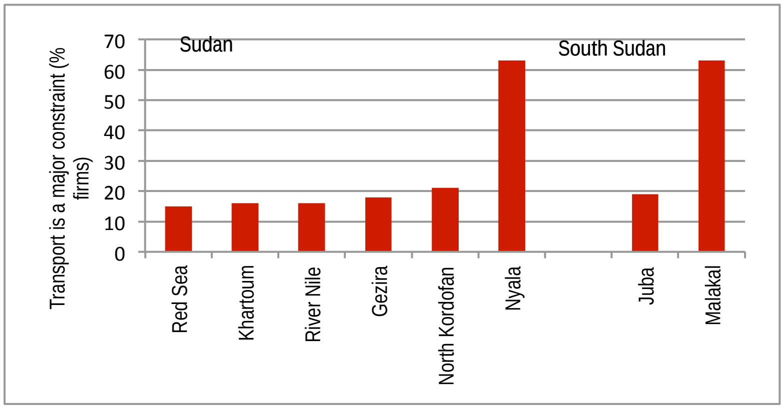


Source: AICD.

Multimodal transport

Current transport conditions are a major impediment to South Sudan's economic and social activity. On average, around 60 percent of South Sudanese firms rated transport as a major-to-severe obstacle to doing business. Transport concerns are especially acute in Malakal, where over 60 percent of firms reported that transport is a major obstacle. In contrast, a smaller percentage of firms (15–21 percent) in Sudan (excluding Nyala in the Darfur region) reported that transport impeded their ability to conduct business (figure 5).

Figure 5. Transport is a major obstacle in parts of South Sudan



Fragmented and underdeveloped corridors, high costs, and complicated trade logistics contribute to the difficulties associated with transport.

Corridors

The absence of a regional transport backbone connecting South Sudan and its neighbors hinders growth and regional integration. On the border with Uganda and Kenya, the regional road network is confined to one main artery. The road connecting Juba with East Africa is the most travelled and the only road network that is generally in good or fair condition. Connectivity to Sudan is underdeveloped; the relevant regional corridor is in bad condition and records very low traffic volumes. During the rainy season (between April/May and October/November), a majority of the roads in South Sudan are impenetrable.

Table 2. Benchmarking Sudan and South Sudan's national network with African aggregates for regional corridors

Corridor	Road in good condition (%)	Implicit velocity (km per hour)	Freight tariff (US cents per tonne-km)
Western	72	6	8
Central	49	6.1	13
Eastern	82	8.1	7
Southern	100	11.6	5
Sudan	26	8.5–13.5	8–10
South Sudan	0	6.4	20

Source: Teravaninthorn and Raballand 2009; Nathan 2010; UNLJC and FAO 2005; Yoshino 2010.

Note: Estimates for Sudan based on routes: Khartoum to Kosti and Khartoum to Port Sudan. For South Sudan, costs are based on varying estimates for travel between Juba to Nimule.
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.

As a result of very poor road quality, South Sudan's corridors record among the slowest-moving traffic rates in the world. Freight movement in Africa as a whole is no faster than the pace of a horse and buggy, and performance in South Sudan is even grimmer. The average pace of 6.4 kilometers an hour (kmph) is comparable to what is observed in landlocked central Africa (table 2). In part, these slow travel times are due to the absence of well-developed road transport infrastructure.

Moving along corridors within South Sudan and between South Sudan and Sudan often requires the use of multimodal transport, further increasing transit times. Multimodal transport is the only option during half the year, when roads are unavailable during the rainy season. River transport services are underdeveloped, ports are underdeveloped, and commercial vessels are old. The services are limited between Juba and Kosti, mainly transporting goods delivered by train from Port Sudan to Kosti, about 1,400 km away from Juba. Freight that has to move via river takes six days longer than if it were to travel only by road (table 3).

Since South Sudan is landlocked, it depends on its neighbors to access coastal gateways. One option is accessing Port Sudan via Khartoum in Sudan. But the harsh intervening terrain makes this a difficult option. Further, compared to regional benchmarks, container dwell time at Port Sudan is over four times that of global best practices, truck cycle time for the receipt and delivery of cargo is 24 times higher than global benchmarks, and crane productivity is less than a third of what is observed in other parts of Africa. Another coastal gateway available is Mombasa, Kenya, through Uganda. Cultural and geographic considerations aside, trading via Mombasa is the most economically viable option for South Sudan.

Table 3. Time and costs associated with transport within all parts of Sudan

Route	Mode of transport	Time (days)	Cost per tonne-km (US$)
Khartoum–Malakal	Road and river	7	75
	Road	5	107
Khartoum–Juba	Road and river	13.5	127
	Road	7.5	
Malakal–Juba	River	2	270

Source: AICD calculations based on data from Yoshino and others (2009); UNJLC and FAO (2005); and Keer-MISC (http://www.keer-misc.com)

South Sudan might also rely on Lamu, Kenya, which is north of Mombasa, as a gateway to ship oil to overseas destinations in the future. An important consideration for South Sudan is the significant port congestion problems that currently plague both Port Sudan and Mombasa. As they significantly exceed their handling thresholds, both ports are facing extended dwell times and delays (though such challenges are more acute in Port Sudan than in Mombasa). As South Sudan becomes better integrated with East Africa, it is recommended that it rely more on Lamu and Mombasa, particularly considering the inefficiencies to be encountered at Port Sudan.

High costs

Freight tariffs in South Sudan are as high as $0.20 per tonne-kilometer (tonne-km)—twice those found in Sudan and four times those in South Africa, the continent's best performer (table 2). These costs are a direct economic consequence of South Sudan's poor surface transport infrastructure and place a significant cost burden on transport users and suppliers. The average transport tariff between Juba and Kampala is $0.18 per tonne-km, or three times the average tariff paid to transport goods from Mombasa to Kampala (approximately $0.06 per tonne-km). Consequently, the overall cost of transporting goods over 980 km between Mombasa and Kampala is $115, and barely covers half the cost of transporting goods between Juba and Kampala, a distance of 630 km (Yoshino 2010).

Poor transport infrastructure forces trucks to carry small loads and face much longer travel times. Small loads automatically increase the average unit cost of transportation. For instance, limitations along the Juba Bridge preclude trucks from carrying any more than 45 tonnes. The poor-quality infrastructure in the south also makes travel times much longer. For example, poor roads between Yei and Kaya (South Sudan's border with Uganda) prolong the travel time of the 90 km journey between the two cities to 24 hours (at an average velocity of 4 kmph), increasing the actual and opportunity costs of travel.

The price differential between South Sudan's freight tariffs and neighboring countries is also explained by the asymmetry of trading patterns between South Sudan and the East African neighbors who are its largest trading partners. The trucking companies that operate in South Sudan are mainly Kenyan or Ugandan companies. These trucks return empty from South Sudan to Uganda, increasing the costs for transport services significantly and creating a de facto barrier to trade. These costs are then transferred to the customer (Yoshino 2010).

Red tape also adds to the costs. Trucks encounter many transit bottlenecks that require formal or informal payments to clear. By way of example, a truck transporting sacks of onions from Kassala to Malakal was subject to tax and fee payments at about 20 different locations, totaling 2,000 SDG ($800) (Yoshino 2009).

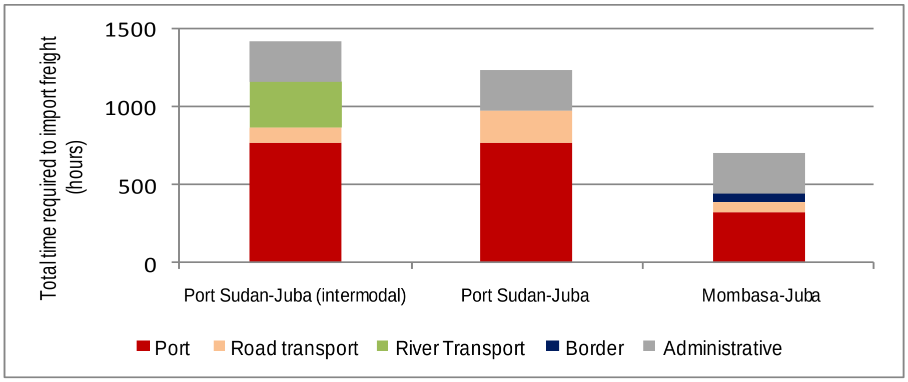
In sum, transport costs are genuinely high and passed through to customers, making South Sudan an expensive place to trade. Around 16 percent of the total cost of production in the food-and-beverage sector can be directly attributed to transport (World Bank 2009b)

Logistics

Poor infrastructure, coupled with high costs, contributes to the long times and costs associated with moving freight within and outside South Sudan. Comparing the competitiveness of the key (and potential) trading arteries—Mombasa or Port Sudan to Juba—suggests that Mombasa is the more competitive option for inbound goods to South Sudan, based on times and costs associated with moving along these arteries. Transit 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; the administrative time spent importing goods to a country; port time, based on the time taken to clear goods at ports; and border time, or the delays incurred when 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 and border delays are quantified into costs based on the assumption that delays cost $5 per day per tonne of imports.

On average, importing freight to South Sudan takes between 30 and 60 days from the coastal gateways of Mombasa or Port Sudan. Mombasa emerges as the best trading route for imports from overseas destinations to South Sudan (figure 6). Two reasons underscore the differences in transit times for imports. First, the inefficiency of port services—particularly the long dwell times at Port Sudan—significantly prolong travel times. And port-related charges increase the total cost of moving transport by as much as 25 percent (figure 7). Second, the road transport network between Juba and Port Sudan is available for only half the year since roads are impenetrable during the rainy season. Freight that has to move via river takes six days longer than if it were to travel only by road.

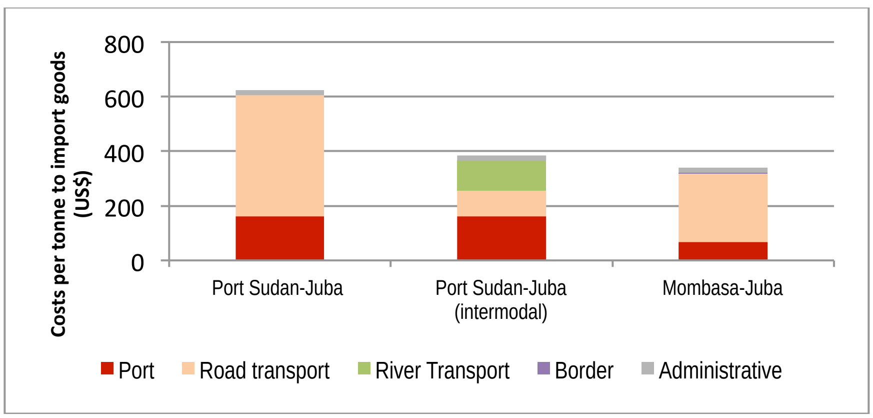
Figure 6. Port and river transport inefficiencies increase the transit times of imports bound for South Sudan



Source: Port data from AICD based on 2006 estimates, road transport times based on AICD calculations, river transport times from KEER-MISC data from 2007, border delays data from Nathan (2010) and Yoshino (2010), and administrative times from Trading across Borders, World Bank.

Note: The administrative times are based on aggregates for all parts of Sudan as a whole since data for South Sudan are not currently available.

Figure 7. Road and river transport costs compose the lion's share of prices for importing freight to South Sudan



Source: Port data from AICD based on 2006 estimates, road transport times based on AICD calculations, border delays data from Nathan (2010) and Yoshino (2010), and administrative times from Trading across Borders, World Bank.

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National road infrastructure

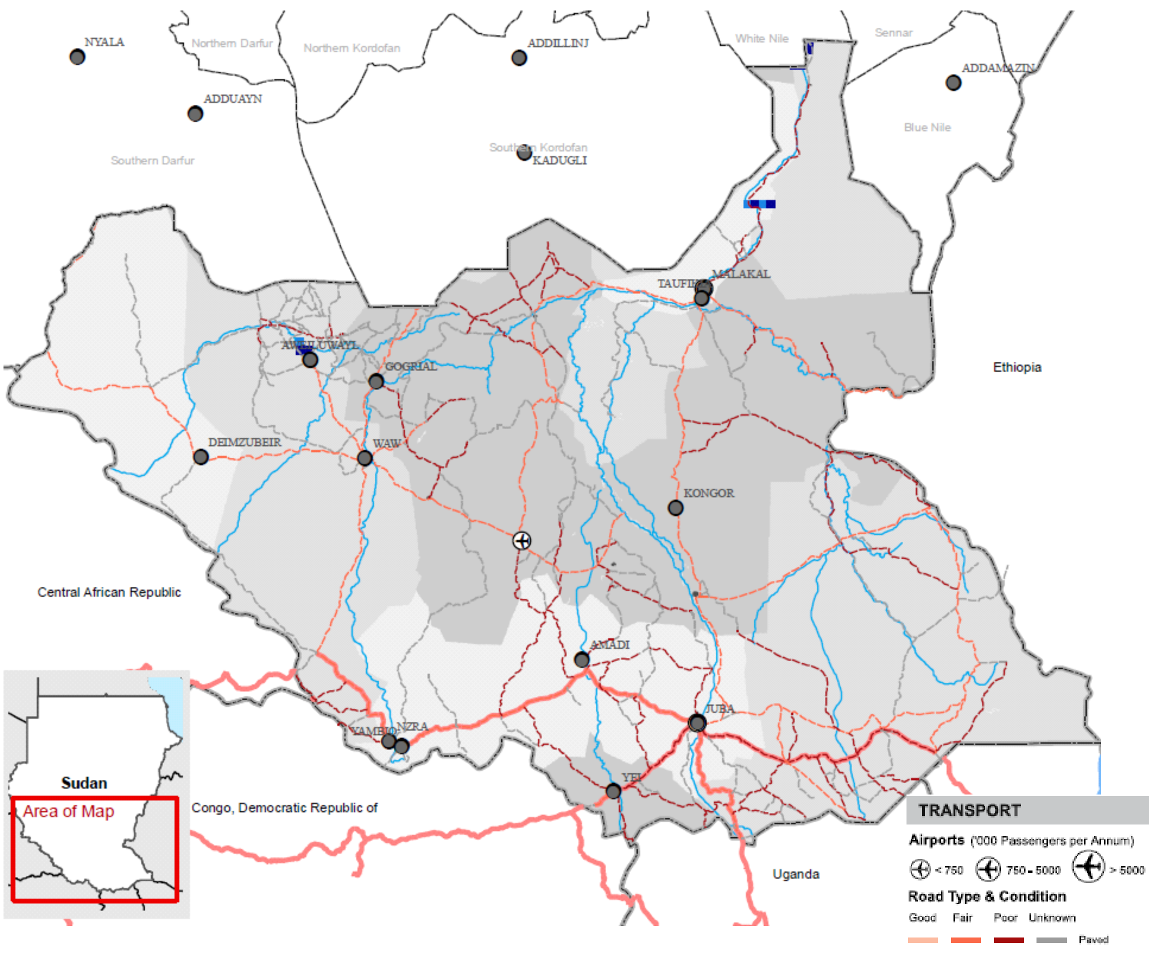
Achievements

During the six-year interim period (2005–10) defined in the CPA, donors strongly supported South Sudan's infrastructure agenda. In the transport sector the priority was to reestablish regional and interstate links and access to seaports through 4,000 km of roads reestablishing access to Sudan, Uganda, and Kenya.

Challenges

Road transport networks in South Sudan are either nonexistent or in extremely poor condition (figure 8). The road transport network has inadvertently fragmented the country; quality road links to connect the different parts of South Sudan are missing. For example, road links that connect the Upper Nile State with Juba are in poor condition. Further, a lack of linkages to its neighbors isolates South Sudan—for example, there is no connectivity with Sudan. The few links that do exist are not navigable at present. There is essentially only one route that links South Sudan to the external world—namely, the route from Juba south toward the Ugandan border.

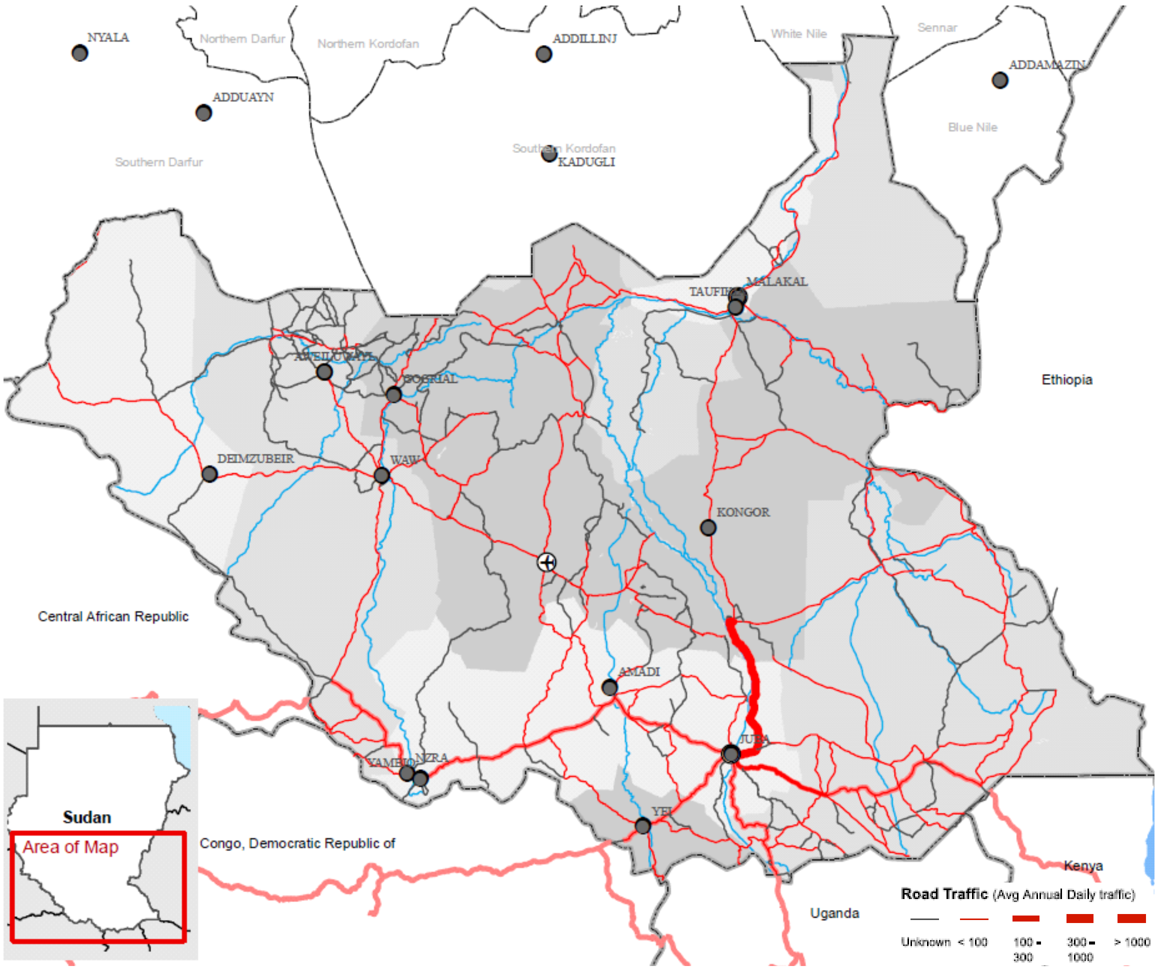
Figure 8. South Sudan road quality



Source: AICD.

The road sector in South Sudan is one of the worst in Africa, and performs well below African low-income, middle-income, and resource-rich country benchmarks in all respects. The problem is twofold. The country's economy is constrained by the sheer absence of roads and by the fact that any existing roads are of very poor quality. Less than 2 percent of the primary network is paved, and no paved roads are in good condition. Less of than a third of the unpaved roads are in good condition, and during the rainy season, which lasts half the year, the unpaved roads are impassable. Most traffic travels along unpaved roads, but the traffic volumes are too low to justify paving them (figure 9).

Figure 9. South Sudan road traffic



Source: AICD.

The high unit costs of road construction impede the expansion of road infrastructure networks in South Sudan. A unit-cost analysis for interurban road rehabilitation and reconstruction across African countries indicates that the cost of construction of roads in South Sudan is extremely high (table 4). Several factors drive these high costs. First, in South Sudan, a construction boom—a typical phenomenon in a postconflict economy—prompted high demand for construction but was stymied by inelastic supply due to a limited supply base for construction work and the limited tradability of the construction work itself.

Construction materials that are normally unavailable locally are very expensive due to the large costs associated with shipping them to a construction site (World Bank 2009a). This is exacerbated by the limited information on the potential of infrastructure development and upcoming investments, and by poor procurement practices. Added to this are questions of political stability and security, factors that tend to improve as a country moves forward or, as in the case of South Sudan, consolidates into itself. Meanwhile, costs are being pushed up by a shortage of skilled operators and technicians and the extraordinarily high cost of living faced by the mobilized labor force. The domestic construction industry is very underdeveloped and, last but not least, the widespread incidence of land mines that need to be cleared prior to construction further increases costs. Until the institutional capacity needed to handle these and other challenges is established, the road sector is not on track to improve.

Table 4. Cost of rehabilitation and reconstruction of two-lane interurban roads

Country	Average unit cost ('000 US$/km)
Congo, Dem. Rep. of	229
Ghana	261
Mozambique	279
Nigeria	330
Ethiopia	388
Malawi	421
South Sudan	760-1000

Source: Taken from World Bank (2009a), originally in Alexeeva, Padam, and Queiroz (2008), and World Bank staff estimates.

Table 5. South Sudan's road indicators benchmarked against those of African peers

Indicator	Unit	South Sudan	Low-income countries	East Africa	Middle-income countries	Resource-rich countries
Classified road density	Km per 1,000 sq-km of arable land area	15	88	101	278	57
Paving ratio	% of primary network paved	2	71.6		32	82.1
GIS rural accessibility	% of rural population within 2 km of an all-season road		23	21	32	20
Paved road traffic	AADT	0	1,341	1,549	3,798	1,408
Unpaved road traffic	AADT	53	39	47	75	54
Classified network condition	Percentage in good or fair condition	0	86	59		80
Overengineering	Percentage of main road network overpaved relative to traffic flows		30		18	15
Paved network condition	% of paved roads in good or fair condition	0	86	79	82	68
Unpaved network condition	% of unpaved roads in good or fair condition	30	56		58	61

Source: Derived from AICD calculations.

Note: For South Sudan: the paving ratio is calculated based on the classified road network that is paved, the paved network condition refers to regional and national roads, the paved road network does not include roads of fair quality because the length of roads with fair quality is unknown.

GIS = geographic information system; AADT = average annual daily traffic.

South Sudan's road sector institutions have serious limitations that hinder their ability to effectively and efficiently implement major road programs. The country also lacks the required policy and institutional framework. Key constraints hindering the implementation of road works include: inadequate implementation capacity; lack of capacity to manage, maintain, and operate existing and new infrastructure; and inability to apply internationally recognized safety and security standards (box 1). A lack of reliable data is also a problem to overcome.

South Sudan's fragmented transport infrastructure networks have impeded agricultural producers in remote areas from effectively connecting to market centers. Even though the land area with high agricultural potential in Sudan and South Sudan is about the same at around 650,000 square kilometers each, the potential has been vastly underutilized in South Sudan (table 6a). In Sudan 75 percent of the arable land yields a moderate—yet acceptable—10 and 50 percent of its agricultural value, while in South Sudan close to two-thirds of the land with high suitability does not even contribute 10 percent of its value agricultural potential (tables 6a and 6b).

Table 6a. Land area in Sudan and South Sudan suitable for agriculture

Percent contribution to aggregate agriculture value	South Sudan	Sudan
< 10% but high suitability	4,381	1.438
10%–50%	2,279	4,793
> 50%	54	265
Total area of high agricultural suitability	6,714	6,496

Table 6b. Distribution of agricultural value between Sudan and South Sudan

Percent contribution to aggregate agriculture value	South Sudan	Sudan
< 10% but high suitability	65	22
10%–50%	34	74
> 50%	1	4
Total area of high agricultural suitability	100	100

Source: AICD

A rough initial estimate is that close to 7,000 km of roads are needed to provide rural accessibility. To attain the most basic connectivity for its arable land, South Sudan will need to start by improving 2,500 km of the national and regional networks from bad to good condition. Long lengths of feeder roads need to be connected to integrate rural areas with the transport backbone. Box 2 further illustrates the challenges faced in the Upper Nile state due to transport bottlenecks.

Box 1. Road sector institutions in South Sudan

In 2005 the Joint Assessment Mission (JAM) led by the United Nations and World Bank recommended that capacity building, development and training, and the preparation of projects for rehabilitation and development of infrastructure be made a priority. Emphasis was placed on developing implementation structures to facilitate sufficiently high fiduciary and procurement standards to enable the execution of labor-based construction activities. The Ministry of Transport and Roads developed a Transport Sector Policy (October 2006) and a Road Sector Strategy Plan, which was approved by the Southern Sudan Legislative Assembly (SSLA) and adopted as a framework for the continuing sector development program. Both of these documents presented the policy and regulatory reforms and institutional development required to improve road infrastructure, yet there is much work still pending on this front.

These policy documents highlighted the importance of addressing transport sector issues comprehensively for all modes of transport—road, rail, air, river, and sea—and of developing a strategy for the largest mode, road transport. The road subsector policy and strategy recognized the importance and urgency of (i) defining institutional arrangements for policy and regulatory functions, (ii) properly managing the implementation of road maintenance and development projects, (iii) generating annual revenue and efficiently managing road financing, and (iv) setting technical standards and specifications for various road classes.

A draft legislative bill to establish a South Sudan Roads Authority (SSRA) is currently under discussion. It is expected that the SSRA will be established first and then a road fund and roads board will follow when capacity is considered sufficient. In the meantime, funds budgeted for annual road maintenance have been allocated by the Ministry of Finance and Economic Planning (MOFEP) on a priority basis. Until the SSRA is established, the planning and implementation of road maintenance programs remain the responsibility of the Roads and Bridges Directorate, itself under the MTR.

Source: Louis Berger Group and Doshi Borgan & Partners. 2010.

Beyond the 7,000 km of roads needed to remedy rural connectivity, an additional 1,300 km are needed to meet regional connectivity standards for key economic nodes, in particular linking Juba to the international frontiers. In addition, to meet urban connectivity standards, South Sudan must extend the paved road network to within 500 meters of urban populations.

Two scenarios are considered to move toward these goals. In the base scenario, all infrastructure is maintained in good condition and higher-end surfacing options are used (asphalt for all regional, national, and urban roads and single-surface treatment for rural roads). In the pragmatic scenario, half the infrastructure is maintained in good condition and half in fair condition, and lower-cost surfacing options are used (single-surface treatment for national and urban roads and gravel for rural roads).

Sizable spending requirements are needed to reach either of these goals (table 7), requiring South Sudan to spend $220 million–$380 million a year over the next ten years. The largest components of this total are improving the condition and maintenance of existing roads (table 7).

Box 2. Transport bottlenecks for agricultural production in the Upper Nile State

The Upper Nile State has among the greatest agricultural potential in South Sudan and accounts for 90 percent of the population's income. The arable land in this region is over 70,000 acres. Gum arabic, which is widely exported, is grown, as are other crops such as maize, sesame, and sorghum. Despite great agricultural potential, farmers across the board suffer from low returns on their economic activity.

An inadequate road network is a binding constraint on unlocking the state's agricultural potential in the short and medium term. At present the road density (km per 1,000 sq km of land area) is only half of what is observed in South Sudan and one-fourth of the road density of Sudan as whole. The existing roads are unpaved (except for a few kilometers between Malakal and Renk), inadequate, and impassable during the rainy season.

Large-scale mechanized farming and medium-scale agriculture yield low returns. One reason for this is the extremely poor condition of the road networks between urban and rural areas (feeder roads) and poor infrastructure, such as a shortage of storage facilities that constrain the expansion of farming areas. These factors have hampered the growth of value-added activities on existing farms and limited market access by raising input costs. Medium-sized farmers in particular are impeded by the inadequate transportation network between Renk and Malakal (which is intermodal between river and road). This also increases the price for agricultural inputs from northern states. These farmers do not receive as much benefit as the large-scale mechanized farmers do in economizing transport and transaction costs.

Small-scale farmers also suffer from low returns on their economic activity particularly due to the deficiencies in the urban-rural network that is required to connect these producers to markets. Average travel times to the nearest market in the state take very long. River transport to rural areas away from the White Nile (along Sobat River) takes much longer than to points along the White Nile. This points to a more acute constraint that smallholders in hinterlands face in accessing markets along the White Nile.

Source: Yoshino and others 2009.

Table 7. South Sudan's spending needs for regional, national, rural, and urban connectivity

	Road length in good condition (km)		Spending needs (US$ million per year over a 10-year period)					GDP share
	Actual	Required	Expand capacity	Upgrade category	Improve condition	Maintenance	Total	
				Basic scenario				
National	0	1,193	0	56	5	20	81	1.3
Regional	0	1,307	0	157	0	35	191	3.2
UAI	6	1,085	63	2	1	2	68	1.1
RAI		6,969	0	12	5	24	40	0.7
Total	6	10,554	63	227	10	81	380	6.3
				Pragmatic scenario				
National	0	1,193	0	42	0	19	61	1.0
Regional	0	1,307	0	62	0	22	85	1.4
UAI	6	462	20	2	1	2	25	0.4
RAI		6,969	0	3	1	50	54	0.9
Total	6	9,931	20	109	2	93	224	3.7

Source: Adapted from Carruthers, Krishnamani, and Murray (2009).

Note: UAI = Urban Accessibility Index; RAI = Rural Accessibility Index.

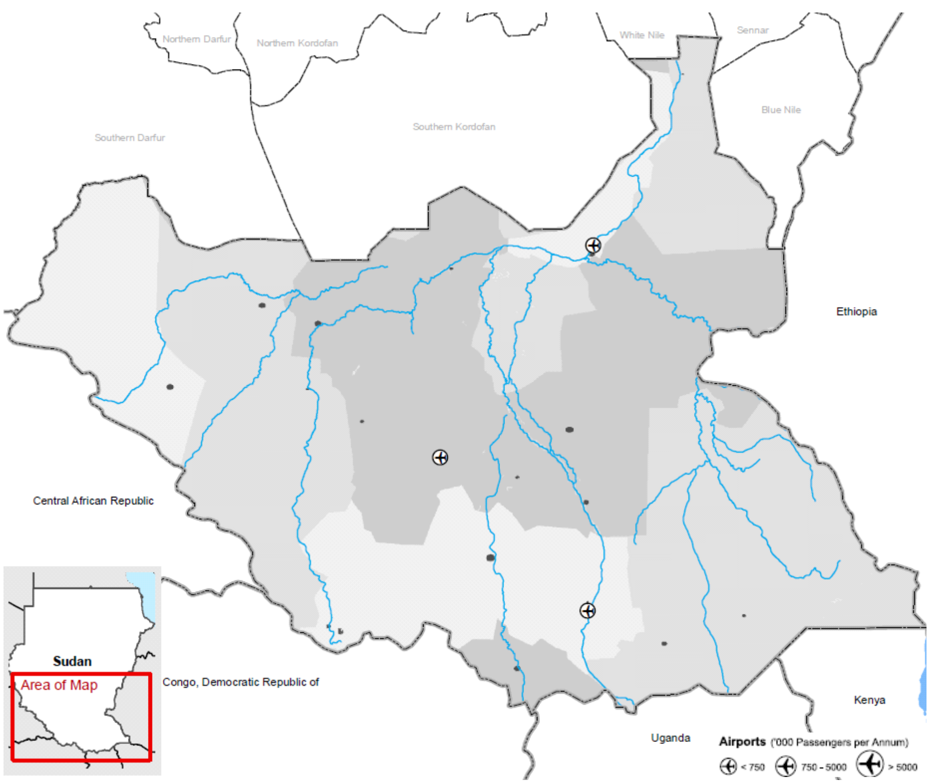
Air transport

Achievements

South Sudan's air transport infrastructure is overall very limited (figure 10). In recent years, driven by the development of oil and mining industries in South Sudan, passenger seats on scheduled airlines have grown dramatically, both internationally in Africa and with Sudan; but despite this uptick, South Sudan has virtually no air transport market within its own region, as measured in scheduled services (figure 11). The Diio SRS shows that in 2007, while there were 219,741 seats for travel within Sudan, there were only 696 seats advertised within South Sudan (table 8). These figures may mask the fact that traffic *between* the two countries has actually grown rather significantly—from 24,452 seats in 2001 to 87,191 seats in 2007. How much of that traffic is hub traffic through Khartoum traveling between points in South Sudan has not yet been determined.

What air connectivity South Sudan does have is largely oriented toward East Africa. Most flights from Juba are to Kenya (Nairobi) and Uganda (Kampala) (annex 1). But the market overall is underdeveloped. Entry into South Sudan from most other international destinations in the past has been through Khartoum.

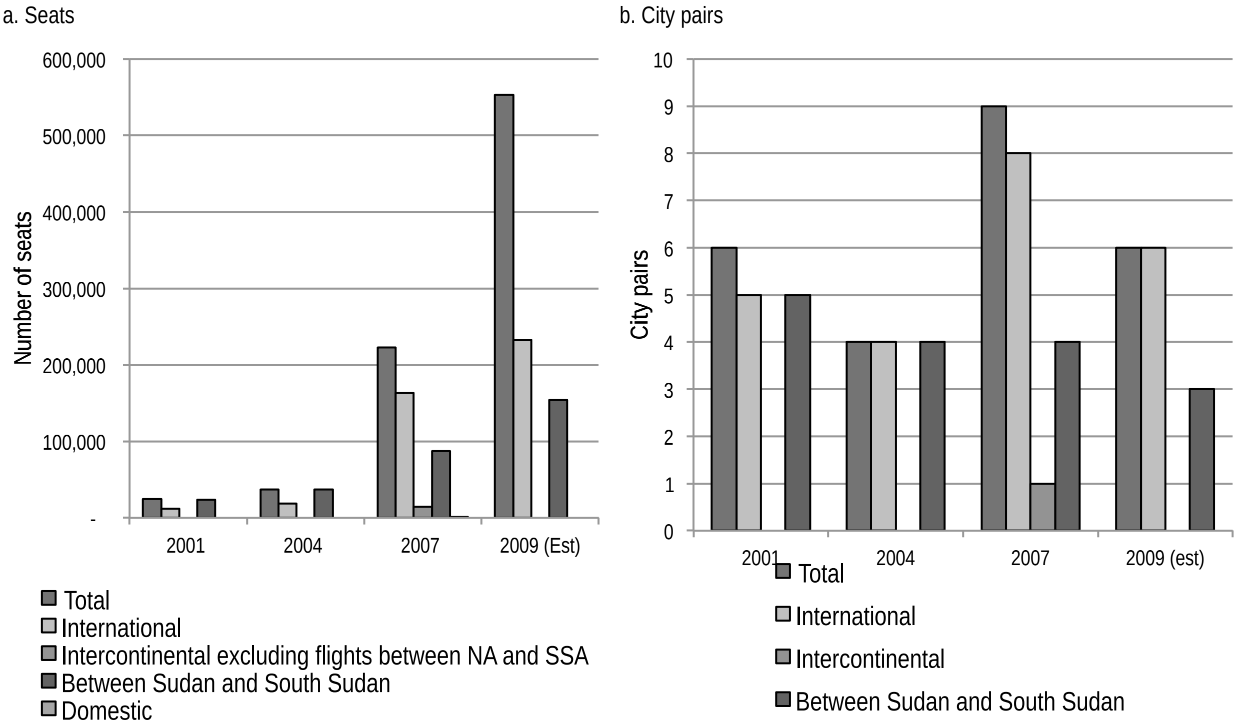
Figure 10. Juba is the main airport in South Sudan



Source: AICD.

Beyond basic connectivity, it is also important to evaluate the convenience and speed of air travel. Even though South Sudan's air transport market is not yet fully developed, the velocity of travel is not significantly higher than that of Sudan for similar destinations. South Sudan benefits from good connectivity with East African regional hubs namely Addis Ababa and Nairobi. (annexes 2 and 3).

Figure 11. Evolution of seats and city pairs in South Sudan



Source: Bofinger 2009. Derived from AICD national database (www.infrastructureafrica.org/aicd/tools/data).
Note: As reported to international reservation systems. NA = North Africa; SSA = Sub-Saharan Africa.

Table 8. Benchmarking air transport indicators for South Sudan[1]

Country	South Sudan	Sudan	Ethiopia	Chad	CAR	Kenya	Egypt
Traffic (2007)							
Domestic travel ('000 seats per year, excluding South)	0.7	218	729	n.a.	n.a.	2,093	5,959
International travel within Africa ('000 seats per year)	164	302	1,837	110	21	3,145	1,886
Intercontinental travel ('000 seats per year)	15	2,052	2,005	89	24	2,755	15,793
Seats available per 100 people	1.6	9.8	5.8	1.8	1	21	27.5
Herfindahl-Hirschmann Index—air transport market (%)	18.49	15.29	70.61	36.35	50.26	39.47	24
Quality							
Percent of seat-km in newer aircraft	19.7	71.9	98.5	99.5	100	80.2	90.7
Percent of seat-km in medium or smaller aircraft	93.3	72	39.7	93.6	23.5	20.8	51.2
Percent of carriers passing IATA/IOSA Audit	0	0	100	0	0	11.1	50
FAA/IASA Audit Status	No audit	No audit	Passed	No audit	0	0	Passed

Source: Bofinger 2009.

Note: The Herfindahl-Hirschmann Index (HHI) is a commonly accepted measure of market concentration. It is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. A HHI of 100 indicates the market is a monopoly; the lower the HHI, the more diluted the market power exerted by one company/agent.

FAA = U.S. Federal Aviation Administration; IASA = International Aviation Safety Assessment; IATA = International Air Transport Association; IOSA = IATA International Safety Audit.

n.a. = Not applicable.

Challenges

As in other infrastructure sectors, years of conflict have resulted in the neglect and destruction of air transport infrastructure. As of 2007 none of South Sudan's four airports receive *regularly* scheduled services. Three of the four have strips that are unpaved or appear in dire need of maintenance**.**

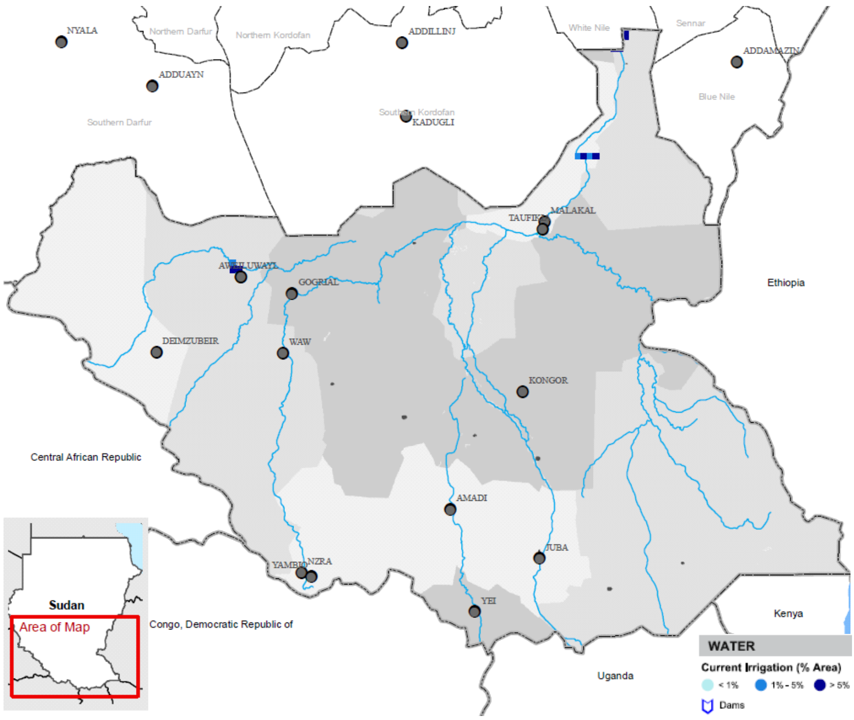
South Sudan has made very few strides in attaining adequate levels of air safety. The EU currently has all airlines based in South Sudan blacklisted, meaning they are not allowed to fly into any EU member country. A complete ban of all airlines from a country is a strong indicator of systemic weakness in governmental oversight, as could be expected in a conflict/postconflict country. A number of small domestic carriers, registered generally as charter operators, are operational, but do not report information to a booking or ticket sales agency. The existence of these operations poses a danger to air safety because these operators could have minimal oversight, could operate questionable or faulty aircrafts, and the airlines' training staff, maintenance crew, and pilots may not have skills consistent with acceptable EU standards.

[1] All data are as of 2007 based on estimations and computations of scheduled advertised seats, as published by the Diio SRS Analyzer. This captures 98 percent of worldwide traffic, but a percentage of African traffic is not captured by these data.

Regional cooperation with East Africa might be a potential solution to these and other air safety challenges. South Sudan could potentially benefit from the air transport developments coordinated across East Africa as a whole, including the newly established East African Community Civil Aviation Safety and Security Oversight Agency (CASSOA).

Water resource management

Figure 12. Water resources in South Sudan



Source: AICD.

One issue that represents a big challenge is the lack of priority and attention afforded to water resource management; the meteorological and hydrological data collection network was destroyed during the conflict and is currently nonexistent, and there is very poor technical and institutional capacity overall.

The Nile presents South Sudan's biggest water management challenge, as well as its biggest opportunity. South Sudan is at the heart of the complexities associated with the Nile Basin Initiative, and the transboundary water management of the River Nile remains an extraordinary challenge. Around 28 percent of the Nile water flows through South Sudan to Sudan and onward to Egypt. So far, within the context of the Nile Basin Initiative, Egypt and Sudan have the primary control over the Nile waters. But South Sudan's independence raises the question of new uses for the Nile waters, and their allocation between Sudan and South Sudan. It is clear that as a country, South Sudan will explore and initiate, sooner rather than later, the honing of the river's hydropower and enormous irrigation potential. Project development along the Nile and its tributaries can certainly augment the economic impact of the Nile waters flowing through the south, but all such interventions will raise questions by other riparian states about the ownership and origin of the waters.

The delicate geopolitics of the region, prior disputes, and environmental concerns complicate the Nile Basin's water resource issues. At present, there is no clarity on how the water rights will be allocated now that South Sudan is an independent country. Yet, the cost of noncooperation is high, including the economic cost of negative environmental impacts, suboptimal water resources development, political tensions over shared resources, and foregone benefits of joint water resources development.

Water supply and sanitation

Achievements

So far, South Sudan's water resource management has been focused primarily on the planning and development of water for drinking in urban and rural areas, with some attention also being paid to irrigation. Since 2004 South Sudan has made progress in creating a very basic institutional framework and initiating essential sector strategic assessments and feasibility studies to rehabilitate dilapidated assets and manage water resources. A new National Water Policy was endorsed by the government in 2007, and the Ministry of Water Resources and Irrigation (MoWRI) was established in 2008 with defined mandates and responsibilities. In 2008 the MoWRI awarded five contracts worth $38 million for scientific and feasibility studies for the construction of three medium-sized dams in Wau and the rehabilitation of the Maridi Dam and Water Station. The three new dams will be dedicated to fulfilling South Sudan's needs for electricity and clean water; while the Maridi dam rehabilitation project is limited to public water supply and irrigation uses.

South Sudan is in the final stages of preparing a water sector strategy that will include more details on the plan to tackle water and sanitation deficiencies. Two major projects, the South Sudan Rural Water Supply and Sanitation Project and the Water Supply and Sanitation project, have been financed for a total of $60 million. These efforts cover water and sanitation investments in both urban and rural areas and focus on the drilling and rehabilitation of boreholes, construction of latrines, and some distribution systems.

Challenges

Yet one-third of South Sudan's population still relies on surface water as its main source of water, with only minimal reliance on utility water (table 9). The reliance on surface water in South Sudan is less than other East African countries on average but greater than resource-rich and middle-income countries, which record 27 percent and 11 percent respectively. Access to piped water is practically nonexistent, and over 60 percent of the population relies on wells and boreholes for access to water. In urban areas in particular lack of access to piped water has forced a heavy reliance on boreholes. The burgeoning use of wells and boreholes for water supply is becoming a policy challenge, as over half the wells and boreholes in Africa do not provide access to safe water.

Three-quarters of the population does not have access to any type of sanitation facility (table 9). Twice as many people in South Sudan relative to other East African low-income and resource-rich countries rely on open defecation. Compared to middle-income countries, seven times as many people rely on open defecation, indicating that the sanitation situation in South Sudan is rather grave. Even in urban areas, over half the population is forced to defecate in the open, while the figure is 80 percent in rural areas (figure 13). Sudan, meanwhile, has only a 10 percent open defecation rate. Almost no one in South Sudan has access to flush toilets compared to 5 percent of the population in Sudan and other African low-income countries. Access to improved latrines in South Sudan is more or less equal to low-income and East African countries but significantly lags Sudan and all other comparator benchmarks. This situation is partially explained by the fact that the rural population in South Sudan accounts for 83 percent of the population, making high-end or midrange solutions simply unaffordable.

Table 9. Benchmarking South Sudan's water infrastructure

	Unit	South Sudan	East Africa	Low-income, nonfragile countries	Resource-rich countries	Middle-income countries
Access to piped water	% pop	—	11	9	13	61
Access to stand posts	% pop	2	14	17	12	22
Access to wells/boreholes	% pop	64	32	39	47	5
Access to surface water	% pop	34	42	34	27	11
Access to flush toilets	% pop	0	4	5	13	48
Access to improved latrines	% pop	19	17	18	37	34
Access to traditional latrines	% pop	6	43	38	22	7
Open defecation	% pop	75	36	38	28	11
Domestic water consumption	liter/capita/day	20	64	51	115	196
Revenue collection	% sales	83	80	94	60	99
Distribution losses	% production	29	38	35	40	29
Cost recovery	% total costs	40	102	89	67	86
Operating cost recovery	% operating costs	56	143	125	94	121
Labor costs	connections per employee	107	103	176	96	203
Total hidden costs	% of revenue					
Average effective tariff	U.S. cents per m3	81	76	77	45	—

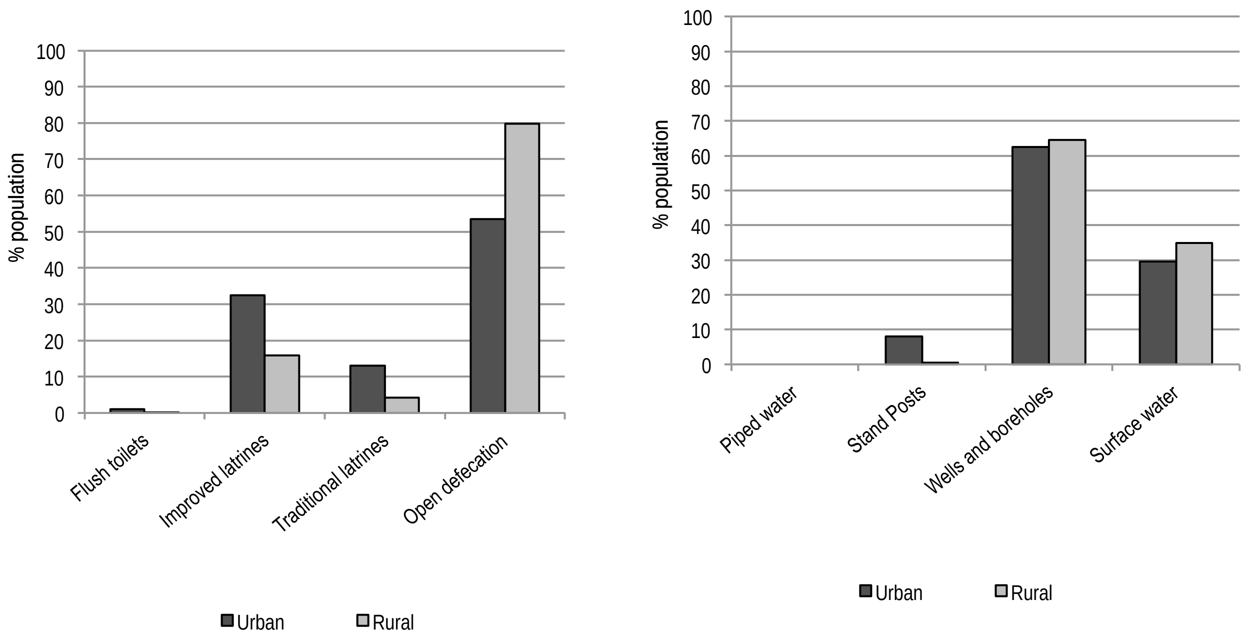
Source: Demographic and Health Survey (DHS) and AICD water and sanitation utilities database (www.infrastructureafrica.org/aicd/tools/data).
Note: Access figures calculated by the AICD based on the 2000 and 2006 DHS figures published by the Joint Monitoring Program (WHO 2010).
— = Not available.

While the urban-rural disparities in South Sudan are not as glaring as in other parts of Africa, this is for the wrong reason: an overall limited level of access. Similarly, there are no glaring disparities between various income levels. Estimations from the recent poverty assessments suggest that a staggering 64 percent of the wealthiest quintile of South Sudanese lacks access to any type of toilet facility. In stark contrast, in Sudan, only 12 percent of the wealthiest quintile of the population has no access to toilets compared to 50 percent of the poorest. Around 2 percent of the wealthiest quintile of South Sudanese had flush toilets and a further 22 percent had access to pit latrines. In terms of water supply, the wealthiest and poorest quintiles of the South Sudanese population relies equally on deep wells and boreholes for water. There is also not much variation in the usage of an open source of water (that is, surface water) across income levels—over 25 percent of the wealthiest quintile relies on open sources of water (World Bank 2010b).

Figure 13. Access to water supply and sanitation is inequitable between urban and rural communities in South Sudan

a. Sanitation

b. Water supply



The overall low rates of access are associated with decaying infrastructure and inadequate maintenance. The infrastructure is decrepit due to neglect during the war. Inadequate allocation of resources to maintenance compounds the situation further and in part explain the poor performance in the water supply and sanitation sectors.

Access to quality services is so limited that it is only realistic to have an incremental approach to increasing access. The incremental strategy could rely on low- and midrange technologies to start, and then expand to higher-end alternatives for service provision in the long run.

In 2007 the South Sudan Urban Water Corporation started water supply operations in four urban areas (Renk, Wau, Juba, and Malakal), but records on water production and distribution and other operational and financial indicators are not available, limiting further analysis on the utility's performance. The limited data, however, suggest that the utility's revenues are insufficient to cover operations, maintenance, and labor costs, and that the utility requires financial assistance from the government to run its operations.

Despite high prices charged for water, cost recovery is only 40 percent of revenues. The average cost of water production in the Upper Nile Water Corporation, at \$1.00–\$1.20 per cubic meter, is broadly comparable to costs faced by utilities in other water-abundant countries in Sub-Saharan Africa. Water tariffs are set at around \$0.80 per cubic meter, on average higher than most other African benchmarks. But cost recovery is very low, at 40 percent of revenues. This seriously undermines the financial sustainability of the utility as revenues cover only around half the operational costs and none of the capital costs, hindering the utility's ability to upgrade and maintain the water infrastructure.

On the other hand, distributional losses are modest relative to other parts of Africa, revenue collection is promising, and labor productivity is better than several African benchmarks. Thirty percent of water production is lost due to leakages in the system. These losses, however, are comparable to what is observed in African middle-income countries and are modest relative to East Africa and South Sudan's resource-rich peers. Over 80 percent of the bills are collected, which is comparable to East Africa and other low-income countries and significantly better than what other resource-rich countries recover. At 107 connections per employee, labor productivity, while better than East Africa and Sudan, falls short of the average productivity of a utility in middle-income countries at 200 connections per employee.

In monetary terms, the Upper Nile Water Corporation loses $1 million annually due to various inefficiencies. The hidden costs are slightly less than in Kenya and Ethiopia, which lose up to 150 percent of their revenues due to hidden costs. For South Sudan, minimizing losses to improve the financial viability of the utility requires addressing the cost-recovery situation, redressing system losses, and improving collections (table 10).

Table 10. Operational indicators for 2005

Utility	Water delivered (million m^3/year)	System losses (%)	Collection ratio (%)	Average total cost ($/$m^3$)	Average effective tariff ($/$m^3$)	Total hidden costs ($ million/year)	Total hidden costs (% revenues)
Upper Nile Water Corporation	3	29	83	1.13	0.85	1	113

Source: Derived from Briceño-Garmendia, Smits, and Foster (2009).
Note: For South Sudan water delivered (million m^3/year) and total hidden costs ($/year) are reported as the sum of the utilities; the other indicators are calculated as weighted averages. Average total cost per cubic meter was calculated assuming a unit capital cost of 40 cents.

Energy

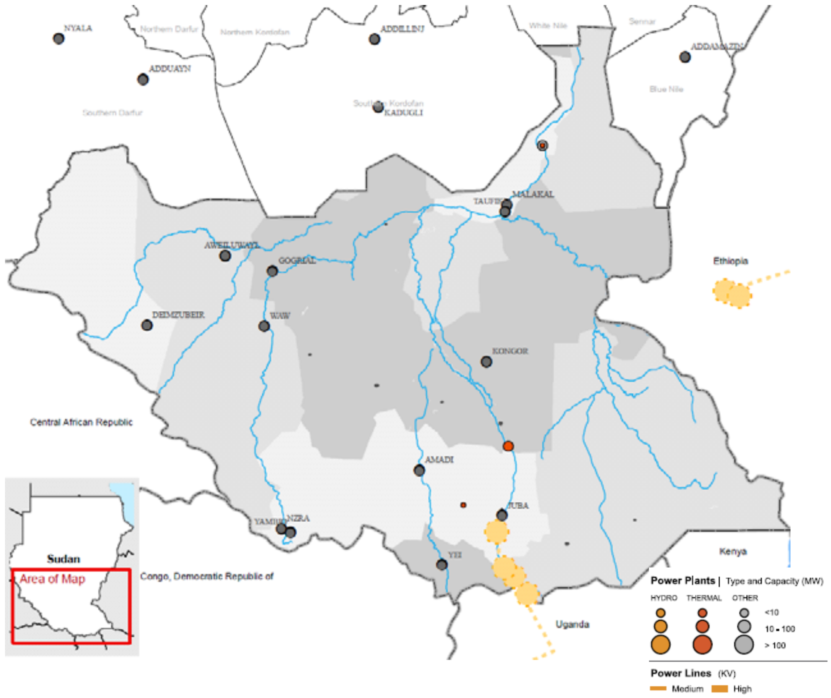
Achievements

Except for some investment in electricity distribution in two small towns, South Sudan has had no significant achievements in recent years in the electricity sector. Some leeway is being made in carrying out feasibility analysis of micro hydropower plants but no projects have materialized.

Challenges

South Sudan's power infrastructure is in an embryonic state, its development severely curtailed by years of civil war (figure 14). The power network consists of a few disjointed generation plants in urban centers. Despite the rich hydropower potential, the power is generated through expensive diesel generation. Estimates suggest that South Sudan has between 25 megawatts (MW) and 62 MW of installed capacity (table 13), or around 3 MW per million people. This is a small fraction of what has been installed in East Africa on average, with installed capacity per million people significantly lagging all other regional African benchmarks. Megawatts per million people in South Sudan equals that of Chad and is around 12 percent of what is found in East Africa on average (table 13).

Figure 14. Power infrastructure in South Sudan



Source: AICD.

Access to power is very low and unequal. Estimates indicate that around 1 percent of people in South Sudan have access to power and this is not available through a full 24-hour period (table 11). These access rates are in glaring contrast with East Africa, where on average 10 percent of the population has access to electricity (16 percent in Kenya). These aggregates are even more striking when compared to other African resource-rich peers. The urban-rural divide is conspicuous when South Sudan's benchmarks are compared to other African countries. Around 7 percent of South Sudan's urban population is electrified compared to over half in Sudan. Virtually no one in South Sudan's rural areas has electricity; around 28 percent of Sudan's and resource-rich countries' rural populations have access to power.

Table 13. Benchmarking power indicators

Indicators	Units	South Sudan	East Africa	Low-income, nonfragile countries	Middle-income countries	Resource-rich countries
Access to electricity (national)	% of population	1	10	33	50	46
Access to electricity (urban)	% of population	6.67	44	86	72.8	79.4
Access to electricity (rural)	% of population	0		12.7	26.3	28
Installed generation capacity	MW	25	1,169	651	36,971	4,105
Installed generation capacity per million population	MW per million population	3	23	20	799	43
Power outages	Days/year		19	10.4	5.9	14.5
Firms that find power a constraint for business	% of firms	>75	55	52	31	56
Firms with own generator	% of firms	70*	50	41	18	63

Indicators	Units	South Sudan	East Africa	Low-income, nonfragile countries	Middle-income countries	Resource-rich countries
Collection rate	% billing	40	94	92	91	70
Revenue per unit	US cents/ kWh		10.5	14	13	13
System losses	% of generation	50	23	24	20	52
		South Sudan		Predominantly thermal		Other developing regions
Average effective tariff	US cents/ kWh	18–29		14.5		5.0–10.0

Source: All data unless specified are for 2005 and based on AICD calculations; Data for South Sudan access to electricity are from 2010 and were obtained from World Bank (2011); data for Installed capacity for South Sudan are from 2009 and were obtained from Platts (2009); data for power outages were derived from Vennemo and Rosnes (2009); data for emergency generation from Eberhard and others (2008); data for firms that find power to be a constraint and firms with own generators are from 2007 and were obtained from World Bank (2009b); data on Sudan collection rate, revenue per unit, and system losses are for 2010 and were taken from World Bank (2011); data for average effective tariff for South Sudan are taken from World Bank (2011). For the thermal benchmark, data represent primarily residential users.
Note: Access to electricity data for urban and rural access in South Sudan are estimates based on calculations from the AICD economic model for power investment needs. Installed capacity per million people was calculated based on Platts (2009).
* The aggregate is based on manufacturing firms.

South Sudan also records very limited usage of modern fuels for domestic consumption purposes across all income levels; in fact, usage is among the lowest in Africa. Recent poverty assessments for South Sudan found that less than 1 percent of the richest household quintile used modern fuels for cooking. Around 70 percent of the wealthiest household quintile and around 86 percent of the country on average used firewood for cooking (World Bank 2010a and 2010b). Comparing South Sudan to other countries in Africa indicates that the country records extremely limited usage of modern fuels overall (table 12).

Table 12. Even the richest households in South Sudan do not use modern fuels for cooking

Usage of modern fuels (%)	All households	Richest households
Sudan (2009)	36.1	64.9
Kenya (2003)	3.45	16.52
Nigeria (2003)	1.19	5.51
Uganda (2001)	0.87	4.34
Ethiopia (2005)	0.31	1.48
South Sudan (2009)	0.3	0.8
Tanzania (2005)	0.24	1.22

Source: DHS various years and World Bank 2010a and World Bank 2010b.

Modern fuel usage for other purposes such as lighting does not vary significantly across urban and rural areas (table 12). Around 63 to 70 percent of lighting is fueled by firewood, paraffin lamps/lanterns, candle wax, or biogas. Around 7.4 percent of lighting in urban areas is provided by electricity or gas. Less than 2 percent of lighting in rural areas is powered by nontraditional fuels (table 13).

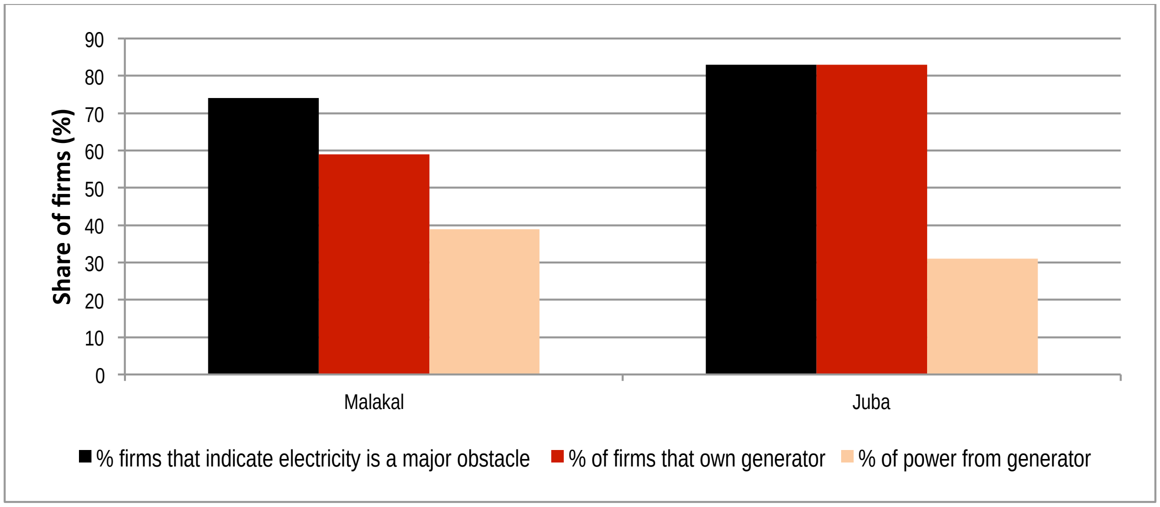
Table 13. Gas and electricity powers very low levels of lighting even in urban South Sudan in 2010

	Electricity	Gas	Public generators	Solar power	Traditional fuels	No lighting
Total	1.20	0.40	1.80	0.90	68.80	26.90
Urban	7.10	0.30	9.60	2.50	63.60	16.90
Rural	0.20	0.40	0.40	0.50	69.80	28.70

Source: Southern Sudan Center for Census, Statistics and Evaluation, 2010.

Businesses record limited access to power in South Sudan and indicate that power is a major impediment to growth and productivity. One hundred percent of firms in Malakal and 87 percent of firms in Juba—the two largest cities in South Sudan—indicate that power is the largest impediment to their business. Around 83 percent of firms in Juba own or share generators to combat erratic power supply. Generators supply as much as 93 percent of the total power consumption in Juba (World Bank 2009b) (see figure 15).

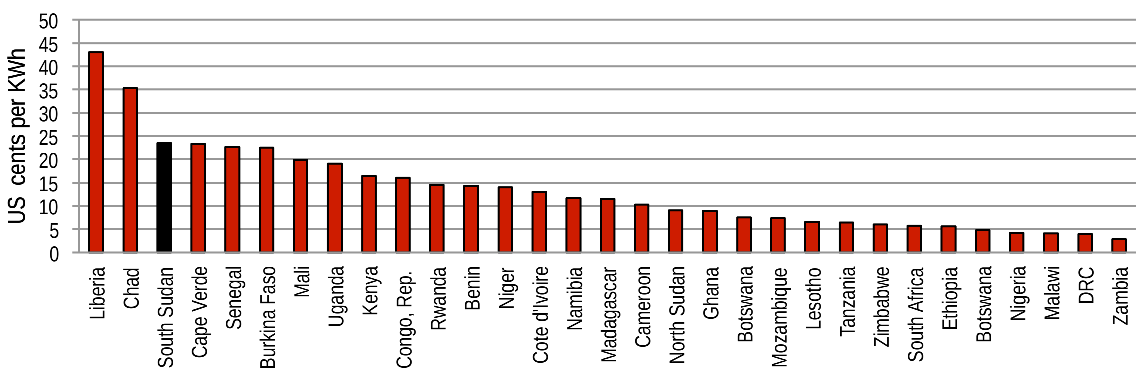
Figure 15. Electricity is a large obstacle to business activity in South Sudan



Source: World Bank 2009a.

South Sudanese power prices range between $0.18 and $0.29 per kilowatt-hour (kWh). This is twice as much as the average African consumer pays, five times what is paid in other developing countries, and more than two times what is paid in Sudan (figure 16).

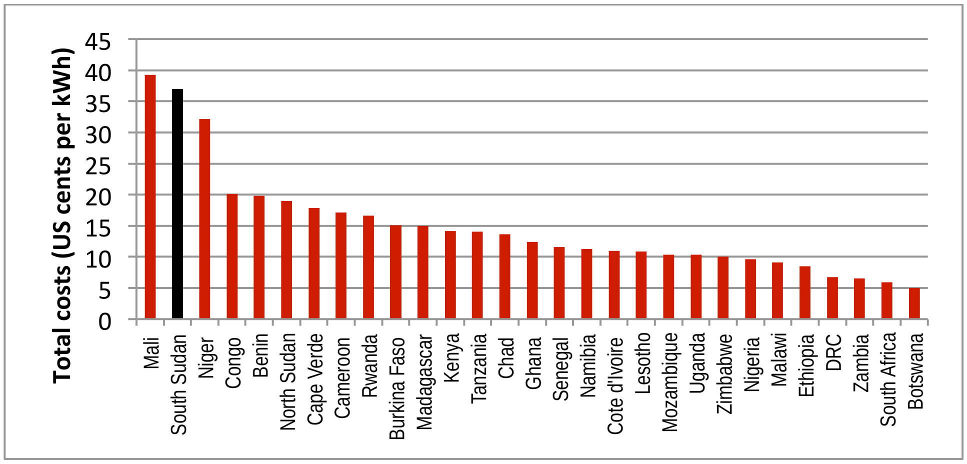
Figure 16. South Sudan's power tariffs are among the highest in Africa



Source: Briceño-Garmendia and Shkaratan 2009; South Sudan's estimates were provided by World Bank staff.

The high prices reflect that South Sudan has one of the highest costs of power production in Africa (figure 17). The average power cost in South Sudan is as high as $0.37 per kWh, essentially double the average cost of power in Sub-Saharan Africa, which has been estimated at $0.18 per kWh. Part of the explanation behind the high power costs lies in the use of small-scale generation that precludes the system from benefitting from the substantial scale economies that exist in this sector. African countries with power systems as small as South Sudan's typically face power-generation costs that can be three times as high as those with larger systems (above 500 MW). South Sudan's production is well below the minimum efficient scale size of around 200 MW.

Figure 17. The costs of producing power in South Sudan are extremely high



Source: Briceño-Garmendia and Shkaratan 2010.

Another explanation for high costs lies in the high price of diesel in the country, reflecting the high cost of road transportation (table 14). It is striking that though Sudan and South Sudan are both oil-endowed, they pay steep prices for diesel relative to other countries in Africa. Further, unlike in the National Electricity Corporation in Sudan that has received fuel subsidies for power production from the government, such subsidies have not been provided to South Sudan's power utility, SSEC. Since the referendum, challenges for power production have been compounded due to even higher fuel prices attributed to inadequate fuel supplies coming into South Sudan from Sudan (Sudan Tribune 2011).

Table 14. High prices of diesel in all parts of Sudan (cents per liter)

	1991	1993	1995	1998	2000	2002	2004	2006	2008
Ethiopia	14	19	24	25	27	32	42	62	89
All parts of Sudan	6	58	25	26	24	24	29	49	125
Uganda	55	71	85	68	75	70	88	101	122

Source: GTZ.

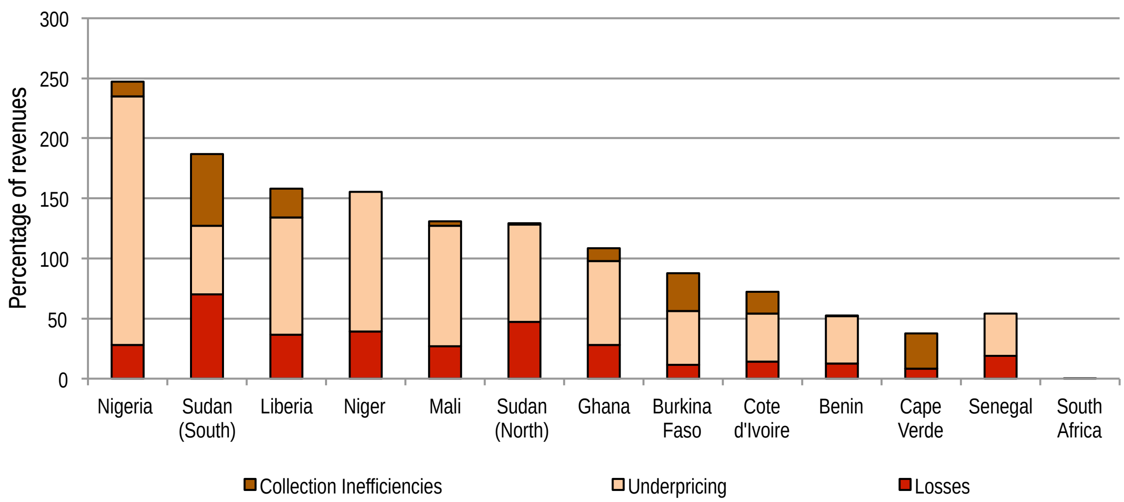
Inefficiencies due to underpricing of power, distributional losses, and lack of adequate revenue collection also add significant costs. In 2006 the tariffs levied recovered only a little over 60 percent of the total costs of power production. For every kilowatt-hour produced, the electric utility lost around $0.14 due to the underpricing of power. The net drain due to underpricing of power was around $2.7 million per year. Additionally, losses in transmission and distribution have been estimated at 50 percent of total electricity produced, five times higher than good-practice standards and double what is observed in other parts of Africa in general. These represent monetary losses of up to $3.3 million a year. Further, despite enormous subsidies to end users implicit in non-cost-recovery tariffs, over 60 percent of electric bills go unpaid, adding a further $2.7 million to the inefficiency price tag. Overall, hidden costs for the SSEC are equivalent to around $9 million a year, or around 188 percent of the SSEC's revenues—system losses amount to 70 percent of revenues, poor collection of bills amount to another 60 percent, and underpricing to 57 percent (table 15). In terms of utility size, the SSEC encounters one of the highest hidden costs in Africa (figure 18). If SSEC is to expand access, redressing these hidden costs must be its first urgent priority.

Table 15. Operational indicators for the SSEC

	Net generation (GWh/year)	System losses (%)	Implicit collection ratio (%)	Average total cost ($/kWh)	Average effective tariff ($/kWh)	Total hidden costs ($ million/year)	Total hidden costs (% revenues)
2006	39	50	40	0.37	0.23	8.7	187

Source: Derived from Briceño-Garmendia, Smits, and Foster (2009); Southern Sudan statistical handbooks 2006–08; World Bank (2011).

Figure 18. Benchmarking the SSEC's high hidden costs due to inefficiencies



Source: Derived from Briceño-Garmendia, Smits, and Foster (2009); Southern Sudan statistical handbooks 2006–08; World Bank (2011).

Improving South Sudan's electricity situation requires a phased approach, starting with supporting and expanding off-grid electrification schemes. Programs that boost off-grid electrification through commercial means can be a viable option. These options not only enhance access to modern lighting in the absence of grid electrification but also boost private sector development. One such option is through the program Lightning Africa. Given the absence of any grid network in South Sudan, the most efficient and rapid way of providing lighting services to the people (particularly in rural areas) would be through the private sector by promoting the low-cost modern lighting offered by photovoltaic (PV) modules. The incorporation of South Sudan into th*e Lighting Africa program* deserves consideration as a practical short-term solution to the country's energy challenges.

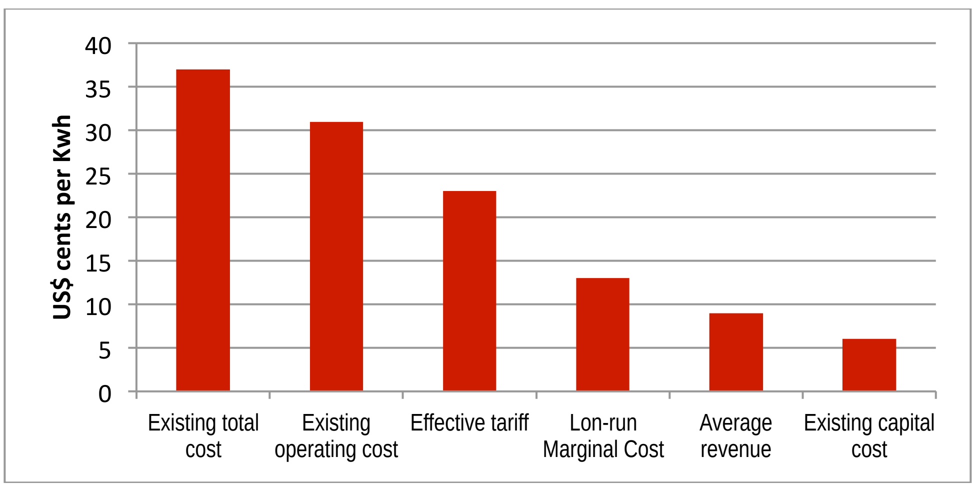
Lighting Africa is a joint International Finance Corporation (IFC) and World Bank program that has to accelerated the development of commercial off-grid lighting markets in Sub-Saharan Africa. The program aims to mobilize the private sector to build sustainable markets to provide 2.5 million people with safe, affordable, and modern off-grid lighting by 2012 through a variety of tailor-made products, many of them in the form of PV solar lanterns. The longer-term goal is to eliminate market barriers for the private sector to bring these innovative products to 250 million Africans by 2030, who currently lack electricity that rely on costly and low-quality candles and kerosene lamps. Improved lighting provides significant socioeconomic, health, and environmental benefits such as new income-generation opportunities for small businesses.

Given the capacity constraints faced in South Sudan, one possible approach to explore on the efficiency front would be the involvement of the private sector through a management contract with targeted incentives to improve some of the key efficiency parameters. In the Democratic Republic of Congo, for example, management contracts are being developed for the power and water utilities to address inefficiencies. A similar approach is being used for the Liberia Electricity Corporation.

In the medium to long term, tapping into the Eastern Africa Power Pool's (EAPP's) energy market might also provide energy solutions for South Sudan. Leveraging cheap hydropower produced in Ethiopia through interconnections either through Kenya and Uganda will provide access to greater amounts of less-expensive hydropower for South Sudan.

In the long run, South Sudan could harness its massive hydropower capacity through the development of additional hydro-based generation. Exploiting the hydropower potential offers South Sudan three key benefits. First, in the long run the cost-recovery situation in South Sudan is more attainable (figure 19). Using a model that simulates optimal (least-cost) strategies for generating, transmitting, and distributing electricity in response to demand increases, it is estimated that the long-run marginal costs of producing power in Sudan would be about $0.13 per kWh, a substantial decrease from the existing $0.37 per kWh. The prevailing tariff will be able to recover long-run costs including capital costs.

Figure 19. Existing tariffs for power are insufficient to recover huge operating costs and long-run marginal costs



Source: AICD calculations.

Second, developing South Sudan's rich hydropower potential elevates South Sudan's role as a key player in regional power trade. Expanding cross-border trade—trade expansion—to leverage lower-cost energy resources that are available in the region as a whole with the addition of cross-border transmission capacity to facilitate the flow of power from production to consumption locations. A counterfactual scenario—trade stagnation—assumes that no cross-border interconnectors will be built and countries will meet the incremental power demands through expansion of their domestic power sectors. South Sudan can boost its own energy supplies, reduce its reliance on oil-based generation, and wheel power to its East African neighbors through the development of over 1,500 MW of power generation and additional interconnector capacity. Engaging in regional trade will enable South Sudan to make lucrative returns on the investment.

Third, by increasing the share of hydropower in the regional generation portfolio, the region could save several million tonnes of carbon emissions a year. Under trade expansion, the weight of hydropower for all parts of Sudan will increase to over 90 percent, making the generation of power more environmentally sound.

Information and communication technology

Achievements

A memorandum of understanding (MOU) between the Sudan and South Sudan has facilitated the development of a mobile market (albeit still in its early stages) in South Sudan. The MOU appointed the National Telecommunication Corporation (NTC) responsible for overall regulation, and allowed Sudatel, Zain, MTN, and Canar to provide nationwide services with Vivacell[2] and Gemtel[3] licensed to provide mobile services in South Sudan.[4] These companies were given access to start building or rebuilding their operations in South Sudan. The NTC was to be restructured with around one-third of its board composed of representatives from the South (*News*, November 12, 2008).

Emergence of international mobile operators has facilitated some investments in telecommunications infrastructure. MTN and Zain have made significant enhancements in improving the telecommunications infrastructure of South Sudan. The presence of five mobile operators has facilitated an increase in the construction of several base towers. Zain's, Gemtel's, Sudani's, and MTN's towers now cover most of South Sudan's large towns and are expected to expand to rural areas in the near future. As of 2010, there were some 317 base stations in South Sudan with Zain and MTN accounting for half of these (SSEC 2010).

Increased competition from several mobile operators has reduced prices. MTN has already provided cheaper service to South Sudanese who have relatives that fled from Sudan to East Africa. Further, MTN's presence in 21 countries has facilitated special arrangements. MTN–MTN callers are allowed to make calls to Kenya, Rwanda, Tanzania, and Uganda at half the price for international calls (Executive 2009).

The construction of an international gateway is now underway and can be expected to further reduce prices of calls and enhance performance. The MOU granted South Sudan the permission to build its own gateway in 2007. The contract was won by Ericsson and is expected to be completed in 2012. The gateway will enable the South Sudan to monitor call traffic made in the country and profit from operators who use it. All operators in principle have agreed to use separate southern gateways for calls. The

[2] Vivacell, owned by Lebanese investors, launched service in 2009 under a license issued in 2007 to NOW (*Reuters*, February 23, 2009).

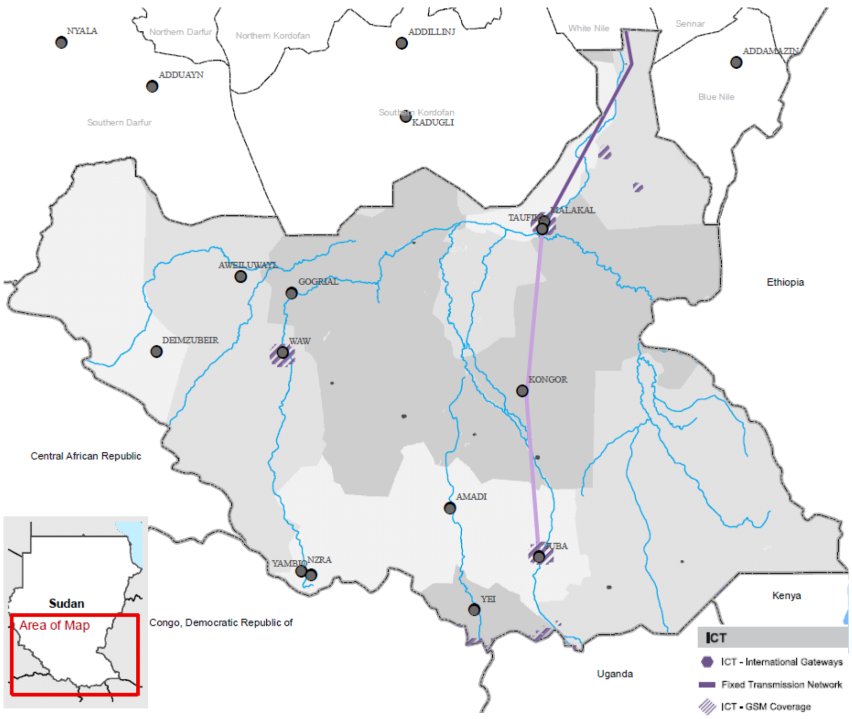
[3] Gemtel was launched by a Ugandan businessman. Some 80 percent was reportedly sold to an investment firm controlled by the Libyan government in 2010 (Wafula 2010).

[4] The Memorandum of Understanding between the Ministry of Information and Communication (GoNU) and the Ministry of Telecommunications and Postal Services (GoSS).

gateway is also expected to drive down prices. The government-owned Gemtel currently uses Uganda's gateway as opposed to Khartoum's. Uganda charges South Sudan's government $50,000 per year for gateway usage. Gemtel lost business in 2008 to MTN and Zain as users switched to save money. At present, to place a call to any of the over 20,000 Gemtel subscribers from any other operator in South Sudan, users have to wait until a Hong Kong satellite beams the call back via Uganda. This delay will be circumvented through the gateway (Executive 2009).

Despite these recent advancements, the telecommunications industry is still in an incipient stage. According to the Minister of Telecommunications and Postal Services of South Sudan, there is no single ongoing project through South Sudan. The telecommunications and postal services inherited from the British are completely destroyed or liquidated by the war due to neglect.[5] While there have been some investments in infrastructure recently, ICT networks are still underdeveloped (figure 20 and annex 5).

Figure 20. South Sudan's ICT backbone infrastructure



Source: AICD.

Challenges

Rough estimates of South Sudan's access to ICT services indicates overall very low levels of penetration. As of 2005, landline subscriptions were 0.11 per 100 people, a fraction of what is observed in Africa on average. The total number of active SIM cards is estimated at around 1 million–1.5 million, which puts the official penetration rate in South Sudan at around 12–18 percent, among the lowest in Africa in mid-2009. Based on these estimates, mobile penetration at 12 subscribers per 100 people is less than half of what is found in other parts of Africa. By comparison, Burundi has a penetration rate of 19

[5] GOSS Ministry of Telecommunication and Postal Services Web site, "Foreword from Minister," www.motps.goss.org/index.php?option=com_content&view=article&id=47%3Aforeword-from-minister&catid=34%3Asite&lang=en.

percent, the Central African Republic and Chad are in the order of 30 percent, and Sierra Leone is close to 40 percent.

There is also very limited mobile penetration in South Sudan. Household surveys from 2009 suggest that only 18 percent of South Sudan's households owned a cell phone. In contrast, over a third of the population in Sudan owns a cell phone. Estimates for 2011 set mobile ownership up to 25 percent of the population still below African averages.

South Sudan records a low 7 users of the Internet per 100 people (table 16). Very low literacy rates in part drive low Internet usage. Further, less than 1 percent (0.7 percent) of the population owns a computer.

Table 16. Benchmarking South Sudan's ICT performance indicators

Indicator	Units	South Sudan	Resource-rich countries	East Africa	Low-income countries	Sub-Saharan Africa
		Various years	2008	2008	2008	2008
Access						
GSM coverage	% population under signal		78	0.02	63	72
International bandwidth	bits/person		18	11	25	39
Internet	users/100 people		9	5	3.5	5.5
Landline	subscribers/100 people	0.11	0.9	0.24	0.8	1.4
Mobile phone	subscribers/100 people	12	38.2	21	24.4	33.1

Source: Data for landline subscribers is from 2005 taken from the Central Bureau of Statistics South Sudan; Mobile phone subscriptions based on World Bank staff estimates for 2011; Internet users is for 2011 taken from Infoasaid (2011).
Note: ICT = information and communication technology; GSM = global system for mobile communications.

Consumers pay rather high prices for the ICT services that they have access to. Access to international ICT networks is via microwave links to satellite connections in neighboring countries. Gemtel has a microwave link to Uganda from where it connects to the fiber network of Uganda Telecom. International bandwidth is very limited in South Sudan and, as a result, prices are very high. Zain charges about 250 SDG for the modem and 50 SDG per month for a 2 GB connection. Vivacell and MTN also offer Internet services at roughly similar rates. VSATs[6] are far more expensive, costing anywhere between $500 and $4,000 a month depending on specifications.

The quality of existing service is also rather poor. Mobile networks are still embryonic in nature. As a result, mobile phone users often have multiple SIM cards to combat patchy services and poor interconnections. Internet connectivity is also rather poor because modems link to the Internet via the mobile phone network, but connection speeds remain slow (Infoasaid 2011).

Institutional obstacles imposed by the governments of Sudan and South Sudan have stymied the growth of the telecommunications market in the past. Despite a demand for fixed-line telephones, licensing arrangements precluded growth in landline connections. In 2005 total capacity of the telephone exchange was almost 9,400 customers and registered customers were as many as 8,856. The neglect of

[6] Very small aperture terminal.

South Sudan's infrastructure has restricted capacity in the area of fixed-line telephony. Unless there are changes in the licensing agreements in South Sudan, fixed-line telephones are not expected to have increased significantly.

Further, the fact that operators licensed to operate in South Sudan have not developed their network more fully indicates that there are noncommercial barriers to expansion. Non–South Sudanese operators report that they have had difficulties obtaining permission from the government to operate in South Sudan. The South Sudanese operators (NOW and Gemtel) also have not been issued with formal licenses recognized by the GNU. In the past this had made it difficult for them to raise finance to invest in networks.

South Sudan has yet to connect to the undersea cable, which has proven to decrease prices for ICT services in other countries considerably. Evidence shows that Sub-Saharan Africa's access to the submarine cable has generally reduced costs of ICT services when international gateways are present (table 17). According to Sudatel, an optical fiber to South Sudan was planned as part of the nationwide backbone (figure 21) but its status is unclear. The existing backbone transmission is believed to be through microwave with eventual connectivity to fiber optic in the north and onward to Port Sudan for international connectivity through undersea cables. One possible option for landlocked South Sudan to gain access to the undersea fiber-optic network is through a backbone from Juba to the Kenyan border.

South Sudan needs to add around 643 km to connect to the fiber-optic cable and establish a strong ICT backbone. South Sudan is missing a link to connect to Uganda, which has largely achieved connectivity to the fiber-optic backbone. Adding these missing kilometers of cable would allow South Sudan to connect to the Ugandan border from Malakal via Juba. Meanwhile, Sudatel has financed the construction of fiber from Khartoum to Malakal.

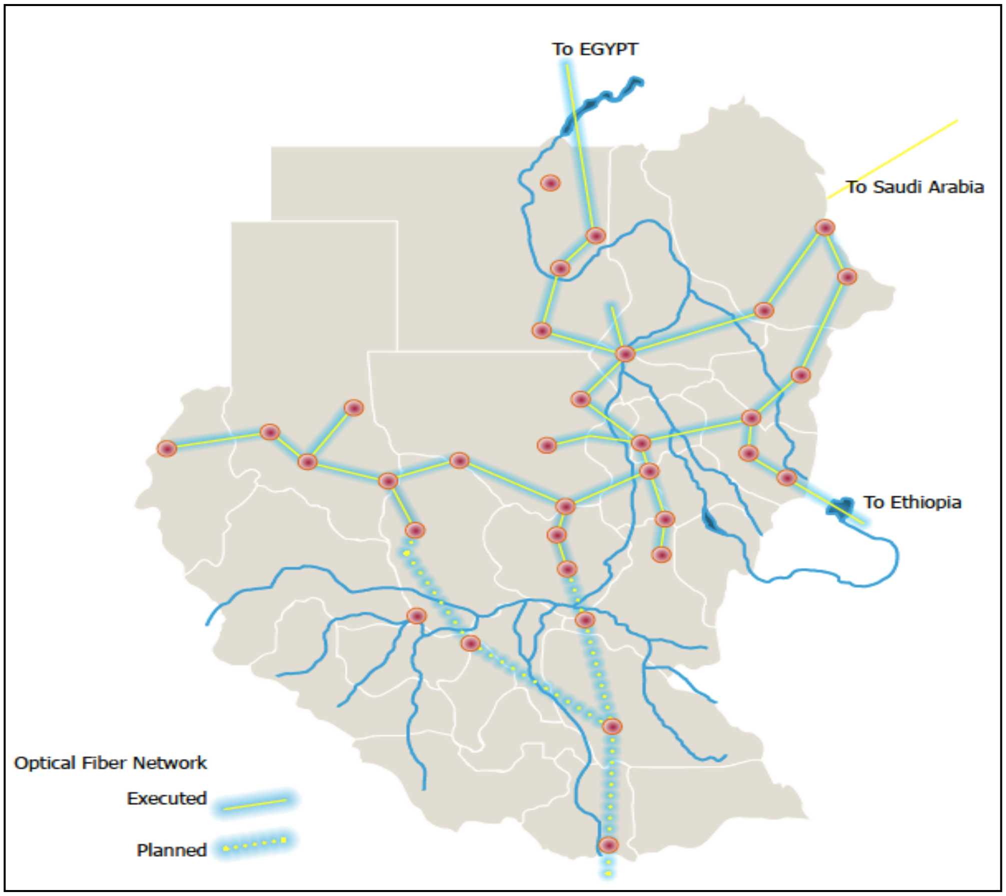
Table 17. Prices of Internet and phone calls in Sub-Saharan Africa, with and without access to submarine cables

US$	Call within region	Call to the United States	Internet dial-up	Internet ADSL
Without submarine cable	1.34	0.86	68	283
With submarine cable	0.57	0.48	47	111
Monopoly on international gateway	0.70	0.72	37	120
Competitive international gateway	0.48	0.23	37	98

Source: AICD calculations.

Note: ADSL = asymmetric digital subscriber line.

Figure 21. Sudatel's fiber-optic network



Source: Sudatel's Annual Report 2008.

Financing Sudan's infrastructure

To meet its most pressing infrastructure needs, South Sudan has to significantly improve the quantity and quality of infrastructure in key areas. For the purpose of this report, illustrative targets have been set using standardized criteria but also taking into account the starting conditions of the region's infrastructure. In the case of South Sudan, the existing conditions are extremely daunting and it is simply not realistic to expect—even in the most optimistic scenario—that South Sudan would catch up with Sudan or any well-performing developing country in a period of 10 years or even more. It is reasonable to assume, however, that the water and sanitation Millennium Development Goals (MDGs) can be attained using a modest and practical mix of technological options and doubling electrification to 5 percent. In the case of transport, national connectivity involves connecting centers with populations larger than 25,000 people. This translates into a requirement of 1,192 km of roads in good condition in the south. What is seen below are development targets that are driven by the country's own circumstances (table 18).

Table 18. Illustrative investment targets for infrastructure in South Sudan

	Economic targets	Social targets
Information and communication technology (ICT)	• Install fiber-optic links to neighboring capitals and submarine cable.	• Provide universal access to GSM signal and public broadband facilities: add 1,299 base stations for urban and 2,144 for rural areas.
Power	• Assuming trade stagnation, estimate optimal (least-cost) investment strategies for generating, transmitting, and distributing electricity in response to demand increases. • Develop 222 MW of new generation capacity (no-trade scenario). • This scenario could be replaced under trade expansion with 1,540 MW of generation capacity (and the needed megawatts in interconnectors).	• Achieve exogenously determined electrification rates: Raise electrification from 1 percent to 5 percent of the population (10 percent urban, 3 percent rural).
Transport	• Achieve regional and national connectivity with good-quality 1-lane paved road by adding or rehabilitating to good condition: 1,193 km for national connectivity, 1,307 km for regional connectivity, 1,085 km in urban areas, and 6,969 km in rural areas.	• Provide rural road access to 100 percent of the highest-value agricultural land based on current production, plus providing rural road access to 50 percent of the nonproductive agricultural land with highest potential. • Provide urban road access within 500 square meters.
Water supply and sanitation		• Achieve Millennium Development Goals by preserving the current mix of sanitation technological options and clearing sector rehabilitation backlog. • Increase population rates with access to improved water to 67 percent and with access to improved sanitation to 61 percent. • Increase access to improved water to 67 percent by achieving the following technology mix: piped water (38% urban, 0% rural), stand posts (13% urban, 2% rural), safe wells (50% urban, 89% rural).

Source: Mayer and others 2009; Rosnes and Vennemo 2009; Carruthers, Krishnamani, and Murray 2009; You and others 2009.
Note: GSM = global system for mobile communications; MW = megawatts.

Only by using an incremental but sustained approach to infrastructure improvements will the challenges faced by South Sudan be manageable. South Sudan has to deal with the difficulties of being predominantly rural and unpopulated, even as its institutional capacity is starting out from a very meager point. Such challenges call for the use of innovative and more modest technological combinations to allow for incremental improvements at a good development pace. The burden of needed spending in terms of the size of the economy is a daunting 23 percent of GDP (table 19).

In absolute terms, meeting the illustrative infrastructure targets would cost $1.4 billion per year over a decade. Capital expenditure would account for 80 percent of this requirement. The transport sector has the highest spending needs—about $711 million—largely driven by the requirement to provide for rural road accessibility that, at $362 million, represents the single-largest item on South Sudan's spending agenda. This includes providing 100 percent access to the land currently hosting the highest agricultural value as well as expanding access to 50 percent of the land with the highest agricultural value potential not yet productive. If South Sudan were only to provide full rural accessibility to its already productive agricultural land, the spending needs associated with rural roads would drop to $40 million (with basic standards). But the latter would also guarantee road access to less than one-third of the land with suitability for agricultural production.

Table 19. Indicative infrastructure spending needs in South Sudan for 2006 to 2015

$ million per year				GDP shares
Sector	Capital expenditure	Operations and maintenance	Total needs	Total needs
ICT	78	21	99	1.64
Irrigation	—	—	—	—
Power (nontrade)	179	29	209	3.46
Transport	524	187	711	11.80
Water supply and sanitation	303	45	348	5.78
Total	1,084	282	1,367	22.7

Source: Mayer and others 2009; Rosnes and Vennemo 2009; Carruthers, Krishnamani, and Murray 2009; You and others, AICD 2009. Derived from models that are available online at www.infrastructureafrica.org/aicd/tools/models.
Note: ICT = information and communication technology.
— = Not available.

The water and sanitation sector is also in disarray, with the second-highest spending needs. About $350 million per year—or 6 percent of South Sudan's GDP—is needed to meet the MDGs in water and sanitation. The water supply and sanitation estimates consider improving the technology mix used to provide improved services. This means that population would get improved services not only through cheaper and simpler technologies (protected boreholes or latrines) but the share of the population getting high-end services (piped water or sewerage) would increase, albeit modestly, over time relative to the other means. The power infrastructure requirements for South Sudan represent another big item, at an estimated $209 million per year. Yet, this only assumes meeting domestic demand.

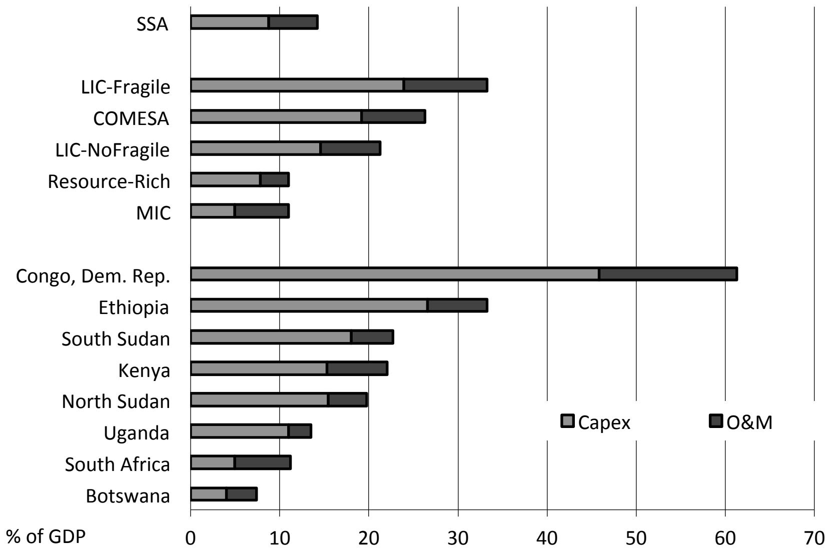
Needs estimates for ICT are the lowest only because of the recent developments of the ICT sector, which has been financed by, and is expected to receive more, private sector financing. The estimates are modest as they do not include the cost of linking any of the regional gateways to submarine cables.

South Sudan's infrastructure spending needs, at about 23 percent of GDP, are twice as high as other resource-rich economies in Africa and broadly comparable to those of LICs such as Kenya, Senegal, and Madagascar (figure 22). Investment needs are about 18 percent of GDP, accounting for 75–80 percent of total needs.

In absolute terms, South Sudan already spends over $450 billion per year to meet its infrastructure needs. This is equivalent to around 7.5 percent in terms of the size of the economy (table 20). These numbers position both South Sudan among average spenders in Africa, comparable to what MICs spend and perhaps slighter higher than other resource-rich countries (figure 23). Most of the traceable spending goes to capital investment, and maintenance flows seem to be almost nonexistent. Most of the spending of the south comes from the public sector and has garnered minimal interest from non–Organization for Economic Co-operation and Development (non-OECD) investors and the private sector, until recently.

Figure 22. South Sudan's infrastructure spending needs in a regional context, as a share of GDP

Estimated infrastructure spending needed to meet targets, as percentage of GDP



Source: Foster and Briceño-Garmendia 2009.

Note: Values excludes irrigation.

LIC = low-income country; MIC = middle-income country; COMESA = Common Market for Eastern and Southern Africa; SSA = Sub-Saharan Africa; GDP = gross domestic product; O&M = operations and maintenance; CAPEX = capital expenditure.

China has an active presence in neighboring countries and is yet to make substantial investments in South Sudan. The largest single financier of infrastructure in Sudan is China, followed by India and Arab countries. Together these account for 40 percent of Sudan's total annual investments, almost entirely allocated to the power sector.

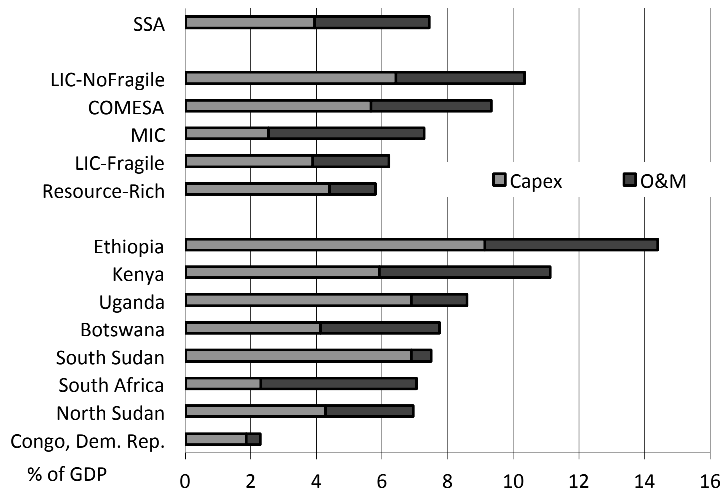
Table 20. Financial flows to South Sudan's infrastructure, average 2001 to 2005

$ millions per year	O&M	Capital expenditure						GDP shares
	Public sector	Public sector	ODA	Non-OECD financiers	PPI	Total CAPEX	Total spending	Total spending
ICT	0.6	0.0	—	0.0	49.5	49.5	50.2	0.83
Irrigation	—	—	—	—	—	—	—	—
Power	18.4	12.6	—	0.0	0.0	12.6	31.0	0.51
Transport	13.0	349.7	—	0.0	3.3	353.1	366.0	6.08
WSS	4.2	0.2	—	0.0	0.0	0.2	4.4	0.07
Total	36.2	362.5	—	0.0	52.9	415.4	451.6	7.50

Source: Derived from Foster and Briceño-Garmendia (2009).

Note: O&M = operations and maintenance; ODA = official development assistance; PPI = private participation in infrastructure; CAPEX = capital expenditure; OECD = Organisation for Economic Co-operation and Development; WSS = water supply and sanitation; ICT = information and communication technology; GDP = gross domestic product.

Figure 23. South Sudan's existing infrastructure spending is average by African standards



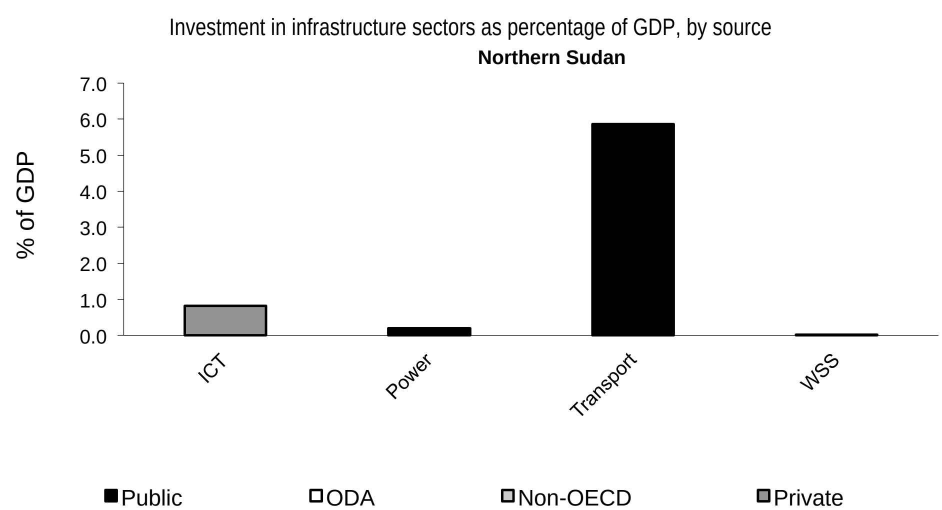
Source: Foster and Briceño-Garmendia 2009.

Note: Values excludes irrigation.

LIC = low-income country; MIC = middle-income country; COMESA = Common Market for Eastern and Southern Africa; SSA = Sub-Saharan Africa; GDP = gross domestic product; O&M = operations and maintenance; CAPEX = capital expenditure.

Capital investments in the south have clearly been concentrated in transport infrastructure and financed by the public sector (figure 24).

Figure 24. South Sudan's pattern of capital investment in infrastructure



Source: Derived from Briceño-Garmendia, Smits, and Foster (2009).

Note: Private investment includes self-financing by households. ODA = official development assistance; OECD = Organisation for Economic Co-operation and Development; ICT = information and communication technology; GDP = gross domestic product; WSS = water supply and sanitation; LIC = low-income country.

How much more can be done within the existing resource envelope?

Even without increasing spending, more resources could be directed toward infrastructure by eliminating inefficiencies. This report quantifies some operational inefficiencies based on measurable and observable performance indicators. Two types of operational inefficiencies are included. The first type relates to operators and/or infrastructure providers, which include utilities, state-owned enterprises (SOEs), and, to some extent, special funds. For this type of estimate, providers within South Sudan will be compared against well-functioning utilities in Africa and/or engineering firms. In this group one finds measurements of (i) underrecovery of costs: comparing effective tariffs and user fees against actual unit costs of providing the service, (ii) overstaffing: assessing the difference between average labor cost per connection of the utility evaluated against a well-functioning utility, (iii) distribution losses: assessing the difference between the distribution losses of the evaluated system against engineering firms having similar age and characteristics; and (iv) undercollection: assessing the ability of the operator to collect emitted bills against a full collection ratio within the year. The second type of inefficiencies is a broad measure of the ability of governmental agencies to execute their budget allocations for capital projects within the fiscal year.

For South Sudan, inefficiencies are dominated by the burden of poor execution of capital budgets. They amount to $35 million annually that, while small in terms of GDP (barely a 0.6 percent), are telling in terms of highlighting the importance of strengthening public expending management capabilities and institutions to make sure that, in an environment with already limited resources (by comparison to needs), available budgets are fully spent (CEM 2010).

South Sudan's operational inefficiencies are a mere 0.01 percent of GDP but represent two times the revenues of operators. In other words, the burden of these inefficiencies to the economy as a whole is still small only because the network is extremely underdeveloped (almost nonexistent). The implications are terrible in terms of expanding power and piped water services to more customers. It is not realistic or even feasible to expect expanding the power and water distribution network via utilities at the existing level of operational inefficiencies.

Table 21. South Sudan's potential gains from greater operational efficiency

$ million per year	ICT	Irrigation	Power	Transport	WSS	Total	Total as share of GDP
Under-recovery of costs	—	—	0.2	—	—	0.2	0.00
Overstaffing	—	—	—	—	—	—	—
Distribution losses	—	—	0.1	—	—	0.1	0.00
Undercollection	—	—	0.4	—	—	0.4	0.01
Low budget execution	0.0	—	0.0	35.2	0.1	35.4	0.59
Total	0.0	—	0.7	35.2	0.1	36.1	0.60

Source: Derived from Foster and Briceño-Garmendia (2009).

Note: WSS = water supply and sanitation; ICT = information and communication technology; GDP = gross domestic product.

— = Not available.

Annual funding gap

South Sudan's annual infrastructure funding gap amounts to $879 million per year, or roughly 15 percent of GDP (table 22). The largest funding gap—equivalent to 40 percent of South Sudan's needs—is attributable to the water and sanitation sector. Transport comes a close second, with its needs representing 35 percent of the total. Power comes a distant, yet very significant, third.

The estimation of the funding gap assumes two key issues. First, existing spending is allocated to areas where spending needs have been already identified. From this perspective, some resources could hypothetically be reallocated from sector A to sector B to increase the economic returns to that spending. But there is not much potential in South Sudan for reallocation. Second, funding gap estimations assume the country can eliminate the existing inefficiencies in spending overnight. From this perspective, the funding gap estimate is a lower bound. Yet, funding gaps look implausibly large when measured relative to the existing annual spending flows.

To cover the annual infrastructure funding gaps, the country would essentially need to more than double its current level of infrastructure spending from 7.5 to 14.6 percent of GDP.

Table 22. Funding gaps by sector

$ millions per year	ICT	Irrigation	Power	Transport	WSS	Total	Total as share of GDP
Spending needs	(99)	—	(209)	(711)	(348)	(1,367)	(22.7)
Existing spending	50	—	31	366	4	452	7.5
Efficiency gains	0	—	1	35	0	36	0.6
Funding gap	(49)	—	(177)	(310)	(343)	(879)	(14.6)

Source: Derived from Foster and Briceño-Garmendia (2009).

Note: Estimates use the base scenario of spending needs. Potential overspending across sectors is not included in the calculation of the funding gap, because it cannot be assumed that it would be applied toward other infrastructure sectors.

WSS = water supply and sanitation; ICT = information and communication technology; GDP = gross domestic product.

—.= Not available

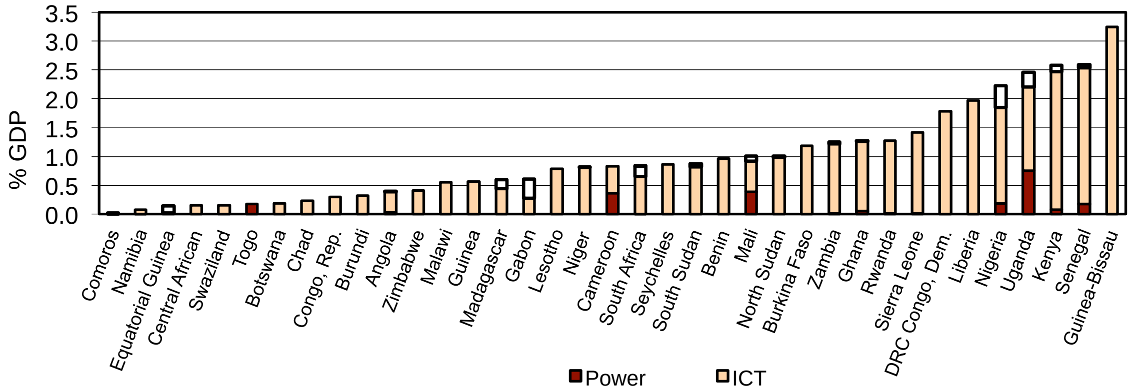
What else can be done?

South Sudan's funding gap is very large relative to the size of its economy, and enormous with respect to its current level of spending. Nevertheless, there are a number of options for making it more manageable, including raising additional finance, taking additional cost-cutting measures, and lengthening the period of time allotted for meeting the illustrative infrastructure targets. In any case, given the magnitude of the gap, difficult decisions will have to be taken regarding the prioritization of the different investments.

There are, however, realistic prospects for increasing the flow of resources to infrastructure. Although not all components of the required infrastructure platform are suitable for private finance (particularly roads, water, and sanitation), other components may be (for example, ICT, power generation, and ports). Challenges for attracting private investors are conspicuous particularly due to the country risks linked to the instability of the country.

South Sudan has not attracted as much private finance into infrastructure as other African peers. Over the early 2000s, private flows into ICT and a 2006 seaport concession near Juba were equivalent to slightly less than 1 percent of GDP. Many other African countries have done significantly better in this area, suggesting there is room for capturing additional resources vis-à-vis the size of the economy (figure 25). Countries such as the Democratic Republic of Congo, Liberia, Nigeria, Uganda, Kenya, and Senegal have all captured between 1.8 and 2.5 percent of GDP, while the most successful country in this regard—Guinea-Bissau—has captured in excess of 3 percent of GDP.

Figure 25. Numerous African countries capture more private investment than South Sudan



Source: PPI Project Database. (http://ppi.worldbank.org), in current $ millions.

China and India might be sources of additional funding given the track record of these investors in neighboring countries, particularly Sudan in the power sector. In fact one project financed by China ($200 million) has already been identified—though not confirmed—for developing power distribution for villages and rural areas in the White Nile State. The role of donors is also expected to increase, which is critical in making the funding gap manageable.

Adopting lower-cost technologies could substantially reduce the cost of meeting the posited infrastructure targets, and help make the funding gap manageable. Meeting the MDGs for water supply and sanitation with lower-cost technologies than previously used (such as stand posts, boreholes, and improved latrines), could reduce the associated price tag from $348 million to $223 million. Similarly, meeting transport connectivity standards using lower-cost road-surfacing technologies (such as single-surface treatment) as well as providing rural accessibility access to the currently active agricultural land, could reduce the associated price tag from $711 million to $232 million in South Sudan. The overall savings from these measures would amount to a sizable $605 million for South Sudan (table 23).

Table 23. Savings from innovation

$ millions	Before innovation	After innovation	Savings	Savings as % of sector funding gap
WSS appropriate technology	348	223	125	37
Roads appropriate technology	711	232	479	155
Total	1,059	454	605	

Source: Derived from Foster and Briceño-Garmendia, AICD Flagship Report, 2009.
Note: WSS = water supply and sanitation.

Finally, if all else fails, it may be necessary to realistically extend the time horizon for meeting the infrastructure targets beyond the illustrative period considered here. In the case of South Sudan, the total amount of inefficiencies is low relative to the economy, as the actual provision of services is almost nonexistent. Therefore, redressing inefficiencies will result in only modest gains.

Within the overall funding envelope, it will be very important to carefully prioritize infrastructure investments. Given the magnitude of the country's funding gap, it will require particular effort to do this without neglecting certain sectors. Hence the need to identify priorities. The foregoing analysis of achievements and challenges suggests the importance of prioritizing key infrastructure interventions for the economy.

Annexes

Annex 1. The number of flights per week between South Sudan and selected neighbors

	Ethiopia	Kenya	South Sudan	Uganda
Ethiopia			4	
Kenya			34	
South Sudan	4	26		17
Uganda			21	

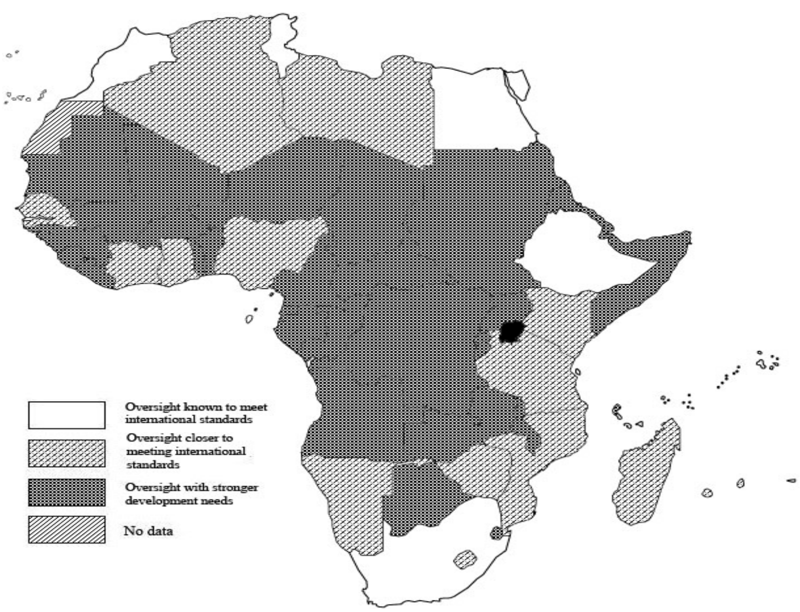
Source: Bofinger 2009.

Annex 2. Benchmarking the speed of South Sudan's air service in kilometers per hour

	Ethiopia	Kenya	South Sudan	Uganda
Ethiopia			521	
Kenya			618	
South Sudan	521	552		453
Uganda			342	

Source: Bofinger 2009.

Annex 3. Status of African air transport safety oversight, using several criteria



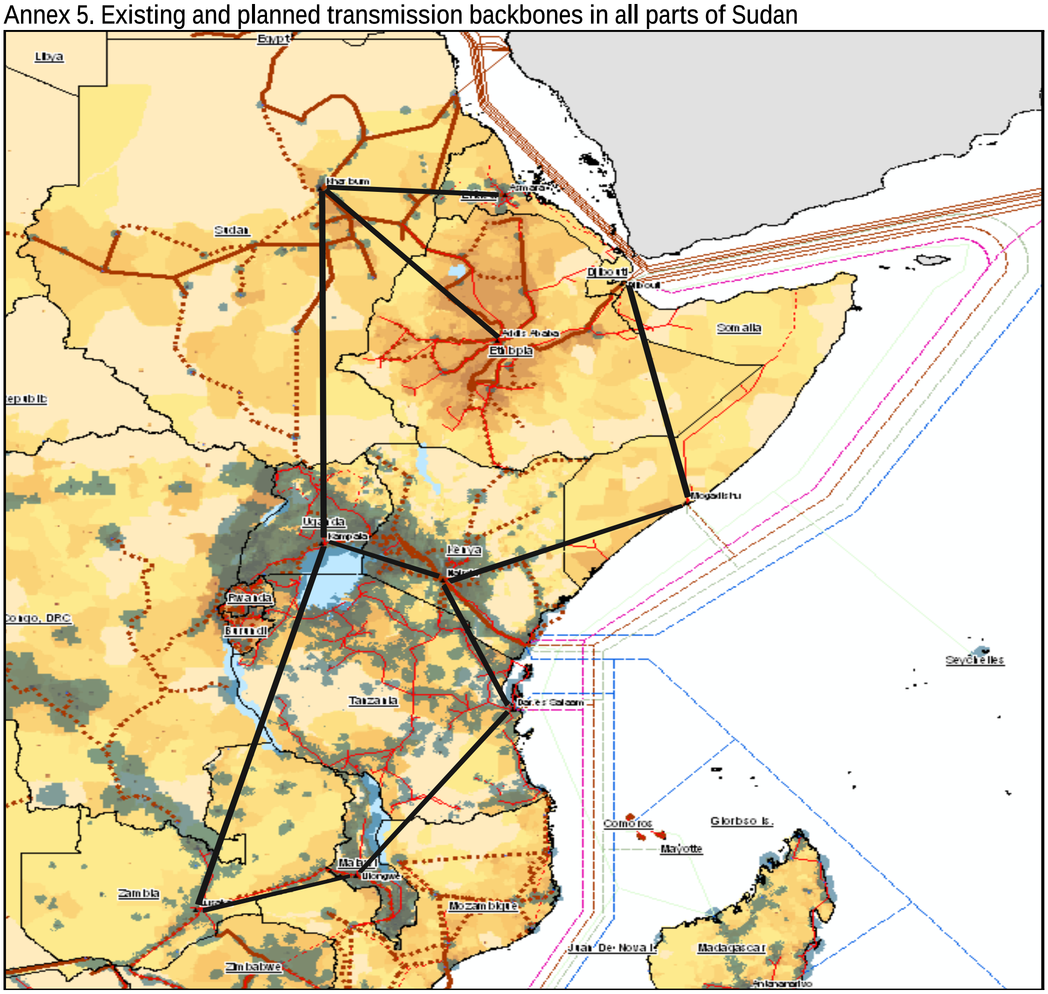
Source: Bofinger 2009.

Annex 4. Benchmarking the number of mobile subscribers in all parts of Sudan against selected African countries

	2003	2004	2005	2006	2007	2008	2009	Average annual growth rate (%)
All parts of Sudan	527,233	1,048,558	1,702,449	4,721,443	8,218,092	11,186,548	13,475,000	57
Egypt	5,797,530	7,585,000	12,828,000	17,787,000	30,065,242	41,272,473	55,352,233	39
Ethiopia	51,234	155,534	410,630	866,700	1,208,498	1,954,327	4,051,703	69
Kenya	1,590,785	3,421,343	5,329,000	7,273,000	11,349,000	16,233,833	19,364,559	41
Nigeria	3,149,472	9,174,209	18,295,896	32,184,861	40,395,611	62,988,492	73,099,310	50
Tanzania	1,041,000	1,852,000	3,400,000	5,607,000	8,328,000	13,006,793	17,469,486	47
South Africa	17,938,000	23,243,000	30,899,000	37,740,000	43,854,000	50,019,000	50,069,000	18
Uganda	776,169	1,165,035	1,525,125	2,326,000	5,163,414	8,554,864	9,383,734	45

Source: Adapted from Ampah and others 2009.

Annex 5. Existing and planned transmission backbones in all parts of Sudan



Source: Mayer and others 2009.

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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 (www.infrastructureafrica.org/aicd/documents), for databases to the data page (www.infrastructureafrica.org/aicd/tools/data), for models go to the models page (www.infrastructureafrica.org/aicd/tools/models), and for maps to the map page (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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