AICD
AFRICA INFRASTRUCTURE COUNTRY DIAGNOSTIC

BACKGROUND PAPER 3 (PHASE II)

Connecting the Continent: Costing the Needs for Spending on ICT Infrastructure in Africa

SUMMARY

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About AICD

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

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

AICD was commissioned by the Infrastructure Consortium for Africa after the 2005 G-8 summit at Gleneagles, which recognized the importance of scaling up donor finance for infrastructure in support of Africa's development.

The first phase of AICD 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 is expanding

to include as many other 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" will be used throughout this report as a shorthand for "Sub-Saharan Africa."

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

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

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

Costing the needs for spending on ICT infrastructure in Africa

Substantial investments in information and communications technology (ICT) and related infrastructure through 2015 will help Africa meet market demand for telecommunications services in Africa. But those investments will not provide universal coverage. In this study, we identify the disparity between the share of telecommunications investments that private markets can be expected to finance and that which the public sector must finance. We call that disparity the public funding gap in ICT infrastructure investment requirements.

Our study answers three questions:

- How much investment in voice and broadband infrastructure would be required to achieve universal population coverage by 2015?
- How much investment in voice and broadband infrastructure would be required to meet market-driven demand through 2015?
- How much investment is required to improve connectivity across Africa's regions?

We answer these questions for the 52 AICD countries, which were examined in two phases.[1] In Phase 1, we analyzed data for 24 countries representative of the situation in Sub-Saharan Africa. Phase 2 of the study added 28 African countries to the analysis, including five North African countries, most of the sub-Saharan countries not addressed in Phase 1, and the island nations of Comoros, Mauritius, Sao Tome and Principe, and Seychelles. Perhaps because most of the larger economies were considered in Phase 1, seven out of the bottom ten African countries in terms of population coverage gaps are in the Phase 2 group of countries.

Our results show that many of the social and economic benefits of widespread use of ICTs are well within Africa's reach. The needed investments are expressed both in absolute dollar amounts and as percentages of gross domestic product (GDP).

The methodologies used to estimate investment needs are different for each of the three questions addressed in the study and for voice and broadband services. The universal coverage analysis uses a newly developed spatial methodology to identify uncovered areas and to assess the potential for full and partial commercial viability at the level of individual cell sites. The market investment forecasts are based on the anticipated number of subscribers nationwide, with subscriber increases based on historical growth trends. Readers are encouraged to refer to the full study for explanations of the different methodologies.

[1] Fifty-three countries are included in the regional analysis; 52 of those are included in the broadband coverage analysis (missing is Somalia, for lack of data); and 51 are included in the voice coverage analysis (missing are Somalia and Guinea-Bissau, also for lack of data).

Toward universal coverage of voice and broadband telecommunications

In this study we use the term universal *coverage* rather than universal *access*. A mandate for universal access reflects a political decision to establish targets for public ICT facilities, service quality, and affordability. Universal coverage, on the other hand, is a more infrastructure-oriented concept that is easier to quantify across countries. In this study a country will have attained universal coverage of voice telecommunications when more than 98 percent of the population lives within range of a mobile telephone signal. Universal broadband coverage is reached when a land connection for a public broadband facility (such as an Internet café) is available within close proximity of more than 98 percent of the population.

Universal coverage is a prerequisite to universal access and may fulfill the requirements of certain countries without further investment. Once coverage is achieved, fulfilling universal access to ICT services becomes a matter of achieving a social consensus on what level of services constitutes a basic right, what skills the population needs to benefit from those services, and whether the political will exists to invest public funds to bring people and services together.

Voice services

Africa already has made great strides in widening access to telephone services. Owing to a lack of data for Somalia and Guinea-Bissau, we analyzed voice services for only 51 countries. Of the total population in those 51 countries, 62.1 percent (557.2 million people) lived within reach of a global system for mobile communications (GSM) network as of the third quarter of 2006, leaving 37.9 percent of the population (340.7 million inhabitants) without access to voice telecommunications. Fully 94.0 percent (314.6 million) of the urban population met our stated access condition, compared with just 43.1 percent (242.6 million) of the rural population.

To ensure universal voice connectivity in Africa and to operate and maintain the necessary infrastructure would require an average annual investment equivalent to 0.2 percent of the combined GDP of the 51 countries. This equates to $2.1 billion each year, or a total of $18.7 billion from 2007 through 2015.

To assess the public funding gap for universal coverage, we divide total investment into two major categories:

- Investment in areas where full coverage is commercially viable and is likely to be funded by the private sector, given efficient and competitive markets. We refer to this as the *efficient-market gap.*
- Investment in areas that lack the potential for full commercial coverage, which we refer to as the *coverage gap.*

The coverage gap is further broken down into two economic zones:

- Those areas with enough commercial viability to support the operating costs, but not the capital costs, of ICT infrastructure. We call this the *sustainable coverage gap.*
- Those areas that lack sufficient market viability to cover either capital or operating costs—the *universal coverage gap.*

Some 30.6 percent (274.7 million) of the population of the 51 countries is in the efficient-market gap—that is, they live in areas where voice telecommunications are likely to be commercially viable. The remaining 7.2 percent (64.7 million) is in the coverage gap, living in areas that do not demonstrate the potential for commercial viability. Just under half of the regions in the coverage gap could generate revenues sufficient to meet operating costs. Subsidizing capital investment could close this sustainable coverage gap. Just 3.9 percent (34.6 million) of the population is in the universal coverage gap, which would require recurrent subsidies for operation.

Closing the efficient-market gap in the commercially viable areas of the 51 AICD study countries would require investments equivalent to 0.07 percent of GDP (table 1). In absolute terms, the amount needed is $7.8 billion—$869.1 million each year from 2007 through 2015. Closing the coverage gap would require an additional investment of 0.10 percent of GDP, translating into $10.8 billion, or $1.2 billion annually.

Table 1 Investments needed to close gaps in voice coverage in 51 AICD countries, 2007–15

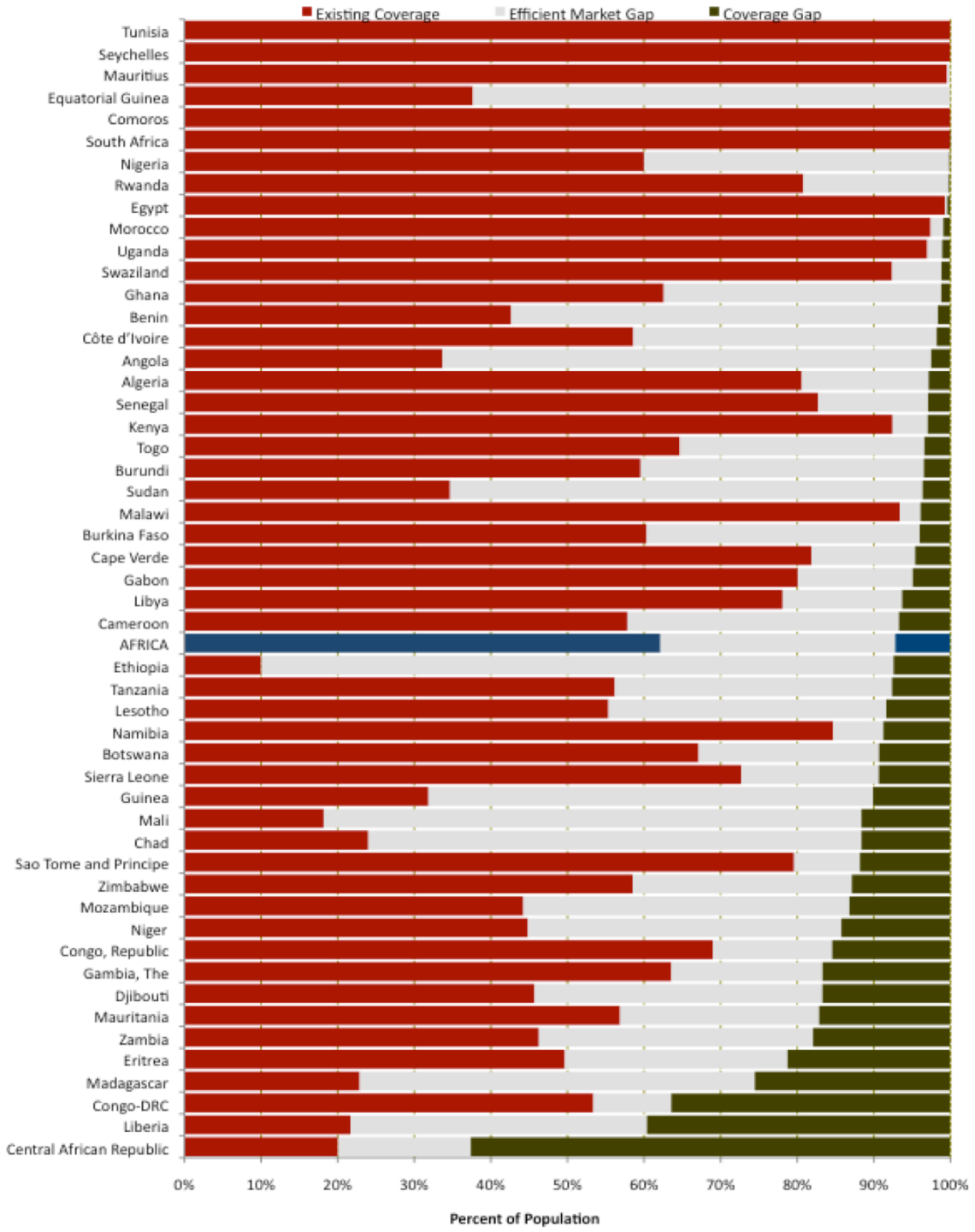
	Efficient-market gap	Sustainable coverage gap	Universal coverage gap
Investment (% of GDP)	0.07	0.03	0.07
Average annual investment ($ millions)	$869.1	$335.2	$869.5
Total investment ($ billions)	$7.82	$3.02	$7.83
Share of population affected (%)	30.6	3.3	3.9

The ratio of current service coverage to the efficient-market gap and the coverage gap varies greatly by country (figure 1). A number of countries have achieved universal coverage for voice services, defined here as mobile infrastructure coverage of more than 98 percent of the population. These countries include Comoros, Seychelles, South Africa, and Tunisia. The projected coverage gap in 28 out of 51 countries falls below the region-wide weighted average of 7.2 percent of the population. However, the gap varies widely among countries. The simple (unweighted) average for the coverage gap in the 51 countries is 9.1 percent of the population with a standard deviation of 12 percent.

According to the results of our analysis, therefore, policy makers in most countries can expect that voice infrastructure will cover more than 92 percent of their population by 2015—*provided they promote effective competition and mobilize private sector resources.*

Figure 1 Results of analysis of gap in voice infrastructure coverage in 51 AICD countries

Bar segments in **red** represent the percentage of the population covered by voice infrastructure as of the third quarter of 2006. Bar segments in **gray** represent the efficient-market gap— the percentage of the population for whom voice telecommunications services are commercially viable given efficient and competitive markets. Bar segments in **black** represent the coverage gap—the percentage of the population for whom services are not viable without subsidy.



Source: Winrock International / Pyramid Research and World Bank.

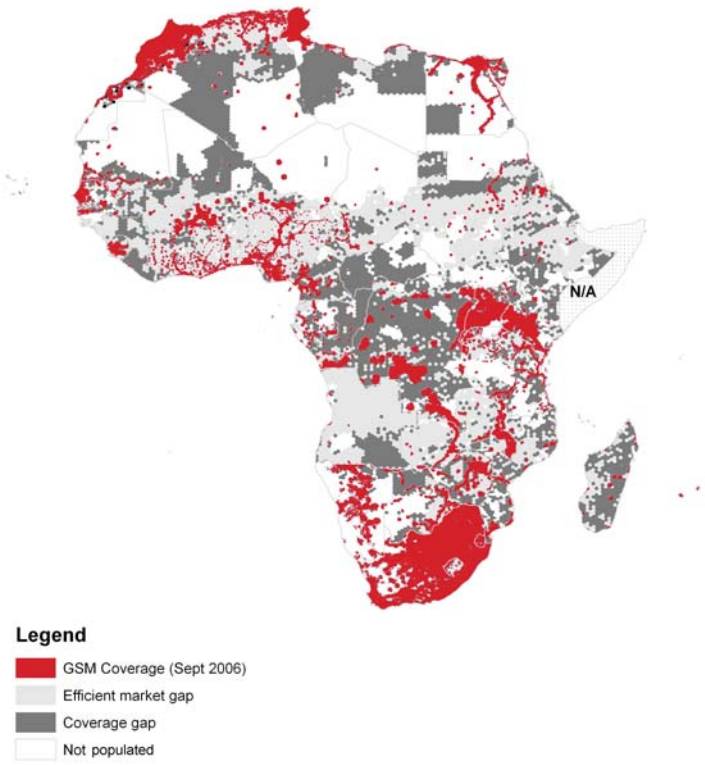
These estimates are premised on the existence of efficient and competitive markets, which cannot be taken for granted. To benefit fully from private investment in commercially viable areas, policy makers should do everything possible to enhance the efficiency and competitiveness of national and regional markets in telecommunications services. Furthermore, the infrastructure costs used to assess viability are based on rules of thumb regarding wireless network planning, and real costs may be quite different in locations that depart greatly from the average. Our results are therefore *our best estimates* of the public funding gap in each country.

The spatial methodology that we used to reach these results pinpoints the areas least likely to be commercially viable because of their particular combination of population density (low), income (low), and terrain (obstructive to wireless signals). The most concentrated areas of nonviability are found in large, poor countries such as the Democratic Republic of Congo, Madagascar, and Sudan (figure 2). Although the geographic areas representing the coverage gap may appear large, it is important to remember that they contain only 7.2 percent of the total population of the 51 countries studied.

Sensitivity analyses performed on the model show that the study's main finding—that the majority of the uncovered population in the 51 countries can be served through the operation of efficient markets—is robust. If the investment costs of voice infrastructure were three times higher than assumed in the model's baseline scenario, the coverage gap would grow from 7.2 percent to 17.3 percent of the population. The private sector could still cover more than 82 percent of the population through efficient and competitive markets. However, the impact on the cost of serving nonviable areas would be more severe. If voice infrastructure costs tripled, the overall cost of closing the coverage gap would more than quintuple to $46.6 billion, or 0.43 percent of GDP.

Figure 2 Gaps in voice infrastructure in 51 AICD countries

Areas in **light gray** represent the efficient-market gap—voice telecommunications services are commercially viable given efficient and competitive markets.
Areas in **dark gray** represent the coverage gap—services are not viable without subsidy.



Source: Winrock International / Pyramid Research and World Bank.

Some countries show much greater sensitivity to changes in the model assumptions than others. This is partly because just over one-fourth of the countries have already achieved a fairly high level of

population coverage (greater than 80 percent), leaving little room for change when model parameters are varied. Population density also seems to influence sensitivity. Nigeria, for example, has a high population density and shows very little sensitivity to either increases in infrastructure costs or decreases in revenue assumptions. On the other hand, Mozambique, Chad, Zambia, and Madagascar all show relatively high sensitivity to changes in infrastructure costs, while the Democratic Republic of Congo and Madagascar are very sensitive to changes in revenue assumptions. To better inform policy debates, regulators and operators from countries that demonstrate high sensitivity to model assumptions are encouraged to produce refined estimates of this study's results by entering precise infrastructure costs and demand data into the model.

Broadband services

Mass access to nonvoice broadband services, particularly in rural areas, is largely unaffordable in most Sub-Saharan countries at current infrastructure costs. This is due to the high end-user costs of broadband connections in areas lack existing copper plant and therefore do not support DSL.

A privately funded approach to building broadband architecture that focused on businesses, wealthy households, and retail outlets for Internet services (Internet cafés and telecenters) could conceivably reach about 86 percent of the regional population. But these results vary widely by country. In the most extreme case, less than 30 percent of the population has the potential for commercial coverage (figure 3).

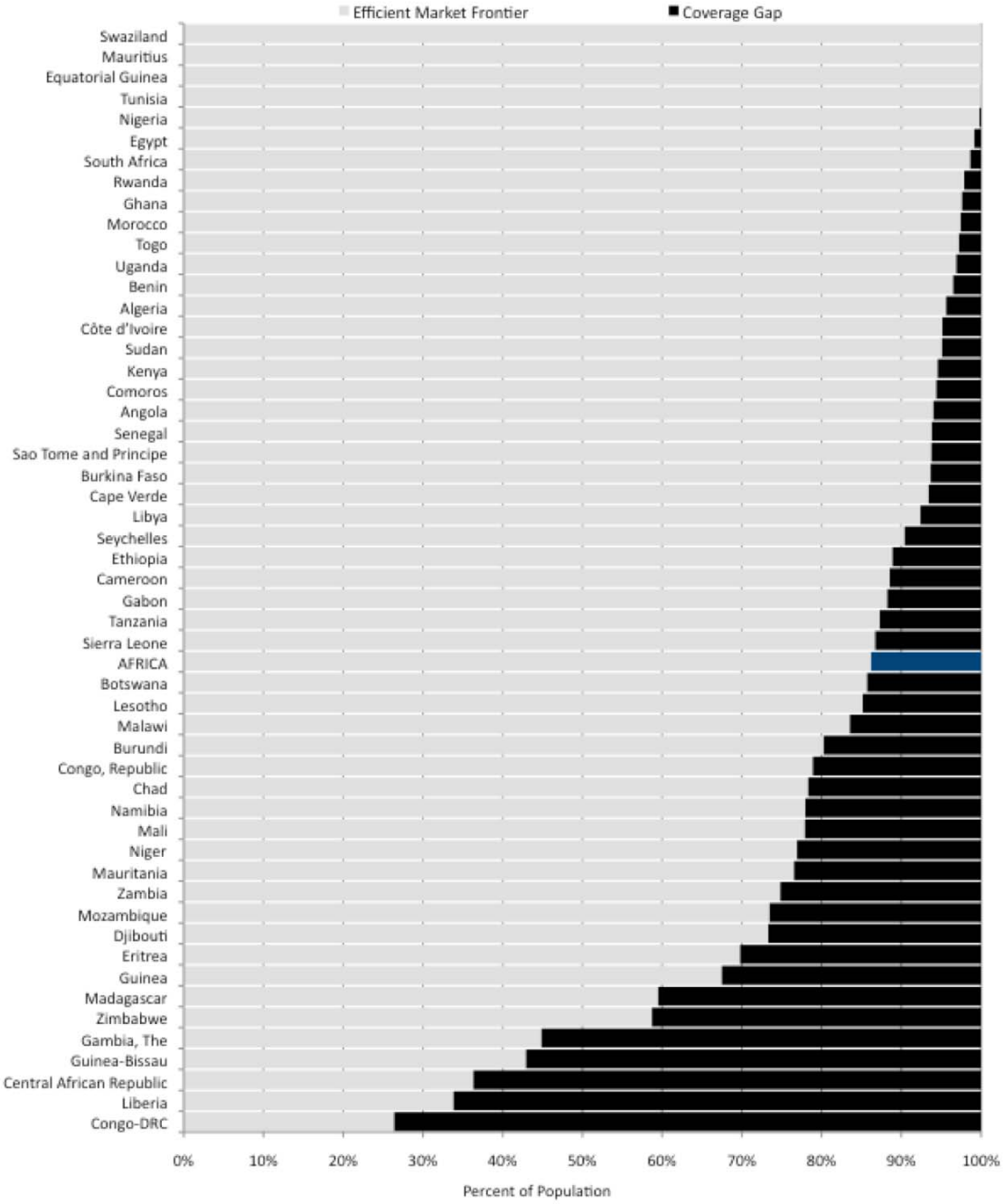
Creating the broadband infrastructure needed to provide universal coverage for the 52 countries would require an investment equivalent to 0.13 percent of GDP through 2015—translating to $13.0 billion, or an average of $1.6 billion per year from 2008 through 2015. The level of investment needed to cover the efficient market (only the commercially viable areas) in the 52 countries is just over half this amount —$7.2 billion, or $904.1 million annually. These estimates do not include the cost of computers, which could be significant, or the operating expense of Internet cafés unrelated to connectivity.

Therefore, closing the coverage gap and extending broadband services to the 13.8 percent of the population living in areas that are not commercially viable would require public investment of $5.8 billion, or $723.9 million per year from 2008 through 2015. The $5.8 billion includes $2.1 billion in initial capital investment and $461.0 million in annual operating expenses. Again, these requirements exclude the cost of computers and the operating expenses of Internet cafés unrelated to connectivity.

Figure 3 Analysis of gaps in coverage of broadband services in 52 AICD countries

Bar segments in **gray** represent the efficient-market gap—the percentage of the population within the service area of broadband infrastructure that is likely to be commercially viable given efficient and competitive markets.

Bar segments in **black** represent the coverage gap— the percentage of the population for whom access to broadband infrastructure is not likely to be viable without subsidy.



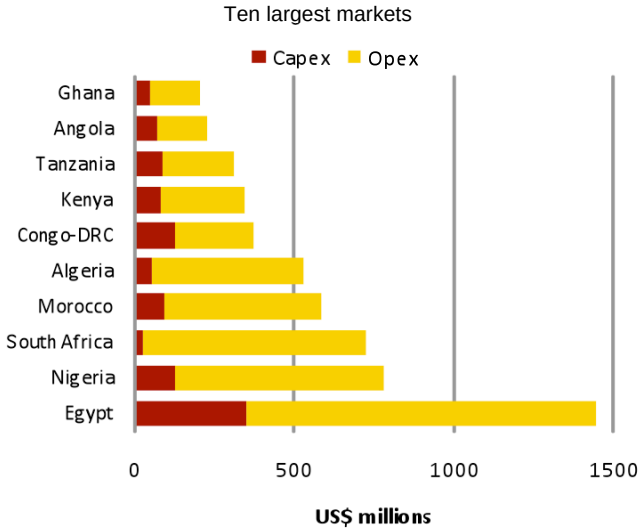
Source: Winrock International / Pyramid Research and World Bank.

Market-driven investment needs

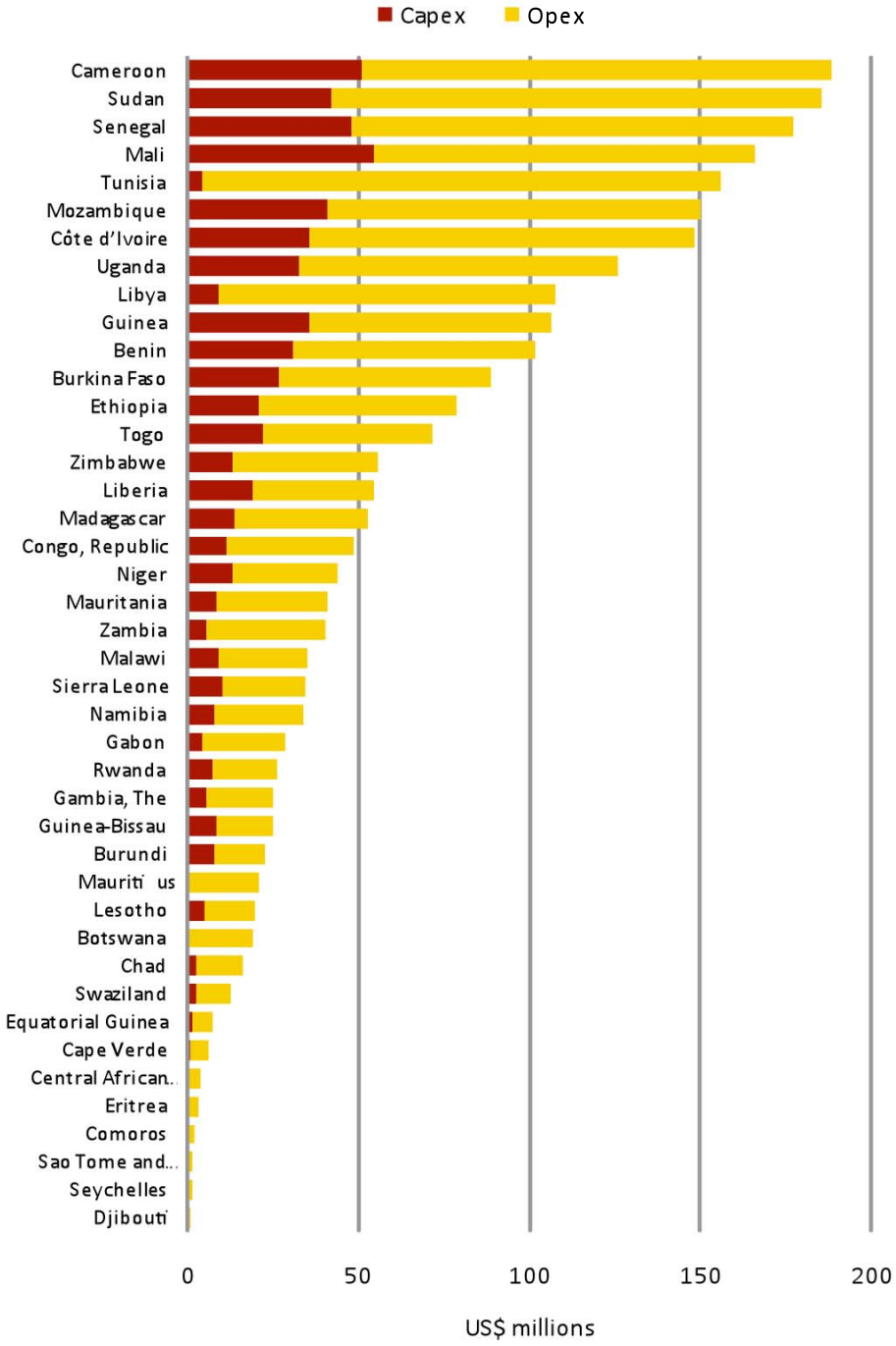
Significant investment is also needed to expand, maintain, operate, and upgrade the capacity of the installed infrastructure base, which presently serves more than 60 percent of the population in Africa and includes most of the urban areas. Investment in urban infrastructure is largely driven by the need for increased capacity rather than the need for wide coverage, which drives infrastructure deployment in sparsely populated areas.

Over the course of the forecast period, 2007–15, market-driven investment in voice infrastructure in the 51 countries considered is expected to reach $8.0 billion annually, for a total of $72.0 billion, or 0.7 percent of GDP. Of this, about one fifth, or $1.7 billion annually, will be required each year for capital expenses, with the remainder spent on operating expenses. Figure 4 provides a breakdown by country.

Figure 4 Average annual market-driven investment in voice infrastructure by country, 2007–15



Remainder of countries

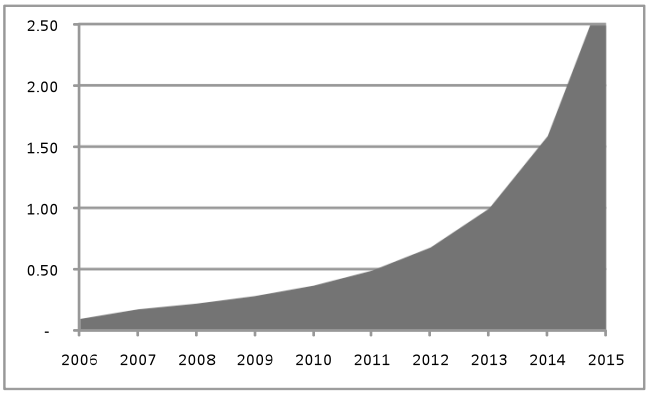


Source: Winrock International / Pyramid Research and World Bank.

Annual market-driven capital investment in broadband infrastructure in the 52 study countries is expected to be around $497.1 million, for a total of $5.0 billion from 2006 through 2015 (or 0.04 percent of GDP). This figure is less than the one presented in the previous section mainly because it does not include operating costs, for which insufficient data are available.

By the end of the forecast period, broadband penetration is expected to reach a regional level of 2.8 broadband lines per 100 inhabitants across the AICD countries—a 29-fold increase from the 2006 level of 0.10 lines per 100 inhabitants (figure 5).

Figure 5 Market-driven broadband penetration forecast for Africa, 2006-2015



Source: Winrock International / Pyramid Research and World Bank.

The cost of regional connections

Africa's need for investment in telecommunications infrastructure presents a key development challenge.

The problem reflects both poor intraregional connectivity and insufficient undersea cables connecting Africa to other areas of the world and to the rich information resources of the global Internet. Ideally, the network of submarine cables surrounding the continent would be completed, ensuring that all coastal countries have access to the intercontinental network At present, Western and Southern Africa have submarine cables, although they do not yet provide full access to all countries. However, there is no submarine infrastructure on the Eastern side of the continent, leading to exceptionally high costs of international communication. In addition, intraregional backbones are needed both to ensure that landlocked countries secure access to submarine infrastructure and to facilitate communications across Africa's main economic regions.

The investment requirements for connectivity expansion are relatively modest (table 2). Based on projects that have already been identified and are already underway, the completion of the intercontinental infrastructure would cost around $1.8 billion, with the private sector playing a major role. Projects currently in the pipeline would probably also cover about half of the intraregional connectivity requirements.

Table 2 Requirements for expansion in intercontinental and intraregional connectivity

	Intercontinental connectivity		Intraregional connectivity	
	Projects	Required investment (US$ millions)	Projects	Required investment (US$ millions)
East Africa	EASSy, TEAMS	260	Connect main hubs within and between subregions, and to submarine cables	51
Southern Africa	Infraco, SRII	510		117
Central Africa	Infinity, GLO-1, WAFS	1,010		75
West Africa				144
Total, Sub-Saharan Africa		1,780		387

Source: Africa Infrastructure Country Diagnostic, 2007 (preliminary findings).

For connectivity within Sub-Saharan Africa, we considered four continental network configurations and estimated the costs for each. To attain a baseline throughput level of 10 gigabytes per second (Gbps), the cost envelope is between $229 and $515 million, or 0.03 to 0.08 percent of GDP for the 52 countries. These investment requirements are relatively modest, and could be met by the operation of efficient markets.

At least 18 major cross-border fiber projects have been proposed throughout Sub-Saharan Africa. In the unlikely event that all of these projects were developed and put into operation, Africa would probably have the necessary infrastructure to absorb future bandwidth demand. Prices would not necessarily be lower, however, especially in markets where transmission capacity is abundant but controlled by telecommunication monopolies, typically state-owned. Therefore, action—such as liberalization of international gateways—will be required to stimulate competition.

Without cooperation between governments (in Africa and elsewhere) and investors, however, the total costs of connectivity expansion could rise quite steeply, and investment might be used inefficiently. Within each country, policy makers have an important role in promoting market entry through operator licensing and spectrum liberalization.

Africa missed out on some of the earlier rounds of infrastructure investment, and it is critical to avoid doing so again. In particular, Africa's future prosperity will depend on its level of integration with the global economy, and this will in turn depend on its connectivity. At the regional level too, as the postwar experience of Western Europe has shown, greater regional integration through trade, communication, and migration can promote economic and social development.