CHAPTER 2

Lessons Learned and Policy Implications

Background / Introduction

Infrastructure planning and implementation involves specific issues of scale, timing and sequencing and relationships between planners, the community and collaborators; between infrastructure and other sectors it enables, and among infrastructure projects.

Some may simply be stand-alone equipment or products. For example, a community health worker might be given a cell phone and a solar lantern for fieldwork. A health clinic might require a few lights, a vaccine refrigerator, a microscope, a centrifuge, a small water pump for an overhead tank, a charging outlet and possibly a computer. A school meals program may benefit from fuel-saving cookstoves in kitchens with improved ventilation. As these examples illustrate, energy, water, and other "infrastructure" technologies often support activities in other sectors and must respond directly to those sectors' needs in terms of size, technologies chosen and the prioritization of their implementation. Other stand-alone technologies, such as a solar micro-grid, portable lanterns, or household cookstoves, may respond less to other sectors' needs, but may require collaborator support in areas such as business development.

Projects with increasing scale and functionality—such as large health centers, schools with computer learning centers, boreholes and larger market centers—tend to depend upon supporting infrastructure with greater capacity and scale, such as road networks, piped water systems, electricity grids, and mobile phone towers and antennae. These may involve higher implementation questions, such as collaboration with entities such as government or the private sector; implementation over long timeframes with multistage, phased construction; and coordination of larger systems, such as electricity and water pumping.

Recurring costs, maintenance, and sustainability are important issues from the outset. Even small systems that function largely in isolation usually require maintenance and recurring costs. Larger systems may initially plan features such as fee-collection systems and government partnerships for maintenance.

Lessons have emerged from the first five years of the MVP as crucial to the implementation of energy and infrastructure programs. Some are applicable at the community level, while others inform broader policy applications.

Lessons Learned from Field Implementation

The following ground-level lessons may be useful for planning and development teams working at roughly the district level, possibly in projects operating in several regions simultaneously.

1. Community linkages and institutional / governmental partnerships are crucial to an accurate and detailed understanding of the area, its needs and existing systems:

- Projects should work with community structures and government demographics and statistics offices to map and assess all settlements, infrastructure systems, and facilities (giving each facility a numerical ID). (See Appendix 1 for a GIS assessment tool)
- Projects should work with existing agencies, NGOs, governments at all levels and national utilities; learn local government systems and identify potential partner organizations to leverage skills, knowledge and government efforts.

2. In the first year, aim for immediate "quick wins" while doing assessments and planning new construction and basic services.

- Equip health workers with cell phones, chargers and portable solar lanterns. Health facilities should have minimum power required for essential services.
- Note gaps in health and education services: areas with poor access to health facilities, low coverage by health workers and poor coverage or overcrowding of primary schools. Plan new facility construction in a manner that leverages procurement at scale and employs low-cost designs.
- Plan school construction to provide the appropriate number of classrooms and gender-segregated latrines.
- Address long distances to cereal grinding/milling (>2km) by working with community/business structures to establish mechanical power services.
- Assess critical gaps in year-round drinking water access. This is the single most challenging task, and requires a combination of community, government and outside expert consultant expertise.

3. Following "quick wins", focus on medium-term project management and design, prioritizing:

- Establish an information management system to share infrastructure project information with multiple participants.
- Work with telecom operators to fill critical network coverage gaps.
- Identify community road and transport problems. Assess whether critical blockages make major roadways periodically impassable. Work with district road officials to prioritize repairs or new construction (culverts, bridges, spot improvements). Where transport services are inadequate, establish a "village vehicle" or similar transport service.
- Consider installing improved stoves in school kitchens to make meals programs more efficient.
- Initiate quick responses to drinking water issues, for example: protect spring catchments, shallow wells or boreholes. Address issues of effective water storage (particularly sub-surface), irrigation and drinking water as a single package.

4. Identify the primary drivers of income growth as high priorities to guide infrastructure planning. For example:

- Integrate electricity planning with plans for irrigation, agro-processing or refrigeration.
- Include transport planning—both roads and services—to ensure access to essential inputs and markets, and health services.

5. Encourage and facilitate standardization and modularization of electricity needs for health/education facilities.

- Difficulty and delay is often caused by an iterative dialogue across multiple specialists to estimate specific electricity needs for numerous, yet fundamentally similar, facilities, then design custom systems for each. An example is the practice of unique and detailed solar PV system specification for each clinic or school.
- Instead, encourage health and education sectors to identify categories of facilities (e.g., health post, dispensary, clinic) with common needs, then modularize the system design by category. Alternately, for facilities of variable size, such specifications would be tied to a clear metric associated with the facility, e.g. the number of classrooms.
- This modularization makes system provision tractable and efficient: Systems can be quickly specified, procured in bulk at a lower cost, and installed with known equipment lists, unit costs and timelines.
- Once such standardized needs and systems are identified, planning at larger scales (district, region or country) becomes easier, particularly with the aid of decision support software that allows data to be easily analyzed or visualized.

6. Local procurement vs. least cost international bulk procurement for solar modules, batteries and associated electronics.

- There are pros and cons to the local procurement of electricity systems (such as standalone or mini-grids). While local procurement supports local businesses, it can also increase costs, particularly in areas where markets are thin and local supply chains are not developed. High costs can force implementers to curtail the number of facilities served, reducing health, education and other MDG-related benefits.
- International bulk procurement, particularly of modularized systems, can reduce unit costs, increasing a project's impact. Moreover, the installation services, local construction materials, and maintenance services can still be locally procured.

7. Regional oversight of infrastructure projects is essential for fast implementation and lasting success.

- Infrastructure planning, especially of novel or unusual technologies, requires skills that may be of limited availability in rural areas, or needed only periodically and for short durations. Hiring experienced engineers/supervisors to oversee infrastructure work at multiple locations can increase effectiveness.

8. The following approaches can help finance initial and recurring costs.

- Public financing is generally necessary for construction of social infrastructure such as clinics, schools and roads. Anticipate the challenge of budgeting and planning for maintenance, since technical staff and transport can be rare and costly in rural settings.
- Local cost recovery is often possible for some portion of the initial expenses (e.g. household fees for electricity connections) and certainly for recurring costs (e.g. electricity tariffs or volumetric pricing of drinking water).
- Innovative ways to provide essential basic services—such as a minimum amount of free potable water or small quantities of electricity at reduced rates (using a "lifeline tariff")—should be investigated and implemented.

9. Planning and budgeting ongoing maintenance.

- Funding maintenance varies by location, sector, and project.
- In principle, grid electricity infrastructure is maintained by a utility, which recovers this cost through tariffs.
- For roads, this modality is generally not feasible, so one might need to budget as much as 10% of the

initial cost as an annual recurrent expenditure. Where possible, local support (particularly government ministries) should be enlisted for future maintenance. Where necessary (i.e. local support is not sufficient) budget should be allocated for continued support of large infrastructure even after the project ends.

- For water infrastructure, especially drinking water, key challenges are obtaining information on quantity of use and system condition, and ensuring timely repair of pumps that can be numerous, dispersed and difficult to reach. Here, novel information and communication technologies (as discussed below) can be vital.

10. New information and communications technologies enable improved infrastructure planning, data collection and management.

- Portable technologies such as smartphones and "tablet" computers that often connect to wireless networks (WiFi, mobile phone) can streamline and accelerate data gathering. These can be combined with data management systems to improve data compiling, monitoring and reporting. Examples include: ChildCount, Open Data Kit (ODK), and the SharedSolar Gateway.

- Planning and decision support tools, such as NetworkPlanner, can help to cost-effectively plan systems to meet infrastructure needs with strong geospatial components, such as electricity networks, or water kiosks.

Policy Implications

Many important issues relate to balancing objectives of, on the one hand, provision of key services and, on the other, establishing a sound basis for economic growth. Given the limited resources of development practitioners, tradeoffs must be considered in prioritizing physical facilities for social needs (schools and clinics) versus systemic infrastructure such as roads, ports, energy and irrigation. Local politics may advocate infrastructure for social services as a visible sign of local progress, since often governments or parastatals have failed to deliver on systemic infrastructure, even after the supposed investments have been made. This is especially true in places where the rural poor are the primary beneficiaries and recognize the immediate necessity of the services provided by schools and clinics, and there is hope that those facilities will in turn bring teachers and health workers.

Systemic infrastructure, on the other hand, can serve as an engine of broad economic growth, potentially lowering transport and processing costs, and allowing for—at least in principle—the idea that such infrastructure for electricity can be well maintained by a utility and hence lower energy costs. The argument is that with raised income levels, populations are better able to feed themselves, the nation can generate internal resources to fund wider facility construction, and the infrastructure makes it easier to attract skilled personnel for the provision of social services. Furthermore, the creation of systemic infrastructure reduces the costs of stand-alone systems.

Given the urgency accorded to health and education in the MDGs, a rapid roll-out of a stand-alone system is sometimes seen to provide an immediate solution, particularly since progress in systemic infrastructure has proven sluggish.

Alongside electricity, roads and water networks, information and communications infrastructure is growing rapidly. The latter includes not only mobile telephony and mobile data, but also systems for mobile exchange, banking and credit, as well as data gathering and software for information tracking and data management. These new systems are becoming increasingly important to enhance opportunities for the poor and improve the efficiency and transparency of the development processes.

The following policy lessons are drawn both from experience gained from on the ground implementation and in working with governments, utilities, international banks and donors, and other key participants and stakeholders.

ENERGY

Electric power has historically been the most difficult infrastructure to implement in Sub-Saharan Africa (SSA), despite leaders in government and international development banks recognizing its critical importance to development. Electricity is among the most politicized sectors. Moreover, the pervasiveness and rapid expansion of cellular telephony have raised expectations for governments to deliver high-quality electricity services to rural areas of SSA.

Africa faces a double disadvantage when it comes to grid extension. The density of demand is low, due to low population densities and the often dispersed nature of settlements; and the unit cost of deployment is high due to thin markets, emerging industrial capacity and the high cost of transport. Implementers must take advantage of high densities where they do exist, while at the same time addressing cost reductions through proper design and procurement.

Rural households are willing and able to pay for reliable electricity: A common assumption is that the poor cannot pay for power. However, initial household survey work in the MVP shows that a significant proportion of rural households might be willing to spend as much as $5 per month on electricity if each household had a wire to the home. Instead of a large backbone of transmission lines, one option is to explore a more decentralized generation option paired with low voltage distribution lines. This approach allows the early deployment of low wattage "micro-grid" systems (less than an amp or so at 220V), which are modular and can be scaled up as demand grows and investment capital becomes available. An intermediate-scale investment in small micro-grids creates an "incremental infrastructure" approach that is smaller and more automated than typical diesel mini-grids, making management easier and more cost-effective.

Good Management and Recovery of Recurrent Costs: Many countries have split vertically integrated electricity monopolies, separating them into 1) power generation, 2) power transmission and 3) power distribution, as is the widely accepted best practice today. Ensuring that recurrent costs are recovered can ensure financial health of utilities. Cost control and the accelerated rollout of electrification, especially in dense areas, can further strengthen utilities.

Develop Regional Linkages for Cross-Border Electricity Distribution: Africa still has substantial low-cost energy sources, such as hydro and geothermal sources that are yet to be developed. In addition, new developments in technology and learning allow energy sources to be tapped with a much lower environmental impact than decades earlier. These hydro and geothermal resources necessarily require multi-country transmission systems. The World Bank and the African Development Bank have been successfully working towards increasing regional connectivity through encouraging dialogue and developing some important regional linkages. Stronger cooperation among countries will lead to lower cost electricity for both the power supplier and the recipient countries.

Address the factors limiting IPPs in Africa: Independent Power Producers (IPPs) have the potential to flourish in Africa, provided that uncertainty and long waiting periods for new energy projects can be reduced, providers can have more autonomy in tariff setting, and assistance with project preparation can be provided. Removing such barriers would enable increased private sector engagement in IPP contracts, working together with small franchisees, allowing numerous "medium scale" (10 MW to 200 MW) power generation projects to come online to meet rural power needs. The following could enable this process:

- **Create a Core Team of Specialists to Facilitate the Entry of IPPs:** There is a need for a "broker" between the government and the private sector that does the due diligence of assessment, project preparation and economic analysis. This assistance could be provided by a team—or "project preparation facility," at an organization such as the World Bank or AfDB—that would build planning capacity and develop projects in countries throughout SSA, preferably in the form of prospectuses for energy sector wide programs. The proposed team would work closely with national energy ministries, utilities, and other relevant planning entities to gather national and multi-country data, then deploy software and decision support tools to assist planning. Currently, valuable time and financial resources are lost contracting for these skills. Moreover, electricity planning work gets repeated without a deeper accumulation of knowledge or capacity building at the national level. In contrast, the proposed "facility" would have the institutional longevity to build a base of experience and knowledge, both regionally and in individual countries, while establishing local partnerships in universities and research institutes.

- **Medium-Scale IPPs can be Attractive Investments when Costing is Done Correctly:** There are many potential "medium scale" hydro, wind, solar-hybrid and biomass projects on the African continent whose construction and technical implementation can be done quickly, but which face lengthy and complex start-up processes. Though they are "medium scale," the processes and scrutiny for these IPPs are similar to those of larger projects. This results in high transaction costs relative to the project's size, fostering reluctance to adopt IPPs. In effect, upfront investment of money and time is squelching potential opportunities. These medium-sized projects could be designed with the technical assistance of the team or "facility" proposed above in order to reduce the risks and costs that the private sector faces in gathering all the information to determine the viability of these IPPs. These medium-scale IPP projects start to look financially attractive when it's not forced to bundle in reinforcements of existing transmission systems, and when it's allowed to locally charge higher tariffs for electricity in more remote areas. Project viability would be further improved by incorporating technologies that improve cost-recovery, such as the best tamper-proof distribution, prepayment meters, and efficient end-use appliances.

Urban-Rural Linkages are Crucial: While much of the discussion about solving solving agro-processing and energy challenges is about rural areas, an urban focus is also important. Urban areas are engines of non-agricultural growth, and entrepreneurial activities in these areas tend to be much higher. In this vibrant setting, it is critical that industry, manufacturing and services all have reliable infrastructure and services, since unreliable electricity, water and transport can hinder competitiveness. Urban-rural linkages are also crucial for rural areas, creating opportunities for rural investment, income generation, acquisition of new skills and talent. However, network infrastructure expansion into rural areas should be supported by other necessary improvements, such as added generation capacity to supply electricity demand in rural areas.

Modern Household Energy Technologies Can Be Introduced To Rural Areas Through Market-Based Programs: Experience in the MVs shows that small, household-scale modern energy products can be distributed through market-driven systems.

- **Households will pay full cost for solar rechargeable LED lanterns.** Multiple manufacturers offer portable LED lighting devices with solar panels, a rechargeable battery and charge-discharge control circuitry at a total retail cost of less than $50, which provides more light at the same or lower cost relative to kerosene lighting. Households have purchased these at full price and used them for durations of a year or more, giving consistently favorable reports of usability and quality.

- **Households will pay for improved stoves with some subsidy.** Improved, imported cookstoves, with high quality control in manufacturing, offer fuel savings of roughly 30-35% relative to the traditional three-stone fire. MVP programs have verified that households will purchase these stoves, typically at ~50 percent subsidy.

- **Supply chains are the primary challenge:** Availability, not cost, has been the key limiting factor in sales of both lanterns and stoves. For sales to scale rapidly, supply chains for sales and service (including battery replacement and warranty fulfillment / replacement for faulty appliances) require rapid scale-up to reach beyond towns and cities all the way to the village level.

- **Favorable tax policies for these technologies are a key factor in maintaining affordability:** Import duties, VAT, and similar costs add up quickly to make lanterns and stoves unaffordable to many village-level consumers. Exemption of household energy products from these costs can help sales expand rapidly.

ROADS AND TRANSPORT

- **Spot improvements are typically a cost-effective manner of improve road networks:** Targeted improvements toward specific infrastructure (culverts, bridges) or impassable segments of roads can improve transport quickly and cost-effectively.

- **Planning Must Account for Maintenance Costs:** In rehabilitating and constructing roads in the MVP, it is clear that roads projects do not stop after the original investment. Roads need to be maintained, and these maintenance costs are generally about 10% of the total cost of the road.

- **Particularly for remote localities, interventions that fill gaps in transport services can have important impacts at relatively low costs:** A "village vehicle" that offers cargo transport services can reduce costs to reach distant markets and improve incomes for villagers while recovering some costs through user fees. Other transport services that can advance the MDGs include time-saving means to get to school; ambulance services for medical emergencies; or less burdensome means of local transport (such as "intermediate" technologies like carts or bicycles)

WATER AND SANITATION

- **Governments in sub-Saharan Africa typically lack funds for capital investments** to meet the water- and sanitation-related MDGs, and most countries rely heavily on donor financing to fill this budgetary gap. But conditions placed on donor funds may require African governments reprioritize their own budgets and workplans, sacrificing control over projects and budgeting[3].

National and local governments have a number of alternatives when drafting water supply development plans. Appropriate solutions vary tremendously from place to place, depending on numerous factors, such as water resources, socio-economic standing of the users, existing infrastructure, availability of energy and topography. This high variability means that there is typically no simple method based on demographic data alone to estimate the costs or type of water infrastructure. In most cases, local expert knowledge is required to evaluate the multiple variables that will inform the choice-of-technology.

- **Technology now Exists to Make Lifeline Tariffs Viable:** Historically, "lifeline tariffs"—provisions to supply a certain minimal quantity of water daily at little or no cost -- have been difficult to implement at existing kiosks due to the high costs of monitoring. Now, emerging technology that allows for remote monitoring of consumption can reduce costs and increase the feasibility of creating lifeline tariffs at water points.

Role of information management

Though often overlooked in infrastructure deployment, information management can enable project planning, implementation and management, by, supporting efficient communication between all levels of

3. Campos, Ed and Pradhan, Sanjay, Budgetary Institutions and Expenditure Outcomes: Binding Governments to Fiscal Performance (September 1996). World Bank Policy Research Working Paper No. 1646

Bicycles as an intermediate form of transportation, Mwandama, Malawi

development organizations, governments and the public, and facilitating transparent financial management within projects. Greater access to information and communication technologies (ICT) has demonstrated numerous livelihood benefits. Information technologies—such as mobile phones, Internet connections in schools and community centers and radio—can enable training of health, education, agriculture, and water personnel. They can allow better management of health delivery systems. Timely information on markets and prices, weather, and off-farm labor can also aid livelihoods. ICTs can be used to improve access to credit and remittances, as well as information on creating and managing businesses. Health benefits may include more timely access to emergency medical transport and services as well as better health information. Radio instruction and Internet access can further education while better access to communications empowers people, increasing the impact of stakeholders' voices. These benefits are often inter-related, and may involve more than one ICT technology. For example, a community radio program links listeners to the Internet in response to requests from callers using mobile phones. Electricity can be supplied using prepaid electricity transactions with a "pay-as-you-go" model that does not regressively penalize small purchases. A Web-based system can provide status of maintenance complaints and real time performance statistics. ■