Addressing the Electricity Access Gap

Background Paper for the World Bank Group Energy Sector Strategy

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Acknowledgments

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Abbreviations

AEI	Africa Electrification Initiative
CODE	Committee on Development Effectiveness
COES	*Comité de Operación Económica del Sistema Interconectado* (Committee of Economic Operation of the Interconnected System of Peru)
CO_2	carbon dioxide
DEP	*Dirección Ejecutiva de Proyectos* (Executive Office of Projects, Peru)
DGER	*Dirección General de Electrificación Rural* (Rural Electrification Office, Peru)
EDENOR	*Empresa Distribuidora y Comercializadora Norte Sociedad Anónima* (North Distribution and Marketing Company, Argentina)
EDESUR	Empresa Distribuidora Sur Sociedad Anónima (in Argentina)
EEPCo	Ethiopian Electric Power Corporation
ENRE	*Ente Nacional Regulador de la Electricidad* (National Electricity Regulating Body Argentina)
ERAV	Electricity Regulatory Authority of Vietnam
ESMAP	Energy Sector Management Assistance Program
EUEI	European Union Energy Initiative
EVN	Vietnam Electricity
€	Euro
FONCODES	*Fondo Nacional de Cooperacion para el Desarrollo* (National Fund for Compensation and Development, Peru)
FOSE	*Fondo de Compensación Social Eléctrica* (Electricity Social Compensation Fund, Peru)
FY	financial year
GDP	gross domestic product
IEA	International Energy Agency
IEG	Independent Evaluation Group (of the World Bank)
kW	kilowatt
kWh	kilowatt-hour
MALT	*mise a la terre* (grounding)
MEM	Ministry of Energy and Mines
OBA	output-based aid
ODA	official development aid
OECD	Organisation for Economic Co-operation and Development

OSINERGMIN	*Organismo Supervisor de la Inversión en Energía y Minería* (Supervisory Agency for Investment in Energy and Mining of Peru)
PC	(EVN's distribution) power company
PEA	Provincial Electricity Authority (Thailand)
PV	Photovoltaic
REA	rural electrification agency
REB	Rural Electrification Board (Bangladesh)
REF	rural electrification fund
SMEs	small and medium enterprises
SHS	solar home system(s)
STEG	Société Tunisienne de l'Electricité et du Gaz (Tunisian Electricity and Gas Company)
SWER	single-wire earth return
$	dollar
UN	United Nations
UNDP	United Nations Development Programme
W	Watt

All dollar amounts are U.S. dollars.

Executive Summary

Achieving universal access to electricity is one of the most important goals set for the energy sector by governments in the developing world. Electricity alone is not sufficient to spur economic growth, but it is certainly necessary. Access to electricity is particularly crucial to human development, as certain basic activities—such as lighting, refrigeration, running household appliances, and operating equipment—cannot easily be carried out by other forms of energy. Sustainable provision of electricity can free large amounts of time and labor and promote better health and education. Electrification can help achieve economic and social objectives.

Access Gap

The International Energy Agency (IEA) estimates that 1.5 billion people lacked access to electricity in 2008, more than one-fifth of the world's population. Some 85 percent of those without electricity live in rural areas, mainly in Sub-Saharan Africa and South Asia (Table E.1). There are large variations in electrification rates across and within regions. Transition economies and countries belonging to the Organisation for Economic Co-operation and Development (OECD) have virtually universal access. North Africa has an access rate of 99 percent, Latin America 93 percent, East Asia and the Pacific 90 percent, and the Middle East 89 percent. By contrast, South Asia has an electrification rate of 60 percent and Sub-Saharan Africa only 29 percent. The populations without electricity in these two regions account for 83 percent of the total world population without electricity. Sub-Saharan Africa has by far the lowest urban and rural access rates at 58 and 12 percent, respectively.

Table E.1: Access to Electricity in 2008

Region	**Population without electricity** millions	**Electrification rate,** %	**Urban electrification,** %	**Rural electrification,** %
Africa	589	40.0	66.8	22.7
North Africa	*2*	*98.9*	*99.6*	*98.2*
Sub-Saharan Africa	*587*	*28.5*	*57.5*	*11.9*
Developing Asia	809	77.2	93.5	67.2
China & East Asia	*195*	*90.2*	*96.2*	*85.5*
South Asia	*614*	*60.2*	*88.4*	*48.4*
Latin America	34	92.7	98.7	70.2
Middle East	21	89.1	98.5	70.6
Developing countries	**1,453**	**72.0**	**90.0**	**58.4**
Transition economies & OECD	**3**	**99.8**	**100.0**	**99.5**
World	**1,456**	**78.2**	**93.4**	**63.2**

Source: www.worldenergyoutlook.org/database_electricity/electricity_access_database.htm.

The relatively high average access rates in certain regions mask problems in some sub-

regions and individual countries. In East Asia, Myanmar has an overall access rate of only 13 percent, Timor-Leste 22 percent, Cambodia 24 percent, and the Democratic People's Republic of Korea 26 percent. In Sub-Saharan Africa, some countries have notably low rates: Burkina Faso, the Democratic Republic of Congo, Malawi, Mozambique, Tanzania, and Uganda have an overall access rate of about 10 percent, with rural access below 5 percent on average (IEA 2009).

Considerable progress has been made in some regions, but significant challenges remain. Achieving sustainable universal electricity access by 2030 may be very difficult in many countries. It is evident that an even stronger focus on electricity access is necessary to meet the needs of the poor and overcome this constraint on development.

Barriers to Electrification

There are several reasons why closing the electricity access gap remains an unfinished agenda.

- ***High costs of supplying rural and peri-urban households***. Most rural communities, as well as many peri-urban areas, are characterized by a low population density and a very high percentage of poor households. Demand for electricity is usually limited to residential and some agricultural consumers, and many households consume less than 30 kilowatt-hours (kWh) per month. The combination of these factors results in high costs of supply for each unit of electricity consumed.
- ***Lack of appropriate incentives***. The high costs of electricity supply in rural areas and the limited capacity of households to pay for the service make it difficult to attract investment in rural electrification. To do so requires a system of tariffs and subsidies that ensures sustainable cost recovery while minimizing price distortions. However, such a revenue-generation scheme is absent in many countries. All too often, tariff subsidies are designed to favor the large majority of consumers, including the well-off, while failing to provide utilities with incentives to invest in rural electrification. Such ill-designed tariff schemes are found is particularly in Sub-Saharan Africa, where subsidies applied to residential consumers are highly regressive (Foster and Briceño-Garmendia 2010).
- ***Weak implementing capacity***. Adequate design and effective implementation of a rural electrification program requires technical and managerial skills that are not always available. Countries committed to extending electricity access need to go through an initial period of strategy development and capacity building. This process may entail new or amended legislation, institutional strengthening, planning, and establishing technical standards and regulatory procedures tailored to the nature of rural electrification.
- ***Electricity generation shortage***. An obstacle to rural electrification in many countries with low access rates is insufficient generation capacity of the main electricity system. Most countries in South Asia are experiencing permanent load shedding. More than 30 countries in Sub-Saharan Africa suffer from systematic generation shortages (Foster and

Briceño-Garmendia 2010). It is unrealistic to expect these countries to make more than modest gains in increasing electricity access by means of grid extension until the capacity constraint is eased. Off-grid electrification has the advantage of not being affected by this capacity constraint.

- ***Population growth***. A further challenge in certain countries is the growth of their rural population. While the migration of population from rural areas to cities is accelerating in the developing world, the impacts of this trend on requirements for rural connections are offset by rising demand due to population growth: in low-income countries, rural population will increase in number to 2040 (UNPD 2007).

Providing sustainable electricity supply of acceptable quality to the 220 million urban residents who currently lack that service faces similar barriers to those in rural areas. These include low household income and low consumption levels, usually exacerbated by pricing and subsidy schemes that give few, if any, incentives to service providers to deliver good-quality supply. Illegal connections and electricity theft are common, as many households are not able to pay cost-reflective tariff rates. Theft is also significant in slums and areas with informal settlements, whose inhabitants often do not meet the legal requirements to become regular customers of the electricity company.

While the various obstacles described above are significant, they have not prevented the achievement of near-complete electrification in most countries in the transition economies, East Asia, Latin America, and the Middle East. However, the challenge is greater in low-income countries where electrification rates are usually much lower and institutions tend to be weaker.

Meeting the Challenge

The IEA estimates that, with appropriate policies, universal access to electricity could be achieved by 2030 with additional annual investment of $35 billion (in 2008 U.S. dollars). This amount is equivalent to 6 percent of the global power-sector investment projected in the Reference Scenario (in which no new policies affecting the energy sector are implemented after 2009), and the added investment would be needed mostly in Sub-Saharan Africa and South Asia (IEA 2009).

The World Bank estimated in 2006 that $860 billion would be needed to connect 600 million additional households to achieve universal access by 2030. These figures (Table E.2) are far above the current levels of investment. There is, therefore, a large financing gap that will be very difficult to be closed. It may not be realistic to expect that such a large amount would be mobilized during the next two decades, particularly in low-income countries where the electrification effort competes with other pressing social and infrastructure needs.

Table E.2: Investments Required for Universal Electricity Access by 2030

	Households requiring access (millions)	**Required investments** distribution	gen./trans.	total	annual
		($ billion)			
Sub-Saharan Africa	200	193	87	280	11
Middle East	40	58	20	78	3
South Asia	335	225	150	375	15
East Asia & Pacific	100	122	47	169	7
Latin America & Caribbean	50	60	26	86	3
Total	**595**	**587**	**271**	**858**	**34**

Source: Bank staff calculations.
Note: gen./trans. = generation/transmission.

The extension of the electricity distribution grid is often the cheapest way to reach new consumers and increase access rates. Off-grid technology options—mini-grids or individual systems—are appropriate to supply populations living in areas far from the existing grid and/or with demand too small to justify the fixed cost of extending the grid. While a purely economic assessment of grid extension or an off-grid solution in a specific case could easily be carried out, governments' decisions on expanding electrification are based on many country-specific political, social, and economic factors, including equitable regional development. In most countries, between 80 to 95 percent of the unserved communities are targeted to receive electricity supply through grid extension.

The increase in primary energy demand and the emissions of carbon dioxide associated with universal access would be very modest even if a significant shift to renewable energy is not achieved. The IEA estimates that bringing electricity to those without access, assuming no change in the fuel mix, would increase carbon dioxide (CO_2) emissions by 1.3 percent in 2030 (IEA 2009). In Africa, where the added generation would be the greatest, CO_2 emissions would increase by 13 percent in 2030. However, per capita emissions in Africa, at 1.4 metric tonnes, would still be about one-tenth of the average in the OECD in 2000 (IEA 2003).

The Way Forward

This paper draws from the documented cases of more than twenty countries in addressing the electricity access gap under different country circumstances, complemented by specific assessments of electrification efforts in Peru, Vietnam, and Sub-Saharan Africa.[1] Analyses of different country experiences help identify the factors contributing to successful electrification, distill lessons on good practice, and propose a way forward.

[1] Sources of case studies and lessons in electrification included *The Challenge of Rural Electrification: Strategies for Developing Countries* (Barnes 2007), *Designing Sustainable Off-Grid Rural Electrification Projects: Principles and Practices* (World Bank 2008a), and the draft report "Review of Experiences with Rural Electrification Agencies: Lessons from Africa" (Mostert 2008).

Successful as well as failed experiences worldwide show that a sustainable approach to electrification must take account of the following key aspects:

- **Sustained commitment of the government to supporting electrification as a priority development objective constitutes the most important feature of successful electrification programs**. A long-term commitment (at least 15 to 20 years) to electrification is a crucial step that frames the institutional, technical, economic and financial design and implementation of specific programs. If the commitment is absent, electrification programs will not move forward and will not be sustainable.

- **Although universal access makes sense from economic and equity perspectives, its financial viability is often uncertain.** The financial viability of electrification for those without access usually requires subsidies to cover part of its capital and/or operating costs, as many unconnected households cannot pay fully for the cost of electricity service. Whether and how to subsidize those who are not able to pay—through funds provided by taxpayers, cross-subsidies from better-off residential consumers or non-residential customers—is a country-specific issue for which there are no superior approaches applicable under all circumstances. It is up to each country to formulate its own strategy, including what priority to allocate to electrification and the type and level of subsidies provided, on the basis of its social, economic, and political conditions.

- **Extending access is particularly challenging for low-income countries with low electrification rates.** Once a country reaches a medium level of electrification and a certain income level—for example, 50 percent electrification and an average per capita income above $3,000 (valued at purchasing power parity)—it becomes easier to achieve universal access because there is an increasing critical mass of taxpayers and electricity consumers able to provide the funds needed to make electrification financially sustainable (Rysankova et al. 2009; Mostert 2008). The challenge is tougher in low-income countries where available resources and the numbers of consumers and taxpayers capable of contributing to subsidies tend to be limited. This situation is often aggravated by poorly performing utilities and regressive pricing policies subsidizing those who can afford to pay cost-reflective tariffs and contributing to systematic deterioration of the operational and financial state of the power sector and its institutional capacity. The consequence is a perverse situation, in which higher-income consumers receive benefits they do not need (through subsidized rates and/or unbilled consumption), leaving few or no resources to expand access. However, outstanding cases of success among low-income countries, as in Bangladesh and Vietnam, clearly illustrate that it is possible to overcome these difficulties through sustained government commitment to a long-term approach with arrangements and procedures that maximize efficiency in the design and implementation of policies, strategies, and programs aimed at expanding access, combined with actions to improve the existing tariff systems and subsidization schemes, as well as in the operational performance of utilities in charge of service provision.

- **There is no evidence for the superiority of any specific institutional model for electrification.** There are successful cases based on public, private, and cooperative models and schemes, as well as rural electrification agencies. A key element seems to be the definition and enforcement of an institutional framework consistent with the country's strengths and the nature of the problems faced, so as to use the limited resources available in an efficient manner. The management of the rural electrification programs requires the leadership of a strong entity, which could be either a distribution utility or a specially designated agency, with an efficient administration and the technical capacity to support the supply chain of contractors and small service providers. Countries have been able to succeed in their electrification efforts using diverse institutional approaches, provided that their programs and strategies include institutional, technical, economic, and financial design and implementation arrangements ensuring their sustainability; efficient execution; and financial and operational sustainability.

Framework Design: A Government Role

Appropriate approaches for institutional, technical, and economic design and implementation are crucial to carry out access expansion programs. Those approaches must cover tasks such as identification of the areas/population to be reached, definition of the components of the investment program (comprising technological options to be applied), methods for economic and financial evaluation (including criteria for assigning priorities), procedures for effective implementation and monitoring, and identification of sources of revenues needed to carry out investments and ensure service sustainability. For each task, it is necessary to set with clarity and apply with transparency the methods and procedures to be followed, including a precise definition of roles and responsibilities of stakeholders involved (government agencies, beneficiaries, incumbent service providers, contractors, non-governmental organizations, and so on). Public disclosure of all the phases in each specific program, from early design to effective execution, and active dissemination of this information can help ensure economic and financial viability of electrification efforts and to protect them against the risk of undue political pressures and discretionary decision-making. Because the cost of providing electricity to rural households is usually high, optimized design, including detailed planning, becomes all the more important. Failure to carry out any one of the above tasks may render a program unsustainable or leave it in the identification phase, as shown by several examples worldwide.

Planning of electricity access programs is a government role that has to be carried out by a capable, and usually centralized, government entity. Building such an institution often requires significant technical support and assistance, which donors are usually able to provide. Common features of successful rural electrification planning include

- a clearly established system to prioritize the areas to electrify and the projects to be selected;

- a long-term multiyear vision aimed at coordinating grid extension and off-grid efforts that should be supported by studies on the optimization of technology options and a grid/off-grid comparative economic analysis, and publicly disclosed market studies;
- a broad regional development approach that takes into account other conditions for rural development (access to education and health services, an adequate transport system, agricultural potential, access to markets, and the capacity of the local manufacturing industry); and
- the design and effective implementation of an institutional framework clearly establishing the roles and responsibilities of the public and private agents involved.

Whichever the approach adopted by a country, the planning of rural electrification programs and criteria for project selection in each program should be established upfront through clear, transparent, and publicly disclosed rules. Each country decides how to prioritize electrification investments among competing regions and/or projects on the basis of its own values, aiming to strike a balance between their economic efficiency and equity objectives. Countries engaged in the "last push" of electrification (e.g., Brazil, Chile) often give priority to the poorest regions. Conversely, countries in the early stages (e.g., Bangladesh) are naturally inclined to heed the financial viability of the investment.

The planning process may give consideration to the following:

- **Grid extension and off-grid options are not mutually exclusive and could be implemented in parallel and, under specific conditions, in sequence**. Grid extension is often the cheapest way to connect new users located not too far from existing networks and relatively easy to implement. Off-grid electrification—mini-grids or individual systems—is suitable in remote areas unlikely to be connected to the grid in the foreseeable future, provided that sustainable supply is guaranteed. In fact, all cases of success reviewed in this paper are based on extension of the grid, complemented, to varying degrees, by supply to isolated rural communities through mini-grids powered by diesel and/or mini-hydro generators. Individual systems, such as solar home systems, are suitable when grid extension and mini-grids are not viable and the expected consumption of households is very low. However, since they provide a limited amount of electricity, solar home systems should be considered an initial transitory, though sometimes long-lasting, step toward a mini-grid or integration into the national grid. Individual systems are likely to be a long-term transitory option for rural populations in countries that currently have very low access rates (mainly in Sub-Saharan Africa), as the service they provide can represent a clear improvement in the quality of life of beneficiaries, even without reaching service levels only achievable through grid connection.
- **Non-conventional renewable energy systems (solar, wind) can complement other sources (diesel, mini-hydro) in ensuring firm energy supply in mini-grids**. Scaling up the use of renewable energy in the energy supply mix of mini-grids should be promoted,

depending on effective availability of those resources and economic and financial viability of their exploitation.

- **Technology choices in off-grid electrification are not relevant in global environmental terms. Therefore, an off-grid technology-neutral approach should be encouraged**. A greater number of technology choices (including diesel mini-grids) is more likely to yield lower costs and a solution more suitable to the community's needs. Such an approach often requires removing regulatory barriers to specific technologies.
- **The planning process should assess the potential for productive uses of electricity and include measures for their promotion**. The experience of several countries, including Bangladesh and Thailand (Barnes 2007), suggests that promotion of and capacity building for productive uses of electricity in rural areas can increase the productivity of rural businesses, enable a more efficient use of the supply infrastructure, and improve the revenues of distribution companies, thereby enhancing the economics of electrification.
- **Local communities should be involved in the planning process of rural electrification programs**. The review of case studies shows clearly that rural electrification programs benefit greatly from local community participation. Involving local communities from the start can help improve the design (Peru, Vietnam), gain local support (Bangladesh), mobilize contributions in cash or in kind (Nepal, Thailand), and increase local ownership, contributing to operational sustainability. In fact, many of the successful experiences have made combined use of top-down and bottom-up initiatives.
- **Incorporating low-cost technologies in the planning and design stage can enable construction costs to be reduced by up to 20–30 percent without compromising service quality, contributing significantly to the pace and scope of electrification programs**. Many countries have been successful in reducing construction costs using technical standards adapted to rural demand patterns—frequently adopting low-cost single-phase distribution systems—and centralized procurement processes.
- **A greater emphasis on reducing the connection cost charged to the poor is a cost-effective way of increasing electricity access.** In several countries, the percentage of communities electrified exceeds by a large margin the percentage of households connected because few households can afford to pay the connection fee. For example, in Ethiopia only 35–40 percent of households are ready to connect (Maurer and Nonay 2009). The paradox is that while the individual connection represents a very small percentage of the total investment required to expand the service, the inability to pay for the connection keeps the access rate down. When the objective is universal access, this cost may have to be subsidized or favorable terms offered for payment.

While challenges in extending access are broadly common to all technologies, there are difficulties unique to off-grid electrification that may justify the use of other business

models. These difficulties are associated with the isolation of the communities to be reached and the need to deal with a variety of technologies, some of which are new to the power sector (solar photovoltaic systems, mini-grids based on diesel or mini/pico-hydropower). Off-grid electrification requires

- greater involvement of local communities and promotion of participation of local or regional small- and medium-size enterprises as contractors providing operation, maintenance, and customer services; and
- simplified regulations with flexible procedures, realistic and enforceable quality-of-service standards, and possible delegation of monitoring tasks to entities that are closer and/or better informed about the services being provided.

The foregoing discussion suggests that a rural electrification agency could be suitable for off-grid electrification.

Efficient Execution

Grid extension is the obvious technical option to achieve universal access in urban and peri-urban areas, and its sustainable implementation requires the joint effort of the government agency responsible for access, the regulator of the grid service, and the utility providing it. However, there are potentially two main obstacles. First, a tariff/subsidy system that provides funds needed to cover investment and operating costs of new consumers may be absent. Second, a regulatory system may fail to provide the distribution company with the incentives to supply consumers—especially those consuming little electricity and with a limited ability to pay—with good service quality. These factors create conditions that lead to illegal connections. The regularization of the electricity service can be addressed through good management practices supported by the application of smart technologies (such as theft-resistant grid designs) together with a consistent economic and service-quality regulation that allows efficient service providers to recover their total costs of supply and a fair return on their investments. However, it is necessary to complement these measures with a legal framework that legitimizes consumers, creates awareness about the value of electricity service, and promotes discipline in the use and payments.

Seeking broad participation in the execution of rural electrification projects can be an efficient way to extend access and mobilize additional financial resources. The provision of electricity in rural areas frequently entails the implementation of projects in remote areas where the distribution utilities have difficulties or it is more costly for them to reach. Programs that have sought broad participation in project execution have been able to mobilize local resources from the private sector, communities and regional governments, thereby enhancing the execution capacity of the utility. The mobilization of additional financing from local communities or private investors (often about 20–30 percent of the capital cost) also increases the leverage of the subsidized resources.

Competition for independently executed and operated concessions with output-based subsidies is useful in leveraging private financial resources and incorporating incentives for efficient implementation of rural projects. Open and transparent bidding processes are useful in reducing costs. Subsidy bidding, through innovative approaches, such as output-based aid, to maximize the number of connections for a given subsidy, is proving to be an effective way of leveraging significant private resources and delivering results.

Financial and Operational Sustainability: A Long-Term Utility Objective

The long-term sustainability of electricity service is essential. As with any other business, electricity distribution needs to be financially and operationally sustainable to be able to attract investors and meet the growing demand of customers. However, often this has been the Achilles heel of electrification. There are many reasons, ranging from pricing policies that kept tariffs below total costs of supply and the failure to create incentives for the provision of adequate customer service to, in remote off-grid systems, focusing mainly on the installation of equipment and largely disregarding operating and maintenance requirements.

A sustainable electricity service in rural and low-income neighborhoods requires a well-designed system of tariffs and subsidies. While a large part of capital costs is usually subsidized through special-purpose funds, many low-income households cannot pay the full cost of operation. Therefore, a system of tariffs and subsidies is required to complement—but not replace—the limited contribution of low-income consumers and ensure the sustainability of the service.

The financial sustainability of electricity service should be guaranteed mostly by the contribution from all consumers. In many middle-income countries this has been achieved through the use of cross-subsidies, that is, subsidies within the tariff system or specially targeted taxes through which higher-income consumers help cover the financial gap. However, in low-income countries with lower electrification rates, cross-subsidies have a limited use, made worse by regressive subsidy schemes. Nevertheless, the main source of revenue for ensuring the financial sustainability of the electricity service is the contribution of a critical mass of non-poor consumers. In this regard, prioritizing access in urban areas makes financial sense in low-income countries. The effectiveness of this approach could be strengthened if complemented with tariff systems and subsidization schemes that are well designed and implemented, and efficient operation of the utilities in charge of service provision.

The following steps can help achieve long-term financial sustainability:

- **A tariff/subsidy policy that recognizes the full cost recovery of an efficient service**. The utility should be rewarded with the subsidy payment upon confirmation that the service provided has been of adequate quality and quantity. Output-based aid mechanisms appear to be a good choice for implementing this principle.

- **A quality control mechanism to ensure that payments to service providers are effectively linked to the compliance with clearly defined quality-parameters for technical and costumer services**. This requires monitoring the quality of service to clients and defining and imposing penalties in cases of non-compliance. The absence of such a mechanism may introduce distortions into the incentive system, as regulated providers would tend to reduce investment and operating costs. The objective is to keep the focus on customer service. In remote areas, this monitoring role can be delegated to rural electrification agencies.
- **"Ring fencing" the finances of operation, maintenance, and customer services**. These should be completely separated from the investment/installation component.

It is up to each country to decide on the type and level of subsidies to be applied. However, subsidies should be well targeted and used for efficient investments and operating costs, and their design should try to minimize price distortions. Donors may prefer not to support subsidies for recurring costs, since these costs steadily grow as access is extended and are not time-bound. However, it is worth noting that subsidies on current/operating costs can be economically efficient and effective in addressing the country's equity objectives.

Low-income countries with low electrification rates face a more demanding challenge that calls for more efficient performance of the power sector and greater and sustained donor support. Given the magnitude of the electricity access challenge and, often, the limited institutional and financial resources available, it is imperative for low-income countries to minimize inefficiencies in the power sector. It is therefore more important to focus on improving the performance of utilities (technical, commercial, and financial) and implementing a well-designed tariff system, even if doing so might not lead to marked gains in access during the initial years. The larger financing gap and weaker capacity of low-income countries justifies a greater and well-coordinated role of donors that should be sustained over a relatively long period, as in the successful cases of the Lao PDR and Vietnam.

In Sub-Saharan Africa, it is essential to overcome the current power sector performance problems for an electrification effort to be sustainable. The challenge could prove insurmountable if electricity prices remain below costs in favor of the few who have access to electricity. The power sector in Sub-Saharan Africa is in the midst of a serious crisis, characterized by sub-optimal development of energy resources, high costs, under-pricing, and large inefficiencies in performance linked to governance constraints and a distorted set of incentives. In particular, under-pricing and regressive subsidies have become a serious impediment to providing electricity to rural areas and the urban poor. Also, technical and non-technical losses are, on average, very high (30 to 35 percent). It is obvious that any effort to extend access will not be sustainable if there is no progress in addressing these sector-wide problems. The inefficiencies of Sub-Saharan Africa utilities generate substantial costs to the economy that, on average, amount to 1.8 percent of gross domestic product (Eberhard et al. 2008).

Introduction

Achieving universal access to electricity is one of the most important goals set for the energy sector by governments in the developing world. Electricity alone is not sufficient to spur economic growth, but it is certainly necessary. Access to electricity is particularly crucial to human development, as certain basic activities—such as lighting, refrigeration, running household appliances, and operating equipment—cannot easily be carried out by other forms of energy. Sustainable provision of electricity can free large amounts of time and labor and promote better health and education. Electrification can make an important contribution toward achieving economic and social objectives.

Expanding access to electricity is particularly challenging in rural areas. The costs and benefits of rural electrification have been examined by two World Bank reports (ESMAP 2002; IEG 2008). The two reports arrive at similar conclusions, including the finding that rural electrification investments can generate sufficient benefits for the investment to be warranted from an economic standpoint.

The ESMAP study yielded a range for the willingness to pay of grid-connected households of $0.10–0.40 per kilowatt-hour (kWh) for lighting and operating a television set alone. This figure, in its upper range, is in excess of the average long-run supply cost. If additional education and health benefits, the benefits associated with public goods (such as street lighting), and global benefits of reduced carbon dioxide (CO_2) emissions, where applicable, are included, the IEG report concludes that the monthly benefit for an average household consuming 30–40 kWh per month is about $60. While this value is well above the long-run supply cost of a power system, it is worth noting that part of these benefits are not received in monetary terms and, hence, cannot be used as a measure of the ability to pay. In both studies off-grid schemes fare less well because they have higher costs and lower benefits.

The provision of electricity also has gender implications. Surveys indicate extensive benefits of electrification to women, including increased scope for evening activities, greater flexibility in organizing household activities as daylight is no longer a constraint, enhanced security, the potential for undertaking income-producing activities such as handicrafts, and reduction in time required for collecting water if electrification improves water supply (World Bank 2007a). Household electricity connections also help narrow long-standing gender gaps in rural areas. For example, the literacy gap has been found to be smaller in electrified villages in the Lao People's Democratic Republic (Systems-Europe 2004).

The benefits of urban electrification overlap with those of rural electrification but not entirely. A workshop on electrification held in Brazil in 2005 (ESMAP 2007a) highlighted the following benefits of providing legal electricity in poor peri-urban and urban areas, some of which are different from the benefits of rural electrification:

- Improved household income from paying lower prices for legal electricity than for electricity sold by illegal operators

- Health benefits from reduction in indoor pollution and the use of boiled water
- Improved household security as a result of fewer fires and light at night
- Reduced violence on women
- Increase in educational levels
- Boost in social status, from social exclusion to social inclusion
- Security from street lighting
- More investments in housing improvements once the neighborhoods are secure.

This paper, prepared as a background paper to inform the forthcoming World Bank Group energy sector strategy, discusses the challenge of scaling up electricity access in developing countries, the efforts involved in achieving universal access, obstacles associated with access extension in rural and urban areas, technology and institutional options, the role of tariffs and subsidies, and elements of success in electrification programs. To that end, the paper draws from the experiences of more than twenty countries in addressing the electricity access gap under different country circumstances, distills lessons on good practices, and makes recommendations for a way forward. The review includes assessments found in the existing literature as well as three case studies carried out for the paper and described in the annexes.

1. Electricity Access Challenge

2.1 Access Gap

The International Energy Agency (IEA) estimates in *World Energy Outlook 2009* that 1.5 billion people lacked access to electricity in 2008, more than one-fifth of the world's population. Some 85 percent of those without electricity live in rural areas, mainly in Sub-Saharan Africa and South Asia (Table 1). South Asia currently accounts for 42 percent of the total number of people in the world without access to electricity, even though the percentage of the population that benefit from electricity increased by about 8 percent over the last three years (IEA 2009). Not having access to electricity not only deprives people of such basic necessities as lighting and communication and constrains their access to social services, but also hampers productivity and economic development. Without electricity, activities are limited to daylight hours. Access to electricity can free large amounts of time and labor and promote better health and education.

There are large variations in electrification rates across and within regions. Transition economies and countries belonging to the Organisation for Economic Co-operation and Development (OECD) have virtually universal access. North Africa has an access rate of 99 percent, Latin America 93 percent, East Asia 90 percent, and the Middle East 89 percent. By contrast, South Asia has an electrification rate of 60 and Sub-Saharan Africa only 29 percent. The populations without electricity in these two regions are 614 million and 587 million, respectively, accounting for 83 percent of the total world population without electricity. Sub-Saharan Africa also has by far the lowest urban access rate, 58 percent.

Table 1: Access to Electricity in 2008

	Population without electricity millions	**Electrification rate,** %	**Urban electrification,** %	**Rural electrification,** %
Africa	589	40.0	66.8	22.7
North Africa	*2*	*98.9*	*99.6*	*98.2*
Sub-Saharan Africa	*587*	*28.5*	*57.5*	*11.9*
Developing Asia	809	77.2	93.5	67.2
China & East Asia	*195*	*90.2*	*96.2*	*85.5*
South Asia	*614*	*60.2*	*88.4*	*48.4*
Latin America	34	92.7	98.7	70.2
Middle East	21	89.1	98.5	70.6
Developing countries	**1,453**	**72.0**	**90.0**	**58.4**
Transition economies & OECD	**3**	**99.8**	**100.0**	**99.5**
World	**1,456**	**78.2**	**93.4**	**63.2**

Source: www.worldenergyoutlook.org/database_electricity/electricity_access_database.htm.

The average access rates for the regions with relatively high access mask problems in some sub-regions and individual countries. In East Asia, Myanmar has an overall access rate of 13 percent, Timor-Leste 22 percent, Cambodia 24 percent, and the Democratic People's Republic of Korea 26 percent. The rural access rate in these countries is about 10 percent. In Sub-Saharan Africa, some countries have notably low rates: Burkina Faso, the Democratic Republic of Congo, Malawi, Mozambique, Tanzania, and Uganda have an overall access rate of about 10 percent, with rural access below 5 percent on average. In Latin America and the Caribbean, where the average rural electricity access rate is 70 percent, the rate in Bolivia is 38 percent and Haiti only 12 percent.

Because of population growth, large increases in the number of new connections will be required in countries with low rates of access just to prevent the absolute number of people without electricity from increasing. While the global total of households without access to electricity fell from 2 billion in 1990 to 1.5 billion in 2005, the reduction was largely due to China (IEA 2006). Excluding China, the number of people without electricity rose over that same period. In the Reference Scenario[2] in the IEA's *World Energy Outlook 2009*—which assumes that governments make no changes to their existing policies and measures—1.3 billion people, or 16 percent of the world's population, would still lack access to electricity in 2030. Four out of five people without access to electricity would live in rural areas, and 490 million would be in South Asia, 700 million in Sub-Saharan Africa. That is, while the absolute number of people without electricity would decline in South Asia and worldwide, it would actually increase by 110 million in Sub-Saharan Africa, despite a projected increase in the electrification rate of this region from 29 percent in 2008 to 47 percent in 2030 (IEA 2009).

Electricity access is increasingly at the forefront of governments' concerns, especially in the poorest countries. Many rural electrification programs and national electrification agencies have been created to monitor more accurately the needs and status of rural development and electrification. As a consequence, considerable progress has been achieved in some regions, but significant challenges remain and achieving universal electricity access by 2030 may be very difficult in a number of countries. It is evident that an even greater focus on electricity access is necessary to meet the needs of the poor and overcome this important constraint on development.

2.2 Extending Electricity Access: A Complex Task

A country can set as its goal universal access or maximizing the present value of net benefits of electrification. That choice is a function of each country's values and objectives. These values will determine the type of strategy adopted, including the approach to overall planning, how to select the areas/regions to electrify first, and the pricing and subsidy policy. That is, the adoption

[2] The Reference Scenario takes account of government policies and measures enacted or adopted by mid-2009. This includes a number of policies to limit greenhouse gas emissions as well as various policies to enhance energy efficiency and promote renewable energy. It assumes, also, that energy subsidies are gradually reduced, but at varying rates across regions (IEA 2009).

of an electrification strategy implies a trade-off between economic efficiency and equity objectives, a compromise that reflects the relative importance given to these objectives by each country.

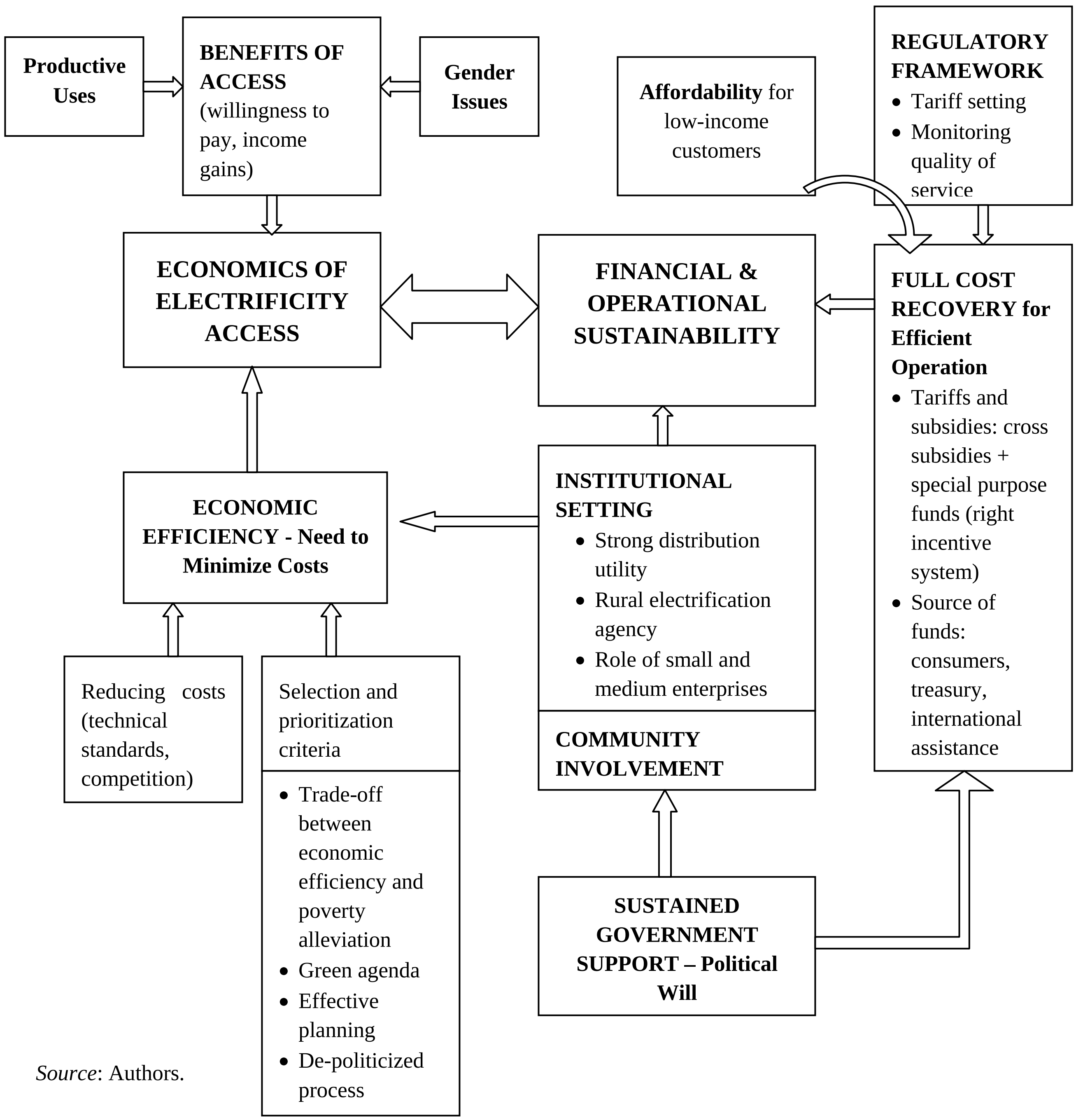
The two extreme strategies would aim at either maximizing net benefits, favoring the connection of well-off households without taking into account social equity, or electrifying everyone regardless of cost. Given the importance of the poverty alleviation and inequality dimensions of electricity access, as well its political implications, countries opt for a compromise between the two competing objectives and tend to target large numbers of low-income households in their electricity access programs. Hence, the challenge is to ensure that

- electricity access investments are economically viable, i.e., that benefits (represented mainly by willingness to pay) exceed costs; and
- electricity services are financially and operationally viable through an appropriate system of incentives.

Figure 1 presents an articulation of the multiple and rather complex dimensions of the electricity access challenge. This includes two main pillars: (1) the economic viability of electricity access and (2) the need to ensure its financial and operational sustainability. Factors affecting the economics of electrification are an effective planning process, the selection and prioritization criteria of projects, efforts to reduce costs through competition and the adoption of technical standards appropriate to the type of service required, and the economic benefits stemming from the provision of the service. Achieving financial and operational sustainability requires a regulatory system that guarantees the full cost recovery of efficient operation while recognizing the limited ability of low-income consumers to pay. Such a system would have a scheme of tariffs that include cross-subsidies, often complemented by special purpose funds, and effective monitoring of the quality of service provided. The implementation of electrification programs also requires an adequate institutional framework that can take different forms, depending on the nature of the problem and the countries' preferences and strengths. This framework can be based on centralized or decentralized approaches, rely on the direct investment of public or private sectors, and involve cooperatives. Whichever the approach adopted, two important features that appear to be present in all successful programs are the sustained support of the government in providing adequate resources and maintaining a clear and stable policy throughout a relatively long period, and active involvement of local governments and communities.

The rest of this chapter discusses rural electrification first, followed by the challenges of urban electrification.

Figure 1: Elements of the Electricity Access Challenge



Source: Authors.

2.3 Barriers to Rural Electrification

Many developing countries have successfully expanded electricity services in rural areas during the last two decades. Such progress notwithstanding, the very low level of rural electrification in most low-income countries is evidence of the difficulties that this challenge presents. There are several reasons why closing the electricity access gap is a tough task.

1. ***High costs of supplying rural and peri-urban households***. Most rural communities, as well as many peri-urban areas, are characterized by a low population density with a disproportionately high percentage of poor households. Demand for electricity is often limited to residential and agricultural consumers, and households use electricity generally during evening peak hours, often consuming less than 30 kWh per month. The low population density means that electricity distribution costs are shared by relatively few people, resulting in high costs for each unit of electricity consumed. Building extensive central grid distribution systems with tens of kilometers of medium voltage and low voltage lines to light a few light bulbs in rural households is expensive. As a result, rural electricity systems invariably have much higher investment costs per consumer and per kWh of sales than urban systems. Due to their technical characteristics, rural systems also have higher technical network losses and operating costs. These higher costs pose three additional challenges that are linked to each other:

(1) Rural, and often peri-urban, households cannot afford to pay the high cost of providing electricity to their villages. In particular, many households are unable to pay the connection fee. This is the main reason why it often takes years for all the targeted consumers to connect after the grid has been extended to their communities.[3]

(2) Unless a cost-recovery tariff is in place, the provision of rural electricity services is not financially viable and, therefore, utilities have a strong incentive to avoid distribution grid extension in rural areas.

(3) The investment required to meet the electricity gap in rural areas often exceeds the capacity of low-income countries to mobilize domestic sources of financing.

It is therefore necessary to implement a tariff and subsidies system that addresses the problem of affordability while guaranteeing the financial sustainability of rural electrification, and mobilize significant support from donors.

Where the costs of reaching distant communities exceed a certain threshold level it becomes cheaper to use off-grid sources of supply, such as mini-grids served by mini-hydro plants or diesel units, and solar-home systems (SHS). However, off-grid electrification also faces the high-cost and low-demand challenges of grid extension in rural areas.

2. ***Absence of an appropriate incentives system***. The high costs of electricity supply in rural areas and the limited capacity of households to pay for the service make it difficult to attract investment in rural electrification. To do so would require a system of tariffs and subsidies that ensure sustainable cost recovery while minimizing price distortions. A key element is

[3] An IEG report on the welfare impact of rural electrification (IEG 2008) notes that, in the Philippines, 50 percent connected within the first three years, but the rate had not reached 80 percent after 20 years. In Thailand 25 percent of households in electrified villages remained unconnected after more than 20 years. In India 90 percent of villages had electricity in the early years of this century, but only 44 percent of rural households had access as of 2004 (Cabraal et al. 2005). Delays by households in connecting to the grid significantly reduce the present value of the gross benefits of grid extension investments. An increasingly common practice in addressing this problem is to allow consumers to pay the connection charges through their electricity bills over a period of several years.

supplementing the revenues that the utilities receive from consumers with subsidy funds to match costs that would be incurred by an efficiently-run service provider. This complementary revenue should be paid upon confirmation of delivery of service of adequate quality. This would ensure that the utilities remain focused on rural service provision. Subsidies can be funded from contributions from the government as well as within the power sector—through cross-subsidies within a consumer category (e.g., lifeline tariffs that favor households with low consumption), between consumer categories (e.g., from large industrial consumers to residential), and/or from urban to rural consumers. However, such a revenue-generation scheme is absent in many countries. A common problem is the implementation of ill-designed subsidies that favor the large majority of consumers, including the well-off, while failing to provide incentives for utilities to carry out rural electrification programs. This is particularly true in Sub-Saharan Africa, where residential subsidies are highly regressive (Foster and Briceño-Garmendia 2010). Other problems associated with the incentive system are (1) subsidy designs that do not incorporate appropriate incentives for quality-service in rural areas, e.g., when a utility is collecting from the service of a particular rural customer less than its costs of supply or when a utility's costs are fully covered by the tariff without confirming that the service provided is satisfactory in both quantity and quality; (2) uncertainties about the stability of tariff systems; and (3) the lack of sustainability of cross-subsidy schemes in low-income countries where a large majority would have to be subsidized by a handful of consumers.

3. ***Weak implementing capacity***. A well-planned, carefully targeted, and effectively implemented rural electrification program requires technical and managerial capacity that is not always in place. Countries that are committed to extending electricity access need to go through an initial period of analysis, strategy development, and capacity building. For example, in Bangladesh, a Rural Electrification Board (REB) was established in the early years to handle the entire grid extension program. The board established clearly stated planning, administrative, and business procedures, which have been consistently put into practice throughout the entire program covering all aspects of the development and operation of distribution systems. By slowly building capacity, the country has been able to provide electricity to 500,000 new customers every year (Barnes 2007). Most countries have to develop an approach appropriate to their social and political realities. This process may entail new or amended legislation, strengthening or creation of institutions, careful planning, defining selection criteria for projects, and establishing technical standards and regulatory procedures tailored to the nature of rural electrification. This is a demanding task that requires a significant commitment of the government and, quite often, a good deal of technical assistance. However, many low-income countries have yet to complete this process. Building the capacity of an effective implementing institution is also a way of achieving the operating autonomy needed to minimize the impact of political interference.

4. ***Power generation shortage***. An important obstacle to rural electrification over the next several years in many countries with low access rates will be their insufficient power generation capacity to serve existing grid-connected demand, combined with the inability to import electricity to cover the gap. According to responses to a questionnaire sent in early 2009 to World Bank energy staff working on projects in different regions, load shedding has recently been an issue in many countries. Nearly all countries in South Asia, and Cambodia and the Lao PDR are experiencing load shedding. A recent study suggests that more than 30 in Sub-Saharan Africa suffer from power generation shortages (Foster and Briceño-Garmendia 2010). Angola, Gabon, Ghana, Kenya, Madagascar, Mauritania, Rwanda, Senegal, Sierra Leone, Tanzania, and Uganda have resorted to short-term leases of emergency generating capacity since 2004. Significant power outages have occurred in Benin, Burkina Faso, Cameroon, Cape Verde, the Democratic Republic of Congo, Ethiopia, Lesotho, Malawi, Mozambique, Namibia, Niger, Sudan, and Zambia.

It is unrealistic to expect these countries to make more than modest gains in increasing electricity access by means of rural grid extension until the capacity constraint is removed. Off-grid electrification has the important advantage of not being affected by the central generating capacity constraint.

*5. **Rapid growth of population***. A further challenge in expanding rural electrification in some countries is the rapid growth of their rural population. While the migration of population from rural areas to cities is accelerating in the developing world, reductions in rural requirements for new connections resulting from this migration are often offset in many countries by rising demand due to population growth. As Table 2 shows, rural population is expected to continue to grow rapidly in Sub-Saharan Africa until 2020, remain at roughly the present level in Asia, and fall in Latin America and the Caribbean and in Eastern Europe. In fact, the rural population will steadily increase to 2040 in low-income countries (UNDP 2007). This is one of the factors explaining the Reference Scenario in *World Energy Outlook 2009*, which foresees that the number of people without access to electricity in Sub-Saharan Africa will increase by 110 million during the next 20 years (IEA 2009).

Table 2: Rural Population (million)

	1980	2005	2020
Sub-Saharan Africa	295	500	623
Northern Africa	67	94	105
Asia	1,942	2,373	2,384
Latin America and Caribbean	128	125	117
Eastern Europe	107	94	83
World	2,711	3,350	3,457

Source: UNPD 2007

While the various obstacles described above are significant, they have not prevented the achievement of near-complete electrification in most countries in the transition economies, East Asia, Latin America, and the Middle East.

2.4 Urban Electricity Access

Out of the global total of 1.5 billion persons without electricity in 2008, about 220 million lived in cities (IEA 2009). The distribution of these between regions varied greatly, with 127 million in Sub-Saharan Africa, 86 million in Asia, 2 million in the Middle East, 4.8 million in Latin America, and 0.3 million in North Africa. Compared to the data of 2005 (IEA 2006), the number of people without access in urban areas decreased by 40 million globally. This decrease is significant in all regions except Sub-Saharan Africa where the number increased by 18 million.

Rapid urbanization in most regions (Table 3) is leading to rapid growth in the need for new urban connections, even in countries that already have high access rates.

Table 3: Urbanization Rates (percent)

	1980	2005	2015	2020
Latin America & Caribbean	65	78	81	82
Eastern Europe	64	68	69	70
Asia	26	40	45	48
Sub-Saharan Africa	24	35	40	42
Northern Africa	40	50	54	56

Source: UNPD 2007.

Meeting the fast growth of urban electricity demand tends to be complicated by the following factors:

1. A large portion of the rapidly growing demand stems from newly connected low-income households, who are likely to consume small amounts of electricity and usually cannot afford to pay a tariff that covers the full cost of supply.
2. An adequate incentive system of tariffs and subsidies that recognizes the full cost of supply is often unavailable. This problem is sometimes exacerbated by a high level of illegal connections and theft, which is caused by the limited ability of households to pay or, for those living in informal settlements, their ineligibility to be connected, and which is accounted as distribution losses. These two factors can pose a serious financial burden on the utilities and discourage them from extending their services to these consumers.
3. The weak financial position of utilities, particularly in low-income countries, makes it very difficult for them to access the financing required for the extension of their distribution grid in a timely manner.

One consequence of urbanization is that an estimated 1 billion people live in slums today (World Bank 2009a). Those families may or may not be able to get legal electricity connections, depending on the laws of the country. However, they may connect illegally to an accessible point of the distribution grid or connect to neighbors who already have access. The latter is a practice that is not considered illegal in some countries, since electricity is being metered and billed to the neighbor. However, this option is far from ideal, as neighbors usually charge a very high un-regulated price (Maurer and Nonay 2009). Legalizing existing consumers and connecting households without previous access requires support from the relevant government authority. This support should include, in addition to an adequate pricing/subsidy policy, the following aspects (ESMAP 2007a):

- Establishing a legal framework to legitimize consumers and connections
- Introducing reward and penalty systems to reduce electricity theft
- Clarifying policy on shanty town upgrading (rather than eradication) and providing other social infrastructure such as improved roads and water and sewage services
- Granting subsidies to needy families and reducing uncertainty by defining tariff and subsidy levels before investments are made.

Extending electricity access in urban areas has the potential to improve the quality of life and the business environment in shanty towns while, at the same time, reducing electricity theft and improving the utilities' financial situation. While there has been progress in regularizing the supply of electricity to low-income urban/peri-urban populations and reducing theft through the use of "smart" technologies (Smyser 2009), a great part of the challenge relies in the implementation of an adequate incentive system and a clear understanding on the obligations of all parties. The "Acuerdo Marco" implemented in the city of Buenos Aires illustrates this concept. In 1994, a four-year agreement was signed between the Federal Government of Argentina, the Provincial Government of Buenos Aires, and the two private utilities responsible for the distribution of electric power in the metropolitan area, EDENOR and EDESUR. The objective was to address all the issues associated with the supply of electricity to 755,000 residential low-income end-users living in poor neighborhoods. Problems included very poor quality of service, inefficient collection of payments, and theft in neighborhoods with different degrees of urbanization. Each signing party assumed specific obligations under the agreement. The utilities were responsible for all actions related to the supply of electricity (connections, operation and maintenance, and the activities of the commercial cycle). The Federal and Provincial governments took the obligation of supporting the field activities and providing subsidies for the financing of the works and payment to the utilities of recognized amounts of uncollected debt. Subsidies were set equal to equal to the taxes that the utilities had to pay for the actual sales of electricity, thus incorporating the right incentive: subsidy payment depended on the actual provision of the service. The implementation of the agreement was highly successful. At present, overall losses in the poorest neighborhoods are below 10 percent and the efficiency in collection is above 97 percent (ENRE undated).

2. Meeting the Challenge

3.1 Investment Requirements to Universal Access

The IEA estimates that, with appropriate policies, universal access to electricity could be achieved by 2030 with additional annual investment of $35 billion (in 2008 U.S. dollars), i.e., the equivalent of 6 percent of the global power-sector investment projected in the Reference Scenario (IEA 2009). This added investment would be needed mostly in Sub-Saharan Africa and South Asia.

Estimations made by World Bank staff in 2006 are consistent with IEA's figures. Bank staff estimated that approximately 600 million additional households would need to be connected to achieve universal access by 2030. The total investment cost would be about $860 billion, including investments in power generation and transmission necessary to meet the demand of newly connected households. The breakdown of costs by region and component is presented in Table 4. These figures are far above the current levels of investment. For example, the investment requirement of $11 billion per year to achieve universal electricity access in Sub-Saharan Africa is equivalent to the region's present investment for the whole power sector (Cabraal 2009).[4] Also, in spite of the increased focus of donors on electricity access, their contribution is quite limited when compared to the total financing requirement.[5] There is, therefore, a large financing gap that will be very difficult to mobilize. While this is largely a matter of government priorities and, to some extent, donor support, it may not be realistic to expect that such a large amount would be mobilized during the next two decades, particularly in low-income countries where the electrification effort competes with other pressing social and infrastructure needs. However, even more modest targets will still require mobilizing considerable financial resources. Increasing access to electricity in Sub-Saharan Africa to 50 percent will require about $4 billion per year through 2030, excluding generation investments (World Bank 2007b).

[4] An annual investment of more than $165 billion is required for the electricity sector in the developing world and an additional investment of about $30 billion to de-carbonize the economy. In Sub-Saharan Africa alone, the required annual investment is estimated at $42 billion. However, current investments comprise only 26 percent of this requirement.

[5] The contribution of official development assistance to public investment in the power sector in Sub-Saharan Africa has been modest, averaging only $700 million per year in the last decade (Eberhard et al. 2008). From FY2000 to FY2008, the World Bank investment commitments for electricity access projects totaled $1,870 million (Barnes 2009). These projects are expected to provide electricity to 7.5 million new households, which correspond to about 1.2 percent of the total number of connections required to reach universal access by 2030.

Table 4: Investments Required for Universal Electricity Access by 2030

	Households requiring access (millions)	**Required investments**			
		distribution	**gen./trans.**	**total**	**annual**
		---------($ billion)------------------------			
Sub-Saharan Africa	200	193	87	280	11
Middle East	40	58	20	78	3
South Asia	335	225	150	375	15
East Asia & Pacific	100	122	47	169	7
Latin America & Caribbean	50	60	26	86	3
Total	**595**	**587**	**271**	**858**	**34**

Source: Bank staff calculations.

Notes: gen./trans. = generation/transmission. The estimates assume that 75 percent of households would get grid connections, with distribution and connection costs of $500 per household for 35 percent of the 75 percent, $800 per household for 15 percent, $1,000 per household for 25 percent, and $1,500 per household for 25 percent. The remaining 25 percent of households would have access to off-grid electricity at an average cost of $800 per household. Additional capacity at system peak required per household connected is equal to the consumer maximum load (kilowatts) × coincidence load factor × system losses factor. The maximum load is assumed to be 0.7 kilowatts (kW) and 0.3 kW for urban and rural households, respectively. The coincident load factor is assumed to be 0.7 and the loss factor 0.85. The urban/rural split is taken from Table 3. The estimates assume $1.5 billion per gigawatt for generation and transmission losses.

Some concerns have been raised about the impact of achieving universal access on CO_2 emissions. More specifically, while recognizing that universal access is a social and economic imperative, some have argued that the access extension should be based largely on renewable energy, which can be more expensive than electricity based on fossil fuels in many circumstances. It is important to note that the increase in primary energy demand and CO_2 emissions associated with universal access would be very modest even if a significant shift to renewable energy is not achieved. The IEA estimates that bringing electricity to the remaining people with no access, assuming no change in the fuel mix, would increase CO_2 emissions by 1.3 percent in 2030. If the generation fuel mix to supply the additional demand were that of IEA's 450 Scenario[6], the increase in energy-related global CO_2 emissions would be a mere 0.9 percent by 2030 (IEA 2009). Even if all added generation were fossil fuel-fired, the increase of CO_2 emissions would be only 1.6 percent worldwide, corresponding to the total emissions of the United Kingdom in 2000. For South Asia and Africa, where the added generation would be the greatest, CO_2 emissions would increase by 9 percent and 13 percent, respectively, in 2030. However, per capita emissions in Africa, at 1.4 metric tonnes, would still be about one-tenth of the average in the OECD in 2000 (IEA 2003).

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[6] The 450 Scenario considers radical and coordinated policy actions across all regions with the objective of stabilizing the concentration of greenhouse gases in the atmosphere at a level around 450 ppm CO_2-equivalent.

3.2 World Bank Lending for Electricity Access

The World Bank's contribution to increasing access is modest compared to the global needs. From 1980 to 2006, the World Bank carried out 120 projects with rural electrification components. These projects brought electricity to more than 130,000 villages and reached nearly 20 million households. There were 33 projects with off-grid components out of the 120 projects, with 31 of them being approved during the last ten years (IEG 2008).

From financial year (FY) 2000 to 2008, approved World Bank projects with rural access components had an aggregated annual target of about 822,000 new connections. Commitments for electricity access totaled $1,870 million (Barnes et al. 2009). World Bank projects approved during the same period are providing $920 million for policy work and capacity building, nearly all of it in support of improved access to electricity. This amount is in addition to the above investment total—equal to just under one-half of it—and is an indication of significant institutional building required for rural access projects.

3.3 Technology Options: Grid Extension and Off-grid

The extension of the distribution grid is often the cheapest way to extend electricity access, as such investments have usually lower costs per connection and are relatively easy to implement. This is certainly the case for all urban and peri-urban areas, where 15 percent of the people with no access to electricity presently live. Grid extension is also the least-cost solution for many rural areas. As a result, governments usually attach high priority to grid extension programs. In most countries, between 80 to 95 percent of the unserved communities are targeted through grid extension. Off-grid technology options—mini-grids or individual systems—are appropriate when the unserved community is too distant from the existing grid and/or their demand is too small to justify the high fixed cost of extending the grid.[7] While the decision to opt for grid extension or an off-grid solution could be easily based on an economic criterion (i.e., the least cost of meeting incremental demand), governments' decisions for electrification are based on many country-specific factors, including equitable regional development, and are rarely either grid or off-grid decisions. Depending on a country's income level and stage of electricity infrastructure development, such decisions often involve trade-offs between financial viability and equity (World Bank CODE 2007).

Until two decades ago, grid extension, diesel-powered mini-grids, and mini-hydropower generators were, in most circumstances, the only electrification options available to rural communities. With the commercial maturation of various small-scale renewable energy-based technologies—from solar photovoltaic (PV) systems to small wind generators and micro

[7] Such as in many Sub-Saharan countries, where off-grid renewable technologies are likely to play an important role in expanding rural electricity access. Nevertheless, off-grid would be the lowest cost option for a minority of households only as grid extension would dominate in denser areas where the majority of households reside (Deichmann et al. 2010).

hydropower—along with the evolution of innovative service delivery models, off-grid has emerged as a viable alternative for increasing electricity access, especially in remote and dispersed communities (World Bank 2008a) or when households' consumption levels are very low and are expected to grow slowly. The last fifteen years have seen a shift from a typically donor-driven "supplier" approach, which has proven to be unsustainable, to a "service" approach that aims at greater local involvement and focuses on arrangements to guarantee the operational and commercial sustainability of off-grid projects. However, the long-term sustainability of off-grid electrification depends on more than technology. It requires effective prioritization and planning to enable economic choices of technology, appropriate infrastructure to ensure that services are maintained over the long run, and sustainable financing to make these capital-intensive technologies affordable.

Among the off-grid technology options, solar systems, wind energy, and micro-hydropower plants have the attraction of being renewable and having low lifecycle greenhouse gas emissions. Because of their renewable and clean-energy features, they are receiving much attention and their costs are expected to come down as a result of technical improvements and increased adoption (ESMAP 2007b). Solar PV technology is the only renewable technology that is not site-specific because it can function virtually in any location, despite geographic variations in the resource, such as solar radiation intensity or the number of days without the sun (World Bank 2008a). In most developing countries the solar resource is available throughout much of the year, while hydropower is affected by site constraints and hydrological variations, wind technologies are affected by the availability of wind, and biomass technologies are dependent on growing seasons. However, solar PV tends to be more costly than other small renewable energy options. A 50-watt (W) solar PV system was estimated to have a levelized cost of $0.62 per kWh in 2005, although this cost is projected to fall to about $0.51 per kWh by 2015 (ESMAP 2007b). The corresponding estimate for a 300W system is $0.56 per kWh in 2005. In contrast, a 300W wind turbine cost $0.30 per kWh, and a 300W pico hydro $0.12 per kWh.

Solar home systems incorporate PV technology. A typical SHS consists of a 10–100 watt-peak solar PV panel, a low-maintenance deep cycle or modified automobile battery to store the solar energy collected in the daytime, and a controller to regulate battery charging, cabling, and low-wattage direct-current lamps. A SHS provides only a small amount of electricity. For example, a 50W SHS operated with a 20 percent capacity factor (the factor used for the above estimate of $0.62/kWh) would provide only 7 kWh of electricity per month. This small amount, however, can be sufficient to operate four 7W compact fluorescent light bulbs and a black and white television set drawing 30W. PV systems are modular and require little maintenance (mainly periodic cleaning of the glass panel), but arrangements must be made to get spare parts and repair services. PV, mainly in the form of SHS, is the predominant technology used for individual households in most donor off-grid projects. About 2 million PV systems for homes and community centers have been installed or are planned in World Bank projects since FY2000 (Barnes et al. 2009).

The Independent Evaluation Group of the World Bank (IEG 2008) points out that the benefits from SHS are usually less than from grid electricity, because the capacity available to consumers is usually less. For example, the IEG's analysis of Sri Lanka showed that the median household total wattage of all light-bulbs used is 360W for grid-connected households and just 60W for SHS users. In addition, households with SHS own practically no electrical appliances other than a television set, whereas a large proportion of grid-connected households own a range of appliances. It may be that, while small SHS have positive net present values of benefits, larger solar systems would not satisfy this criterion since the benefits from electricity consumption in excess of a few kWh per month would not be sufficient to pay back the extra costs of larger systems. This indicates that a SHS could become a transitory solution—toward a mini grid or the integration to the national grid—in populations where electricity demand is expected to grow fast.

Like grid electrification programs, off-grid programs typically require subsidies, although off-grid operations are fully commercial in some countries. However, the off-grid subsidies often comprise smaller percentages of investments than the on-grid subsidies (World Bank 2008a).

Off-grid projects require more preparation resources than grid-based projects and often require much technical assistance. An important requirement is the presence of companies or community organizations willing and able to provide the selected technologies to consumers and to service them over their lifetimes. A risk is that off-grid sources may suffer from technical problems resulting from a lack of technical capacity in rural areas and logistical difficulties of servicing equipment. For example, in the Lao PDR, more than 6,000 households were given SHS under the Southern Provinces Rural Electrification Project. However, a survey in 2006 revealed that more than 80 percent of the systems were not working properly or were working at low levels of service (IEG 2008).

3.4 Comparative Costs of Rural Grid- and Off-grid Technologies

Table 5 presents levelized generation costs for various power generation technologies. The costs include capital costs, fixed and variable operation and maintenance costs, and fuel costs.

Table 5: Levelized Power Generating Costs for Various Technologies (2005)

Generating Type		Rated Output (kW)	Cost (U.S. cents/kWh)
Solar PV		0.05	62
		0.30	56
		25	51
		5,000	42
Wind		0.30	35
		100	20
		10,000	7
PV-wind hybrid		0.30	42
		100	31
Solar-thermal with storage		30,000	13
Geothermal	Binary	200	16
	Binary	20,000	7
	Flash	50,000	4
Biomass Gasifier		100	9
		20,000	7
Municipal. Solid Waste/Landfill Gas		5,000	7
Biogas		60	7
Pico/Micro-hydro		0.30	15
		1	13
		100	11
Mini-hydro		5,000	7
Large Hydro		100,000	5
Diesel/Gasoline Generator		0.30	65
		1	51
		100	20
	Base Load	5,000	9
Micro-turbines		150	32
Combustion Turbines			
	Natural Gas	150,000	13
	Oil	150,000	23
Combined Cycle	Natural Gas	300,000	6
	Oil	300,000	12
Coal Steam Sub Critical (with flue gas desulphurization and selective catalytic reduction)		300,000	4
Oil Steam		300,000	7

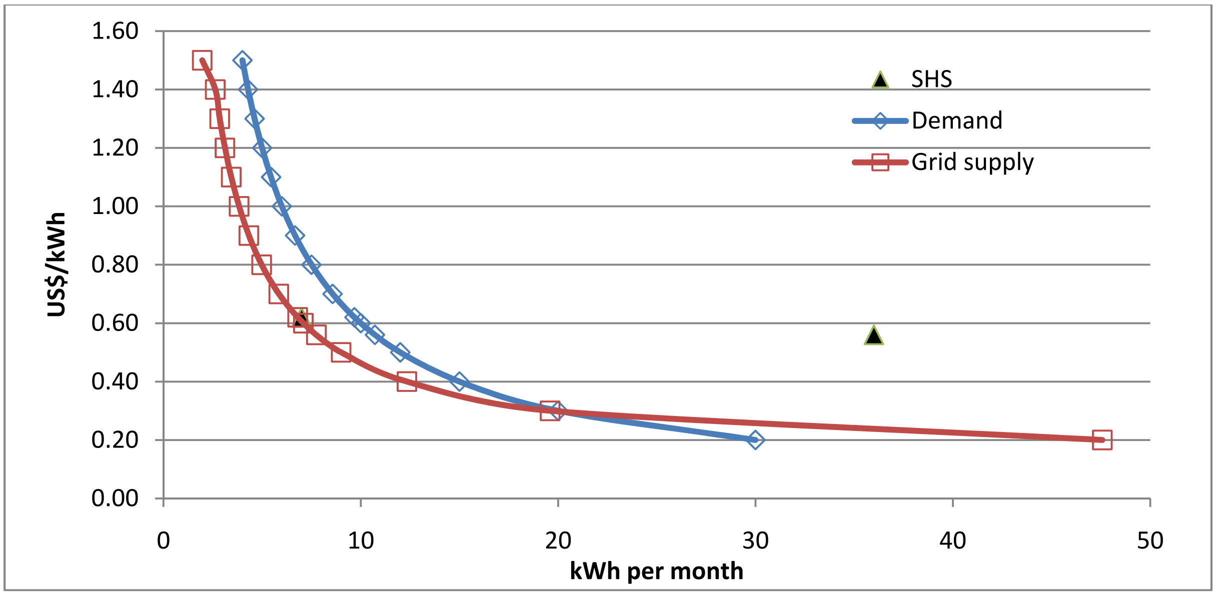
Source. ESMAP 2007b.
kW = kilowatts.

The table shows that the cost of a commonly used 50W solar PV (SHS) system of $0.62 per kWh far exceeds the costs of typical large power generation technologies found in countries with low access: for example, $0.05 per kWh for large hydro, $0.09 for a 5MW base-load diesel unit (but the cost of diesel-based generation has risen considerably since these cost estimates were made), and $0.13 for a natural gas combustion turbine. However, SHS do not require transmission, distribution, and connection. Pico- and micro-hydro costs are relatively low, but costs of connection (without meters in the case of the smallest units) need to be added for these technologies, as they do for the other renewable energy technologies. The fact that SHS are more widely used than any other option suggests that either the other decentralized technologies are not available in the areas where people use SHS, or they are considered inferior despite their apparent cost advantage.

On average, costs of providing electricity to grid-connected consumers will be lower than costs of providing electricity to off-grid consumers. However, for communities and households that are beyond some critical distance from the main supply sources, the levelized cost per kWh of grid extension will be greater than for off-grid supply. Off-grid supply is intended for exactly such markets. However, the large difference between the levelized cost of supply of $0.62 per kWh for a 50W SHS and actual tariffs for grid customers of $0.13 per kWh in Sub-Saharan Africa (Eberhard et al. 2008) gives the impression of a very large cost difference between the two options. In fact, the difference is much less, partly because the average tariff of $0.13 is below the cost of supply to rural consumers, and, more importantly, because that tariff does not include the connection cost—Adding the levelized connection unit cost of $400, for example, would raise the tariff to about $0.25 per kWh for monthly consumption of 30 kWh and to about $0.55 for monthly consumption of 7 kWh, which is the amount provided by a 50W SHS. Nevertheless this calculation shows an important advantage of the grid connection over the SHS, namely that increased electricity consumption by a grid consumer reduces its levelized cost per kWh significantly, whereas an increase in demand by a household relying on a SHS would require purchasing a second SHS, which would not reduce the levelized cost at all, or a larger unit, which would reduce the cost only slightly.

The above points are illustrated in the demand/supply hypothetical diagram shown in Figure 2 below (Hamilton 2009). The figure compares the demand curve of a typical small electricity consumer with the levelized costs per kWh for a grid extension and SHS options. The figure helps clarify how decisions concerning the choice of technology are significantly altered in situations where household incomes are low and their expected household consumption is small. The fixed costs of rural grid extension dominate the bills of households with small consumption, as the levelized costs per kWh soar to extremely high levels. Although poor households have a high willingness to pay for a few kWh per month, they may not be able to afford paying the still higher costs associated with grid extension at low levels of consumption. This means that the required subsidies for rural grid extension financially viable could be too large to be sustainable. Off-grid technologies such as SHS may be economic and financially attractive under these conditions, since they are available at lower costs for small amounts of consumption.[8] It should be noted that this rationale for off-grid technologies is different from the argument for off-grid electrification in far-off areas at the fringes of rural grids, where communities are widely dispersed and costly to supply for that reason.

Figure 2: Electricity Demand and Supply Option



Source: Hamilton 2009.

Notes: The household demand curve in the figure is shown as a curve with a constant price elasticity of demand equal to –1. Empirically derived curves for lumens used in the economic analysis of the Tanzania Energy Development and Access Expansion Project have elasticities very close to –1 (World Bank 2007c). A downward sloping supply curve is shown for a new connection costing $400 in an already electrified community, with the electricity itself costing $0.13/kWh.

3.5 Institutional Options

In addressing their electricity access needs, countries have followed different institutional models. Broadly, there are four main distinct approaches.

[8] Figure 2 shows that the levelized cost of electricity grid supply falls from $1.50/kWh for monthly consumption of 2 kWh to $0.60 per kWh for 7 kWh and to $0.20 per kWh for 48 kWh. The supply curve for a new connection intersects the demand curve at monthly consumption of about 20 kWh and a price of $0.30/kWh. While the household would choose the SHS in the absence of the option to connect to the grid, in this case the household would choose the grid connection since they would get more electricity for their monthly expenditure of $6.00. However, for a grid connection cost above the threshold of $720, which corresponds to a total monthly cost of $6.00, the supply curve for a new connection would not intersect the demand curve at all, leaving the SHS as the only option the household could afford. The SHS option is shown as two points, one for a 50W SHS that produces 7 kWh per month at a levelized cost of $0.62 per kWh, and the second for a 300 W SHS that produces 36 kWh per month at a levelized cost of $0.56 per kWh. The demand curve passes between these two points, indicating a preference for a SHS that would supply about 10 kWh per month at a price of $0.60 per kWh. If a SHS with this size is not available, the household would choose the 50 W SHS.

- ***Electrification through public companies***. While in the 1990s there was a strong move to privatize public power companies because they were considered inefficient and driven by political agendas, in many countries the state-owned utilities have taken the lead in addressing rural electrification programs. Examples include Lao PDR, Mexico, Thailand, and Tunisia.

- ***Private and decentralized electrification companies***. Countries with private distribution companies have been able to address their rural electrification needs through these companies, in spite of the commonly held notion that their business interests are not compatible with extending the service to markets that are perceived unprofitable. This has required creative subsidy programs, Chile being one example, to encourage private companies to serve rural areas.

- ***Rural electrification agencies (REAs)***. In response to the lack of interest of distribution utilities in engaging in rural electrification, and in the hope of minimizing political interference, many countries have opted to establish a specially designated institution to manage multi-year earmarked resources to support rural electrification projects. This approach is often accompanied by a rural electrification fund (REF) that is managed jointly or by a separate entity.

- ***Rural electrification cooperatives***. Several countries have adopted the cooperative approach derived from the U.S. experience. Examples of developing countries include Bangladesh, Costa Rica, and the Philippines. In this model, the people being served by the cooperative are the owners of the distribution company, which is supervised, and often supported, by a centralized agency.

Some countries have used a mix of these approaches, demonstrating that they are not mutually exclusive. For example, the extension of electricity services in Costa Rica is provided by a vertically integrated public utility and rural electrification cooperatives. Also, REAs work jointly with contractors, private or public utilities, and cooperatives for the implementation of rural projects.

There appears to be no evidence that countries with successful electrification programs follow one specific institutional model. This indicates that the institutional form is not as important as the adherence to strict business principles in operating distribution companies in rural and urban areas and strong and sustained backing from the respective governments.

3.6 Pricing and Subsidy Policy

An important condition for the sustainable development of the power sector is the presence of a tariff system that guarantees an overall revenue that covers the costs of efficient operation and provides the right price signals for an efficient allocation of resources and rational consumption. This condition can be met through an appropriate tariff structure and level that reflects the costs of supplying electricity that differ on account of location, type of consumer, and time of day. Most developing countries incorporate considerations other than economic efficiency in setting their electricity tariffs—usually related to equity—and hence depart from a strictly cost-based structure. A frequently adopted policy that departs from such a structure is the application of nationally uniform tariffs. Addressing the electricity access gap poses another challenge to the sustainability objective of the power sector: low-income households, who dominate those without access, all too often are unable or unwilling[9] to pay the full cost of extending access, and, in addition, the cost of supplying electricity in rural areas is usually higher than in cities. For example, due to the higher capital costs of reaching remote areas and the low levels of household consumption, the unit cost of supplying electricity in rural Peru could be two to five times higher than in cities (Revolo 2009). Under these circumstances, a suitable system of subsidies is needed to ensure that service in rural areas and low-income urban neighborhoods is not neglected and remains an important focus of the distribution company. Most rural electrification programs in the world include some sort of subsidy that is justified on equity grounds.

Common subsidies include capita subsidies, connection subsidies, and cross-subsidies:

- ***Subsidies for capital costs of rural electrification projects*** are usually covered through special purpose funds (e.g., REF) and frequently supported by donors. Often substantial, this subsidy covers the full investment cost in some cases. Many countries apply a project selection process that aims at minimizing this subsidy, thereby reducing the subsidy per connection and enabling a larger number of households to be connected. Typically, the contributions of local governments and/or private providers reduce the size of the capital cost subsidy by 20 to 30 percent.

- ***Subsidies for connection costs*** address what is often the last main obstacle to electrification, as many poor households cannot afford the cost of connection and house-wiring, which often amounts to a considerable sum. Common practices range from a delayed monthly payment of the connection fee over a relatively long period to a complete subsidy (regarding connection costs as capital costs and subsidizing connection through the capital subsidy). Recent output-based aid approaches combine schemes that provide a performance-based subsidy to cover connection costs linked to the delivery of pre-agreed outputs, including the provision of services on a sustainable basis and an energy efficiency component (Maurer and Nonay 2009).

- ***Cross-subsidies within the tariff system*** include those within a consumer category, such as lifeline tariffs which aim at favoring low-consumption households; between consumer categories, e.g., from commercial and/or industrial to residential; or through uniform tariff policies, e.g., from urban to rural consumers. While cross-subsidies are common and have proven to be quite effective in financing rural electrification in middle-income

[9] In fact, as the cost of extending electricity access is higher than the average cost of supply, new consumers are often unwilling to pay a price higher than the prevailing national rates.

countries—a good example is Thailand, where a very successful rural electrification program was financed mostly through an urban to rural cross-subsidy—they may not be as effective in low-income countries with lower levels of electrification rates. For example, in Sub-Saharan Africa where only 29 percent of the population has access to electricity and where the average residential tariff at $0.13/kWh is already relatively high (Eberhard et al. 2008), there are not enough existing consumers to provide the financing required to bridge the electricity access gap through cross-subsidies at costs that most consumers would consider reasonable.

As with all other subsidies, there have been problems in implementing electricity subsidies. Subsidies have often failed to meet their stated objectives of making services more affordable to poor households, particularly in low-income countries where the populations with access to electricity are often the middle- and upper-income households. Untargeted or indiscriminate subsidies, such as lifeline tariffs applied within a bracket well above the amount typically consumed by poor or rural populations, are often regressive, Sub-Saharan Africa being perhaps the most prominent example. Also, subsidies are quite frequently too complex or difficult to administer to target groups, or discriminatory with respect to specific technologies, not allowing users to make an efficient choice. A consequence of poorly designed and/or implemented subsidies is that they bring two significant equity problems: (1) poor targeting efficiency, whereby the rich capture a disproportionately high share of the subsidy, and (2) high exclusion of the poor, who do not benefit because they lack access to electricity.

It is up to each government to decide upon the type and size of the subsidies for electricity. The decision on their design and adoption may also reflect national values expressed through a political process. The rationale for the subsidy may not be explicitly stated in many countries, but it is useful to review the justifications so that the effectiveness of the subsidy program can be assessed. According to most theoretical frameworks for subsidies, the following three criteria need to be considered in evaluating a subsidy (ESMAP 2002):

- **Efficiency**. Is the project an efficient investment for society? That is, the project being subsidized needs to be justified in economic terms.
- **Equity**. Do the subsidies actually reach those less favored? The design should ensure that subsidies will reach the targeted population.
- **Effectiveness**. Will the project work? It is necessary to ascertain that the project through which the subsidies will be channeled is well designed and will be successful.

The effectiveness of the subsidy scheme in promoting equity can in turn be assessed by asking the following three questions (Komives et al. 2005):

- How well does the subsidy target benefits to poor households?
- What proportion of poor households as a whole receives the subsidy?
- How significant is the amount of subsidy received by poor households?

3.7 Electrification and Regulation

The main functions of a regulatory system are to set maximum tariff levels, establish standards for minimum quality of service, and specify entry and exit conditions for the power market. While there has been important progress in the design and implementation of good regulatory practices in established electricity systems, the design of regulatory systems to support rural electrification faces special challenges, particularly for off-grid electrification. Rural electrification can be undertaken by different types of enterprises (e.g., public, private, or community-based), each with different incentives. Also, these enterprises may use grid extension or off-grid electrification. Successful electrification often requires that the traditional functions of regulation must be performed in simpler, non-traditional ways. This is particularly true of off-grid electrification, which is characterized by low revenues and small isolated villages in remote areas where it is difficult to provide services and implement regulation. Reiche et al. (2006) propose the following four principles for creating regulatory systems that will help rather than hurt electrification, with an emphasis on off-grid electrification.

Principle 1 – Adopt light handed and simplified regulation. Complying with a regulatory rule costs time and money. The costs are particularly important for off-grid operators because most off-grid enterprises operate at the edge of commercial viability. They have high costs because they serve small households and low revenues because these households usually buy only small quantities of electricity (typically 50 kWh or less per month). Unnecessarily cumbersome regulation can easily destroy the commercial viability of these enterprises. Therefore, in designing a light-handed regulatory system to support electrification, three questions need to be asked: (1) whether the information is really needed, (2) whether the number of review and approval steps can be reduced, and (3) whether the regulator can delegate some regulatory tasks to other entities. Bolivia and Cambodia offer examples of light-handed regulation:

- In Bolivia, the threshold for operators of isolated systems that require a concession was increased from an installed generating capacity of 300 kilowatts (kW) to peak demand of 500 kW. This step relieved operators of the legal constraints on cooperative concessions and very costly reporting requirements and technical standards.
- In Cambodia, maximum tariffs for privately owned mini-grid operators are set on the basis of published tariff tables that relieve the operators of the obligation to make an initial tariff filing with the regulator or to return to the regulator with requests for revisions.

Principle 2 – The national or regional regulator should be allowed (or required) to contract out or delegate, either temporarily or permanently, regulatory tasks to other government or non-government entities. In many countries, REAs or REFs function as a de facto regulator. Typically, the agency/fund imposes certain requirements (such as maximum allowed tariff or a certain quality of service) in return for providing grants or subsidized loans. It would be appropriate for the regulator to delegate or contract out some traditional functions to the

REA/REF. This would lead to more efficient regulation because the agency is usually more knowledgeable about the technical operations of the provider and has better appreciation of the cost implications of different regulatory requirements, and delegation will facilitate coordination between subsidy rules and tariff regulation and reduce the risk of duplication and over-regulation.

In Bangladesh, more than 60 rural electrification cooperatives have been created since 1978. They are supervised and controlled by the Rural Electrification Board, a semi-autonomous entity located within the ministry. In addition to acting as a banker, technical advisor, procurement agent, construction agent, manager supervisor, and trainer, the REB also functions as a regulator by setting maximum prices and minimum requirements for quality of service.

Principle 3 – The regulator should be allowed to vary the nature of its regulation depending on the entity being regulated. Regulation methods (e.g., how tariffs are set or what needs to be regulated) should vary depending on the type of regulated entity. However, many regulatory systems do not encourage such flexibility. They are either silent about the regulatory methods or embody the view that "one size fits all." This does not do justice to the significant variations in electrification models, and it is better to provide the regulator with the legal authority to vary its methods. For example, when a community-based organization supplies its own electricity, the universal regulatory concern that the operator may charge higher monopoly prices disappears. Owners of a cooperative do not have an incentive to charge monopoly prices because this would affect their own finances. Hence, self-supply offers the possibility of self-regulation. Such an approach has been adopted in Sri Lanka for off-grid village hydro systems that are owned and operated by cooperatives societies. The government continues to fix technical specifications and technical standards, but prices are set by the cooperative (as membership fees rather than tariffs).

Principle 4 – Quality-of-service standards must be realistic, affordable, monitorable, and enforceable. Regulators often ignore regulation for quality of service. This happens because it is easier to specify and monitor tariff levels than service quality, which is multi-dimensional and compliance is often difficult and costly to monitor. However, there is a real danger in ignoring the quality of service because the sustainability of electrification depends on it. A workable quality-of service system should have the following characteristics:

- Standards should be based on customers' preferences and their willingness to pay for the cost of a specific quality level. Standards need not to be uniform across all customers but a menu with too many choices can increase the transaction costs and reduce transparency.
- Standards should be established for both technical and commercial dimensions of the service.
- Required levels of service and associated penalties and rewards should be phased in over time and synchronized with changes in tariff levels.

- Where feasible and efficient, penalties should be paid to individual consumers affected by poor service quality.
- The regulatory entity should have the legal authority to delegate or contract out to third parties, subject to appropriate oversight, monitoring of the quality of service and the imposition of penalties.

This last element of contracting out has been built into a new quality-of-service monitoring system for SHS in Bolivia, where a technical control unit consisting of ministry staff is responsible for monitoring compliance with the pre-specified standards and can impose penalties when operators fail to meet the standards.

3. Review of Experience

This section presents the findings of a review of recent experience of developing countries in their efforts to extend access to electricity. The aim is to identify the main factors contributing toward successful electrification, where success is judged by (1) the number of new connections provided through grid extension or off-grid, and (2) the financial and operational sustainability of the service provided. This section draws upon *The Challenge of Rural Electrification: Strategies for Developing Countries*, which has a number of case studies (Barnes 2007)[10]; *Designing Sustainable Off-Grid Rural Electrification Projects: Principles and Practices*, which pulls together lessons from some 15 years of the Bank's experience in designing and implementing off-grid electrification projects in developing countries around the world (World Bank 2008a); and the draft report "Review of Experiences with Rural Electrification Agencies, Lessons from Africa" prepared for the European Union Energy Initiative (EUEI), which contains a set of case studies (Mostert 2008)[11].

In addition, new case studies on Peru, Vietnam, and Sub-Saharan Africa were undertaken to supplement the existing studies:

- **Peru** has increased coverage and reduced costs through strong public support. The government has set and been implementing a National Plan for Rural Electrification, and the World Bank has had a rural electrification project since 2006.
- **Vietnam** increased access to electricity in rural areas from 15 percent to 95 percent in just 15 years. The World Bank has had three projects for rural electrification, the most recent being the Rural Distribution Project approved in 2008. The Bank has also carried out studies on the welfare benefits of rural electrification in the country.
- A number of countries in **Sub-Saharan Africa** have set up REAs to lead the overall rural electrification effort or provide support to electrification projects outside the main grid. The REAs in the region are usually linked to REFs.

The findings are presented under four headings: (1) the economics of access to electricity, (2) financial and operational sustainability, (3) the need for an effective institutional framework, and (4) a sustained government commitment to the electrification effort. It is worth noting that the findings include successful practices of low-income countries that started from a low level of electrification. Bangladesh has been successful in implementing a transparent and effective planning process and in promoting productive uses of electricity, as well as achieving a financially sustainable rural electrification program. Guinea has an interesting experience in reducing costs. Bangladesh and Nepal have benefitted from the active participation of local communities in the design and implementation of projects, and the Lao PDR and Vietnam are

[10] The "Challenge of Rural Electrification" includes ten thorough case studies. The cases reviewed include Bangladesh, Chile, Costa Rica, the Philippines, Thailand, and Tunisia.
[11] Case studies included Burkina Faso, Côte d'Ivoire, Ethiopia, Guatemala, Guinea, Mali, and Nepal.

outstanding cases of electrification that illustrate the importance of a long-term government commitment.

4.1 Economics of Electricity Access

Benefits of Access. It is widely accepted that the provision of electricity enhances the household's quality of life and stimulates the economy in a broader sense. One immediate benefit is improved lighting. Electrification also improves the quality of health services and spurs income-generating activities by enabling the use of irrigation pumps and other economic activities. That is, rural electrification can generate sufficient benefits for the investment to be warranted from an economic standpoint (IEG 2008).

Households' willingness to pay for electricity is directly associated with the costs that they would avoid from more expensive energy sources (e.g., kerosene, dry cells) and their awareness of potential income gains. There are several illustrations of this willingness to pay:

- In Bangladesh, where rural residential tariffs start at $0.05/kWh for monthly consumption up to 300 kWh, field research concluded that 49 percent of rural consumers would be willing to pay up to 25 percent more for electricity, and 7.9 percent would pay 10 percent more (Barnes 2007).
- In Guatemala, monthly consumption of 30 kWh at a social rate of $0.09/kWh would translate to monthly expenditure of $4.00, which represents 8 percent of the average rural household income. Households are ready to pay this price, because the alternative energy cost is approximately $5.75 per month (Mostert 2008). Consequently, consumer payment rates in Guatemala are very high.
- Surveys of households in Sub-Saharan Africa have shown varying levels of avoided costs and willingness to pay. In Mali, avoided costs from electricity average €16 per month. Surveys held in the country concluded that the willingness to pay for electricity in rural areas averaged €11.1/month, ranging from €8.2 to €16.7 (Mostert 2008). In Senegal, most rural households already spend $2–24 per month on kerosene and dry cell batteries to meet their lighting and small power needs, and hence are likely to be willing and able to pay for electricity use (de Gouvello et al. 2007). In Guinea, rural surveys obtaining data on avoided costs found that the willingness to pay for basic electricity services was about $1.6/month (Mostert 2008), which would cover the cost of 12 kWh per month at the average tariff of the Sub-Saharan region ($0.13/kWh).

Productive uses. The promotion of, and capacity building effort to encourage, productive uses of electricity in rural areas have the potential to contribute to increasing the productivity of rural business as well as achieving a more efficient use of the electricity supply infrastructure and improving the revenues of distribution companies, thereby enhancing the economics of electrification. There are, however, two important barriers to the productive use of electricity: the lack of technical knowledge and skills of potential users and the financial means to acquire relevant equipment (ESMAP 2008). In Bangladesh, the potential for productive uses by cooperatives is a key factor in increasing their revenues and meeting the requirements to qualify for electrification. Cooperatives are therefore encouraged to engage in productive uses and do so particularly in agriculture (e.g., rice mills, tube-wells). In Thailand, the Provincial Electricity Authority (PEA) was successful in promoting replacement of diesel motors with electric motors, mostly for rice mills, in villages with lower-than-expected consumption of electricity. To this end, the PEA facilitated financing for villages to purchase electric motors and other equipment. The importance of incorporating financing for productive uses into the rural electrification program was evident in Chile; absent such a financing mechanism, the economic impact of electrification was sometimes limited (Barnes 2007).

Incorporating economic efficiency into the process. There are two ways of incorporating efficiency into the electrification effort: (1) establishing an effective planning process that identifies the country's needs and electrification opportunities, taking into account the financial viability of investments and their economic impact on the region, and that establishes rational and transparent criteria for the selection and prioritization of projects; and (2) minimizing construction and operating costs.

- ***Transparent planning focused on cost-effectiveness***. The cost of providing electricity to rural households is usually high, even among the best planned rural electrification programs. A transparent planning process with clear criteria designed to balance cost savings with equity considerations offers two advantages: (1) a cost-effective program and a set of rules for the selection of projects aimed at ensuring the economic and financial viability of electrification effort, and (2) protection from political interference. Failure to adopt such a process may render an electrification program unsustainable, require higher subsidies and, consequently, place undue pressure on public finances. Planning is a public role that should be led by a capable, and usually centralized, government entity. Common features of successful planning of rural electrification include (1) a clearly established system to prioritize the areas to receive electricity and the projects to be selected, (2) a long-term, multi-year vision that coordinates the extension of the grid and off-grid efforts and takes into account the manufacturing capacity of the country, and (3) a broad regional development approach that takes into account other conditions for sustainable rural development (access to education and health services, an adequate transport system, agricultural potential, access to markets). Some examples of useful experience in rural electrification planning and project selection are given below:
    - Thailand offers a good case of central planning for rural electrification. The PEA prepared a national plan that was sufficiently detailed to serve as a blueprint for the government, the PEA, and officials responsible. The plan included guidelines and the criteria for the selection of villages to electrify, organizational

requirements, etc. Since this plan was incorporated into Thailand's Five-Year National Economic and Social Development Plan, it protected the PEA from political interference (mainly through objective selection that was formalized in this manner). While regions were selected on the basis of their level of underdevelopment and political instability, villages were selected based on economic criteria. Key factors in village selection were proximity to the grid and roads, the size of the village and the expected number of customers, potential for productive uses, the number of public infrastructure facilities, and the village's willingness to contribute to construction costs (Barnes 2007).

- One of the main characteristics of the success of the rural electrification program in Bangladesh is its centralized planning. From the outset, the REB established a clearly defined master planning process that prioritized system investment according to revenue generation. This model was used universally. The program benefited also from sustained and consistent technical assistance since its beginning and the long-term commitment of the government (Barnes 2007).
- In Tunisia, the country's regional planning processes and successive five-year plans incorporated rural electrification into broader integrated rural development objectives, producing synergistic effects. Indeed, growth in rural electrification and national socioeconomic indicators are strongly correlated. Rural electrification involved rigorous centralized planning with major regional and sub-regional inputs and initiatives. The selection criteria for rural development projects had multiple components, including income levels, unemployment, environmental quality, gender status, expected returns, and costs per job created (Barnes 2007). In practice, these criteria were complemented by incentives provided to the utility *Société Tunisienne de l'Electricité et du Gaz* (STEG, Tunisian Electricity and Gas Company) to select at an early stage those projects that generated more revenues (through a ceiling on the subsidy level).
- The selection criteria for projects in Chile and Peru included minimization of unit costs and subsidies. This mechanism has helped reduce costs and draw contributions from local investors and communities, enabling the central government to reach an additional 30 percent of rural households using the same resources.
- Good coordination between grid extension off-grid electrification is essential to avoid duplication or sub-optimal investments. Establishing criteria for comparative assessment should be part of the planning effort. Some countries have chosen practical rules of thumb to do so. For example, in Morocco, the *Office National de l'Electricité* (National Electricity Office) uses a cut-off cost of €2,500 per (medium- and low-voltage) household connection to choose off-grid in the place of grid extension. In Burkina Faso, the grid is extended to communities

located within 50–60 kilometers from the nearest 33-kilovolt line. Ethiopia also uses a similar minimum distance criterion (Mostert 2008).

- ***Reducing costs***. In many cases, careful attention to system design can enable construction costs to be reduced by up to 20–30 percent (ESMAP 2000), contributing significantly to the pace and scope of electrification programs. If electricity use is likely to be limited—for lights and small appliances, a pattern common in rural areas—there is no justification for applying the same standards as those for high-consumption urban areas. Many countries have been successful in reducing construction costs using technical standards adapted to rural/low demand patterns, frequently adopting low-cost single-phase distribution systems (typically single-wire earth return, or SWER), centralized procurement processes, and/or incorporating incentives for cost reduction into open and transparent bidding. Three examples are given:
  - Guinea appears to be the champion of low costs. The country has adopted a radical policy that aims at maximizing the number of connections for a given amount of financial resources (Mostert 2007). Following this policy, they are achieving extremely low costs per connection in mini-grids based on diesel generation: €130–180, including all costs. While this practice implies a very short-term view that appears to be delaying the development of off-grid renewable options (which cost four to five times more per connection) and casts questions on the sustainability of the approach, it is interesting to see how far this cost-reduction strategy will go. The main aspects of the low-cost strategy of the *Bureau d'Electrification Rurale Décentralisée* (Office of Decentralized Rural Electrification) are (1) meeting basic needs by operating diesel grids only 4 hours a day, although longer hours of operation can be provided if there are customers using electricity for production; (2) always choosing the lowest-cost technical solution, e.g., not including meters or load limiters, cheap wooden poles even if they do not last long; (3) cost-shared training to all actors in the supply chain (consultants, construction companies, project developers); (4) monitoring prices of goods and services; (5) centralized equipment purchase; (6) keeping transaction costs low through built-in coordination of procedures; and (7) monitoring the quality of financed work and equipment.
  - In Thailand, the PEA followed a comprehensive strategy to reduce costs that included (1) system standardization, including technical, equipment, and other components; (2) standardization of all equipment and components used for construction of distribution systems, including a centralized procurement process and bulk purchases; (3) reliance on locally manufactured materials, which were often cheaper than imported materials; and (4) a strategy to promote electricity use that included credit lines to cover connections and wiring costs and a campaign for productive uses (Barnes 2007).

- In Tunisia, STEG has fostered a cost-cutting culture that has been maintained through three decades with innovative technical options. The MALT (mise a la terre, grounding) system, a predecessor of SWER, permitted a cost reduction of 18–24 percent. This was not without difficulties because, being a new technology, it faced resistance from engineers more familiar with traditional system designs. The utility monitored the process closely and solved problems as they were encountered. SWER was adopted after a few years, reducing costs even further (Barnes 2007). Another factor that helped reduce costs in Tunisia was the participation of local manufacturing industry that was supported by a specific business development program.

4.2 Financial and Operational Sustainability

Making service sustainable is one of the main challenges in extending access, both in rural electrification and in low-income urban areas. While a large portion of capital costs is usually subsidized through specially designated funds (frequently supported by donors), more financial assistance is often needed because many households cannot pay the full cost of operation. Middle-income countries with high access can use cross-subsidies, but cross-subsidies in countries with low electrification rates have limited effectiveness. Policies of many low-income countries that effectively target subsidies to the better-off exacerbate this problem, resulting in very high tariffs to rural households and greatly limiting the benefits of rural electrification. For example, rural households in Mali pay tariffs that vary from €0.26 to €0.30 per kWh; rural households in Burkina Faso pay three times more than urban households for electricity (Mostert 2008). How much can be charged to rural or poor households without undermining the country’s equity objectives and how to enable the service provider to recover the full cost of efficiently managed provision of quality service are two important policy questions.

Countries have addressed the problem of financial sustainability in different ways, depending on the nature of their own challenges, strengths, and opportunities. All have resorted to a subsidy system that often covers operating costs. Different types of subsidies are described below:

- ***Electricity tariffs and subsidies in Peru***. The main principle of the Peruvian model is the full recovery of costs by the distribution company. While capital costs are strongly subsidized, costs of operation, maintenance, billing, and collection are higher in rural areas where consumption levels are lower—average monthly consumption per customer in rural areas in Peru is 30 kWh and about 12 kWh for newly connected customers, against average urban monthly consumption of 100 kWh—and households are less able to pay. Under these circumstances, extending access in rural areas requires a system of subsidies that recognizes the lower income levels of rural households and higher costs of supply. The Peruvian system includes three types of subsidies (Revolo 2009):

1. ***Subsidy on capital costs*** applied to grid extension, mini grids under 500 kW, and off-grid electrification. The size of the subsidy varies from 77 to 100 percent of the total investment. Sources of funding are government social and electricity funds, donors, and contributions from local governments.
2. ***Internal tariff subsidy***. This is a system of cross-subsidies with two components aimed at reducing the prices of generation in isolated systems and compensating for the differences in distribution costs between urban and rural areas.
    - Subsidy to generation in isolated systems. Revenues from grid-connected customers are channeled through a REF to compensate for the differential between the generation costs in isolated systems and the bus bar prices of the national grid.
    - A compensation for the difference in the distribution costs between rural and urban areas. This is a typical cross-subsidy funded directly by urban consumers through the distribution tariff.
3. ***Consumption subsidy***. This is a typical lifeline tariff that aims at protecting low-income households whose monthly consumption is below 30 kWh.

Overall, rural households pay a tariff slightly higher than the urban tariff, while the supply cost could be two to five times higher. The Peruvian subsidy system protects low-income rural households and compensates for the higher costs faced in rural and isolated areas and maintains attention to low-income customers who make lower contributions, because aggregate revenues earned by distribution companies are designed to cover the costs of efficient operation fully.

- The experience of Bangladesh in rural electrification is particularly important because, in spite the country's relatively low coverage rate, half a million new customers gain access every year. Being a low-income country, Bangladesh provides a particularly relevant example of how rural electrification programs can succeed in adverse economic conditions. This achievement has been made possible through a well-run and well-managed rural electricity program (Barnes 2007). The program has a system of subsidies to support the viability of the electricity cooperatives that includes such financing incentives as long tenor loans, low-interest rates, and five-year grace periods; a government grant to the REB that covers one third of the capital costs; a low bulk energy tariff; and cash-flow support to the cooperatives that lasts up to five years of operation. The latter is an unusual feature of the Bangladeshi model that recognizes the need to provide financial support to the electricity cooperatives during their first five years of operation, a period after which they are expected have learned the business (with continuing technical assistance from the REB), built an attractive market, and become largely financially independent.

- Output-based aid (OBA) can be useful in achieving sustainable electricity service if the aid/subsidy to the provider is linked to quality-of-service targets. In Ethiopia, the number of electrified towns has been growing very fast during the last five years. The upfront cost of connection is a more serious barrier to extending access than the monthly payments for consumption, and only 35–40 percent of household in electrified areas are usually ready to connect. The average cost of grid connection is $50 to $100 per households, this when $75 represents 15 percent of the annual income of an average household in many areas. The paradox is that while connecting a customer represents only 3 percent of the total investment, this connection cost keeps access down. An ongoing OBA program aims at accelerating the pace of connections. The program offers a $35 payment to the utility Ethiopian Electric Power Corporation (EEPCo) upon verification, by an independent agent, of pre-agreed outputs, including the connection and provision of services on a sustainable basis. The connection package comes with two compact fluorescent lamps, which make electricity more affordable to the poor and at the same time reduce the cross-subsidy that the EEPCo provides through the lifeline tariff (Maurer and Nonay 2009). OBA can be useful also in off-grid projects. For example, the Bolivia SHS project includes a monitoring procedure to verify compliance with quality-of-service standards that is contracted out to private contractors in remote areas (Reiche et al. 2006).

4.3 Effective Institutional Framework

Electricity access programs need to be well planned, carefully targeted, and effectively implemented. This requires an effective institutional framework. The review of different country experiences supports the view that there is no superior institutional model. Public, private, and cooperative approaches have led to both success and failure. These models are also not necessarily mutually exclusive. What is important is the choice and strengthening of a framework that takes advantage of the country's strengths and considers the nature of their specific challenges. For example, in countries with an egalitarian tradition, such as Costa Rica, the cooperative system may work very well. When there is a strong public utility, such as in Tunisia and Vietnam, the utility can be relied upon to lead the electrification effort. When there is a strong private sector or the presence of a critical mass of entrepreneurship, particularly in rural areas, a variety of private participation options can work well if the correct incentive system is put in place.

Involving local communities and small and medium enterprises (SMEs) can be particularly helpful:

- **Benefits of community involvement**. The review of case studies shows clearly that rural electrification programs benefit greatly from the involvement of local communities. The participation of local communities from the start of a project offers the advantages of improving the design (Lao PDR, Peru, Vietnam), avoiding disputes and gaining local support (Bangladesh), and mobilizing cash or in-kind contributions (Nepal, Thailand). Community involvement also increases local ownership considerably, thereby helping to ensure the operational sustainability of the service. An interesting feature present in Burkina Faso and Mali is the role of women's associations in the management of multi-purpose platform projects that usually include diesel generation, mills, battery chargers, and pumps; a set of installations is chosen by the community with the aim of increasing productivity using electricity.

- **Role of SMEs**. SMEs have a particularly important role to play in remote areas that distribution utilities find difficult to cover. This role can take the form of maintenance and customer service provision in rural low-voltage systems (Vietnam) and off-grid systems (Peru), or as contractors in the construction of small-scale rural grids. The provision of technical and capacity building support is often a useful complementary input in helping distribution utilities extend their services through SMEs.

Many Sub-Sahara African countries have created REAs and REFs. The European Union Energy Initiative undertook a study to see whether the cost-advantages of centralized rural electrification stemming from economies of scale and scope could be outweighed by cost-savings achieved by allowing private actors in a decentralize scheme. The study examined seven case studies, paying special attention to the speed of electrification, under the assumption that a decentralized approach supported by a REA would increase the number of connections due to the mobilization of additional capital and financing resources, the higher efficiency of private investors, and greater opportunities for demand driven projects. The study suggests that centralized approaches are superior from this perspective (Mostert 2008):

- Côte d'Ivoire and Ghana are examples of countries in the early stages of rural electrification that achieved good progress with centralized approaches, whereas the annual connections achieved by REA/REFs (except Ethiopia and Nepal) were all well below those in the centralized model.
- Morocco and Guatemala are examples of countries in the final stages of rural electrification that successfully used a single company to connect a large number of un-served communities.
- The REA/REF approach makes more sense when applied to the implementation of off-grid projects, as in Ethiopia, Guinea, Mozambique, and Nepal during the initial stages of rural electrification. However, it is not clear whether this approach remains effective once a country reaches the final stage of rural electrification.
- The data reviewed do not allow conclusions to be drawn on the cost-effectiveness of REA/REF-based decentralized versus centralized rural electrification in off-grid electrification.

- When assessing strategies for total rural electrification (grid and off-grid), the study arrives at the following conclusions:
    - Burkina Faso's experience suggests that it is not possible to achieve country wide rural electrification through the efforts of small-scale private companies.
    - Top-down approaches based on the preparation and tendering of projects tend to be too lengthy, suggesting that it would be better to support demand-driven projects as they are put forward.

There are two other important findings:

- With the possible exception of Senegal, the REA/REF approach has attracted very little private capital into rural electrification, and the willingness or ability of commercial banks to co-finance rural electrification projects, supported by REA/REFs, has been disappointing.
- The REA/REFs have not received much donor funding for rural electrification projects. With the exception of Tanzania, donors' response has been slow. Part of the explanation could be that REFs are still new and more experience is required to gain confidence. In addition, there are two important constraints: (1) donors ring-fencing their own projects due to the lack of flexibility (or harmonization) of their financial management and procurement procedures, and (2) donor interest shifting from infrastructure to social programs.

While the numerical superiority of the centralized approach found in Mostert's study is quite clear, it should be noted that a study of this type could have an inherent selection bias, because many countries that opted for a decentralized approach had weak institutions to begin with and the poor performance of the utilities was precisely the main reason for establishing a separate REA.

There are some arguments in support of the REA/REF approach:

- The decentralized REA/REF model has given higher visibility to rural electrification as a policy goal and, hence, there is more focus on its objectives in the public and private sectors.
- Relying on a REA and a REF tends to harness entrepreneurial capacity and broader participation is likely to benefit from a more transparent process (checks and balances). These advantages are more relevant when dealing with remote areas where off-grid plays an important role.
- Practitioners argue that REA/REFs have proven to be less vulnerable to political interference than the existing utilities, because they are better protected by their governance rules and there is anecdotal evidence that governments have respected their independence more.

Bangladesh presents an outstanding case where its REA, the REB, has functioned well. Although the REB has more functions than a typical REA[12] and enjoys the advantage of high population density in rural Bangladesh, it is useful to see what are the key factors in its success (Barnes 2007):

- There was rigorous centralized planning, design, and construction, and decentralized operational responsibility.
- Standardized procedures and practices—clearly stated planning, engineering, administrative, and business procedures—have been adopted and followed.
- Performance-based measurements have been implemented. A management system that links pay and promotion to measured compliance of the rural electricity cooperatives is in place.
- Day-to-day commercial practices have been effectively implemented. Billing and collection procedures have resulted in collection rates exceeding 95 percent. Rotating meter reader routes and centralizing collections in rural banks have effectively limited fraud and theft.

Without question, rural electrification requires considerable government effort in creating an enabling environment, planning, dissemination of opportunities, and attracting financing from non-government sources. REA/REFs can play that role. However, it is not clear whether this role cannot be fulfilled by other entities, such as the ministry responsible for electricity. Another issue that is particularly important in Sub-Saharan Africa is that the REA/REF, by mandate, does not deal with urban electrification, leaving unattended more than 40 percent of households without electricity in urban areas.

It is worth mentioning that some elements of the centralized and decentralized approaches are not mutually exclusive. For example, Peru and Vietnam do not have a separate REA, but both countries have been successful in mobilizing broader participation at the local level through the contributions of communities and regional utilities, respectively. Also, bottom-up initiatives are possible in both approaches. Many of the most successful experiences worldwide have in fact combined top-down and bottom-up initiatives.

In summary, there is no consensus among practitioners on this topic and it is evident that more research is needed. Early evidence indicates that the REA/REF approach cannot be proposed as a standard policy for the Sub-Saharan African countries but needs to be designed and decided upon on a country-by-country basis.

In designing and making choices on a rural electrification program in Sub-Saharan Africa, it is important to address the following issues:

[12] The REB is an agency of the Ministry of Energy and Hydrocarbons in Bangladesh responsible for planning and implementing all investments in rural electrification, overseeing the performance of rural electric cooperatives, providing technical assistance, regulating prices and managing loans and grants provided by donor agencies.

- ***An appropriate incentives system***. Whatever the model adopted, it is crucial to have in place a set of incentives that guarantee the operational and financial sustainability of the rural electrification business. Tariffs, complemented by subsidies where appropriate, must enable full cost recovery of efficient operation. Transparent procedures for subsidy calculation, eligibility, and approval, and light handed regulation are also important. Bypassing this requirement or postponing its implementation, as sometimes a REA/REF would appear to do in the interest of speed, compromises the sustainability of rural electrification.

- ***Institutional support structure for rural electrification***. The line ministry, the power regulator, the utilities, and the REA/REF must be of high quality. A REF for grant support should ideally be co-financed by a tariff surcharge. Adequate planning, efficient administration, and the capacity to support the supply chain of small scale service providers are all essential.

- ***Availability of an adequate human resource base***. When human resources are thin, particularly with respect to specialized professionals in the field, the choice of the institutional structure—in particular any proposal to create new institutions—should be assessed carefully. It seems likely that the rural electrification program should be supported by a strong technical assistance component aimed at training professionals in technical and administrative disciplines.

- ***Adequate resources for each stage in the supply chain.*** A critical mass of project developers, consultants, and installers (construction and electricians) must be available in sufficient quantity and quality for the success of a decentralized effort.

- ***Availability of investment finance***. Investment finance for rural electrification investments must be available from banks in sufficient quantities and at adequate terms (tenor beyond ten years and attractive interest rates), particularly when opting for a decentralized approach.

- ***Retail supply of electricity***. Retail supply must be provided by companies with the technical and financial strength to maintain the service over the long term. The potential for local SME contribution and their technical assistance requirements should be assessed when designing a rural electrification program, in particular in off-grid systems.

4.4 Sustained Government Support

Sustained efforts maintained over decades are needed to achieve universal access. Even under the most favorable conditions, it takes at least 15 to 20 years to make significant progress in electrification (say reaching a national electrification rate of 90 percent). It is therefore not surprising that a feature common to all successful electrification efforts is the government's sustained commitment to electrification as a priority development agenda. While government commitment is important for a variety of programs, it is all the more important for electrification because there is no compelling business case to electrify people who cannot pay cost-recovery prices. This commitment entails an effective planning process which, by nature, is a public role: establishing clear rules for the selection and prioritization of electrification projects, setting up a suitable system of tariffs and subsidies, and making the resources to undertake these tasks available. In low-income countries, this effort is usually complemented by donor support, thus adding to the public sector role the need to coordinate donor activities efficiently.

Bangladesh, Chile, Lao PDR, Thailand, Tunisia, and Vietnam offer illustrations:

- Sustained government support for electrification in Bangladesh has already lasted more than 25 years. During that period, priority was given to building the institutional framework, supported by well-coordinated donor activities, and maintaining a rational and stable subsidy system (Barnes 2007).
- Benefits of rural infrastructure programs cannot be fully realized within a single administration term. The success of Chile's rural electrification program in attracting private firms to provide the service hinged on a high level of multiyear financial and political commitment through various national agencies, including the energy sector regulator, *Comisión Nacional de Energía* (National Energy Commission) and the planning ministry, as well as strong regional government buy-in. The government targeted $500 million to support the electrification program and government agencies provided technical assistance to local governments in establishing a methodology for cost/benefit analysis and prioritization of rural electrification projects, as well as calculating the grant required for projects to achieve an adequate rate of return (Barnes 2007).
- In Lao PDR, the government's sustained support to electrification over the last fifteen years has increased the access rate from 15 percent to 69 percent. This rapid pace of access extension was achieved through a comprehensive approach led by government agencies (the utility Electricite du Laos and the Ministry of Energy and Mines) that includes an aggressive grid extension program and off-grid delivery systems, and paying special attention to the financial performance of the utility and piloting innovative approaches that target the poor and female-headed households.
- In Thailand, a key factor for success was the sustained support of the government for 25 years in mobilizing funds, establishing an autonomous agency to deal with rural electrification, implementing the agency's autonomy, and implementing a tariff/subsidy that guarantees the financial viability of the PEA (Barnes 2007).
- The Tunisian rural electrification program increased the rural access rate from only 6 percent in the mid-1970s to 97 percent by the end of 2004 (Barnes 2007), thanks to the government commitment to include electricity access as part of a broader, integrated rural development program that emphasized social equity. Three pillars of their development

plan were education, health, and rural electrification. There was continued government support to institutions and a considerable subsidy, amounting to about 80 percent of the entire capital cost.

- The success in providing access to electricity to a population of more than 40 milion in less than 20 years in Vietnam has been made possible to a great extent by the strong government commitment to support rural electrification and the adoption of a long-term national plan that has been implemented in phases (Van Tien 2009). Sustained support for public investment, which was matched by local community participation and funding, was possible because of the government's resolve to adhere to long-term goals while implementing its program in two phases. The first phase was aimed at providing access to rural households at a fast pace though tolerating some degree of inefficiencies. The second phase, which is still underway, focuses on efficiency and sustainability, such as investments to upgrade and rehabilitate existing systems and establishing an enabling environment (regulatory framework, tariff system, incentives for an efficient operation and provision of a good rural service) for the long-term sustainability of rural electrification.

4. The Way Forward

Successful as well as failed experiences worldwide show that a sustainable approach to electrification must take account of the following key aspects:

- **Sustained commitment of the government to supporting electrification as a priority development objective constitutes the most important feature of successful electrification programs**. A long-term commitment (at least 15 to 20 years) to electrification is a crucial step that frames the institutional, technical, economic and financial design and implementation of specific programs. If the commitment is absent, electrification programs will not move forward and will not be sustainable.
- **Although universal access makes sense from economic and equity perspectives, its financial viability is often uncertain.** The financial viability of electrification for those without access usually requires subsidies to cover part of its capital and/or operating costs, as many unconnected households cannot pay fully for the cost of electricity service. Whether and how to subsidize those who are not able to pay—through funds provided by taxpayers, cross-subsidies from better-off residential consumers or non-residential customers—is a country-specific issue for which there are no superior approaches applicable under all circumstances. It is up to each country to formulate its own strategy, including what priority to allocate to electrification and the type and level of subsidies provided, on the basis of its social, economic, and political conditions.
- **Extending access is particularly challenging for low-income countries with low electrification rates.** Once a country reaches a medium level of electrification and a certain income level—for example, 50 percent electrification and an average per capita income above $3,000 (valued at purchasing power parity)—it becomes easier to achieve universal access because there is an increasing critical mass of taxpayers and electricity consumers able to provide the funds needed to make electrification financially sustainable (Rysankova et al. 2009; Mostert 2008). The challenge is tougher in low-income countries where available resources and the numbers of consumers and taxpayers capable of contributing to subsidies tend to be limited. This situation is often aggravated by poorly performing utilities and regressive pricing policies subsidizing those who can afford to pay cost-reflective tariffs and contributing to systematic deterioration of the operational and financial state of the power sector and its institutional capacity. The consequence is a perverse situation, in which high-income consumers receive benefits they do not need (through subsidized rates and/or unbilled consumption), leaving few or no resources to expand access. However, outstanding cases of success among low-income countries, as in Bangladesh and Vietnam and more recently the Lao PDR, clearly illustrate that it is possible to overcome these difficulties through sustained government commitment to a long-term approach with arrangements and procedures that maximize efficiency in the design and implementation of policies, strategies, and programs aimed at

expanding access, combined with actions to improve the existing tariff systems and subsidization schemes, as well as in the operational performance of utilities in charge of service provision.

- **There is no evidence for the superiority of any specific institutional model for electrification.** There are successful cases based on public, private, and cooperative models and schemes, as well as REAs. A key element seems to be the definition and enforcement of an institutional framework consistent with the country's strengths and the nature of the problems faced, so as to use the limited resources available in an efficient manner. The management of the rural electrification programs requires the leadership of a strong entity, which could be either a distribution utility or a specially designated agency, with an efficient administration and the technical capacity to support the supply chain of contractors and small service providers. Countries have been able to succeed in their electrification efforts using diverse institutional approaches, provided that their programs and strategies include institutional, technical, economic, and financial design and implementation arrangements ensuring their sustainability; efficient execution; and financial and operational sustainability.

5.1 Framework Design: A Government Role

Appropriate approaches for institutional, technical, and economic design and implementation are crucial to carry out access expansion programs. Those approaches must cover tasks such as identification of the areas/population to be reached, definition of the components of the investment program (comprising technological options to be applied), methods for economic and financial evaluation (including criteria for assigning priorities), procedures for effective implementation and monitoring, and identification of sources of revenues needed to carry out investments and ensure service sustainability. For each task, it is necessary to set with clarity and apply with transparency the methods and procedures to be followed, including a precise definition of roles and responsibilities of stakeholders involved (government agencies, beneficiaries, incumbent service providers, contractors, non-governmental organizations, and so on). Public disclosure of all the phases in each specific program, from early design to effective execution, is an effective way to ensure economic and financial viability of electrification efforts and to protect them against the risk of undue political pressures and discretionary decision-making. Because the cost of providing electricity to rural households is usually high, optimized design, including detailed planning, becomes all the more important. Failure to carry out any one of the above tasks may render a program unsustainable or leave it in the identification phase, as shown by several examples worldwide.

Planning of electricity access programs is a government role that has to be carried out by a capable, and usually centralized, government entity. Building such an institution often requires significant technical support and assistance, which donors are usually able to provide. Common features of successful rural electrification planning include

- a clearly established system to prioritize the areas to electrify and the projects to be selected;
- a long-term multiyear vision aimed at coordinating grid extension and off-grid efforts that should be supported by studies on the optimization of technology options and a grid/off-grid comparative economic analysis, and publicly disclosed market studies;
- a broad regional development approach that takes into account other conditions for rural development (access to education and health services, an adequate transport system, agricultural potential, access to markets, and as the capacity of the local manufacturing industry); and
- the design and effective implementation of an institutional framework clearly establishing the roles and responsibilities of the public and private agents involved.

Whichever the approach adopted by a country, the planning of rural electrification programs and criteria for project selection in each program should be established upfront through clear, transparent, and publicly disclosed rules. Each country decides how to prioritize electrification investments among competing regions and/or projects on the basis of its own values, aiming to strike a balance between their economic efficiency and equity objectives. Countries engaged in the "last push" of electrification (e.g., Brazil, Chile) often give priority to the poorest regions. Conversely, countries in the early stages (e.g., Bangladesh) are naturally inclined to heed the financial viability of the investment.

The planning process may give consideration to the following:

- **Grid extension and off-grid options are not mutually exclusive and could be implemented in parallel and, under specific conditions, in sequence**. Grid extension is often the cheapest way to connect new users located not too far from existing networks and relatively easy to implement. Off-grid electrification— mini-grids or individual systems—is suitable in remote areas unlikely to be connected to the grid in the foreseeable future, provided that sustainable supply is guaranteed. In fact, all cases of success reviewed in this paper are based on extension of the grid, complemented, to varying degrees, by supply to isolated rural communities through mini-grids powered by diesel and/or mini-hydro generators. Individual systems, such as solar home systems, are suitable when grid extension and mini-grids are not viable and the expected consumption of households is very low. However, since they provide a limited amount of electricity, solar home systems should be considered an initial transitory, though sometimes long-lasting, step toward a mini-grid or integration into the national grid. Individual systems are likely to be a long-term transitory option for rural populations in countries that currently have very low access rates (mainly in Sub-Saharan Africa), as the service they provide can represent a clear improvement in the quality of life of beneficiaries, even without reaching service levels only achievable through grid connection.

- **Non-conventional renewable energy systems (solar, wind) can complement other sources (diesel, mini-hydro) in ensuring firm energy supply in mini-grids**. Scaling up the use of renewable energy in the energy supply mix of mini-grids should be promoted, depending on effective availability of those resources and economic and financial viability of their exploitation.

- **Technology choices in off-grid electrification are not relevant in global environmental terms. Therefore, an off-grid technology-neutral approach should be encouraged**. A greater number of technology choices (including diesel mini-grids) is more likely to yield lower costs and a solution more suitable to the community's needs. Such an approach often requires removing regulatory barriers to specific technologies to avoid locking in technologies.

- **The planning process should assess the potential for productive uses of electricity and include measures for their promotion**. The experience of several countries, including Bangladesh and Thailand, suggests that promotion of and capacity building for productive uses of electricity in rural areas can increase the productivity of rural businesses, enable a more efficient use of the supply infrastructure, and improve the revenues of distribution companies, thereby enhancing the economics of electrification.

- **Local communities should be involved in the planning process of rural electrification programs**. The review of case studies shows clearly that rural electrification programs benefit greatly from local community participation. Involving local communities from the start can help improve the design (Peru, Vietnam), gain local support (Bangladesh), mobilize contributions in cash or in kind (Nepal, Thailand), and increase local ownership, contributing to operational sustainability. In fact, many of the successful experiences have made combined use of top-down and bottom-up initiatives.

- **Incorporating low-cost technologies in the planning and design stage can enable construction costs to be reduced by up to 20–30 percent without compromising service quality, contributing significantly to the pace and scope of electrification programs**. Many countries have been successful in reducing construction costs using technical standards adapted to rural demand patterns—frequently adopting low-cost single-phase distribution systems—and centralized procurement processes.

- **A greater emphasis on reducing the connection cost charged to the poor is a cost-effective way of increasing electricity access.** In several countries, the percentage of communities electrified exceeds by a large margin the percentage of households connected because few households can afford to pay the connection fee. For example, in Ethiopia only 35–40 percent of households are ready to connect. The paradox is that while the individual connection represents a very small percentage of the total investment required to expand the service, the inability to pay for the connection keeps the access rate down. When the objective is universal access, this cost may have to be subsidized or favorable terms offered for payment.

5.2 Efficient Execution

Grid extension is the obvious technical option to achieve universal access in urban and peri-urban areas, and its sustainable implementation requires the joint effort of the government agency responsible for access, the regulator of the grid service, and the utility providing it. However, there are potentially two main obstacles. First, a tariff/subsidy system that provides funds needed to cover investment and operating costs of new consumers may be absent. Second, a regulatory system may fail to provide the distribution company with the incentives to supply consumers—especially those consuming little electricity and with a limited ability to pay—with good service quality. These factors create conditions that lead to illegal connections. The regularization of the electricity service can be addressed through good management practices supported by the application of smart technologies (such as theft-resistant grid designs) together with a consistent economic and service-quality regulation that allows efficient service providers to recover their total costs of supply and a fair return on their investments. However, it is necessary to complement these measures with a legal framework that legitimizes consumers, creates awareness about the value of electricity service, and promotes discipline in the use and payments.

Seeking broad participation in the execution of rural electrification projects can be an efficient way to extend access and mobilize additional financial resources. The provision of electricity in rural areas frequently entails the implementation of projects in remote areas where the distribution utilities have difficulties or it is more costly for them to reach. Programs that have sought broad participation in project execution have been able to mobilize local resources from the private sector, communities and regional governments, thereby enhancing the execution capacity of the utility. The mobilization of additional financing from local communities or private investors (often about 20–30 percent of the capital cost) also increases the leverage of the subsidized resources.

Competition for independently executed and operated concessions with output-based subsidies is useful in leveraging private financial resources and incorporating incentives for efficient implementation of rural projects. Open and transparent bidding processes are useful in reducing costs. Subsidy bidding, through innovative approaches, such as output-based aid, to maximize the number of connections for a given subsidy, is proving to be an effective way of leveraging significant private resources and delivering results.

5.3 Financial and Operational Sustainability: A Long-Term Utility Objective

The long-term sustainability of electricity service is essential. As with any other business, electricity distribution needs to be financially and operationally sustainable to be able to attract investors and meet the growing demand of customers. However, often this has been the Achilles heel of electrification. There are many reasons, ranging from pricing policies that kept tariffs below total costs of supply and the failure to create incentives for the provision of adequate customer service to, in remote off-grid systems, focusing mainly on the installation of equipment and largely disregarding operating and maintenance requirements.

A sustainable electricity service in rural and low-income neighborhoods requires a well-designed system of tariffs and subsidies. While a large part of capital costs is usually subsidized through special-purpose funds, many low-income households cannot pay the full cost of operation. Therefore, a system of tariffs and subsidies is required to complement—but not replace—the limited contribution of low-income consumers and ensure the sustainability of the service.

The financial sustainability of electricity service should be guaranteed mostly by the contribution from all consumers. In many middle-income countries this has been achieved through the use of cross-subsidies, that is, subsidies within the tariff system or specially targeted taxes through which higher-income consumers help cover the financial gap. However, in low-income countries with lower electrification rates, cross-subsidies have a limited use, made worse by regressive subsidy schemes. Nevertheless, the main source of revenue for ensuring the financial sustainability of the electricity service is the contribution of a critical mass of non-poor consumers. In this regard, prioritizing access in urban areas makes financial sense in low-income countries with low rates of urban electrification. The effectiveness of this approach could be strengthened if complemented with tariff systems and subsidization schemes that are well designed and implemented, and efficient operation of the utilities in charge of service provision.

The following steps can help achieve long-term financial sustainability:

- **A tariff/subsidy policy that recognizes the full cost recovery of an efficient service**. The utility should be rewarded with the subsidy payment upon confirmation that the service provided has been of adequate quality and quantity. Output-based aid mechanisms appear to be a good choice for implementing this principle.
- **A quality control mechanism to ensure that payments to service providers are effectively linked to the compliance with clearly defined quality-parameters for technical and costumer services**. This requires monitoring the quality of service to clients and defining and imposing penalties in cases of non-compliance. The absence of such a mechanism may introduce distortions into the incentive system, as regulated providers would tend to reduce investment and operating costs. The objective is to keep

the focus on customer service. In remote areas, this monitoring role can be delegated to rural electrification agencies.

- **"Ring fencing" the finances of operation, maintenance, and customer services**. These should be completely separated from the investment/installation component.

It is up to each country to decide on the type and level of subsidies to be applied. However, subsidies should be well targeted and used for efficient investments and operating costs, and their design should try to minimize price distortions. Donors may prefer not to support subsidies for recurring costs, since these costs steadily grow as access is extended and are not time-bound. However, it is worth noting that subsidies on current/operating costs can be economically efficient and effective in addressing the country's equity objectives.

Low-income countries with low electrification rates face a more demanding challenge that calls for more efficient performance of the power sector and greater and sustained donor support. Given the magnitude of the electricity access challenge and, often, the limited institutional and financial resources available, it is imperative for low-income countries to minimize inefficiencies in the power sector. It is therefore more important to focus on improving the performance of utilities (technical, commercial, and financial) and implementing a well-designed tariff system along the lines presented in this section, even if doing so might not lead to marked gains in access during the initial years. The larger financing gap and weaker capacity of low-income countries justifies a greater and well-coordinated role of donors that should be sustained over a relatively long period, as in the successful cases of the Lao PDR and Vietnam.

In Sub-Saharan Africa, it is essential to overcome the current power sector performance problems for an electrification effort to be sustainable. The challenge could prove insurmountable if electricity prices remain below costs in favor of the few who have access to electricity. The power sector in Sub-Saharan Africa is in the midst of a serious crisis, characterized by sub-optimal development of energy resources, high costs, under-pricing, and large inefficiencies in performance linked to governance constraints and a distorted set of incentives. In particular, under-pricing and regressive subsidies have become a serious impediment to providing electricity to rural areas and the urban poor. Also, technical and non-technical losses are, on average, very high (30 to 35 percent). It is obvious that any effort to extend access will not be sustainable if there is no progress in addressing these sector-wide problems. The inefficiencies of Sub-Saharan Africa utilities generate substantial costs to the economy that, on average, amount to 1.8 percent of gross domestic product (Eberhard et al. 2008).

Specific issues in ensuring the sustainability off-grid electrification

While challenges in extending access are broadly common to all technologies, there are difficulties unique to off-grid electrification that may justify the use of other business models. These difficulties are associated with the isolation of the communities to be reached and the need to deal with a variety of technologies, some of which are new to the power sector (solar photovoltaic systems, mini-grids based on diesel or mini/pico-hydropower). Off-grid electrification requires

- greater involvement of local communities and promotion of participation of local or regional small- and medium-size enterprises as contractors providing operation, maintenance, and customer services; and
- simplified regulations with flexible procedures, realistic and enforceable quality-of-service standards, and possible delegation of monitoring tasks to entities that are closer and/or better informed about the services being provided.

The foregoing discussion suggests that a REA could be suitable for off-grid electrification. The experience of some countries (e.g., Mali) highlights the synergies and savings of setting up a broader energy agency to address household fuels and other energy matters rather than an agency focused only on electricity.

5.4 The Role of Donors and the World Bank

Much progress has been made in extending electricity access in developing countries, but significant challenges remain. In spite of its relatively large contribution—$1.86 billion[13] in supporting investments during the period FY2000–FY2008 (Barnes, Singh and Shi 2009)—the World Bank is but one of many players in promoting electricity access and it is clear that coordinated approaches among international donors and the countries themselves are necessary to tackle the challenge of providing electricity services to the world's poorest populations. Sustained donor support is needed in two equally important areas:

- Financing the subsidies to cover capital and operating costs of electrification projects, particularly in low-income countries
- Technical assistance to strengthen institutions, both for the public sector in fulfilling its planning, regulatory, and administrative role, and for actors in the private sector, particularly local ones, engaged in the supply chain.

The financing gap in low-income countries is enormous, making harmonization of donors' financial management and procurement procedures all the more urgent. The recent experience in the Electricity Access Scale-up and Sector-Wide Approach Development Project in Rwanda introduces an option for donor coordination (World Bank 2009b).

The importance of technical assistance cannot be over-emphasized. The World Bank Group's experience in several countries, including the Lao PDR and Vietnam, has shown that if effective technical assistance is provided early on to strengthen regulatory, institutional, and financial

[13] The regional distribution of World Bank lending for household electricity during this period was 37 percent in Africa, 33 percent in East Asia and the Pacific, 23 percent in South Asia, and 7 in Latin America and the Caribbean.

frameworks and institutions, subsequent investments and projects become easier to implement and more effective in delivering results.

Annex 1: Peru Case Study

Country Context

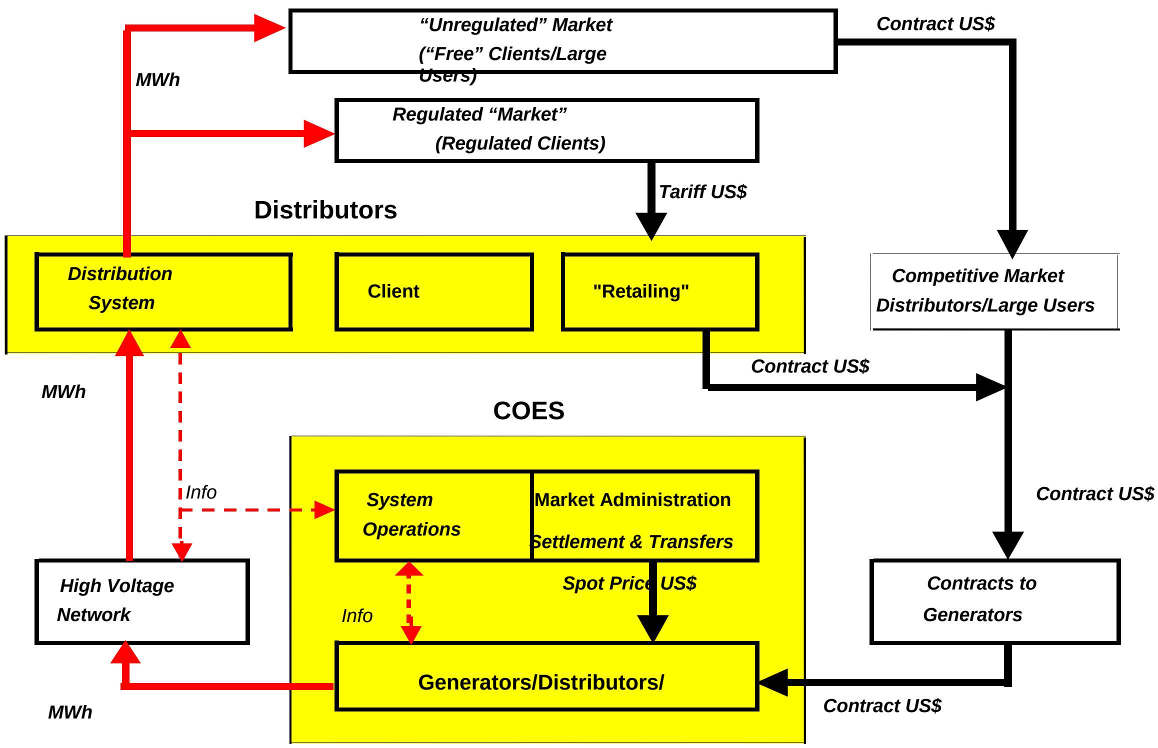
The 1980s was a lost decade for Peru. The country had fallen into a dismal performance caused by weak macroeconomic and heavily interventionist policies. By the early 1990s, the economy was ravaged by hyperinflation and falling output, with seventy percent of the external debt in arrears and foreign reserves exhausted. The power sector was facing a deep crisis, reflected in very low quality of service, inefficient public utilities, extremely serious financial difficulties, and one of the lowest countrywide coverage ratios in Latin America at 54 percent. In the predominantly poor rural areas, which accounted for one-third of the population, less than 7 percent had access to electricity.

The problems in the power sector were linked to its legal framework, which guaranteed a public monopoly, and to interventionist policies that relied strongly on widely spread subsidies as a tool to control inflation and redistribute income. The power sector in Peru was reformed between 1992 and 1993, in line with a neoliberal economic reform that emphasized the reduction of an oversized public sector. With the objective of improving overall performance and mobilizing private financing, the sector was unbundled, followed by a privatization and concession process. A new legal and regulatory framework was established by the Electric Concessions Law. Ownership of major sector assets was transferred to private hands. The new legal framework created a sector regulator, now called *Organismo Supervisor de la Inversión en Energía y Minería* (OSINERGMIN, Supervisory Agency for Investment in Energy and Mining),[14] and an independent system operator, *Comité de Operación Económica del Sistema Interconectado* (COES, Committee on Economic Operation of the Interconnected System). Figure 3 presents the structure of the Peruvian electricity market.

One shortcoming of the reform in the early 1990s was the requirement that distribution companies extend electricity only to households located within 100 meters of their last pole, thereby not providing sufficient incentives to pursue access expansion aggressively. As a result, rural electrification was confined to direct investment by the central government, not receiving funds from regional governments or the service providers.

[14] The Electric Concessions Law of 1993 (LEC) established OSINERG, the predecessor to OSINERGMIN (mining was added in 2007). The law granted budgetary autonomy to the regulator and stipulated the methodology for setting rates, granting concessions, customer service guidelines, and accountability of operators. In 2001, OSINERG was merged with the Commission for Electricity Tariffs (CTE), assuming its tariff regulation function. A mature and technically strong entity with a board of directors appointed through a competitive process, including its President, OSINERGMIN has gained a reputation for being a professional and efficient agency.

Figure 3: Peruvian Electricity Market Structure



Source: World Bank 2008a.

The distribution business. The privatization of distribution did not proceed as planned. Privatization in the power sector started in 1994 and progressed swiftly until 1997. Between 1997 and 2000 the privatization process slowed down considerably due to domestic and foreign factors, such as the impact of the Asian financial crisis and continually declining public approval. By the late 1990s the economic reform, and in particular the privatization process, had lost political support, because growth was perceived to be increasing inequality. The distribution segment of the electricity service at present has 4.35 million customers, of whom 1.92 million are served by privately-owned companies and the remaining 2.43 million by various regional publicly-owned distribution companies. The two largest private distribution companies, Luz del Sur and Edelnor, serve the capital city Lima with 1.76 million costumers. These companies have a concentrated and profitable market, with good technical and financial indicators, and report full coverage within their concession areas. The access challenge lies in areas managed by the provincial public utilities.

Distriluz is the largest of the publicly-owned companies, serving 1.43 million customers, or about 7 million people, in several medium-sized cities with moderate load concentration. Distriluz's market is not highly profitable but has a sufficient return for business retention and modest market expansion. Two other distribution companies—Sociedad Eléctrica del Sur Oeste serving 262,000 customers in Arequipa and Electro Sur Este serving 266,000 customers in Cusco—have similar characteristics. The remaining publicly-owned distribution companies serve a large number of relatively small cities and towns with low load concentration, and rural areas with dispersed communities and low demand.

Tariffs. The Peruvian electricity tariff scheme is designed on the basis of a full-cost recovery principle. The regulated generation tariff is set by OSINERGMIN every year, based on the results of an auctions process.[15] The transmission and sub-transmission networks have open access and tariffs are regulated based on costs and the results of competitive bidding for transmission expansion. Transmission tariffs are recalculated every year. The distribution tariffs are regulated based on costs of an efficient distribution operation and taking into account the characteristics of the specific market served by the company. In particular, markets are sub-divided into five typical areas: high-density urban, medium-density urban, low-density urban, urban-rural, and rural. The tariffs are recalculated every four years. The tariff for a typical regulated final user is the sum of the tariffs for generation, transmission, and distribution.

Rural Electrification Program

Rural electrification faces particularly difficult challenges in Peru. The large distances separating many isolated communities and highly rugged terrains make extending access to electricity in rural areas very difficult, resulting in high installation, operation, and maintenance costs. As elsewhere, these difficulties are exacerbated by the low level of electricity consumption of most rural households.

After the reform of the early 1990s, the rural electrification effort was limited to direct investment by the central government. Investments were carried out through social funds and implemented by the *Dirección Ejecutiva de Proyectos* (DEP, Executive Office of Projects) of the Ministry of Energy and Mines (MEM). This centralized top-down model has a number of acknowledged limitations, an important one being its full reliance on the government's political will to support the program and its capacity to mobilize adequate financial resources. Consequently, the progress made in extending access was uneven and, in spite of spending an average of $40-50 million per year, rural coverage in 2006 was still below 30 percent, one of the lowest levels among Latin American countries and particularly low for a middle-income country. Nor had there been significant progress in providing (off-grid) electricity in isolated areas or in developing renewable energy technologies.

In recent years the government has strengthened its commitment to reduce the electrification gap. To that end, the government has increased public investment markedly, taking advantage of the country's current macroeconomic health, and is seeking alternative approaches, such as a bottom-up decentralized framework and the use of new technologies—especially renewable

[15] Legal amendments of 2006 (Law Nº 28832) established an obligatory auction mechanism for the regulated market, which is gradually replacing the previous administrated tariff system based on a marginal cost approach. There is an unregulated generation market for large consumers that account for about 40 percent of the national market.

energy—to serve remote populations. This renewed effort is supported by the General Law for Rural Electrification (*Ley General de Electrificacion Rural* N^{o} 28749), passed in June 2006) and Legislative Decree N^{o} 1001 of May 2008. They established the institutional framework for the promotion and development of rural electrification; established and protected sources of financing, including the establishment of a Rural Electrification Fund (REF); opened doors for private participation; allow DEP to execute projects within the concessions of the state-owned distribution companies, including the rehabilitation and/or improvement of existing installations; and regulate the financing agreements with the distribution concessionaires.

The 2009–2018 National Plan for Rural Electrification has the following targets (DGER 2009):

- Increase rural electricity coverage from 30 percent (in late 2007) to 69 percent in the medium term (2011) and 84 percent in the long term (2018).
- Mobilize $2.2 billion in 2009–2018.
- Strengthen an integrated management system to provide adequate support and data control of the projects designed and executed under the National Plan.

The government is working to meet these ambitious targets through scaling up the centralized program of DEP/MEM, complemented by a World Bank-supported Rural Electrification Project, which is aimed at increasing economic efficiency and attracting broader participation and financing from regional and local governments and service providers. Since May 2009, both programs have been led by the *Dirección General de Electrificación Rural* (DGER, Rural Electrification Department), ensuring coordination between them as well as alignment with the government's priorities and goals.

DEP/MEM Rural Electrification Program. The DEP/MEM program constitutes the main tool of the government for achieving its ambitious electrification targets. The program's investment costs are fully subsidized and funded through government social funds, including *Fondo Nacional de Cooperacion para el Desarrollo* (FONCODES, National Fund for Compensation and Development) and REF. The program is executed by DEP and, once the construction phase is completed, rural electricity systems are turned over for operation either to the state-owned distribution companies or to ADINELSA (Administration Office of Electric Infrastructure), a specially created state-owned asset-holding company that manages the systems under operation contracts with the state-owned distribution companies or municipalities. Connection and meter costs are considered part of the concessionaire's investment and customers are not specifically charged for connection. While in the past this program had its ups and downs (from an investment of $135 million in 1996 to $18 million in 2002), it has gained a considerable momentum in recent years and is progressing at a very rapid pace. The rural access rate is estimated to have increased from 38 percent in 2008 to 45 percent in 2009, benefitting 465,000 newly connected people at a cost of about $180 million. This is a significant increase from 29.5 percent in 2007 (DGER 2009m 2010). MEM's proposal is supported by the strong fiscal position of the state, which appears to be able to meet the financing target as planned, and an experienced 300 staff-strong department, DEP, in the ministry.

Projects under the DEP/MEM program are subject to the following evaluation criteria:

- Compliance with technical and quality standards applicable to rural electrification, with equipment and materials durability of 20 years[16]
- A socio-economic evaluation confirming that the project yields a positive present value over a period of 20 years
- A financial analysis using market values and revenues from tariffs, consisting of payments by customers and subsidies.

Projects are prioritized according to the following criteria:

- Provincial electricity coverage ratio—the area with the lowest coverage ratio is given priority first
- District poverty index—districts with higher poverty index are given priority
- Level of preparedness of the project
- Presence of supporting power infrastructure (transmission lines, substations).
- Present value of socio-economic benefits
- Investment per capita—projects with the lowest investment per capita are given priority
- Geographical location—frontier areas are favored.

The above factors are sometimes in conflict. For example, many districts with a high poverty index are located far from the existing transmission system and, often, require a higher investment per capita because they are remote. But these factors are reportedly weighted in a way that gives greater priority to the social and poverty alleviation objectives than to economic efficiency objectives (maximum economic returns or minimum subsidy). This approach increases costs but extends access in regions where it may be more difficult to operate and maintain power infrastructure than elsewhere, and avoids cherry-picking whereby power companies selectively choose attractive customers (low cost, strong ability to pay) first.

The World Bank supported Rural Electrification Project. The objective of this project is to provide electricity to rural households and businesses that do not have access to modern energy services, as well as introduce an approach to rural electrification that would result in more efficient provision of rural electricity services. It was designed with view to serving as a model for future programs and improving the sustainability of the rural electrification effort. The project is financed by a $50 million IBRD loan and a $10 million GEF grant, complemented by a contribution of $51 million from the government of Peru and $33 million from service providers and private enterprises (World Bank 2006). The project was approved by the World Bank in March 2006.

The project has five main components: (1) investment in rural electrification projects to provide new electricity connections to customers using both conventional grid electricity and renewable

[16] Peru's technical and quality standards for rural electricity services aim at achieving lower investment and maintenance costs, considering the lower level of consumption per household. Medium voltage installations are for 22.9/13.3 kilovolts, predominantly for one phase-SWER. The standards also include longer spans between poles/towers and less stringent reliability standards (duration and frequency of interruptions and voltage drop).

energy systems; (2) technical assistance to catalyze private sector participation and create capacity for a demand driven approach for rural electrification, as well as promotion of renewable energy; (3) a pilot program to promote productive uses of electricity; (4) a small hydro generation financing facility to provide project financing during construction and the initial period of operation; and (5) project management.

The progress reported during the project's mid-term review mission of May 2009 includes the following main aspects (World Bank 2009c):

- ***Rural electrification sub-projects***. This component provides subsidies to cover the capital costs of electricity access projects implemented by service providers (the concessionaires, which are usually public distribution companies). Sub-projects include grid extension, mini-grids, and provision of services through renewable energy systems. MEM signs a contract that establishes the conditions of the subsidy and the contractors' responsibilities with the concessionaire. The subsidy is calculated as the amount required for the project to yield a return of 14 percent on the concessionaire's investment. Contributions of local or regional governments are deducted from the subsidy amount. The eligibility criteria for sub-projects to receive a subsidy are

    - a profile sub-project document, including safeguards screening;
    - a minimum of 1,000 new electricity customers;
    - a minimum investment by the concessionaire of 10 percent of the capital cost;
    - an economic rate of return above the requirement of the National System of Public Investment, which is currently 14 percent; and
    - a maximum subsidy of $800 per connection.

    To maximize the impact of central government funds, the main prioritization criterion for the selection of sub-projects is minimizing the subsidy per connection. The use of these eligibility and selection criteria clearly incorporate economic efficiency incentives and are therefore expected to yield low unit connection cost. The assessment performed at the appraisal stage (2005–2006) estimated that the foregoing selection and prioritization process would reduce costs by about 30 percent relative to a standard DEP/MEM sub-project. Despite the subsidy minimization criterion not having been applied to date, as there has not been a need to reduce the number of sub-projects beyond those that are eligible, the World Bank project is reportedly yielding connection costs that are lower than those of the DEP/MEM program.

    A sub-component of special interest is the introduction of photovoltaic (PV) systems in isolated areas. The World Bank project has been able to take significant positive steps in this field. The project has followed a broader approach that involves local governments, drawing from an existing outsourcing practice,[17] supporting technical assistance required for the preparation of sub-projects, and setting an appropriate tariff system. Consequently, distribution companies are in a better position to extend their regulated service in isolated areas using independent PV systems. As of mid-2009, more than 9,000 PV sub-projects had been presented to MEM, representing the first significant step in developing solar systems in Peru. The additional financing being considered would help achieve a lot more.

Overall, this component is performing satisfactorily. After a relatively slow start, the response of the distribution companies has exceeded expectations. The average subsidy for grid extension sub-projects has reached 77.5 percent of the investment cost, much lower than the maximum accepted (90 percent) and connection costs have shown a declining trend from $1,163 to $937 per connection. The grid extension effort is expected to benefit 120,000 new customers (about 550,000 people). A possible extension of the project, which is being considered by both the government and the World Bank, would double these figures.

- ***Productive uses of electricity***. This component aims to carry out a promotional and marketing campaign to encourage productive uses of electricity and develop business assistance in rural areas to promote economic activities utilizing electrical equipment. So far, the project has been working in one specific region, Cuzco, where up to 800 micro-entrepreneurs are being supported in the adoption or the increase of electricity for productive uses—mainly milling, coffee, cocoa, bakery, dairy products, and carpentry (Tarnawiecki 2009). The promotion and consultation process is helping to build capacity in the field and is also yielding important lessons in identifying the potential for increasing productive uses, constraints, and possible solutions (such as the development of an institutional platform that includes financing institutions and/or tariff incentives in addressing the impact of increased electricity bills associated with productive uses). The promotion campaign is being improved and replicated in other regions. This promotion and capacity building effort has the potential to contribute markedly to increasing the productivity of rural business and improving the living conditions in rural areas, as well as achieving a more efficient use of the electricity supply infrastructure and increasing the revenues of the distribution companies.

- ***Collaboration with the distribution companies and the local municipalities***. Prior to the off-grid pilot project, distribution companies did not have information on the market for off-grid service extension. A market has been identified through the development of demographic, socio-economic work. Municipalities have played a key role in performing

[17] Distribution companies regularly contract SMEs for operation and maintenance and commercial tasks in rural communities as a strategy to control costs of distribution services over extensive territories. Main SME models are the CASE (*centro de administración de servicios eléctricos*) and the CAP (*centros autorizados de pagos*), SMEs comprising a few people that engage in operation and maintenance (CASE) and commercial (CAP) services in multiple communities.

and financing many socio-economic studies that identified communities suitable for off-grid extension. With this valuable information and the recognition of existing demand for off-grid services, replication of sub-project proposals in the future rounds is now considered feasible.

Measures to ensure financial and operating sustainability. An important element of the Peruvian model is the full recovery of costs to the concessionaire/distribution company. While capital costs are strongly subsidized and installations are turned over to the concessionaire without any debt obligation, costs of operation, maintenance, and provision of customer services are higher in rural areas where consumption levels are lower—the average monthly consumption per customer in rural consolidated areas is 30kWh, and around 12 kWh for newly connected customers, against the average urban consumption of 100 kWh—and the ability to pay for the service is also lower. Under these circumstances, extending access in rural areas requires a system of subsidies that acknowledges the lower income and electricity consumption levels of rural households and higher costs of supply resulting from the remoteness of the location. The inability of rural consumers to pay fully for the cost of supply in particular highlights the importance of designing a system of cost-effective subsidies to ensure the recovery of the costs of an efficient operation—whatever the amount contributed by the customer—to ensure that the service in rural areas is not neglected and remains a priority for the distribution company. Reflecting the government's social objectives, while the power sector policy does not mandate a single tariff structure nationwide or the concept of universal access, the political objective that all citizens be treated equally is reflected in the country's tariff and subsidy policies.

The Peruvian system includes three types of subsidies, which are applied to meet financial sustainability and social equity objectives:

- ***Subsidy on capital costs*** applied to grid extension, mini grids under 500 kW, and off-grid electrification. The size of the subsidy varies from 77 percent (World Bank project) to 100 percent (DEP/MEM program) of the total investment. Sources of funding are government social and electricity funds (FONCODES, REF, and others), donors, and local government contributions. The annual amount of this subsidy varies depending on the progress made in connecting new customers. The capital subsidy has been estimated to be more than $200 million per year in recent years.
- ***Internal tariff subsidy***. This is a system of cross-subsidies that includes two components aimed at reducing the prices of generation in isolated systems and compensating for the differences in distribution costs between urban and rural areas.
    - Subsidy to generation in isolated systems. In this scheme, revenues from grid-connected customers are channeled through the REF to compensate for the differential between the generation costs in isolated systems and the bus bar prices of the national interconnected system. The annual compensation is about $24

million, reducing electricity prices in isolated areas by 16 to as much as 61 percent (for privately owned diesel-fuel generation).

- o Internal subsidy on the regulated tariffs for distribution. The objective is to compensate for the difference in the distribution costs between rural and urban areas. The subsidy is a classical cross-subsidy and is funded directly by urban consumers through the tariff. Law N° 25844 established a methodology for the calculation of the subsidy on the basis of a set of weighted factors calculated for each utility. Subsidies are applied for each of the five typical distribution sectors. The annual compensation is about $13 million. In the highest-cost case (distribution sector 5, rural), this cross-subsidy reduces the distribution tariffs by about 22 percent.

- ***Consumption subsidy***. The first subsidy introduced in the electricity tariff scheme in 2001, this subsidy aims at protecting low-income households with monthly consumption below 30 kWh. It also lowers the tariff for those with monthly consumption below 100 kWh (Table 6). The subsidy is channeled through the *Fondo de Compensación Social Eléctrica* (FOSE, Electricity Social Compensation Fund). The total amount of the subsidy is about $31 million per year, which is collected through an extra charge of 3 percent on households consuming more than 100 kWh per month.

Table 6: FOSE Tariff Subsidy Scheme

Users of	**Area**	**Tariff reduction for monthly consumption lower or equal to 30 kWh**	**Monthly consumption exceeding 30 kWh but less than 100 kWh**
Interconnected systems	Urban	25%	A reduction equivalent to 7.5 kWh/month
	Rural	50%	A reduction equivalent to 15 kWh/month
Isolated systems	Urban	50%	A reduction equivalent to 15 kWh/month
	Rural	62.5%	A reduction equivalent to 18.75 kWh/month

The aggregate impact of the subsidy system is considerable. In 2009,[18] the total subsidy, including the capital cost subsidy and the cross-subsidies outlined above, reached about $250 million, or about 12 percent of the power sector revenues.

As a consequence of the cross-subsidy system, rural households pay a tariff slightly higher than the urban tariff, despite their supply cost being possibly two to five times higher. In the extreme case of a high-cost isolated generation system, subsidies reduce the contribution of a low-income

[18] On February 8, 2010, a MEM press release stated that the country's investment in rural electrification reached S/.528 million in 2009 ($182 million) and announced the government's goal of reaching an electricity access rate of 94 percent by July 2011.

rural household to 16 percent of the total cost. Table 7 presents the cumulative impact of different subsidies on a low-income household in a typical isolated mini-grid.

Table 7: Impact of Subsidies on Tariffs for an Isolated Mini-Grid
(US cents/kWh)

	Full Cost	With internal tariff subsidy	With internal tariff subsidy and FOSE
DAV secondary grid	22.01	9.01	3.38
DAV primary grid	9.58	3.98	1.49
Capacity cost	3.32	3.32	3.32
Energy cost	17.80	5.76	2.16
Total	52.71	22.07	8.28

Source: Revolo 2009.

Overall, the Peruvian subsidy system appears to be protecting low-income rural households and compensating for the higher costs faced in rural and isolated areas without incorporating any significant distortions, since distribution companies are compensated on the basis of the services they provide in an amount that is aimed to cover fully the costs of efficient operation. However, the fast pace of the rural electrification effort is testing the efficacy of the regulatory system, as distribution tariffs are recalculated only every four years. It is not clear whether the annual tariff adjustments for distribution are able to keep pace with the rapid changes in the cost structure of some distribution companies, as large numbers of new customers are connected every year.

Lessons Learned

The global experience suggests that the institutional setup in the sector is not critical for the success of rural electrification programs. There are cases of success based on models as diverse as direct public intervention, rural electric cooperatives, and systems of incentives to bring in the private sector. Compliance with a set of principles, rather than the choice of an institutional model, seems to be the key to success. Fundamental elements of effective rural electrification include a sustained government commitment, an effective prioritization of rural electrification projects, financial sustainability, and customer focus. **The Peruvian experience confirms the importance of sustained government support and a regulatory system that guarantees financial sustainability**, the two main pillars of the country's effort.

The government's political will to support a large public investment program appears to be achieving unprecedented progress in reducing the electricity access gap. Considering as self-evident the economic and social benefits of rural electrification, the DEP/MEM is engaged in an ambitious program, taking advantage of the availability of public funds and aiming to solve the problem in a few years. This involves a very rapid pace that would be constrained more by the public sector's implementing capacity than by the availability of financial resources. In parallel, the government has taken ownership of a World Bank project designed to introduce economic efficiency into this effort and attract broader participation and financing from communities, regional governments, and service providers.

The fast pace of electricity service expansion has pros and cons. The benefits of rapid expansion are clear: more people are reached in a given span of time than otherwise, with associated social and economic benefits. That the selection process for projects is designed to reduce the chances of cherry-picking enhances the program's impact on poverty alleviation. The fast pace of investment, however, raises questions about the program's efficiency and sustainability: whether the pressure to move fast is compromising the rigor of the prioritization and planning process, possibly raising costs. It is not the intention of this paper to present a view on the tradeoffs between economic efficiency and equity objectives. The balance between these objectives is a matter of societal values that are expected to be addressed within the political process of each country. What the Peruvian experience highlights is the importance of a government political will in securing adequate financial resources, strengthening institutions, and reducing the electricity access gap.

The second pillar of the Peruvian model is a well-designed system of tariffs and subsidies, aimed at ensuring financial and operational sustainability. A tariff that guarantees full cost recovery to concessionaries is essential for sustaining good-quality service and service expansion. It does so by compensating the concessionaires to ensure full cost recovery of an efficiently operated system. That said, the regulator does not have sufficient resources to monitor satisfactorily the companies' technical performance. In fact, this is a universal problem that constitutes a main challenge to the efficient functioning the power sector and, in particular, the rural electrification programs of many countries.

The regulation of distribution companies needs to keep pace with rural electrification. Its rapid pace presents a new challenge for the program's sustainability, as the cost structures of some distribution companies are likely to change rapidly upon the incorporation of a large number of new customers. Consequently, costs per customer are likely to increase while the revenue per customer declines. Regulated tariffs for distribution are usually set every four to five years, subject to annual adjustments based on an established indexation mechanism. During periods of rapid growth, it is essential that this tariff captures effectively the expansion plans for distribution companies and the impact that this would have on the level and structure of costs. Failure to do so could harm the companies' financial position and undermine the sustainability of the rural electrification effort. This highlights the need to monitor closely the impact of a rural investment program as large as the one in Peru on the cost structure of distribution companies and, when justified, proceed with extraordinary tariff adjustments.

The following preliminary lessons can be drawn from the progress to date in the implementation of the World Bank rural electrification project:

- **Eligibility and prioritization criteria of projects that emphasize the minimization of unit costs and subsidies does, in fact, reduce costs**. Also, a broad approach aimed at attracting the participation of regional governments and service providers can help mobilize additional financial resources. The contribution of these parties in the investment effort would allow the central government to reach an additional 30 percent of rural households using the same resources. It is worth noting, however, that a criterion that is based excessively on minimizing costs and subsidies could lead to cherry picking and discriminate against poor rural households.

- **Regulatory, technical, and capacity building support can help distribution companies extend their regulated service through SMEs to off-grid communities, using independent PV systems**. The project's main pilot activity has provided support to distribution companies, and there is a high level of interest from distribution companies to replicate the experience in other parts of the country.
- **An important lesson stemming from the project is that the close collaboration with the distribution companies and local municipalities increases the likelihood of success of off-grid projects**. Prior to the pilot project, distribution companies did not have much information on the market for off-grid service extension. Municipalities played a key role in performing and financing much of the socio-economic studies, which enabled the identification of communities. With this valuable information available, and the recognition of existing demand for off-grid services, replication of subproject proposals is now considered feasible.
- **The promotion and capacity building effort to encourage productive uses of electricity has the potential to contribute significantly to increasing the productivity of rural business and improving the living conditions in rural areas**, as well as achieving a more efficient use of the electricity supply infrastructure and increasing the revenues of the distribution companies.

Annex 2: Vietnam Case Study

Country and Power Sector Context

Vietnam's GDP per capita grew annually at 5.9 percent on average between 1998 and 2008 (World Bank 2009d). The economy has proven to be resilient to shocks and negative impacts, such as high commodity prices, poor weather, and health hazards (SARS, avian influenza). The country has been increasingly integrated into the world economy and became the 150th member of the World Trade Organization in January 2007.

Power Sector background. In the 1990s, Vietnam's power sector was facing the challenge of meeting the needs of a fast growing and rapidly industrializing economy. Electricity demand was growing at an annual rate of 13 to 15 percent. Government targets for economic and social growth required increasing electricity supply at a rate 1.7 times faster than that for GDP. In 1993, 70 million people still lacked access to electricity, and only 54.8 percent of the 8,860 rural communes, and less than 15 percent of the rural households, had access to electricity. In response, the government made rural electrification a main component of its poverty reduction program—electrification would address imbalances in development and enhance overall welfare levels by providing reliable lighting sources and improving health care, education, and other social services.

Development plans for energy infrastructure represented an investment of about 5 percent of GDP, needing careful use of the limited financial resources available to the country. The government aimed to address these challenges by (1) raising and restructuring electricity tariffs to increase internally generated funds; (2) promoting energy conservation and efficiency; (3) increasing private investment in power generation and developing natural gas; (4) equitization (privatization of state-owned enterprises, targeting mostly small enterprises) of distribution companies; and (5) meeting the funding gap using donor financed programs, particularly for its rural electrification program.

In the early 1990s, the government's rural electrification program had been hampered by poor institutional arrangements and lack of sufficient capital. Almost 90 percent of rural electricity distribution was carried out by commune electricity groups that had no legal status, minimal technical competence, and little financing. Regulation of the power sector suffered from several drawbacks:

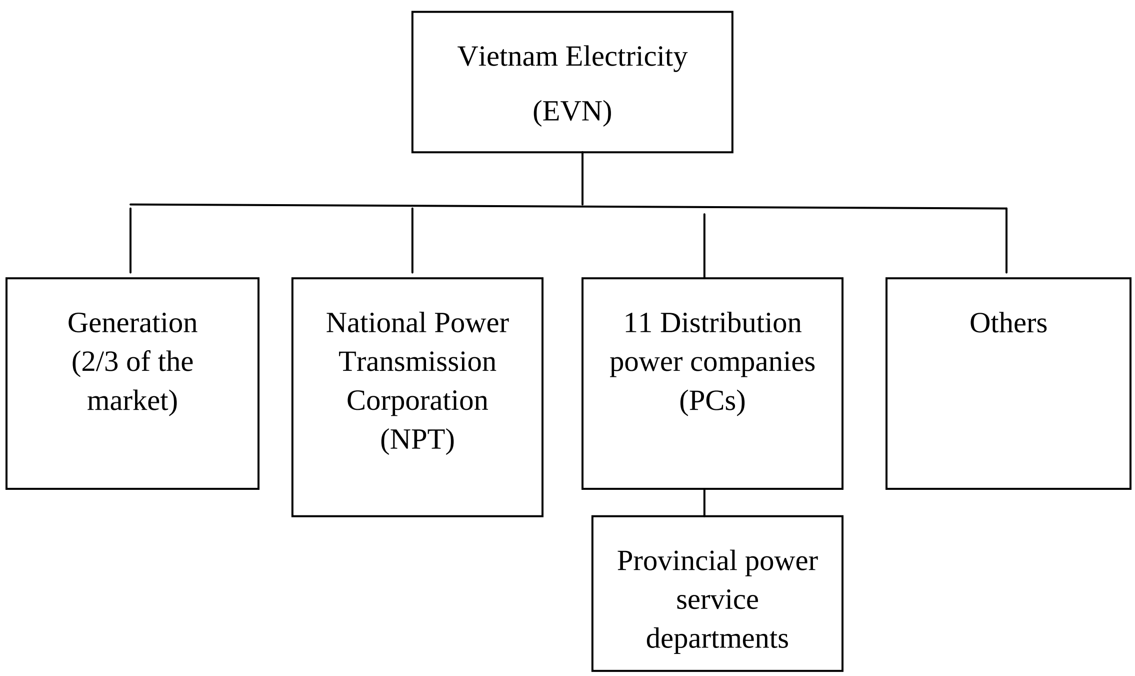
1. There was no effective legal and regulatory framework for the power sector.
2. The government's oversight and regulation functions were not separated from the operation of the sector by Vietnam Electricity (EVN).
3. There were no technical standards for rural electrification.

As a result, Vietnamese government agencies and power enterprises were unable to decentralize decision making and exercise administrative/management oversight of local energy activities without interference. One of the basic requirements for successful rural electrification—effective local implementing agencies with a high degree of operating autonomy, technical competence, and good leadership—was missing.

In the late 1990s, the government sought the World Bank's support to cover the financing gap for rural electrification and pilot institutional arrangements, seeking decentralization of the rural electrification program and building local capacity. Accordingly, the first rural electrification operation (Rural Energy Project) of the Bank was approved in FY2000. This effort was followed by a series of subsequent projects.

Sector Structure and Ongoing Reform. The main electricity provider is EVN, a state owned enterprise which owns about two-thirds of all generation capacity in the country. Today, through its subsidiary National Power Transmission Corporation (NPT), established in July 2008, and eleven distribution power companies (PCs), EVN owns and operates transmission and medium-voltage distribution systems, and low-voltage distribution systems supplying main urban areas and some rural areas. Figure 4 presents the structure of EVN. Losses (technical and non-technical plus own consumption) fell from more than 20 percent in 1998 to 11 percent in 2008.

Figure 4: Structure of Vietnam Electricity



One third of the country's power generation is produced by two internationally-owned private companies operating under build-own-transfer arrangements and a group of Vietnamese independent power producers. About two thirds of the low-voltage distribution is owned and operated by local distribution utilities which purchase power from EVN. As such, the responsibility for extending electricity services in rural areas is shared between local distribution utilities and EVN's 11 PCs.

In November 2004, the government passed Electricity Law, the first law to govern the power sector in the country. The law aims to create a competitive electricity market and diversify forms of investment in the power sector. Importantly, the law provides for a new authority in the power sector—the first electricity regulator in the country. The Electricity Regulatory Authority of Vietnam (ERAV) was established in 2005. Since then, the government has been implementing reform which aims at ultimately unbundling the sector and establishing competition in generation. The sector is in a state of transition, which includes a gradual reform of its tariff policy.

The power sector has been able to keep pace with the extraordinary increases in demand during the last decade and maintain satisfactory financial performance, while its tariffs are quite low international standards. The main goal for the future is to continue meeting rapidly increasing demand and maintaining acceptable-quality service. In doing so, the sector faces five key short- to medium-term challenges: (1) optimizing power investments, particularly for generation; (2) financing the investments required; (3) implementing the reforms in the power industry and restructuring EVN; (4) improving access and service quality; and (5) addressing shortcomings in the tariffs.

Tariff System. While World Bank reports indicate the need to adjust the tariff policy and even to increase tariffs, EVN's average bulk supply tariff in 2008, about 5.3 cents/kWh, was sufficient to make a profit. However, there have been periods when average tariffs were below costs and external sources (predominant sources being low-cost loans from the government and state commercial banks) were used to make up for the deficit.

Studies on the distribution and bulk supply tariffs undertaken in the mid-2000s (Economic Consulting Associates and Robert Vernstrom & Associates 2005; Antmann 2007) recommended that the residential subsidy be limited to low-income/low-consumption customers and the cross-subsidization between consumer categories be revised, and single, cost-reflective bulk supply tariff be implemented, based on the following observations:

1. Three consumer groups—residential consumers supplied directly by EVN, wholesale residential consumers, and irrigation customers—were paying significantly less than they should, partly on account of an excessively large lifeline block for residential consumers.
2. Industrial and commercial consumers were paying significantly more than they should.
3. There were too many tariff categories.
4. The mechanism for setting differentiated bulk supply tariffs to each of EVN's PCs was excessively complex, lacked transparency, and did not provide adequate cost signals.

Tariff reforms are underway. A new, transitional tariff structure went into effect in March 2009. It established a geographically uniform bulk supply tariff for all PCs as well as uniform retail tariffs for residential consumers. The tariff system maintains cross-subsidization within consumers categories (a rising block tariff) and between categories (from industrial and commercial customers to residential and rural customers). The calculation and setting of electricity retail tariffs were unbundled into separate generation (power purchase) costs, transmission charges, distribution network services (distribution margin) and other costs.

Because the characteristics of the markets served—customer mix, density of connections, consumption levels, and so on—are different, a uniform bulk supply tariff cannot match different costs of efficient operation of each PC. To take account of varying costs, a cost allocation procedure is used to enable each PC to collect its actual revenue requirement. Before 2009, EVN assigned specific bulk energy tariffs to each PC, an excessively complex procedure which was not transparent, often perceived as arbitrary, and did not provide signals to distribution companies or end-users about the true cost of supply. The current system is a clear improvement, because it explicitly sets a uniform bulk supply tariff and, in addition, includes a compensation amount that could be positive or negative. That is, there is a transfer through the tariff system without recourse to any fund.

On the retail side, there is a rising block tariff structure (Table 8), applied uniformly throughout the country. The first block was reduced from 100 kWh to 50 kWh to improve targeting to the poor and energy efficiency. The tariff for the second block was increased to eliminate the subsidy. The previous arrangement of setting different bulk supply tariffs for each PC was replaced by a single bulk supply tariff for all PCs. Local distribution utilities purchase electricity from PCs at a price set at the residential tariff minus an allowance for local distributor costs. A new multiyear distribution tariff system is under preparation and is expected to be implemented in 2010. The new retail tariff will be applied to both PCs and local distribution utilities and is expected to be based on performance standards and designed to include incentives for efficient operation.

Table 8: Tariff Structure Effective from March 1, 2009

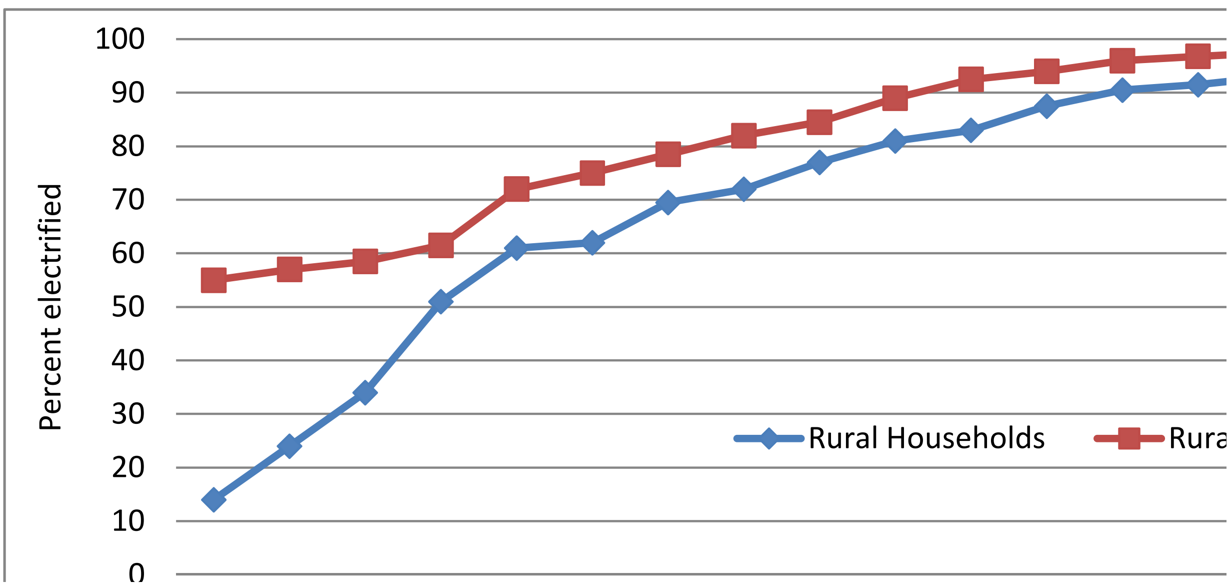
Consumption Block (kWh)	**Retail Tariff (VND/kWh)**	**Bulk tariff to local distribution utilities (VND/kWh)**
0-50	600	420
51-100	865	605
101-150	1,135	795
151-200	1,495	1,120
201-300	1,620	1,215
301-400	1,740	1,305
> 400	1,790	1,345

Source: Van Tien Hung 2009
Note: VND = Vietnamese dong

Rural Electrification Program

Access to electricity in rural areas has increased dramatically during the last decade, marking the program one of the most successful in the world in recent history. The percentage of rural households with access to electricity increased from 34 in 1995 to 94.5 percent in 2008, providing electricity to an additional 40 million people. The percentage of communes with access to electricity increased from 58 to 98 during the same period (Figure 5). The success of Vietnam's program in providing electricity, predominantly through grid extension, is due mainly to the commitment of the government to rural electrification, and the definition and systematic implementation of medium- and long-term national plans as a matter of priority, with public investment support to match local community funds, and the active participation of local governments and communes.

Figure 5: Rural Electrification Rates in Vietnam



Source: World Bank 2009e.

Prior to 1995, rural electrification was handled mostly by individuals or groups at the commune level, who bought power from the PCs at subsidized tariffs and sold it to final consumers at unregulated or locally regulated tariffs. The service was poor and expensive, and its legal status was unclear. As the government began to give greater priority to rural electrification, legal steps were taken to establish the legal status and responsibilities of all parties, and EVN started to play a more active role in extending the medium-voltage grid and providing technical assistance to the local distribution utilities responsible for the low-voltage service (typically serving about 1,000 households). In the communes where EVN directly owns the low-voltage system (which comprise about one third of the total), EVN engaged service agents to manage commercial and maintenance activities. This system has been quite successful. Usually a local person, the service agent typically serves 300 to 1,000 customers and takes care of the bill collection, meter recording, and maintenance/inspection of lines and right-of-way. The system of engaging service agents reportedly reduces EVN's operating costs by about 30 to 40 percent.

Important steps in the rural electrification effort include the following:

- In 1995, the Community Electricity Groups and District Electricity Groups were established formally as part of the Commune and District administration.
- Responsibilities for distribution were clearly demarcated: EVN is responsible for the medium-voltage system (up to the outlet of 22/0.4 kilovolt transformers, with the exception of those communes where EVN owns the low-voltage system) and local distribution utilities are responsible for the low-voltage system.
- The legal utility status and a prior licensing process of companies and cooperatives providing low-voltage services were established.
- Technical specifications for rural networks were established.
- In 2000, the government issued a Rural Electrification Policy document, which established the principles for selecting communes to be connected:
    1. The commune should have reasonable potential for economic development so as to ensure that energy consumption will be sufficient to justify the investment.
    2. Connecting the commune to the grid should be the least-cost solution to electricity supply electricity.
    3. The selection should follow a process focused on economic efficiency and participation of local communities and households.
- Retail tariffs have been regulated, initially setting a ceiling and, since March 2009, a uniform national tariff.

The rural electrification program has required a major public investment effort, matched by significant local contributions. Table 9 presents investment costs for a sample of rural electrification projects. It shows that local governments and consumers contributed significantly, as much as 60 percent of the total investment in the early years. However, the increase in annual investment of recent years—doubling from $40.5 million to $84 million—was due to an aggressive program carried out directly by EVN and its subsidiaries.

Table 9: Investment Costs in Rural Electrification and Costs Sharing for a Selected Group of Rural Electrification Projects

	1996-2000		2001-2004		1996-2004	
	VND billion	**%**	**VND billion**	**%**	**VND billion**	**%**
EVN	1,402	40	4,086	70	5,488	58
Local governments	1,637	46	1,409	24	3,046	32
Other	52	1	70	1	122	1
Consumers	449	13	314	5	763	8
Total	3,540	100	5,879	100	9,419	100

Source: Van Tien Hung 2009.
Note: VDN = Vietnamese dong. VND 9,419 is about $0.6 billion. The total investment for rural electrification in the country is estimated to be on the order of $2.7 billion (for an average connection cost of $400 per household).

Capital costs for rural electrification have been funded through multiple sources, including customer contributions; commune, district, province, and central government budgets; special surcharges on urban customers; private investors; debts; EVN's retained depreciation; and international donors.

The Vietnamese rural electrification program has followed a long-term plan that focused during its initial years on the main objective of connecting rural communes rapidly and attracting broad local participation. This goal was nearly totally accomplished effectively. Starting in the mid-2000s, a second phase is focusing on improving efficiency and supply reliability through more efficient technical operation, and establishing an enabling environment to guarantee the sustainability of the program. With a proper design and management setup, and the use of adequate technical standards, technical losses in rural low-voltage systems are reported to have dropped from an average of 30 percent in the late 1990s to about 7 to 10 percent in 2009.

World Bank support to rural electrification. As mentioned earlier, the first World Bank lending operation for rural electrification (Rural Energy Project) was aimed at helping to cover the financing gap and developing institutional arrangements for the decentralization of the rural electrification program and building local capacity. This operation was followed by three additional credits (including a major 'additional financing') totaling $720 million in International Development Association (IDA) credits approved during the period 2000–2009,[19] in support of investment projects that amounted to $1 billion, i.e., the IDA credits covered 72 percent of the total cost of the projects. Table 10 presents a summary of the World Bank's projects. These projects have been designed to address the changing needs of the power sector while keeping, as main objectives, narrowing the financing gap, strengthening institutions, and building capacity. There has, however, been a gradual shift in alignment with the changing focus of the country's rural electrification program, from increasing access through grid extension to improving

[19] A fourth IDA credit ($202 million equivalent) for the Renewable Energy Development Project was approved in FY09. While this project includes investment in rural areas, it is not strictly a rural electrification project. Its main development objective is to increase the supply to the national grid from renewable energy sources.

systems efficiency and reliability through rehabilitating and upgrading the existing systems. The World Bank has been the main donor supporting Vietnam's rural electrification effort. Other donors include Japan, the Organization of the Petroleum Exporting Countries, Sweden, and, more recently, the Asian Development Bank.

Table 10: World Bank Projects Supporting Rural Electrification in Vietnam

Project	Fiscal Year	Development Objectives	IDA credit ($ million)	Project cost ($ million)
Rural Energy Project	2000	Expand rural access to electricity, define and establish an institutional mechanisms for rural electrification, and promote renewable energy sources	150	201.3
Second Rural Energy Project	2004	Improve access to good-quality, affordable electricity services to rural communities in an efficient and sustainable manner.	220	341
Second Rural Energy Project – additional financing	2009	Improve access to good-quality, affordable electricity services to rural communities in an efficient and sustainable manner.	200	250.6
Rural Distribution Project	2009	Improve the reliability and quality of medium-voltage service to targeted retail electricity distribution systems	150	207.2
Total			**720**	**1,000**

Sources: World Bank 2000, 2004, 2008c.

The implementation completion report for the Rural Energy Project rates the project *satisfactory* on all accounts, except for the performance of the implementing agency which was rated *highly satisfactory*. The report's ratings confirm the overall perception that rural electrification has been effectively managed in Vietnam and suggest that this project was efficiently executed. The Rural Energy Project exceeded its original targets, connecting 976 communes (45 percent more than the target) and providing electricity to more than 550,000 households (41 percent above the target). Moreover, the targets were exceeded at a low average unit cost of $363 per household connected (27 percent lower than the estimate at the time of project appraisal). The report cites the following factors for the project's success: commitment and involvement of local authorities, coordination mechanisms and close supervision, standardization of technical specifications, and cost-effective procurement packaging. The project helped design and test decentralization and cost sharing arrangements, and provided the groundwork for future projects through standardization of technical design and approaches for the management of electricity distribution in rural areas (World Bank 2007d).

Financial and operational sustainability. Admittedly, the initial efforts of the government did not focus on the sustainability of rural electrification but on connecting rural communes rapidly and attracting a broad local participation. As mentioned above, this first goal has been practically achieved in a very effective manner. Sustainability was a second goal within a medium- to long-term plan. The institutional strength of EVN and its subsidiaries, the establishment of adequate technical standards for rural systems, and evident ownership and active participation of local governments and communes have been important factors in achieving the second goal. The long-term effectiveness of the local distribution utilities, on the other hand, is not yet clear, because their technical and financial performance varies widely. The transitional tariffs established in March 2009 (Table 8) constitute a test that would identify which local distribution utilities have the financial strength and efficiency to deliver quality rural service and reduce power losses. It is understood that those that cannot perform would be consolidated/absorbed by the corresponding PCs, which, in principle, should have the required capacity.

The financial sustainability of the rural electrification program depends mainly on two conditions: (1) the financial health of the power sector as a whole, and (2) a tariff system that guarantees distribution companies full cost recovery of efficiently run operation and provides the right incentives for the provision of good-quality services to rural customers. EVN's average bulk supply tariff and the average retail tariffs applied nationwide may be low compared to international standards. However, they appear to be sufficient to guarantee satisfactory overall financial performance in the power sector. While there have been periods when average tariffs were below costs and external sources had to be used to bridge the gap, it is generally accepted that there are no longer problems with tariff levels and the government's policy ensures the overall financial health of the power sector.

Current government actions are aimed at achieving the second goal, which has not yet been clearly met. The new multiyear distribution tariff system, expected to be implemented in 2010, will apply to both PCs and local distribution utilities, and will be based on performance standards and designed to include incentives for efficient operation. Residential subsidies are proposed to be targeted more, reduced, and managed with more transparency, particularly with respect to funds specifically designed for rural electrification.

Benefits of Rural Electrification in Vietnam. The Vietnamese experience offers a large and varied body of information on the impact of rural electrification. An econometric analysis used panel data collected in 2002 and 2005 for some 1,100 households from six regions. The sample included households that were unconnected in 2002 but connected by 2005, households that had obtained electricity connection prior to 2002, and households that remained unconnected through the second survey in 2005. Electrification appears to have increased school enrollment by about 10 percent for both boys and girls, and the number of completed school years by 52 percent for boys and 15 percent for girls (Khandker et al. 2009). A monitoring study on the same sample of households aimed at tracking the changes in people lives resulting from electricity service concluded that the main benefits of rural electrification included improved lighting, better communication, higher rural productivity, and greater school enrollment. The use of time saving appliances such as rice cookers and fans to improve home comfort all contributed to higher levels of well being for those areas gaining reliable electricity service for the first time (Barnes et al. 2009).

Lessons Learned

Vietnam's extraordinary success in providing access to electricity to more than 40 million people in such a short period can be attributed to a well balanced program that includes a top-down approach led by EVN and its subsidiaries, complemented by a bottom-up approach that has attracted broad and active participation of communes and individuals at the local level.

Crucially important was the government's strong commitment to rural electrification and the adoption of a long-term national plan that was implemented in two phases. The first phase focused on rapid rural electrification. The second phase, which is still underway, has shifted the focus to efficiency and sustainability, including establishing an appropriate regulatory framework, tariff system, and incentives for efficient operation and satisfactory quality of service. Among the components making rural electrification a success are the following:

- **The effective leadership of a strong utility** (EVN) that planned and implemented medium-voltage and low-voltage projects in rural areas, and provided technical assistance to the weaker utilities
- An effective **partnership between the state utility (EVN) and local utilities**
- **Broad participation of local governments and communes** in sharing costs and responsibilities
- **A clear demarcation of responsibilities** between utilities and local communities
- The establishment and enforcement of **technical standards for rural systems**
- **Outsourcing commercial and maintenance services** in rural low-voltage systems
- **An open and effective consultation process** prior to the design and implementation of projects
- **Strong desire of people** to have electricity, ranking electricity high among basic infrastructure services (electricity, roads, schools, clinics).

The predominantly public nature of the power sector and political continuity have provided advantages in maintaining a long-term plan and a phased approach. Without direct public investment and publicly-owned utilities, it might not have been possible to attract funding for the massive rural electrification investment in the first phase while the enabling environment required to guarantee its sustainability was not in place yet. During great part of the implementation of the program, full recovery of distribution costs was not guaranteed nor were there transparent rules for the compensation of the higher costs of typical rural operation.

Annex 3: Rural Electrification Agencies in Sub-Saharan Africa

The African Context

An inadequate supply of infrastructure services in Sub-Saharan Africa is widely acknowledged as deterring economic development and poverty reduction (Calderón and Servén 2008). The region's infrastructure performance ranks consistently. Electricity is by far the region's largest infrastructure challenge, with more than 30 countries facing regular power shortages and many paying high premiums for emergency power. The 48 countries in Sub-Saharan Africa generate about the same amount of power as Spain. When South Africa is excluded, per capita electricity consumption is only 124 kWh and is *falling*. Costs are higher than in any other developing region, while electrification rate is less than half of that in South Asia, the second lowest region is in the world. The high costs of power generation and distribution are further subsidized, benefitting mainly the rich. Even if major potential efficiency gains can be captured, Sub-Saharan Africa would still face an annual infrastructure funding gap of $31 billion, mainly in power (Foster and Briceño-Garmendia 2010). Extending access must be seen in this overall context.

The current crisis in the power sector can be traced to a number of problems (Eberhard et al. 2008):

- ***Africa unplugged***. The installed capacity for power generation in Sub-Saharan Africa (68 gigawatts) is much lower than that in any other region. Excluding South Africa, the total capacity is only 28 gigawatts, equivalent to the capacity of Argentina. As much as one-fourth of that capacity is not available because of aging plants and poor maintenance, and power supply is highly unreliable. Overall, capacity has remained stagnant during the last three decades. As a result, the gap between Sub-Saharan Africa and the rest of the developing world has widened over time. The deficiencies of the region's power sector are a serious constraint on long-term growth and competitiveness.

  Only 29 percent of the Sub-Saharan African population has access to electricity. The average rate of electrification in rural areas is extremely low at 12 percent, against 58 percent in developing countries. The second lowest is South Asia at 48 percent, followed by Latin America at 70 percent (IEA 2009).

- ***Reform progress***. Sub-Sahara Africa gradually joined the global trends in power sector reform that began in the late 1980s. By 2006, most countries had enacted a power sector reform law, introduced private participation, corporatized state-owned power utilities, and established sector regulatory bodies. The experience to date offers several observations and lessons:

1. Most countries did not complete the reform process, resulting in hybrid power markets characterized usually by a public single-buyer/generator, presenting new challenges in policy, regulation, planning, and procurement.
2. While independent power producers have added around 3,000 MW of new capacity, a large number of projects involving concessions, leases, or management contracts have been disappointing.
3. Regulators are far from independent in most cases, governments often exert pressure to modify or overturn decisions, and the turnover of commissioners have been high.
4. Certain reform principles of the 1990s—notably unbundling and privatization leading to wholesale and retail competition—have not seemed appropriate for the region, because many markets are too small for effective competition.

- ***High costs and under-pricing***. The price of power in Sub-Saharan Africa is higher than in other regions. The average tariff in 2005 was $0.13/kWh, about twice that found in other developing regions and almost on par with high-income countries. The small scale of most national power systems, declining availability of hydropower in some countries, continuing or growing reliance on oil-based generation, and high distribution losses (about 23 percent) are responsible for high costs. Tariffs have been particularly high in countries reliant on emergency diesel-fueled power generation. These high tariffs notwithstanding, the sector suffers from widespread under-pricing. Most countries recover only operating costs. In most cases, governments or donors have subsidized capital costs. Residential subsidies are highly regressive: only ten percent of the bottom half of the income distribution has access to electricity, while three-quarters of households with access are in the top 40 percent.

  The inefficiencies of the region's utilities, combined with widespread subsidy practice, generate substantial hidden costs to the economy. These costs, on average, amount to 1.8 percent of GDP, and may be as large as 4 percent in some countries. About half of these costs stem from under-pricing and the other half from distribution losses and inefficiencies in billing and collection,

- ***Unexploited energy resources***. Sub-Saharan Africa is well endowed with energy resources, but these remain largely unexploited. Africa's energy future lies greatly in hydropower. The economically feasible hydropower potential is estimated at 937 terrawat-hours a year, of which only 7 percent has been developed. There are also large proven oil reserves and important gas reserves. However, these energy resources are concentrated in a handful of countries that are often removed from the main centers of power demand. An uneven distribution of resources and the distance separating hydropower sites from economic centers have forced many countries to adopt technically inefficient forms of generation based on imported diesel or heavy fuel oil to serve small domestic power markets. As an average, the production costs of diesel plants

($0.27/kWh) are almost three times higher than the costs in a predominantly hydro system. Energy trade would help exploit these resources more.

The REA/REF Approach

Many African countries have opted for establishing a rural electrification agency (REA) to manage multi-year earmarked resources (mostly grant funds) on a transparent and non-discriminatory basis to support the implementation of rural electrification projects. This decentralized model is often accompanied by the establishment of a rural electrification fund (REF). Some countries have a REA that manages a fund, some a REF with a secretariat, and others with a REA and a REF as separate legal entities. Because REAs and REFs are relatively new, there is not much literature or analysis about them.

Proponents of REAs and REFs, envisaged as involving the participation of multiple private actors (private power companies, projects developers from outside the conventional power sector, and community cooperatives), cite the following reasons for supporting them:

- They help minimize political interference in the process of selection and implementation of rural electrification projects.
- They are in response to the utilities' lack of interest in engaging in the rural electrification business, both in the grid extension to rural areas and off-grid services.
- They can mobilize additional capital for rural electrification.
- Private investors may be more efficient than state-owned power utilities.
- Sponsors of projects may be more open to demand-driven projects.
- Private sector participation can help draw the interest of commercial banks to larger investment volumes.
- Small and medium project concessions promoted in the REA/REF model can facilitate the entry of national private actors to the rural electrification business.
- The creation of a REF can help pool donor contributions into a single fund.

All these factors can foster entrepreneurial dynamism and speed up the rural electrification process.

The REA/REF replaces, or offers an alternative to, the traditional centralized rural electrification approach, where a single national utility or major regional power utilities have a monopoly concession for rural power supply. An important factor in selecting an approach is the level of national and rural electrification that has been reached. Table 11 presents a grouping of countries according to the approach adopted and the stage of rural electrification, including countries outside of Sub-Saharan Africa, whose experience has been assessed recently.

Table 11: Different Approaches to Rural Electrification

Stage	Centralized	De-centralized
Initial stage of electrification	Cote d'Ivoire, Ghana, Lao PDR	Total rural electrification: Burkina Faso, Mali, Uganda Off-main grid rural electrification: Ethiopia, Guinea, Mozambique, Nepal
End phase of electrification	Guatemala, Morocco, Peru, Thailand, Vietnam	Chile

Source: Mostert 2009 and authors.

While the size and structure of REAs vary considerably from country to country, a REA's key role is to promote and manage rural electrification projects (Madon 2009):

- Dissemination of information on the rural electrification institutional and regulatory framework, available financial and technical support, and rural electrification experience
- Development of rural electrification services, financial services, and least-cost innovative options; capacity building; and strengthening of national expertise and the supply of technical services
- Planning, coordination, and supervision of rural electrification project implementation, including project selection, contracting, and provision of technical assistance
- Monitoring and quality control of rural electrification activities.

When a REA also incorporates a REF, its role encompasses the management of the fund's (public and donors) resources, including financial management and accounting responsibilities, disbursement of subsidies, and coordination of donors and commercial banks.

Whether or not to establish a REA raises several questions:

- Are the natural cost-advantages of centralized rural electrification stemming from economies of scale (in finance, investments, and management) and scope (integration of planning and implementation) counterbalanced by the competitive forces of unleashing private actors in a decentralize scheme?
- It is possible in an environment characterized by weak institutions and limited human resources to establish a strong REA to take the lead in the country's rural electrification effort and improve performance efficiency?
- Can a REA be protected more effectively from political interference than the established state-owned power utility?
- To what extent can the promotion and management functions of a REA be fulfilled within the existing institutional framework, i.e., between the line ministry and the power utility?

- Utilities are not interested in the rural electrification business because this is perceived as highly complex and its financial sustainability cannot be guaranteed. Often, the main problem relies in the absence of an appropriate incentive system—a tariff policy complemented by a subsidy mechanism that guarantees the recovery of full costs of an efficient service. In such a situation, Could a REA compromise the financial and operational sustainability of rural electrification by not forcing the government to address this problem directly?

Experience in the Implementation and Operation of REA/REFs

The experience of Sub-Saharan African countries in implementing REAs is relatively new. Therefore, it is difficult to draw robust conclusions on their performance. There has been only one assessment on the topic (Mostert 2008) and a second study is underway. The first study included a comparative assessment of the centralized and decentralized approaches, looking at seven case studies: Burkina Faso, Côte d'Ivoire, Ethiopia, Guatemala, Guinea, Mali, and Nepal. The ongoing study, commissioned by the European Union, focuses on the role played by REF through an in-depth analysis of experience in eight countries: Cameroon, Ghana, Mali, Mozambique, Senegal, Tanzania, Uganda, and Zambia. This section is based on the existing study, the discussion on the topic held at a rural electrification workshop held last June (Africa Electrification Initiative 2009), and interviews.[20]

Mostert's study focuses mainly of the first question set above: are the cost-advantages of centralized rural electrification counterbalanced by the cost savings in a decentralize scheme with private actors? The study examines seven case studies, paying special attention on speed of rural electrification, on the assumption that a decentralized approach would increase the number of connections due to the mobilization of additional capital and financing resources, private investors would be more efficient, and there would be greater opportunities for demand-driven projects.

The study findings are summarized in section 4.3. On balance, a centralized approach appeared to be more effective than a decentralized scheme, except perhaps in off-grid applications. Achieving universal access using only small-scale private companies would be especially difficult. At least in the seven countries studied, REAs and REFs have attracted little private capital, nor have donor funds flown markedly to them.

REAs and REFs can play a useful, if not limited, role. The weight of evidence to date would suggest that a decentralized approach based on a REA/REF cannot be recommended as a standard policy for the Sub-Saharan African countries.

[20] Dana Rysankova (World Bank), Therese Hindman Persson (Econ Poyry AB), and Wolfgang Mostert.

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