

Electrification and Regulation: Principles and a Model Law

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and Clemencia Torres de Mästle**



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and Clemencia Torres de Mästle**

The World Bank, Washington, DC



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FOREWORD

An often-repeated statistic is that an estimated 1.6 billion people in the world do not have access to basic energy services. At international conferences dealing with electrification, speakers have often pointed out that any attempts at “scaling up” electrification will not be sustainable unless they are supported by workable economic regulatory systems. While there is widespread agreement on the need for regulatory systems that “help” rather than “hinder” electrification, the reality is that very little systematic work has been done on what such a system should look like.

This report by Kilian Reiche, Bernard Tenenbaum, and Clemencia Torres represents a major first step in defining such a system. The report presents four general principles that would need to be satisfied by such a system. The principles provide a compass that shows where one needs to go, but the authors also recognize that little is accomplished by enunciating general principles. Government officials, regulators, and rural electrification specialists need more specific guidance on how to implement general principles in real world situations. Therefore, the report carefully illustrates each of these general principles with numerous detailed examples of emerging regulatory practices associated with different forms of electrification in five developing countries. In so doing, the authors show how general principles can be implemented through actual regulatory practices. Finally, the authors recognize that it will be impossible to implement the principles unless they are supported by a strong legal foundation. To provide this foundation, the report concludes with proposed elements of a model law based on the principles.

This report had its genesis in a workshop of Latin American electricity regulators and energy sector officials. Although the initial work was prepared for Latin America, the principles, accompanying examples, and the model law are equally relevant for Africa and Asia. Funding for the Latin American workshop and follow-up work came from the Energy Sector Management Assistance Programme (ESMAP) and Energy and Water Department (EWD). This report should be viewed as a major “first installment” on how to operationalize regulation to support electrification. I look forward to further follow-up efforts, both inside and outside the World Bank Group, to extend this pioneering work.

Jamal Saghir

Director, Energy and Water
Chairman, Energy and Mining Sector Board



ABSTRACT

The paper presents one of the first systematic attempts at defining workable regulatory systems that will “help” rather than “hinder” electrification with emphasis on off-grid electrification. It does this by first presenting four general principles that would need to be satisfied by such a regulatory system:

Principle 1—Adopt light-handed and simplified regulation.

Principle 2—Allow (or require) the regulator to “contract out” or delegate, either temporarily or permanently, regulatory tasks to other government or nongovernment entities.

Principle 3—Allow the regulator to vary the nature of its regulation depending on the entity that is being regulated.

Principle 4—Establish quality-of-service standards that are realistic, affordable, monitorable, and enforceable.

To make these principles more concrete, each one is illustrated with detailed descriptions of real world regulatory practices from five developing countries that support or do not support the principles. Since it would be impossible to implement the recommended principles and practices in the absence of a strong legal foundation, the report concludes with the proposed elements of a model law based on the four principles.

ACKNOWLEDGEMENTS

This paper could not have been written without the assistance of many friends and colleagues inside and outside the World Bank Group. These individuals helped us to develop an understanding of the “ground-level realities” of electrification and regulation in many developing countries. They gave freely of their time and insights to make sure that we got the facts right and understood what the facts really meant. They include Pedro Antmann, Carlos Arias, Douglas Barnes, Enrique Birhuett, Dan Blanchard, Anil Cabraal, Walter Canedo, M. Ananda Covindassamy, Philippe Durand, Johannes Exel, Christophe de Gouvello, Chandrasaker Govindarajalu, Ghislaine Kiefer, Dominique Lallement, Ramiro Mendizabal, Ty Norin, Klaus Preiser, Badri Rekhani, Pierre Rieszer, Juan Manuel Rojas, Dana Rysankova, Osvaldo Soliano, Witold Teplitz, Dan Waddle, Fiona Woolf, and Joseph Wright. Of course, none of them should be held responsible for any errors of fact or interpretation that remain despite their best efforts to educate us.

Rebecca Kary was an excellent editor who reminded us that our goal was to communicate information and ideas to a wide audience and not just to write another report for a small group of specialists.

Finally, we wish to acknowledge the financial assistance of the Energy Sector Management Assistance Programme (ESMAP) and the World Bank’s Energy and Water Department. ESMAP provided funding that allowed us to organize the July 2004 Buenos Aires clinic, which focused on the interaction between regulation and electrification. ESMAP also provided further assistance through the DFID-funded Energy Small and Medium Enterprise (SME) program. This allowed us to expand the background research prepared for the clinic into a full paper. And finally, we owe a special debt of gratitude to Jamal Saghir, the Director of the Energy and Water Department. Jamal supported us throughout the process and, as always, reminded us that the overarching goal was to develop insights and recommendations that will promote electrification. We hope this paper helps to achieve that goal.

ABBREVIATIONS AND ACRONYMS

| | |
|--------|---|
| AC | Alternating current |
| BPDB | Bangladesh Power Development Board |
| CGAP | Consultative Group to Assist the Poor |
| COELBA | Concessionaire of the state of Bahia, Brazil (Companhia de Eletricidade do Estado da Bahia) |
| DC | Direct current |
| DESA | Dhaka Electricity Supply Authority |
| EAC | Electricity Authority of Cambodia |
| EdM | State-owned national utility in Mozambique |
| EJEDSA | The concessionaire responsible for all dispersed users in the province of Jujuy, Argentina (Empresa Jujeña de Sistemas Energéticos Dispersos, Sociedad Anónima) |
| ESMAP | Energy Sector Management Assistance Programme |
| ICT | Information and communication technology |

| | |
|-------|--|
| IDTR | Decentralized Infrastructure for Rural Transformation (Infraestructura Descentralizada para la Transformación Rural) |
| kV | Kilovolt |
| kW | Kilowatt |
| kWh | Kilowatt-hour |
| MOU | Memorandum of understanding |
| MSME | Micro, small, and medium-sized enterprise |
| MW | Megawatt |
| NERA | National Economic Research Associates |
| PBS | Palli Bidyut Samities |
| PV | Photovoltaic |
| REB | Rural Electrification Board |
| REE | Rural electrification enterprise |
| SHS | Solar home system |
| TCU | Technical Control Unit |
| USAID | U.S. Agency for International Development |
| VMEEA | Vice-Ministry of Electricity and Alternative Energy (Bolivia) |
| WHS | Wind home system |

EXECUTIVE SUMMARY

Regulation is government control of a business. When a government regulates an enterprise, it imposes direct and indirect controls on the enterprise's decisions or actions. *Electrification* is the supply of electricity to households, public facilities, or businesses that have had limited or no access to electricity. The design of regulatory systems to support electrification is complicated by the fact that electrification can be undertaken by different types of enterprises (for example, public, private, or community-owned), each with different incentives. These enterprises may use very different technologies: *grid electrification* (the extension of existing transmission and/or distribution grids) or *off-grid electrification* (the installation of decentralized facilities that are not connected to existing transmission and/or distribution grids). Off-grid technologies are increasingly applied to electrify remaining areas that are too remote or dispersed to be reached via grid extension. Decentralized technologies often require decentralized supply solutions (usually involving small and medium-sized enterprises) with specific requirements for regulation. **This paper proposes some first, general principles for creating regulatory systems that will "help" rather "hurt" electrification, with emphasis on off-grid electrification.**

In thinking about how to design such a "helpful" regulatory system, the starting point should be the two "golden rules of regulation":

Rule 1—Regulation is a means to an end. What ultimately matters are outcomes (such as sustainable electrification)—not regulatory rules.

Rule 2—The benefits of regulation must exceed the costs of regulation.

The paper's focus is on how these two general rules can be applied to regulatory systems that affect electrification. Our principal conclusion is that successful electrification often requires that the traditional functions of regulation (e.g., setting maximum tariff levels, establishing minimum quality of service standards and specifying entry and exit conditions) must be performed in non-traditional ways.

Four Regulatory Principles

This very general conclusion is based on four regulatory design principles implied by the two "golden rules". To make these principles more relevant for practitioners, each is illustrated below with examples of emerging regulatory practices in several countries.

Principle 1—Adopt light handed and simplified regulation.

Complying with a regulatory rule costs time and money. This is true regardless of whether the regulated enterprise is privately, publicly or community owned. For off-grid operators, one should be especially conscious of the costs of regulation because most off-grid enterprises operate on the "razor's edge" of commercial viability. They have high costs because they often serve small isolated households and low revenues because these households usually can afford to buy only small quantities of electricity (typically 50 kWh or less per month). Unnecessary regulation can easily destroy the commercial viability of these enterprises.

In designing a light-handed regulatory system to support electrification, three questions need to be asked:

1. Is the information really needed?
2. Can the number of review and approval steps be reduced?
3. Can the regulator delegate some regulatory tasks to other entities?

In *Bolivia*, prior to 2000, all operators of isolated village minigrids above 300 kW installed generating capacity were required to acquire concessions. This created two problems. First, concessions could legally be granted only to entities that were shareholder companies. This conflicted with the fact that many minigrids were operated by cooperatives. And second, the reporting requirements and technical standards for concessionaires were impossible (that is, too costly) to satisfy for many of the smaller rural systems. A partial solution was introduced in 2000. The threshold of

regulation was raised to 500 kW peak demand, and cooperatives were allowed to maintain their legal status for an initial period of seven years. Discussions are now under way to lower reporting and technical requirements for all minigrids in villages with less than 2,000 users.

In *Cambodia*, a novel, light-handed approach to tariff setting has been proposed for several hundred isolated, privately owned minigrid operators. These suppliers, known as rural electrification enterprises (REEs), usually operate small, second-hand diesel generators that produce electricity for sale to retail customers in one or more contiguous villages. It has been recommended that the maximum tariffs of these small operators be set through published “Tariff Tables.” The “Tariff Tables” would relieve the REEs of the obligation to make an initial tariff filing with the regulator or to return to the regulator with requests for revisions in the tariffs. For each class of REEs, maximum tariffs would be set on a generic rather than on an individual enterprise basis with automatic adjustments keyed to a prespecified formula.

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 nongovernment entities.

In many countries, a rural electrification agency or fund functions as a de facto regulator. Typically, the agency or fund imposes certain requirements in return for giving grants or subsidized loans. For example, it may specify a maximum allowed tariff, a required technical quality for new installations, or technical and commercial quality for post-installation service. These are traditional regulatory functions—even if they are rarely described in that way.

Given this reality of de facto regulation, it makes sense for the regulator to delegate or “contract out” some traditional regulatory functions to the rural electrification agency or fund. This should lead to more efficient regulation for several reasons. The agency will almost always be more knowledgeable than the regulator about the specific technical operations of the electrification provider; the agency will have a better appreciation of the cost implications of imposing different regulatory requirements; it will facilitate coordination between subsidy rules and tariff regulation; and it will reduce the risk of duplication and over-regulation.

In *Bangladesh*, more than 60 rural electric cooperatives, known as PBSs, have been created since 1978. The cooperatives are supervised and controlled by the Rural Electrification Board (REB), a semi-autonomous agency located within a ministry. In addition to acting as a banker, technical advisor, procurement agent, construction agent, manager supervisor, and trainer, the REB clearly also functions as a regulator by setting maximum prices and minimum quality-of-service standards. To perform these functions, it has also created a uniform system of accounts. Since the REB “walks like a regulator and talks like a regulator,” it would be duplicative to add a new separate regulator with regulatory jurisdiction over the PBSs’ retail service.

Principle 3—The regulator should be allowed to vary the nature of its regulation depending on the entity that is being regulated.

A regulator should be allowed to vary its methods (for example, how tariffs are set or what needs to be regulated) depending on the type of regulated entity. Many regulatory statutes do not encourage such flexibility. They are either silent about regulatory methods or embody the view that “one size fits all.” This does not do justice to the significant variation in electrification supply models (see figure ES-1). The better approach is to provide the regulator with explicit legal authority to vary its methods depending on the type of entity being regulated.

For example, when a community-based organization self-supplies electricity, the universal regulatory concern that the operator may charge monopoly prices disappears. Owners of a cooperative do not have an incentive to charge monopoly prices because this would be equivalent to taking money from one pocket and putting it in another pocket. 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 community based cooperative societies. While the government continues to fix technical specifications and safety standards, the prices charged for sales of electricity within the village are determined by the cooperative’s board of directors, not by a government ministry. In fact, since the community is self-supplying electricity, the charges are designated as membership fees rather than tariffs.

Principle 4—Quality-of-service standards must be realistic, affordable, monitorable, and enforceable.

Regulators often ignore quality-of-service regulation. This happens because it is easier to specify and monitor tariff levels than quality-of-service standards. Tariffs are uni-dimensional. They can be readily observed in customer bills. In contrast, quality of service is multi-dimensional, and compliance is often difficult and costly to monitor, especially for dispersed off-grid systems. However, there is a real danger in ignoring quality of service. Whatever goodwill is created through electrification will quickly disappear if quality of service falls short of what customers were expecting. But there is also a danger in creating standards that are too strict; exaggerated service standards create unnecessary costs.

A workable quality-of-service regulatory system should have the following characteristics:

- The standards should be based on customers’ preferences and their willingness to pay for the costs of providing the specified level of quality. The standards need *not* be uniform across all customer categories or geographic areas. Offering a menu of service levels allows customer choice – but it can also increase transaction costs and decrease transparency if there are too many choices.
- Standards should be established for both technical and commercial dimensions of 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.
- The regulatory entity should have the legal authority to delegate or contract out quality-of-service monitoring and the imposition of penalties to a third party subject to appropriate oversight.

This last element—contracting out—has been built into a new quality-of-service monitoring system for solar home systems in Bolivia. A Technical Control Unit (TCU) consisting of three individuals within the Vice-Ministry of Electricity, Alternative Energy and Telecommunications is responsible for monitoring compliance with the

prespecified quality-of-service standards of Bolivia’s IDTR project and it can impose penalties when operators fail to meet these standards. Two reporting forms were created for monitoring purposes—a complaint form and an annual visit form. If a customer has a complaint about the performance of the system, he or she must initially contact the operator. If communication problems exist, the user can also make contact via the municipal government authority. The operator is required to log in the complaint and put it into a Management Information System that can be audited for accuracy by the TCU or a contractor hired by the TCU. Audits will be contracted out to a private contractor who “will witness what he sees.” To reduce costs, the contractor will perform the audit on a sample basis (20 out of 1,000 customers). If the audit finds that the operator failed to meet the specified quality-of-service standards, then a larger sample may be taken and penalties will apply to the full 1,000 customers in the sample.

A Model Law to Promote Electrification

Good intentions—increasing electricity access—do not necessarily lead to good outcomes. *If the four regulatory principles are to be implemented, they need to be incorporated into legal instruments.* To facilitate this outcome, the paper includes specific elements or standards of a model law. The recommended standards deal with the following eight topics:

1. Flexibility to allow other Entities to Act on Behalf of the Regulator.
2. Flexibility in Regulatory Methods.
3. Eligibility and Authorizations.
4. Tariff Setting.
5. Subsidies.
6. Quality of Service.
7. Coordination with other Government Entities
8. Model Documents.

A Caveat

While the full paper breaks new ground in dealing with issues that have previously only been alluded to or touched on very lightly, its coverage is not complete. The paper’s focus is largely limited to off-grid electrification, which is typically associated with rural electrification of a remote and/or dispersed population. More work is needed to develop workable regulatory approaches to promote electrification in periurban

areas. In addition, several important regulatory issues, that relate both to rural and urban electrification, are not addressed in this paper. These include: setting tariff levels and structures (with and without metering); coordinating tariffs with subsidies; establishing regulatory approaches for different forms of bidding (e.g., for minimum subsidies, minimum customer connection charges or minimum tariffs); encouraging “regularization” of informal service providers; and designing “handoff” arrangements when the main grid connects to a previously isolated minigrid. We hope to address these issues in future research.

1. REGULATING ELECTRIFICATION

Investors need confidence. Consumers need protection.

—Chinese government official (2001)

...people deserve a regulatory system that works for them, not against them.... We do not have such a regulatory system today.

—U.S. government presidential order (1993)

Regulation means government control of a business. When a government regulates an enterprise, it imposes direct and indirect controls on the decisions or actions of that enterprise. The focus of this paper is on developing general principles for economic regulation of enterprises—whether publicly, privately, or community-owned—that wish to supply electricity to households, public facilities, or businesses with limited or no access to electricity. Such electrification can be achieved through grid electrification (the extension of existing transmission or distribution grids, or both) or off-grid electrification (the installation of decentralized facilities that are not connected to existing transmission and distribution grids).

In this paper, we pay special attention to regulation of off-grid electrification. There are two reasons for this emphasis. First, off-grid electrification will become increasingly more important because many communities and households that have yet to be electrified are relatively isolated, and off-grid electrification may be the only economically rational choice. This will be a growing phenomenon in Latin America. Second, the regulatory issues associated with off-grid electrification have received little attention in the general literature of power sector regulation.¹ This literature has generally focused on regulation of large entities operating geographically integrated systems and not on regulation of small and medium-sized enterprises operating geographically isolated systems.

Certain regulatory functions, such as setting maximum tariffs and fixing minimum quality-of-service standards, are universal. They need to be performed for monopoly enterprises, whether large or small, integrated or isolated. This observation, however, does *not* imply that the

regulation should always be performed in the same way. The “standard” regulatory approaches may not be workable for some of the newer forms of electrification. Therefore, when designing regulatory systems for different forms of electrification, more attention should be paid to the specific economic, institutional, and technical characteristics of the enterprises that are being regulated. For example, future electrification in rural areas will often be performed by small or medium-sized enterprises. In addition, many of these enterprises will not be economically viable, unless they receive an initial direct or indirect capital cost subsidy.² Even with such subsidies, the underlying economics of the enterprise will remain fragile. Finally, the technologies for producing and distributing electricity will vary widely. Given these characteristics, more attention should be paid to designing and operating regulatory systems that work for rather than against sustainable, fast, and efficient electrification.³

The principal question considered in this paper is whether the regulatory approaches traditionally used in regulating one or more large central utilities need to be modified when regulating a large number of small, decentralized entities.

Electrification Markets: A Matrix of Supply Models

Historically, the dominant electrification model in developing countries has been grid extension by large state owned utilities that was financed by cross-subsidies from existing customers or by government grants. In recent years, the “universe” of electrification models has become much more diverse. Today, supply models for electrification include the following:

- Grid extension by an existing distribution company (Brazil, Colombia, Ghana, Guatemala, and Nicaragua).
- Grid extension by a local village, municipality, or private company (Colombia and Nicaragua).
- Bulk resale by a cooperative or private entrepreneur of grid-supplied electricity to a new area or an area that had previously been supplied by an isolated generator (Bangladesh, Cambodia, and Costa Rica).

¹ A good survey of the general literature on regulatory theory and practice can be found on the Website of the Public Utilities Research Center at the University of Florida (<http://bear.cba.ufl.edu/centers/purc/>).

² The need for subsidies to promote rural electrification is not limited just to developing countries. For example, rural electrification in France was supported by capital cost grants covering more than 70 percent of installation costs (Garnier 2005). Probably the single best analysis of the theory and practice of subsidies to promote electrification can be found in Komives and others 2005.

³ Some forms of electrification (solar home systems and isolated hydro-based minigrids) use renewable energy. In these cases, if the regulatory system is successful in promoting electrification, it will expand the use of renewable energy. In effect, a single regulatory system produces two societal benefits—rural electrification and renewable energy.

- “Fill-in” or “densification” of service to new households in a community that is connected to the main grid or that is served by an isolated minigrid (Bolivia, Cambodia, India, and Mozambique).
- Sale of electricity to newly connected households or those that have illegal connections in urban slums (Brazil, India, the Philippines, and South Africa).
- Isolated village or municipal minigrid combined with stand-alone generation operated by a community organization, a private entrepreneur, a state-owned utility, or a partnership of two or more of these entities (Bolivia, Cambodia, Ethiopia, Mozambique, Nicaragua, Philippines, and Sri Lanka).⁴
- Connected minigrid with a distributed generator operated by a community organization, a private entrepreneur, or a partnership of the two (Cambodia, Nicaragua, and Sri Lanka).
- Solar home systems (SHSs) installed under a dealership or vendor delivery model (India, Indonesia, Kenya, and Sri Lanka), a fee-for-service delivery model (Argentina, Laos, Morocco, and South Africa), or a mix of these (Bolivia).
- SHSs installed through a legal obligation imposed on the existing holder of a concession for a grid-connected distribution system (Argentina and Brazil).
- Private or community-owned and operated battery charging stations (Honduras, Nicaragua, and Nigeria).

What has led to the emergence of these many diverse forms of electrification? And why does it matter for regulation? Several factors seem to be relevant:

- **The emergence of private distribution companies.** Power sector reform usually results in some combination of restructuring and privatization. Private distribution companies are understandably reluctant to serve

unprofitable customers. Unless the reform package includes both explicit incentives and obligations to pursue electrification, most private companies will not pursue grid or off-grid electrification. Without incentives and obligations, most private distribution companies will focus on existing and more profitable core markets, typically located in urban areas. This is a different situation from the traditional state-owned utilities that can be “ordered” to extend the grid.

- **The completion of less costly electrification.**⁵ It should not be a surprise that most enterprises, whether public or private, will first pursue less costly and more profitable forms of electrification. They are not being “bad;” instead, they are being economically “rational.” As a consequence, those who remain without electricity are likely to be least desirable customers. They will be poorer on average and live in isolated areas that are distant from existing electricity lines. Generally, they will have a low immediate potential for increasing their consumption,⁶ a limited capacity to pay, and limited access to credit and information about potential supply options.⁷ Therefore, it should not be surprising that traditional electricity suppliers view them as high-risk customers because of their low consumption and the high cost of supplying them.
- **The increasing expense of grid electrification.** Using grid electrification to reach increasingly more isolated rural households is very expensive. For example, the cost of connection in some rural areas of Brazil has been estimated at several thousand dollars per connected household. In contrast, decentralized forms of electrification have the potential to provide basic service to remote, rural areas at lower costs (typical connection costs are in the range of US\$300–1,000 per user). It makes little sense to spend scarce government resources on expensive grid extensions when basic electricity service could be provided through cheaper off-grid options.

⁴ In some countries, they are referred to as “independent grids.” They are independent because they are stand-alone grids that are not connected to a larger national or regional grid. If a local grid is a stand-alone grid, it requires its own source of generation. If a local grid is connected to the national or regional grid, it may not have any generation of its own. Therefore, the term *minigrid* usually includes both independent and connected grids. The defining characteristic of both types of minigrids is that they are autonomously operated by some entity other than the operator of the national or regional grid.

⁵ This is definitely the case in Latin America, where most of the closer-in communities (that is, the “low-hanging fruit”) have now been connected. See ESMAP 2005a,b,c. In countries such as Bolivia, Brazil, and Mexico, it is not uncommon to hear estimates of US\$3,000–4,000 per new connected household.

⁶ For many rural households, electricity consumption remains below 50 kWh per month long after they get access. As an example, about two thirds of the rural households in Bolivia with grid-based electricity use less than 50 kWh per month (see IDTR 2003a). This is in contrast to the 400 kWh per month average electricity consumption of a typical European household and about 900 kWh per month in the United States.

⁷ Barnes 1996; Cabraal, Schaeffer, and Cosgrove-Davies 1996.

- **The emergence of new or improved, decentralized technologies.** Off-grid technologies to serve isolated rural users have improved and become more standardized. Off-grid technologies include (a) village grids without connection to the national backbone grid that are based on thermal generation, renewable energy (for example, micro-hydro, biomass, solar, or wind) or hybrid combinations of these; and (b) stand-alone, single-user systems with diesel, pico-hydro, small wind, or photovoltaic (PV) generators.
- **The requirement for decentralized technologies to have decentralized business models.** The defining characteristic of these off-grid technologies is that they are installed close to the users, but often far away from the offices and facilities of existing utilities. Because of the remote locations of customers, the business models (and regulatory solutions) that worked reasonably well for traditional grid extension are often not suited for off-grid technologies. Off-grid technologies require different business models that

use different approaches for operation, maintenance, customer service, and billing. Therefore, off-grid systems are often best owned and operated by micro, small, and medium-sized enterprises (MSMEs) or user associations. Decentralized business models will often require decentralized regulation.

Policy makers and regulators are often uncertain as to how to deal with this diverse universe of supply options. It is usually easier to go with what is “familiar” (that is, grid extensions and the standard regulatory approaches) than to try to develop more particularized solutions. In deciding how to respond to this “new world,” a simple listing of electrification supply models, such as the one given on the previous page, is not very helpful for thinking about how to modify existing regulatory frameworks and electrification policies. If the goal is to try to create more rational regulatory policies, then there is a need to organize the universe of supply options in a way that illuminates rather than obscures possible regulatory options. The matrix in table 1 is designed for this purpose.⁸

Table 1. Matrix of Electricity Supply Models

| | | GRID EXTENSION | CONNECTED VILLAGE MINIGRID | ISOLATED VILLAGE MINIGRID | SINGLE-USER SYSTEM | |
|----------------------|----------------------|-------------------------------|--|--|---|---|
| | | GRID <-----> | | | OFF-GRID | |
| FORM OF OWNERSHIP | Private (for profit) | Small, decentralized | Small grid reseller (India) | Hydro minigrids selling to local customers and to the main grid (China, Nicaragua) Formerly isolated minigrid now connected to grid, (Cambodia) | Diesel or hydro minigrid (Cambodia, Ethiopia) | SHS (Honduras, Indonesia, Kenya, Sri Lanka) PV/wind/diesel water pumping (Brazil, Chile, Mexico) WHS or pico hydro (Argentina, Mongolia, Nepal) |
| | Nongovernmental | Large, centralized | Privatized concessionaire extends grid (Argentina, Chile, Guatemala, Uganda) | Technology neutral electrification concession (Senegal) | Off-grid concession (Argentina) | SHS (Bangladesh, Bolivia, Morocco, South Africa) |
| Public (state-owned) | Nongovernmental | Cooperative | Cooperative finances grid extension (Bangladesh, Costa Rica, United States) | | Multi-service Coop with diesel or hydro microgrid (Bangladesh, Bolivia, Philippines) | Agricultural Coop using diesel genset (Bolivia) |
| | Public (state-owned) | Other community organizations | Small “community gateways” (Bolivia) | | Community microgrids (Brazil, Cambodia, Honduras, Indonesia, Nicaragua, Sri Lanka) | Diesel genset or renewable energy to power a school, clinic, community center (Argentina) PV Battery Charging Stations (Nicaragua) |
| | | Small, decentralized | Small state-owned utility extends grid (Brazil, Colombia) | | Municipal diesel or hydro minigrid (Bolivia) | |
| | | Large, centralized | State utility extends grid and sells at retail (Botswana, Mozambique, Thailand, Tunisia) | | Residual state-owned isolated diesel-minigrids with fuel subsidies (Cambodia Nicaragua) | SHS (Mexico) |

Table 1 presents the diverse universe of electrification options organized by two parameters: technology and form of ownership. Technologies are ordered along the horizontal axis. They range from centralized, grid-connected options to decentralized, nonconnected, single-user systems. Forms of ownership are ordered along the vertical axis. They range from state-owned utilities and community organizations (such as community councils and cooperatives) to private, for-profit firms. The dominant historic model of grid extension by state-owned power enterprise is in the lower left-hand corner. The newer electrification options arise as one moves up and to the right within the matrix.

Although this matrix “orders” the universe along the two dimensions of technology and form of ownership, these are only two parameters out of a much larger set of characteristics that distinguish one electrification option from another. These two “organizing” characteristics were chosen because they are particularly useful in focusing attention on important regulatory design issues.⁹ This does *not* mean, however, that decisions about regulatory design can be automatically answered by simply locating the combination of technology and form of ownership in one the matrix cells. To do so would be dangerous and naïve. In particular, it would ignore the importance of other parameters not shown in the matrix. These other parameters include, among others (a) the delivery model (for example, fee-for-service, dealers, or hybrids in the case of SHSs); (b) types of subsidies (for example, connection versus consumption and targeted versus untargeted) received; (c) the process for selecting operators and, in particular, whether there was any competition in selection (for example, competition in the market, for the market, by project, by cluster, or by yardstick); (d) where there was competition, the parameters that were bid (tariff levels, connection charges, minimum required subsidies, or number of new customers to be connected); (e) allocation of risks between the suppliers, consumers, and government; (f) the stage of market development; and (g) the financing structure. Each of these parameters is relevant to the design of a regulatory system.

What are some of the regulatory design issues that are suggested by the matrix? Some issues are common to all cells, whereas other issues are peculiar to specific cells. For example, the two universal regulatory issues of setting maximum tariffs and minimum quality-of-service standards apply to all the cells. However, even though the same tasks need to be accomplished, this does not imply that they need to be performed in the same way. Consider the case of the community organizations shown in the middle rows. When electrification is performed by a community organization, the customers are the owners. Since there is no incentive for the owners to charge high prices to themselves, this suggests that a form of self-regulation may be possible for a community organization that is operating an isolated minigrid. If the same grid were taken over by a private operator, the regulatory situation changes dramatically. Absent any regulatory controls, the new private operator will have both the incentive and the ability to charge monopoly prices to users in the community. Therefore, self-regulation is no longer an option. However, the traditional option of setting tariffs based on a detailed review of the supplier’s own costs, the regulatory norm for many large power enterprises, will not be workable because of the sheer number of such entities and the limited resources available to most regulatory entities.

Regulatory issues also differ depending on whether a supplier is connected to a larger regional or national grid. The regulatory issues for a nonconnected minigrid operator are the traditional issues of price and quality of service for retail customers. When this minigrid becomes connected to the main grid, a whole new set of regulatory issues arises. The new issues include the physical terms and conditions of connection; prices for wholesale sales by the operator of the larger grid to the minigrid operator; prices for sales by the minigrid operator to the larger grid or other noncontiguous grid-connected entities; the right of the minigrid operator to buy from and sell to other noncontiguous grid-connected entities; the price for transmission and ancillary services to reach these noncontiguous grid-connected entities; and how revenues from wholesale sales are shared between the minigrid operator and its retail customers. Finally, suppliers in all cells of table 1 face the common issue of many

⁸ The matrix was used to facilitate discussion in a 2004 ESMAP working clinic on policy and regulatory issues of electrification that was attended by regulators and policy officials from six Latin American countries. It was also used for a parallel ESMAP study (ESMAP 2005c). The examples in the matrix cells are meant to be illustrative.

⁹ Other recent studies with different purposes use somewhat different organizing principles. See, for example, the study on electrification subsidies in Latin America (ESMAP 2005c) and the ongoing study of small service providers in the water and electricity sectors by Kariuki and Schwartz (2005). Alternative versions of table 1, with several different combinations of parameters, were used during the preparation of the Bolivia IDTR model in designing a new SHS business model (described more fully under principles 1 and 3 in chapter 2).

customers having a low ability to pay. This implies that none of the electrification models will be commercially viable unless external or cross subsidies are provided, at least for initial capital costs. This, in turn, implies that the regulatory system must be coordinated with a subsidy system. This creates complications that do not exist for enterprises that are commercially viable without subsidies. It also raises the question of whether it might be more efficient to delegate some traditional regulatory functions to the subsidy-granting body rather than trying to coordinate the provision of subsidies and the setting of tariffs between two separate government entities.

The Basic Design Questions

In designing any regulatory system, four basic questions must be answered:

- What entities should be regulated? (*Jurisdiction*)
- What activities or parameters should be regulated? (*Coverage*)
- How should the regulation be performed? (*Methods*)
- Who should perform the regulation? (*Division of Responsibility*)

The principal conclusion of this paper is that the answers to these questions must vary by technology and form of ownership if the electrification program is going to be successful. In the remainder of the paper, we discuss the reasons for this general conclusion and the different types of regulatory systems that will work best for the different types of entities represented in the various cells of table 1.

Two Golden Rules of Regulation

In addressing the four basic questions of regulatory design, it is always important to remember two “golden rules.” They are meta-principles for the design of any regulatory system:

- **Rule 1**—Regulation is a means to an end. What ultimately matters are outcomes (here, sustainable electrification), not regulatory rules.
- **Rule 2**—The benefits of regulation must exceed the costs of regulation.

Rule 1 should be displayed prominently on the desk of every regulator. Much has been written about the theory and practice of regulation, but regulators sometimes forget that the overriding goal of any regulatory system, both for consumers and investors, is “performance not processes.” In the words of a Brazilian villager without access: “the most expensive electricity is when there is no electricity.” The outcome that should be sought is sustainable and rapid electrification at the lowest possible cost while meeting minimum acceptable technical and commercial quality-of-service standards.¹⁰ If the regulatory system does not help to achieve this goal, it is not “adding value.”

Rule 2 stands for the proposition that a regulator can help to maximize the benefits of electrification by minimizing the costs of regulation. As one small private investor in India observed: “Unfortunately, the single most common mistake made by my country’s electricity regulators, who live comfortably in the capital, is that they forget that their rules cost time and money.” Regulation creates both direct and indirect costs. The direct costs of regulation are the budget of the regulatory entity and the costs incurred by regulated entities to comply with the regulator’s rules (for example, improved transformers or more extensive reporting requirements).¹¹ In the case of electrification, the biggest regulatory costs are likely to be indirect. Given the fragile economics of many off-grid enterprises, too many regulatory requirements may stop an enterprise from

¹⁰ In this paper, we do not discuss how to measure the societal benefits that result from electrification. Once a government has made a decision to pursue a certain electrification target, this decision becomes a “given” for the regulator whose job should be to minimize the direct and indirect regulatory costs of achieving that goal. Two examples of careful studies that attempt to measure societal benefits are Meir 2003 and ESMAP 2002. Both publications attempt to estimate the increased consumer surplus (that is, the area under an estimated demand curve) that results from moving up the energy ladder from inferior to superior forms of energy.

¹¹ The indirect costs paid by a regulated entity may be formal or informal. A formal cost would be a license fee going to the regulatory agency, whereas an informal cost would be a bribe paid to a regulatory official to process and approve the license application.

initiating or completing an electrification initiative at all. And when regulation pushes the enterprise over this “tipping point,” the regulator will have failed in protecting consumers if they are forced to continue obtaining electricity from automobile batteries at US\$2–3 per kilowatt-hour when an off-grid supplier could have provided more and better electrical service at US\$0.20–0.50 per kilowatt-hour.¹²

Even if both of these regulatory meta-principles are fully satisfied, this, by itself, does not guarantee the success of an electrification program. This is another way of saying that appropriate regulation is a necessary, but not sufficient, condition for the success of electrification programs. More important than regulation is the fundamental commercial viability of the business model that underlies the electrification effort. If the business model is not viable (that is, costs are not covered by revenues and subsidies), the electrification effort will inevitably fail. However, even if the business model is commercially viable, a poorly designed or implemented regulatory system can destroy any electrification initiative, most often by smothering it with too much regulation. Our focus then is on how to create regulatory systems that do not destroy what they should be trying to create.

Why Regulate?

The traditional justification for any kind of economic regulation is to protect consumers against monopoly abuse. A supplier of electricity services may have monopoly power because it is a natural monopoly, which means simply that it is more efficient for one supplier to provide services rather than several suppliers. Alternatively, it may have monopoly power because a government has granted it a legal monopoly even if it is not a natural monopoly. This happens whenever a government has concluded, correctly or incorrectly, that a single supplier should provide the specified service rather than multiple competing suppliers.¹³ In other words, some natural monopolies arise because of the underlying structure of costs, and some “unnatural” monopolies arise because of a government decision or action.

Consumers are hurt whenever an electricity supplier exercises monopoly power. Monopoly power can be manifested through high prices, inferior service (for example, interruptions, safety problems, and inaccurate billing), or a combination of the two. This, in turn, implies that the two principal functions of any economic regulatory system are price regulation and quality-of-service regulation.

Regulation is also needed to protect investors. This is true regardless of whether the investors are private investors or community-based organizations (for example, a cooperative or a village electricity committee). If a company or community is going to make an investment, it needs to know beforehand what its rights and obligations will be after the investment is made. To be more specific, it needs to know the prices that it will be allowed to charge—so it can estimate expected revenues—and the service standards that it will be required to meet—so it can estimate expected costs. In addition, investors need to know for how long they have permission (that is, legal authority) to provide a service, whether that right is exclusive or nonexclusive, and whether there will be some compensation if the license is taken over by another party.¹⁴ A good regulatory system will provide this information and ensure that whatever commitments are written in licenses, concessions, and permits will actually be honored.

Important Dimensions of Regulation

Any regulatory system has two important dimensions: *regulatory governance* and *regulatory substance*. Regulatory governance refers to the institutional and legal design of the regulatory system. It is the framework within which regulatory decisions are made. Regulatory governance is defined by the laws, processes, and procedures that determine the enterprises, actions, and parameters that are regulated, the entities that make the regulatory decisions (the electricity regulator or some other government entity), and the resources and information that are available to them.

¹² The same issue arises in deciding how to regulate microfinance institutions. If these small lending institutions are forced to comply with the same reporting and fiduciary requirements as larger established banks, they will not survive, and the poor will either lose access to credit or be forced to pay extremely high interest rates for any credit they might obtain. See Christen, Lyman, and Rosenberg 2003.

¹³ A government can create the functional equivalent of a legal monopoly by deciding to give connection subsidies to only one supplier.

¹⁴ This is usually described as entry regulation. In the case of an isolated minigrad operator, it would depend on regulatory decisions relating to the duration of the license, conditions under which the license can be renewed or revoked and whether there is any compensation to the operator if the national or regional grid reaches the geographic area served by the minigrad operator. We use the term license as a generic term for any government-granted permission (for example, concession or permit) to supply a particular service.

Regulatory governance is the “how” of regulation.
It involves decisions about:

- The accountability of the regulator.
- The division of initial and ongoing responsibilities among the regulator, policy maker and any ministries, electrification funds, or subnational political entities.
- Decision-making and organizational autonomy of the regulator.
- Transparency of decision making by the regulator or other entities that are making de facto regulatory decisions.
- The predictability and speed of regulatory decision making.
- Judicial and nonjudicial mechanisms for appealing regulatory decisions.

Regulatory substance refers to the content of regulation. It is defined by what is regulated and how it is regulated. It is the actual decisions, whether explicit or implicit, made by the specified regulatory entity or other entities within government that may make de facto regulatory decisions. **Regulatory substance is the “what” of regulation.**

The most important substantive regulatory functions involve:

- The setting of tariff levels and structures.
- The setting of quality-of-service standards.
- The setting of entry and exit requirements.

Making decisions on these basic economic parameters is the traditional key function of any economic regulatory system.

Functions and Tasks: Regulation and Policy

To perform these universal regulatory functions, certain common tasks must be undertaken. Generally, a regulator or some other entity that has been assigned regulatory functions must perform four tasks:

- Gather information and data.
- Establish rules.
- Monitor the implementation of the rules.
- Enforce the rules.¹⁵

Regulatory functions and associated tasks are described in more detail in the first two columns of table 2. The traditional regulatory functions of setting maximum tariffs and minimum quality-of-service standards need to be performed for all regulated enterprises in the power sector, regardless of whether they are traditional power enterprises operating on the central grid, new power enterprises that are installing SHSs, or distributed generators providing electrical service on an isolated minigrid. For enterprises that are operating on the central grid, the designated regulatory agency will normally perform both tariff-setting and quality-of-service regulation and the four tasks associated with these two functions.

However, the traditional strategy of one national electricity regulator “doing it all” is usually *not* a sensible strategy when regulating enterprises that provide off-grid electrical services. In other words, successful off-grid electrification requires that the traditional functions and tasks of regulation be performed in nontraditional ways. What this means is that successful electrification requires that the traditional regulatory functions and tasks are often best performed by entities other than the national electricity regulator. What this means is that successful electrification requires that the traditional regulatory functions and tasks are often best performed by entities other than the national electricity regulator. The rest of the paper is devoted to exploring why nontraditional regulatory techniques need to be developed and how they can be implemented for different forms of electrification.

¹⁵ In some Latin American countries, monitoring and enforcement are grouped together as a single activity and referred to as “supervision.”

Regulation does not exist in isolation. Regulatory decisions must be consistent with policy decisions. In the case of grid and off-grid electrification, it is critical that these regulatory functions and tasks be coordinated with two key government policy decisions: mandated connection targets and levels of subsidies that are given to providers of electrification services or their customers.¹⁶ These two policy decisions, typically made by a government ministry or rural electrification fund, are the policy platform on

which the regulator must operate. Although it is the government that normally makes these two policy decisions, the regulator or some specialized electrification entity will usually be tasked with implementing the government's policy decisions. Since connection targets and subsidies levels are so critical for successful electrification, they are also listed in table 2, even though they are typically "policy" rather than "regulatory" decisions.

Table 2. Regulation and Policy for Grid and Off-Grid Electrification

| FUNCTIONS | | | | |
|---|---|--|--|--|
| REGULATION | | POLICY | | |
| Price regulation | Service quality regulation | New Connections | Subsidies | |
| Gather information and data | | | | |
| <ul style="list-style-type: none"> • Get information on current and projected tariff revenues and costs. • Get information on willingness-to-pay for alternative service levels. | <ul style="list-style-type: none"> • Obtain information on current service levels. • Carry out technical studies on the feasibility and cost of different service standards (technical and commercial). | <ul style="list-style-type: none"> • Gather information on existing coverage. • Define the meaning of new connections. | <ul style="list-style-type: none"> • Determine the magnitude of subsidy funds that will be available. • Decide which communities and/or entities will have priority to limited subsidy funds. | |
| Establish rules | | | | |
| <ul style="list-style-type: none"> • Set tariff levels and structures in the absence of competition, with provisions to link some parameters to inflation. • Establish procedures for adjusting tariffs for unexpected events or at the end of a specified tariff period. | <ul style="list-style-type: none"> • Define quality standards for different types of technologies and providers and for different customer categories. • Specify the date by which standards must be achieved. • Specify penalties for failure to achieve standards. • Determine how compliance will be measured and monitored. • Specify events that excuse compliance. | <ul style="list-style-type: none"> • Establish connection targets. • Specify the dates by which connection targets must be achieved. • Determine how compliance will be measured and monitored. • Specify events that excuse compliance. | <ul style="list-style-type: none"> • Decide on the levels of capital and operating cost subsidies for eligible entities. • Decide on how and when the subsidies will be disbursed. • Decide on the actions (for example, connections, maintenance visits) that will trigger disbursement. | |
| Monitor the implementation of existing rules | | | | |
| <ul style="list-style-type: none"> • Audit financial accounts, if necessary or feasible. • Ensure that tariffs comply with rules. | <ul style="list-style-type: none"> • Monitor service to ensure that mandated levels of service quality are being achieved. | <ul style="list-style-type: none"> • Monitor connections to ensure that connection targets are met. | <ul style="list-style-type: none"> • Monitor performance to verify that recipient has performed the actions that qualify for subsidies. | |
| Enforce decisions | | | | |
| <ul style="list-style-type: none"> • Define tariff adjustments on basis of performance. • Apply sanctions if tariff rules are violated. | <ul style="list-style-type: none"> • Apply sanctions if the operator has failed to achieve the standards. • Specify events that excuse compliance. | <ul style="list-style-type: none"> • Apply sanctions if the operator fails to meet coverage targets. • Specify events that excuse compliance. | <ul style="list-style-type: none"> • Withhold subsidies for nonperformance, or apply penalty or refund requirements. | |

Source: Bank staff and Trémolet, Shukla, and Venton 2004.

Structure of the Paper: From Principles to Standards

The paper's structure is based on a hierarchy of guidance that goes from the general to the specific. It starts with the two previously described meta-principles, moves on to four general principles, and concludes with seven standards. The four principles are intended to provide guidance on where the regulatory system needs to go. However, it is not very helpful to tell regulators and government officials that "this is where you should end up." In fact, such advice is often resented. One government official in a developing country described this approach as the "World Bank's propensity for making grand pronouncements." If any real progress is going to be made, regulators and government officials need specific advice on "next steps" rather than just general statements on "end points." Therefore, in the final section of the paper, we propose a list of seven standards designed to operationalize the four general principles. The standards are written so that they can be elements of an electrification law or decree. They are designed to serve as formal building blocks of a regulatory system that would work "for" rather than "against" electrification.

The Significance of Examples

Principles and standards are easy to enunciate. What is more difficult is to implement them in complicated, real-world situations. To make the four principles more concrete and relevant, each principle is first discussed and then illustrated with several real-world electrification examples from developing countries. However, the significance of these examples should not be misinterpreted. In the literature of development, it is

very common talk about "best practices." These examples do not necessarily represent "best practices." The more accurate description would be "emerging practices" that have the possibility of becoming "best practices."

Two Important Caveats

The reader should be aware of two caveats when reading this paper. The first is that the principles and standards do *not* define a complete regulatory system. Instead, they represent a subset of a larger set of regulatory principles and standards required for successful electrification. In a future paper, we intend to present additional principles and standards covering other important issues, such as tariff levels and structures; coordination of tariffs and subsidies (for connection or consumption); regulation when there are different forms of bidding (for example, bidding for minimum subsidies, for minimum customer connection charges, or for minimum tariffs); "regularization" of informal service providers; and "handoff" arrangements when the main grid connects to a minigrid.¹⁷

The second caveat is that the paper's emphasis is on regulatory issues associated with off-grid electrification. Off-grid electrification is typically associated with rural electrification. Electrification is also needed in rapidly growing periurban areas. Usually, these are the informal slums that surround major metropolitan areas. It is our intent to explore regulatory design issues for periurban electrification in future work.¹⁸

¹⁶ We will use the term connections to describe the provision of electricity service to new customers. If the *connection* is to a grid (whether national, regional, or isolated), the customer will receive alternating current (AC) service. If the service is provided by a single user system (for example, an SHS or wind home system), the customer will receive either direct current (DC) or alternating current, but will not be connected to a larger grid. For simplicity, both forms of electrification are called connections in this paper.

¹⁷ For example, some of the questions that would need to be addressed for tariff setting would include the following: Should there be a review of the operator's maximum and minimum tariffs? Should the review be one-time or periodic? What entity should perform the review—the regulator, the subsidy-providing entity, or a subnational level of government? If the operator is selected through some form of competitive procurement (for example, bidding a maximum tariff, bidding for a minimum subsidy per connected household, or bidding a connection charge), how should that competition affect the nature of the tariff review? Should there be different tariff structures depending on whether the generation technology is relatively standard (for example, a diesel generator) versus generation technologies whose costs vary considerably with site characteristics and resource availability (for example, hybrid renewable energy technologies)? If there is regulatory review of tariffs, should the review be based on the operator's own costs—benchmarked costs for similar providers or some other arrangement? Should connection payments be charged separately from usage charges? For customers who are metered, should the tariff be a one-part tariff (for example, a kilowatt-hour charge) or a multipart tariff (for example, a usage charge, a customer charge, and a connection charge)? For customers who are not metered, how should peak demand or total consumption be controlled to reduce inefficient consumption? How should tariff setting be coordinated with the provision of subsidies?

¹⁸ A rich source of information on periurban electrification can be found in the presentations made at the ESMAP-hosted Slum Electrification Workshop held in Salvador da Bahia, Brazil, in September 2005. The presentations are available at <http://wbln0018.worldbank.org/esmap/site.nsf/pages/Slum+Electrification+Workshop>.

2. BASIC PRINCIPLES FOR REGULATING ELECTRIFICATION

Principle 1: Light-Handed and Simplified Regulation

Principle 1 is a corollary of a general and widely accepted principle of regulation. The general principle applies to all forms of power sector regulation, not just the regulation of grid and off-grid electrification. In the United Kingdom, the general principle is referred to as “proportionality.” In the United States, it is described as “smart regulation” and “cost effective” regulation. And in Australia, it is known as “minimum necessary regulation.” Although the specific terms used to describe the concept vary from country to country, the concept is the same: **a well-functioning regulatory system is one that minimizes the costs of regulation.**

The rationale for this principle is straightforward. It does not make sense to regulate more than is absolutely necessary because regulation imposes costs on those who are regulated and on the economy in general. Any regulation will cost time and money to comply with. This is true regardless of whether the enterprise is privately, publicly, or community owned. Most off-grid providers of electricity do not have “deep pockets.” They are enterprises that are often just barely commercially viable so that any unnecessary regulation can destroy their viability.

Overregulation is not a problem that is peculiar to the power sector. It is, in fact, a central issue for the overall economy of any country. In recent years, there has been growing empirical evidence that “heavy-handed” regulation or overregulation clearly hurts economic development. This evidence was recently presented in a 2004 World Bank study that examined the levels of regulation for the same five common business processes and actions in more than 145 countries. As shown in figure 1, the pattern is clear: poorer countries have much more complicated and extensive business regulation than developed countries. For example, it takes two days to start a business in Australia, but 203 days in Haiti and 215 days in the Democratic Republic of the Congo.¹⁹

It is worth highlighting the report’s principal conclusion:

Businesses in poor countries face much larger regulatory burdens than those in richer countries. They face 3 times the administrative costs, and nearly twice as many bureaucratic procedures and delays associated with them.²⁰

Since many of these poor countries are also the same countries that desperately need electrification, it is critical to try consciously to avoid overregulation in designing the regulatory systems to promote electrification. Overregulation also goes hand-in-hand with corruption. As one Asian energy minister observed, “the more pieces of paper that are required, the more opportunities for bribes.”

Achieving light-handed regulation requires that those who are designing or implementing a regulatory system for grid and off-grid electrification must ask the following questions:

- Is the information really needed?
- Can the number of review and approval steps be reduced?

EXAMPLE 1: Isolated Minigrids: Flexible Filing Requirements and Lower Service Quality Standards

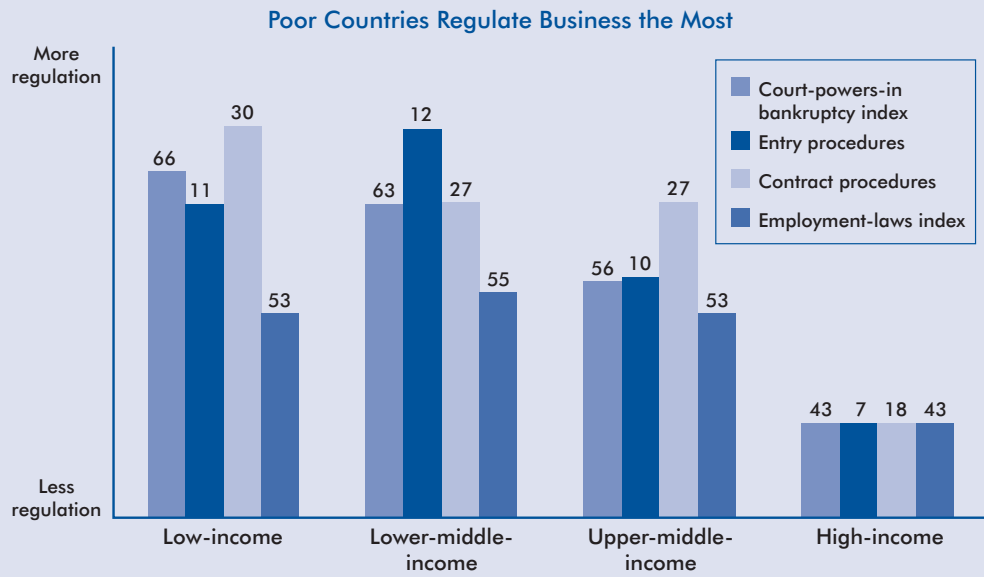
Overregulation is a major issue for small, isolated village minigrid operators, which are often “spontaneous” rather than “nurtured” enterprises.²¹ In other words, they did not come into existence because of some formal government program. For example, in many Asian countries it is not uncommon for a small private entrepreneur to buy a second-hand diesel generator, run wires to 100 or more households in a village, and supply them with electricity for several hours each evening, with monthly charges usually keyed to the number of lightbulbs or small appliances that are connected rather than to kilowatt-hour consumption as measured by a meter. Such mini-enterprises are operated by private entrepreneurs (most commonly in Asia), cooperatives, or local government units (typically in Latin America).

¹⁹ World Bank 2004, p. xxxi.

²⁰ World Bank 2004, p. 3.

²¹ In this context, the term *isolated* means that the system is not connected to the national or provincial high-voltage (typically 220 or 115 kV) or medium-voltage (usually 33 or 22 kV) power grid.

FIGURE 1. How Business Regulation Varies across Countries



Note: The indicators for high-income countries are used as benchmarks. The average value of the indicator is shown above each column.

Source: World Bank, Doing Business in 2004, pg. xii

About 150 such enterprises operate in Bolivia,²² at least 200 in Cambodia,²³ and several hundred in Ethiopia. It is hard to get accurate information on the number of such enterprises because they mostly operate in the “informal” economy and therefore rarely appear in government statistics.²⁴ Historically, they have not been regulated, either because no regulatory entity existed or, if a regulatory entity did exist, its rules and regulations were usually ignored. In other words, the norm is de facto deregulation (which, of course, is the ultimate form of light-handed regulation) though it clearly was not planned that way.

In Bolivia, about 50 operators of the existing isolated village minigrids were surveyed in 2002 as part of the project preparation for the Decentralized Infrastructure for Rural Transformation (IDTR) program.²⁵ Even though the Bolivian energy law requires that these enterprises obtain a formal concession from the national electricity regulator if their installed generation exceeds a maximum local generation capacity of (originally) 300 kW, the rule was not enforced in most cases. Becoming a

concessionaire requires that the new concessionaire become incorporated by creating a “shareholder company” (known as **sociedad anónima** in Latin American countries). Since more than two-thirds of the smaller rural suppliers are cooperatives (while some of the medium-sized systems are co-owned by municipalities or prefectures), the legal requirement that they convert themselves into private companies directly conflicts with their current status as cooperatives, a legal status that they wish to maintain. Moreover, the reporting requirements and technical standards for concessionaires would be impossible to satisfy for many of the smaller rural systems. Faced with this conflict between what the law requires and what is economically feasible, Bolivia found itself with a de facto system of bimodal regulation: full regulation for the largest distribution concessions and nonexistent regulation for the bulk of the isolated minigrid operators.

To address the conflict between “cooperative” and “concession” status, a new type of transitional contract known as **contrato de adecuación** was introduced as

²² Mendizabal 2003. This report was prepared in 2003 as a background study during preparation for a World Bank loan to the Bolivian government.

²³ Enterprise Development Cambodia 2001.

²⁴ When regulators are given the responsibility to regulate these informal enterprises, the regulators will often have an incentive to underestimate the number of such enterprises to avoid the appearance that they are failing to perform their required regulatory functions.

²⁵ IDTR 2003b.

a partial, interim solution in 2000. This new regulatory arrangement allowed the cooperatives to continue providing electricity service to their members without having to acquire concession status. The transitional contracts have an initial four-year term with the possibility of an extension of four more years. To ease the regulatory burden on minigrad operators who have old diesel generators larger than 300 MW, but who are serving a relatively small customer base, the 300 kW generation threshold was changed to 500 kW system peak demand. However, this was only a partial solution, since the cooperatives above 500 kW are legally required to satisfy all the reporting and technical standards of concessions, even if they are not formally concessions.

There have been lengthy discussions of the more general problem of overregulation of small off-grid suppliers. Several independent consultants have proposed systems of graduated regulation for rural off-grid systems.²⁶ One proposal is to create three categories of rural off-grid suppliers, based on system load size, and define less burdensome forms of regulation for the two smaller sizes. Systems with a demand above 1 MW would continue to be regulated as before. Operators of systems between 300 kW and 1 MW demand would have fewer reporting requirements and less stringent service standards (see table 3). A third regulatory category would be established under this specific proposal for minigrad operators with a peak demand below 300 kW. Operators in this lowest size category would have no obligation other than to register themselves once and provide a yearly update of basic information.²⁷

If they meet this minimal requirement, they would be eligible to receive much needed technical assistance.²⁸ Technical assistance is an important concern for the small rural village grid providers, because technical and administrative capacity is often low. A 2002 survey of Bolivian off-grid providers confirmed that many of them recognized this lack of capacity and asked for training. SHSs would either be regulated by the government entity that provides installation subsidies funding their installation or by the national electricity regulator under a new separate category.

A second proposal would create an even simpler structure with only two categories of rural system sizes. These categories would be based on the population served instead of load or generation levels. As an example, all systems for towns and villages with a population fewer than 20,000 would fall under a new “rural electrification” category and enjoy lighter regulatory obligations than the systems serving communities with populations greater than 20,000.

Both proposals share the same common idea. Where possible, standards for reporting and quality of service in the smaller rural off-grid systems would be lower than for the main power grid, so that costs can be reduced and tariffs can be lower and electricity services more affordable for (future) rural users.

Table 3. Examples of Lower Quality-of-Service Standards Proposed for Isolated Minigrads in Bolivia

| 1. Technical product quality | Current regulation | Possible future norm for isolated minigrad systems |
|--|--------------------|--|
| a. Voltage level | +/- 7.5% | Between $\pm 10\%$ and $\pm 12\%$ have been proposed for the new threshold (TBD) |
| b. Phase shift | < 3% | < 5% |
| c. Disturbance of communication appliances (cell phone, radio, TV) | None | None |
| 2. Technical service quality | | |
| e. Frequency of service interruption | < 7 times per year | Between <20 and <25 times per year |
| f. Duration of service interruption | < 12 hours | Between < 36 hours and <48 hours |
| 3. Commercial service quality | | |
| g. Consumer complaints | < 6% | < 10% |
| h. Billing | < 0.15% | < 0.35% |
| i. Average response time | < 24 hours | < 80 hours |
| TBD, To be determined. Source: Unpublished consultant's report prepared as preparation for a World Bank loan. | | |

²⁶ Mendizabal 2003. Similar proposals have been made in Senegal for what might be described as a “concession lite.” Our discussion of developments in Bolivia is based on information that was available as of January 2006. The new government of President Evo Morales is now conducting a fundamental review of existing and proposed electrification programs.

²⁷ This is explicitly provided for under the new Nigerian Electric Power Sector Reform Law 2005. The law states that “...the Commission may establish simplified procedures for undertakings and businesses that are limited in size and scope so as to expedite the application and licensing process.” Section 63 (8).

²⁸ Presentation of Enrique Birhuett Garcia during ESMAP working clinic in ESMAP 2005b.

EXAMPLE 2: Isolated Minigrids: Generic Tariff Setting

A novel, light-handed approach to tariff setting has been proposed for the several hundred isolated, privately owned minigrid operators in Cambodia.²⁹ These suppliers, known as rural electrification enterprises (REEs), usually operate small, second-hand diesel generators that produce electricity for sale to retail customers in one or more contiguous villages. At present, it appears that the regulator has accepted the prices that are currently being charged. A phased-in, alternative tariff-setting approach has been suggested by an outside consultant. The consultant's proposal is that the maximum tariffs of these small operators would be limited through published Tariff Tables.

The Tariff Tables would specify a maximum allowed retail price (that is, a tariff ceiling) for minigrid operators "under different circumstances." An operator would have the flexibility to charge any price up to the specified maximum. The Tariff Tables would relieve the REEs (also referred to as small licensees) of the obligation to make an initial tariff filing with the regulator or to return to the regulator with requests for revisions in the tariffs. Another element of the proposal is that the maximum ceiling tariffs would be automatically adjusted on some periodic basis for changes in diesel oil fuel prices.³⁰ This would be similar to the automatic fuel or purchase power adjustment clauses that are commonly used by larger, grid-connected distribution enterprises in many countries.

The essence of this proposal is that maximum tariffs would be set on a generic rather than on an individual enterprise basis.³¹ In other words, tariffs would be based on general benchmarks rather than on each enterprise's own cost of service.³² Such an approach raises three implementation questions.

First, on what basis are the tariff categories established? Since there is some evidence of economies of scale (that is, unit costs tend to be lower as the number of customers increases and volume of sales increases), it has been suggested that the tariff categories be keyed to some measure of enterprise size. Others have argued that this is too simplistic. They contend that any tariff categories would also have to be keyed to geographic location.³³

Second, will the benchmark costs be keyed to an estimate of average or best practice efficiency? The advantage of using a benchmark is that it creates an incentive for an enterprise to be more efficient. It is, in effect, a simple form of performance-based regulation. However, whenever regulators use benchmarks for setting tariffs, there is always the possibility that some enterprises will always be "on the wrong side of the benchmark" because their costs are higher for reasons that have nothing to do with their own internal efficiency.³⁴ For example, two REEs of the same size could have widely different production costs simply because one of them may be located in a more isolated location. If number of customers is the one and only characteristic that defines tariff categories, the more isolated REE will be penalized because of its

²⁹ See NERA 2004. A similar approach is being pursued by the national water regulator of Paraguay. Faced with the daunting task of being required to regulate the tariffs of more than 1,300 small water systems, the Paraguayan regulator has stated that it will try to group them according to similar technical, economic, and geographic characteristics. The costs of providing service for a "typical system" will be calculated and used to set tariffs for all systems in that group. Rather than revising existing tariff agreements, this will be done on a prospective basis.

³⁰ This is an important element of the proposal because fuel costs constitute about 70 percent of the average cost (including depreciation) for a typical REE (Chanthan and Mahé 2005, p. 13). A significant increase in diesel fuel prices without any parallel adjustment in tariffs could easily bankrupt an REE. For example, the average price paid by REEs for a barrel of diesel oil jumped from about US\$20 in 2003 to more than US\$30 in 2005. An important decision will be how frequently to adjust the tariff for fuel price changes. The adjustment could easily become too complicated for both the operator and its customer if the tariffs are adjusted too frequently.

³¹ This is in contrast to the Philippines where the national electricity regulator currently requires that each of the 119 rural electricity cooperatives make a separate tariff filing based on the cooperative's own cost of service.

³² Essentially the same approach was used by the U.S. Federal Power Commission in regulating the prices of hundreds of natural gas producers in the late 1960s and early 1970s. Initially, the commission tried to regulate prices "with 'cost based' limit on prices in each contract of every individual producer." This approach was a total failure, however, because "there are too many producers, too many contracts and too many cost elements to determine the regulated price on each sale." In 1960, the commission decided to set maximum tariffs of the producers using the concept of "area rates." The area rates were based on the commission's estimates of the average costs of exploration and production for existing gas production in certain specified geologic basins. The assumption was that the costs of production would be roughly comparable for all producers in the same basin. Unfortunately, it took the commission eight years to reach a decision on the first area rate. The general consensus now is that the area rates were set too low and that the area rates were the principal cause of major shortages of natural gas in the United States in the late 1970s. In 1989, the U.S. Congress passed a law that eventually led to total deregulation of natural gas producer prices. See MacAvoy 2000.

³³ Technology is a constant. Almost all REEs currently generate electricity from small diesel generators.

³⁴ For example, some electricity distributors in Colombia have argued that their costs are higher because they are providing electricity in areas where there is active fighting between the government and rebels. On the general problem of establishing benchmarks in regulation, see Shuttleworth 1999.

location. It appears that this problem has been anticipated. The proposal provides that any REE has the right to make an application to the regulator for a different tariff if it “believes that it is in special circumstances and therefore cannot charge the relevant tariff in the Tariff Table without damaging its financial viability.”³⁵

Third, will political authorities require uniform tariffs for main grid and minigrid customers? The retail customers of some REEs currently pay about US\$0.50–0.80 per kilowatt-hour. This is two to three times higher than the price paid by the grid-connected retail customers in some of Cambodia’s provincial towns.³⁶ Presumably, this reflects some combination of small size, the inherent costliness of generating electricity at isolated locations using diesel fuel that has to be trucked in, and the risk of operating in these areas—but probably also the exercise of some monopoly power. It is not easy for the regulator to set tariffs that reflect the first three factors, yet also prevent the exercise of monopoly power. If, in the future, the government decides, as a matter of policy, that the customers of the REEs should pay prices that are comparable to the lower prices paid by grid-connected customers, the government would be forced to provide large subsidies to these enterprises or face the possibility that the REEs will simply go out of business.³⁷ And if this happens, it is not obvious that consumers have been “protected” if they are forced to going back to batteries that cost the equivalent of US\$2–3 per kilowatt-hour.

Principle 2: Delegate or Contract Out Regulation

The national or regional regulator should be allowed (or required) to temporarily or permanently delegate or “contract out” regulatory tasks to other government and nongovernmental entities.

Although it may be legally necessary for the national or regional regulatory to have final formal responsibility over all entities within a country that provide electrical services to consumers, it does not logically follow that the regulator should be required to perform all the regulatory functions and tasks shown in figure 1. In our view, it is often more efficient for the regulator to “delegate” or “contract out” traditional regulatory functions for entities that are providing off-grid electrical service—or not to regulate at all.³⁸

Benefits of Delegation

Delegation is especially desirable if there is a functioning rural electrification agency or rural electrification fund. In most countries, such an agency or fund will provide capital (and sometimes operating cost) subsidies to entities that provide electrification services. The rationale for the subsidies is to close the gap between relatively high costs and the generally low capacity to pay in remote rural markets. Not surprisingly, electrification agencies will require one or more quid pro quos from entities that receive these subsidies. For example, the electrification agency may specify a maximum price that the operator can charge its customers. In addition, it may impose certain output requirements: number of new connections,

³⁵ NERA 2004, p. 23.

³⁶ This is shown in the annual report of Cambodia’s national electricity regulator (available on the Internet at www.eac.gov.kh/report.php). In contrast, customers of the Northern Imhabane minigrid concession in Mozambique, the country’s first minigrid concession, have protested strongly that the US\$0.14–0.15 per kWh that they are paying is unfair when comparable grid- and non-grid-connected customers of the state-owned national utility (EdM) are paying about US\$0.08 per kilowatt-hour. Both enterprises—EdM and the Northern Imhabane concessionaire—have received major capital cost subsidies from the Mozambican government. However, EdM has an additional advantage, which is not available to the stand-alone private operator, of being able to continue to subsidize its ongoing operating costs with cross-subsidies from urban customers in the capital.

³⁷ The World Bank is proposing to lower the commercial costs of some REEs through access to grants from a newly created Rural Electrification Fund. The grants would be used to subsidize connection and generation capital costs of selected REEs. The proposed grants are US\$45 for each new connected rural household. The proposed grant for generating facilities is US\$400 per installed kilowatt of mini- and microhydro facilities and US\$100 for a 40 watts-peak SHS. A major problem with the current design of the REF is that it can provide grants, but not loans or credit supports to lower financing costs, which are currently in the range of 18–28 percent for most Cambodian REEs. If an REF is to be successful, it has to be able to provide access to lower-cost loans, as well as grants. At present, subsidized loans are available only to EDC, the state-owned utility. For any of its World Bank-supported electrification activities, EDC is eligible to receive 2 percent loans with a 25-year term and 7-year grace period.

³⁸ In the literature of regulation, this is known as “regulatory forbearance.” It means that the regulator is given the legal discretion to decide when and how it will regulate. This, in turn, requires that the relevant law be enabling rather than highly prescriptive. For example, when new long-distance telephone companies entered the U.S. telephone market in the 1980s, the U.S. regulator decided to “forebear” from regulating these entities as a way of encouraging competition. A similar approach is suggested in the Nigerian Electric Power Sector Reform Act 2005. The new regulatory commission is given explicit legal authority to exempt power generators or distributors from the requirement of having a license as the commission “may determine from time to time.” Section 54(2). The law also provides that “different standards may be determined for different licenses...”. Section 73(3).

technical quality of the installations, and the technical and commercial quality of the post-installation service. These various requirements constitute the traditional dimensions of price and quality-of-service regulation, even if they are given another name. So the rural electrification agency or fund is, in effect, a de facto regulator.³⁹

If the rural electrification agency or fund is already the de facto regulator (because of the conditions and requirements imposed on the operator as a quid pro quo for receiving subsidies, either in bilateral subsidy agreements or in general subsidy fund guidelines), it probably makes sense to convert the de facto regulator into a de jure regulator—for several reasons:

- The agency or fund is almost always more knowledgeable than the regulator about the specific technical operations of the electrification provider, especially in the case of off-grid service provision.⁴⁰
- The agency or fund will have a better appreciation of the cost implications of imposing different regulatory requirements.
- If the regulator decides to undertake traditional regulatory tasks, it will simply be repeating many of the determinations already made by the rural electrification agency.
- There is an obvious need for coordination between the electrification agency and the regulator, although mandated coordination between different government entities is usually slow and tends to produce conflicts.
- The two sources of income for typical off-grid operators are subsidies and tariffs. Therefore, subsidy rules and tariff regulation need to be coordinated closely.⁴¹
- It would avoid confusion and create greater clarity that, in turn, would reduce regulatory risk.
- It would minimize the risk of duplication and overregulation.

Types of Delegation

All of this suggests that delegation of regulatory tasks—whether formal or informal, temporary or permanent—is a rational strategy for regulation of off-grid electrification. If a country decides to pursue this strategy, three general types of delegation are possible. The first is **full and permanent delegation**. Under this arrangement, the legislature or national regulator has decided that the rural electrification agency or fund should be granted full and final legal authority to decide on tariffs and quality-of-service requirements. This would be in addition to its regular functions—establishing rules for connection requirements and associated subsidies.⁴² If this option is adopted, there would be no further formal review of the agency or fund’s decision by the regulator. However, it seems unlikely that a regulator would want to permanently and irrevocably delegate its decision-making authority to some other entity with no possibility of taking back that authority. For example, there is always a danger that the other entity may go out of existence or may be unable to perform the delegated regulatory functions for budgetary reasons, and the regulator would be blamed. Most rural electrification agencies or funds are not set up to be long-term regulators.

A second type of delegation is **partial and temporary agency delegation**. Under this arrangement, the national or provincial regulator designates the rural electrification agency or fund as its temporary agent. The essence of this approach is that one of these entities has been authorized to act on behalf of the regulator for certain functions for a specified period or until a specified event occurs (for example, until an isolated minigrid becomes connected to the main grid). It is not complete and irrevocable delegation because the regulator reserves the right to take back any decision-making authority that it delegates to another entity if the regulator disagrees with the actions or decisions of its designated agent. In other words, the regulator retains the legal authority to reverse or modify the decision made by its agent. At a practical level, this does not imply that the regulator must formally review each and every decision of its agent. Instead, it can simply require that certain key actions or

³⁹ This was essentially the regulatory approach taken by the United States when it electrified millions of rural households in the 1930s. Regulation was not performed by a national or state electricity regulator. Instead, it was performed by the Rural Electrification Agency that gave subsidized loans to rural electrification cooperatives. For a full description of U.S. electrification programs, see Barnes 2005.

⁴⁰ In addition, the electrification agency or fund will sometimes employ field personnel that will have direct knowledge of the installation.

⁴¹ This is not easy to do when there are two separate entities. It creates what has been described as the “chicken and egg” problem in one Asian country. The Rural Electrification Fund will not give subsidized loans and grants, unless the minigrid operator has a license issued by the regulator. However, the regulator will not issue license unless it has assurance that the minigrid operator has access to subsidized loans and grants to ensure its financial viability. One solution is to create a memorandum of understanding between the regulator and Rural Electrification Board that describes what entity performs which activities and how their activities will be coordinated to minimize delay and duplication.

⁴² See ESMAP (2005c) for an overview on issues involved in subsidy design for electrification in Latin America.

decisions be filed with it on an informational basis. The action or decision will be deemed to be approved if the regulator takes no action within a specified period. For other actions or decisions, the regulator might not even require that the operator make an informational filing. Instead, it would simply allow affected parties to file a complaint with it if they felt aggrieved by the agent's action. This is usually described as "regulation by exception."

As a general proposition, this second form of delegation is probably the preferred approach. It can be implemented if the national electricity law is written such that the national or provincial regulator has final legal authority over the provision of all forms of electrical service within its jurisdiction, but the law also allows (or requires) the regulator to delegate regulatory tasks to other entities. To avoid jurisdictional confusion or the reluctance of a regulator to give up any of its responsibilities, it is usually best if the law includes an explicit statement to this effect rather than leaving it as an unstated possibility.⁴³

This last point is important. It is important that a regulator's authority to delegate some or all of its regulatory authorities, whether done permanently or temporarily, be made explicit because the presumption in many legal systems is that a government entity, which has been assigned a responsibility, normally does not have the legal right to reassign this responsibility to any other entity. In common law systems, this legal doctrine is referred to as **delegatus non potest delegare** (that is, what is delegated by the legislature cannot be redelegated to another entity unless the law specifically allows for redelegation). Therefore, if one accepts the general principle that it is more efficient and effective for entities other than the national regulator to regulate small, off-grid providers, it is critical that the law be written so that redelegation, whether temporary or permanent, be explicitly allowed under the law.

Even if the regulator is given explicit legal permission to "delegate" or "transfer" some regulatory functions, the regulator may still be unwilling to do so because of bureaucratic inertia, a desire to protect his "regulatory turf," or simply fear that he will be blamed if the entity

that is acting on his behalf fails to perform well. One option for overcoming this reluctance to share authority would be to specify in the law how regulatory functions should be shared. The problem, however, with this approach is that the law may "get it wrong," and then it will be difficult to make corrections because the requirements are written into law (and laws are not easy to change). Another option is to include a provision in the law that requires the regulator to make a specific proposal at periodic intervals to a minister (or some other identified individual or body within the executive branch) on how regulatory functions that affect electrification should (or should not) be shared with other governmental and nongovernmental entities. The minister would have the authority to accept, reject, or modify the proposal in a decree that has the force of law. This second approach recognizes that the most efficient solution for sharing regulatory authority may change over time and therefore the law requires periodic reevaluations.

A third type of delegation is "contracting out." Contracting out has been defined as:

"[T]he use by a regulator of an external contractor, instead of its own employees to perform certain function(s). Such external contractors can be consultants, individuals, other government entities (in country or outside, including at a regional level) or NGOs."⁴⁴

Contracting out by regulatory entities is more widespread than is generally realized. Trémolet and her colleagues found that 75 percent of regulatory agencies contract out functions. The most common forms of contracting are for performing tariff reviews, monitoring compliance, drafting legal opinions, and conducting dispute resolution. Most contracting out is advisory (as opposed to binding) in nature. Stated differently, even though the regulator has contracted out a certain function, the regulator still retains full legal responsibility for all final decisions related to that function. The outside individual or entity is simply assisting the regulator because the regulator may not have the in-house capability to perform the task, or it can be performed more efficiently and effectively by an

⁴³ This is especially important in civil law countries because government entities in these countries normally do not have the right to perform a function unless they are explicitly authorized by law. In contrast, government entities in common law countries are often allowed to perform functions if the functions are generally consistent with their assigned responsibilities, even if the particular function is not explicitly mentioned in law.

⁴⁴ Trémolet, Shukla, and Venton. 2004, p. i.

outside entity. Even for this limited form of delegation, however, it is best for the law to be explicit that the regulator has the authority to contract out functions.

Up to this point, our discussion of delegation or contracting out has focused on rural electrification agencies or funds. However, these are not the only entities that can receive tasks from the regulator. The regulator should also have the authority to delegate regulatory tasks to community-based organizations or lower levels of government, such as municipalities or provincial governments.⁴⁵ The rationale is that, all other things being equal, regulation of decentralized electricity suppliers should be performed by an entity that is close to the customer and operator.

Whenever possible, the promotion of decentralized energy service providers should be accompanied by decentralized regulation.

EXAMPLE 3: Regulation by a Ministry: Solar Home Systems in Bolivia

In 2005 the Government of Bolivia successfully bid out performance-based subsidies to encourage private operators to install about 15,000 individual SHSs over a period of three years in four provinces of the country.⁴⁶ The IDTR program, like most government-supported national SHS programs, is run by a ministry that “wears several hats.” In this case, the Vice-Ministry of Electricity and Alternative Energy (VMEEA) is the promoter, subsidizer, and de facto regulator (at least initially).⁴⁷

How is the ministry the de facto regulator? It is the regulator because in the subsidy agreement with each operator (all of whom were chosen in 2005 through an international competitive bidding for 14 service areas), the ministry specifies the nature and duration of the service obligation, establishes a maximum price for the SHSs to be installed,

and determines in detail the quality-of-service standards that operators must satisfy, as well as the method for monitoring compliance with these standards. These are the traditional functions of a regulator (see figure 1).

The ministry has established these important regulatory parameters and obligations, so that potential operators will have full knowledge of the regulatory “rules of the game” before they bid on a proposed number of connections (the bidding variable) for a fixed total level of subsidies per area.⁴⁸ Is it efficient for the ministry to act as the de facto regulator in this case? The answer is “yes”—at least during the early years. The ministry, through its specialized vice ministry, has much greater knowledge of the economics and operational requirements of SHSs than the regulator. Moreover, the ministry, like a regulator, knows that it has to balance the interests of consumers and investors if the program is to be successful. Consumers have to be convinced that they are getting “good value” for their money (that is, not being charged monopoly prices) and investors have to see the genuine possibility that they will be able to earn a profit on their investment. Unless the ministry can satisfy these two constituencies, the program will be unsustainable and will probably be viewed as a political failure. As a consequence, the ministry is likely to have even stronger incentives than a regulator to balance the interests of consumers and investors.

In Bolivia, as in most other countries, the national electricity regulator has little or no interest in getting involved in regulating individual SHSs. If offered the possibility of regulating individual SHSs, most electricity regulators would probably say:

I regulate 220 volt AC electricity systems not 12 DC volt electricity systems. I have more than

⁴⁵ For example, the 1994 Colombian water law explicitly authorizes the national water regulator to delegate tariff setting to municipal and provincial governmental entities if their regulatory actions are consistent with general principles enunciated by the regulator. Presumably, this was necessitated by the fact that it would be impossible for a single national regulator to review the tariffs of more than 1,700 separate water and sanitation entities. In theory, the Colombian national water regulator is supposed to review the actions of the municipal and provincial governments to ensure compliance with its principles. In practice, this does not seem to happen. A colleague, Eric Groom, has suggested the alternative of “contracting out” the monitoring of compliance with the national regulator’s tariff principles. His specific proposal is that this monitoring function be contracted out to one of several prequalified, private auditing firms. The auditors would, in turn, have their audit reports spot-checked by a review panel. If an auditor were found to have provided inaccurate information, it would be removed from the panel of prequalified auditors. The workability of such an arrangement would depend on the specificity of the tariff principles whose implementation is being audited.

⁴⁶ IDTR 2003b.

⁴⁷ A more detailed description of this innovative Bolivian project—which bids out decentralized energy and information and communication technology (ICT) services under medium-term service contracts against performance-based subsidies—can be found in IDTR 2004b.

⁴⁸ At the time of this writing, all 14 areas have successfully been awarded. The winning bids all exceeded the minimum user number defined by the Bolivian government as *conditio sine qua non*. In the best areas, the gain from bidding these medium-term service contracts out was up to 35 percent, and the average gain was 25 percent (or about US\$2.5 million at a total subsidy amount of about US\$10 million). This is the result of a very intensive transaction marketing and a best-practice, performance-based bidding document for a whole package of decentralized services, reaching from installation and maintenance to training and monitoring tasks.

enough work just trying to regulate the AC system. I don't have the budget and staff to try to regulate what is essentially a renewable electricity generating appliance located in someone's home. I am more than happy to let the ministry run this program.

In fact, the norm in many countries is that the national electricity regulator has no legal jurisdiction over individual SHSs.⁴⁹ Therefore, it would be inaccurate to say that the electricity regulator in Bolivia has delegated this authority to a government ministry. The reality is that the regulator never had the authority in the first place.

This is not true in all countries. In other countries, such as Argentina and Brazil, the government has decided that the best strategy for "universalization" is to establish a regulatory quid pro quo. The essence of this quid pro quo is that the distribution company, which is currently serving grid-connected retail customers, is also required to provide some form of electrical service, whether it is an SHS or a stand-alone minigrid, to households that are beyond the economic reach of the grid.⁵⁰ In such situations, the regulator will be forced to get involved in setting the terms and conditions of solar home service or other forms of off-grid electrification, unless it has the legal authority to delegate this responsibility to some entity.

EXAMPLE 4: Regulation by a Ministry: Grid-Connected Cooperative Resellers in Bangladesh

The rural electricity cooperatives of Bangladesh represent a rural electrification success story.⁵¹ Since 1978, more than 60 rural cooperatives have been created. These cooperatives—known as PBSs⁵²—have succeeded in providing electricity connections to more than 2.5 million rural households with new connections growing at more than 500,000 new customers per year in several recent

years. On average, these cooperatives have systemwide total losses of 17 percent, a relatively low level of losses among South Asian distribution utilities. Equally impressive is that their collection rates average well above 95 percent, a very high number by international standards.

The PBSs are supervised, controlled, and regulated by the Rural Electrification Board (REB), which is a semi-autonomous agency located within the Ministry of Energy and Hydrocarbons. The REB performs a wide range of functions. Since its creation in 1978, it has managed more than US\$900 million in loans and grants from international aid agencies. These external grants and loans have allowed the REB to provide subsidized loans to individual PBSs. The REB also provides extensive technical assistance to the managers, board members, engineers, and linemen of the PBSs. The REB conducts central procurement and actual construction of most new facilities for the PBSs. In addition, the REB maintains close control over the operations and finances of the individual PBSs. This is accomplished through an "Instructional Series", a comprehensive set of operational guidelines that covers engineering, financial functions, administration, accounting, and training.⁵³

The REB's control over individual PBSs is tight. As one knowledgeable observer commented, "Although PBSs are autonomous in theory, REB retains much financial and managerial control over them, including the power to set performance goals and allocate annual bonuses." The heart of the control and monitoring system is found in Form 550, which provides monthly summaries on all operational and financial characteristics of individual PBSs. (See box 1 for a summary of the principal elements of Form 550.) Form 550 allows the REB to monitor the commercial viability and internal management of individual PBSs. In addition, the REB usually provides one of its own staff members to serve as the general manager of new PBSs for an initial period of time. The extent of REB

⁴⁹ SHSs are a relatively new technology. From the regulatory point of view, they can be thought of as something between a consumer good (like a refrigerator or a computer) and a very small, decentralized power plant with generation and distribution at the very same place.

⁵⁰ See ESMAP 2005a. The same approach has been used in the Argentine province of Jujuy (Covarrubias and Reiche 2000). One utility executive described this as the "hostage" approach to electrification. He elaborated that the unspoken understanding is that the regulator's willingness to give favorable tariff determinations for customers on the main grid depends, in part, on how well the company's rural electrification subsidiary does in providing service to poor rural customers. He said that even though his rural electrification subsidiary does not make a lot of money, it does buy the parent company considerable "goodwill."

⁵¹ This discussion of Bangladesh is based on "Rural Poverty and Electricity Challenges in Bangladesh," which is chapter 4 of Barnes 2005.

⁵² The cooperatives are called Palli Bidyut Samities (PBS). In recent years, many of the new customers have been customers who were previously served by DESA and BPDP, two state-owned utility systems.

⁵³ The Instructional Series is closely modeled on the Rural Electrification Bulletin series developed for U.S. rural electricity cooperatives. This reflects the fact that the REB elected to model Bangladesh's rural electrification program after the U.S. rural cooperative system. The Philippines made the same choice, but has had much less success in applying the U.S. coop model than Bangladesh. See Barnes 2005.

control and monitoring is so extensive that the PBSs could almost be thought of semi-autonomous franchises of a large corporation. Micro-management by a regulator is normally a sign of regulatory failure, but when there is already micro-management by some government entity, which seems to be the case in Bangladesh, it would be counterproductive and inefficient to create additional oversight by a separate regulatory entity.

Box 1: Form 550—The Heart of REB’s Performance-Monitoring Process

- A: Revenue and Expense Statement.** Summarizes PBS operating revenues and expenses.
- B: Aging of Accounts Receivable.** Provides data on receivables from PBS members for the current month, 30 days, and over 90 days.
- C1: Balance Sheet.** Summarizes PBS assets and liabilities, including a summary statement of long-term debt obligations.
- C2: Changes in Utility Plant.** Summarizes the value of all PBS assets, any assets retired for the current month, and changes for the year to date.
- D: Consumer Sales and Revenue.** Summarizes sales by customer category for the current month and year to date.
- E: Energy and Demand Data.** Summarizes energy and demand data at each substation metering point within the PBS.
- F: Plant and Consumer Data Sheet.** Summarizes the total number of in-service, disconnected, and idle connections. Also summarizes the kilometers of line constructed by the PBS and length of lines taken over from the Dhaka Electricity Supply Authority (DESA) or the Bangladesh Power Development Board (BPDB).
- G: Accounts Payable Statement.** Summarizes payments due to the BPDB for power and to REB (two government-owned utilities) for outstanding loans.

Is there a need for regulation by a separate regulatory entity in this case? We think not. In addition to being a banker, technical advisor, procurement agent, construction agent, management supervisor, and trainer, the REB is clearly also functioning as a regulator. It performs the traditional functions of a regulator: setting maximum prices and minimum quality-of-service standards.⁵⁴ Like a traditional regulator, it has also specified a “uniform system of accounts.” Moreover, it has established a sophisticated and effective system of incentive regulation. This system, known as the Performance Target Agreement, is an annually negotiated agreement between the REB and PBS managers. It includes 21 performance targets for reducing system losses, increasing sales, meeting customer expansion levels for various categories, and maintaining and improving collection rates. It is probably fair to say that the REB “walks like a regulator and talks like a regulator,” even if it is not formally called a regulator. Therefore, it would seem counterproductive and inefficient to add a new separate regulator with regulatory jurisdiction over the PBSs’ retail service.⁵⁵

EXAMPLE 5: Regulation by a Community: Isolated Minigrids in Cambodia

In Cambodia, many small private enterprises operate isolated minigrids that typically provide electricity service to a few hundred households and small businesses in a single village.⁵⁶ These informal, spontaneous “bottom up” enterprises, known as REEs, are not the result of any formal government programs. They exist for the simple reason that there are willing buyers and willing sellers.⁵⁷

The Cambodian REEs all face similar challenges: increasing connections to new households, expanding hours of service, and improving the quality of the distribution facilities (for example, eliminating uninsulated wires, constructing medium-voltage wires, and introducing adequate grounding).⁵⁸ Achieving these outcomes requires investment capital that many of the REEs do not have. When financing is available, it often comes at high interest rates (20 percent or more) through loans of short duration (1–2 years) and high collateral requirements (2–3 times

⁵⁴ Elements of its regulation of tariffs could be improved. Issues relating to tariff regulation (level and structure) and its interaction with subsidies will be discussed in a future report.

⁵⁵ Separate regulation of the retail service provided by U.S. rural electricity cooperatives is also the exception rather than the rule. As in Bangladesh, the de facto regulator is the Rural Electrification Agency of the U.S. Department of Agriculture. However, the prices paid by the U.S. cooperatives for bulk power purchases are under the jurisdiction of the national electricity regulator, the U.S. Federal Energy Regulatory Commission.

⁵⁶ It is estimated that as many as 600 such enterprises may be selling electricity to 60,000–120,000 households in more than 700 villages.

⁵⁷ A recent worldwide survey found evidence of about 7,000 small private sector providers of electricity in 32 countries that serve an estimated 10–50 million customers. The numbers are even higher if one includes community and public systems. The 7,000 operators include minigrid operators, as well as providers of SHSs and other forms of household electricity-generating equipment. See Kariuki and Schwartz 2005, p.19.

⁵⁸ During weekdays, the REEs typically provide electricity just during evening hours (for example, 5–11:00 PM). Consequently, the current electricity service provides little or no value for businesses that operate during daylight hours.

the size of the loans). Given these difficulties in financing and the ongoing need for capital cost subsidies, the Cambodian government recently created a Rural Electrification Fund (REF) to provide capital cost subsidies and technical assistance to REEs.⁵⁹

One such REE is located in the village of Smau Khney about 40 kilometers south of the capital. Like most Cambodian REEs, it operates a diesel-fired minigrid system. In 2004, GRET, a French NGO, developed a form of decentralized regulation for the Smau Khney REE. The regulatory arrangement is based on a 15-year “contract of power supply” between the Commune Electrification Committee (a local government unit) and a local private developer living in the village.⁶⁰ The power supply contract is supported by a second contract between GRET and the Commune Electrification Committee that provides a US\$45 grant for each new household that is connected as either a metered or unmetered customer. The program has been successful in that 220 new households have been connected in slightly more than a year, average monthly consumption is reported to have increased from 8 to 16 kWh, and the developer will soon be installing a second 50 KW generator to increase the hours of available service on weekdays.

This arrangement has effectively led to a sharing of regulatory responsibilities between the Electricity Authority of Cambodia (EAC), the national electricity regulator, and the commune government. This can be seen in box 2, which summarizes the principal obligations and requirements in the power supply contract.

The contract is as an example of “regulation by contract,” since it includes engineering requirements that affect technical quality of service (quality of the conductors, distance between poles, and minimum voltage levels at different locations on the distribution grid) and economic requirements that affect commercial quality of service (hours of service and tariffs for poor households). In addition, it specifies the actual tariffs to be paid by poor

Box 2: Power Supply Contract for the Private Operator of a Minigrid in Smau Khney, Cambodia

- **Technical engineering requirements (for example, grounding, types of poles, and distance between poles and cables).**
- **Location of meters.**
- **Responsibility for meters that are intentionally broken or tampered with.**
- **Number of new customers to be connected (for example, 280 households).**
- **Limit on time to connect new customers (1 year).**
- **Amount of the capital cost subsidy (US\$45 per household).**
- **Connection and reconnection rules for customers.**
- **Duration of service on weekdays (6 hours) and weekends (11 hours).**
- **Subsidized tariff for poor households (US\$1.20 per 10 watt lamp per month).**
- **Duration of the contract (15 years).**
- **A local system for handling complaints.**
- **Funding of subsidies for poor customers and the administrative expenses of the Commune Electrification Committee through an annual US\$5 fee per household.**

households. However, the contract does not completely replace the regulator. For example, the contract includes two very specific disclaimers that state that both tariffs and general conditions of service will simply reflect the decisions of EAC. Therefore, the contract can be viewed as an example of a partial, downward delegation of regulatory responsibilities to the community organization that represents the interest of final consumers.⁶¹ It clearly does not eliminate regulation by the EAC, since the REE

⁵⁹ Initially, the REF’s financial assistance will be limited to providing capital cost subsidies for connections and renewable generation. At a later stage, the REF may also provide guarantees to lower financing costs to REEs.

⁶⁰ A detailed discussion of the arrangement can be found in Chanthan and Mahé 2005.

⁶¹ A very similar approach has been used in Paraguay. Small private operators of separate water and sanitation systems enter into contracts with local communities that must be approved by the national government ministry that is responsible for rural water and sanitation systems and the national water regulator. These private operators, known as *aguateros*, operate under model contracts that are particularized for the needs of specific communities. As in Cambodia, the private operator receives a capital cost subsidy from a fund administered by the national government. See Drees, Schwartz, and Bakalian 2005. One major difference is that in Paraguay, there is a formal competition (run by the rural water ministry) for the right to serve particular communities and to receive the associate subsidies. One consultant in Cambodia has referred to the absence of competition as the “missing link.”

is still required to get a license from the EAC. However, the power supply and incentive contracts complement and particularize the EAC’s more general regulatory rules.

This sharing of regulation for an isolated minigrad appears to produce four major benefits.

- **First**, the village government feels **more ownership** because it directly negotiated the contract with the local developer. Consequently, the village government views itself as responsible for ensuring that the developer complies with the terms and conditions of the supply contract. This is quite different from relying on a regulator in the far-away capital to administer a piece of paper called a “license” whose terms and conditions may be unknown to the village and largely beyond its control. The fact that the village negotiated the contract gives it a greater stake in the success of the enterprise.⁶² This is not just a passing theoretical observation. The sense of ownership has been manifested in concrete and specific ways. For example, the developer has reported that the village committee has given active assistance in collections, locating poles in optimal locations, and explaining the need for tariff increases when fuel costs doubled.⁶³ Where local ownership increases so significantly, user satisfaction is likely to increase, too.
- **Second**, the village government can **assist in monitoring** compliance with quality-of-service standards. It is easy for a national regulator to issue quality-of-service standards for decentralized energy service providers. However, it is difficult and expensive for a national regulator to actually monitor whether the providers in distant and isolated villages are actually complying with the standards. If a village government is actively involved, it can act as the regulator’s “eyes and ears” at the local level.⁶⁴ This is likely to be more effective and less costly than if the regulator were to try to maintain a large compliance staff in the capital that would need to make numerous field trips to villages

around the country. However, if the village government is going to perform the monitoring function, it will need resources. In Smau Khney, the power supply contract requires that the private operator provide the Commune Electrification Committee with an annual budget of about US\$200.⁶⁵

- **Third**, it reduces the likelihood of **corruption**. The Cambodian electricity regulator has a high reputation for integrity and honesty. The regulator places considerable emphasis on transparency of process.⁶⁶ Unfortunately, such honesty and transparency are often not the norm in poor countries. All too often there is the “official fee” and the “unofficial fee” for government services and approvals. Such corruption is less likely to occur when regulation is shared with a village governmental body. The overriding incentive for the village is to get results: reliable electricity for new and existing customers. If there are delays or requests for bribes, this will raise the cost of electricity to the village. Therefore, the village committee has a strong incentive to take timely action in a way that a national regulator would not.
- **Fourth**, it allows communities to act as “monitors” rather than “operators.” Collective decision making is always slower than individual decision making. Moreover, committees and boards are susceptible to personality and political conflicts. This is not to say that it is impossible for a community to own and operate a minigrad system or buy in bulk from the main grid. There are successful examples in Bangladesh, Costa Rica, and the Philippines, among others. But if a community-based organization, whether a cooperative or village electrification committee, is to be successful, it often requires considerable time and nurturing. Therefore, in many countries, it may be more efficient to limit the role of the community to that of a regulatory monitor rather than a system operator.

⁶² Interestingly, such decentralization of ownership fits not only the decentralized character of off-grid technologies well, but also the increased decentralization of government (authority and funds) that is taking place throughout Asia.

⁶³ Interview with the developer, Mr. Srey Sokhom, in Smau Khney on October 22, 2005.

⁶⁴ However, it may be the case that a village or small municipality simply may not have the technical capacity to conduct such monitoring. In this situation, it may be more efficient for a provincial or regional government to provide such services (often by hiring specialized private consultants) for the benefit of villages and municipalities. This is explicitly allowed for in the Colombian water sector. A combination of assigning local communities a control function for service quality regulation, contracting out basic monitoring and reporting tasks to the providers themselves and checking both through regular performance audits is envisioned in the Bolivia IDTR program, a subsidized SHS program described elsewhere in this paper.

⁶⁵ In the Paraguayan rural water and sanitation sector, the small private water operators are required to pay 5 percent of their annual billings for connections and annual charges to the local users’ association and 2 percent of their annual billings to the national regulator.

⁶⁶ For example, public hearings are held on the issuance or extension of licenses for individual REEs.

Although the sharing of regulation between the national and regional regulator can produce these benefits, it may also produce costs. The biggest danger is that there will be overregulation. The combination of national and local regulation could lead to too many requirements, which may conflict, and too many approvals, which may cause delays. In general, this does not appear to have been the case in Smau Khney. The national regulator reviewed the “supply contract” to ensure that it did not conflict with the license that he had issued.⁶⁷

One technique for minimizing possible conflicts is to create model agreements between the village and the developer that the regulator has preapproved. This avoids the need to “reinvent the wheel” every time a village wants to enter into a contract with a private developer. Such model agreements have been used in developed and developing countries as well. For example, most French municipalities use a model document, developed by the association of municipalities, when granting a concession for the private provision of water and sanitation services. Similarly, a model 14-page concession agreement is used in Paraguay whenever a community allows a private operator to build and operate a water and sanitation system.

Principle 3: Vary Regulation by Type of Entity

The regulator should be allowed to vary the nature of its regulation depending on the entity that is being regulated.

A regulator should be allowed to vary its methods of regulation depending on the type of entity that is being regulated. Unfortunately, many regulatory or reform statutes do not allow for this flexibility. They are either silent about regulation of grid versus off-grid electrification or embody the view that “one size fits all.” This is not a

good approach because it will lead to unnecessary disputes about what the regulator is legally allowed to do under the existing statute. In our view, the better approach would be for the electricity or regulatory law to be written (or amended) to provide the regulator with explicit authority to vary its regulatory rules and procedures (concessions vs. licenses vs. permits) depending on the nature of the entity that is being regulated (small vs. large, grid vs. off-grid, private vs. community based).⁶⁸ This general principle can be illustrated with two examples.

EXAMPLE 6: Solar Home Systems: Fee-For-Service, Dealership, or Hybrids

SHSs can be provided under a variety of different business models.⁶⁹ Two of the most common business models are the fee-for-service model (Argentina, Morocco, and South Africa) and the “dealership” or “vendor model” (China, India, Indonesia, Kenya, and Sri Lanka).⁷⁰

Under the fee-for-service model, key components of the solar equipment (the PV module, charge controller, and battery—and in some cases even the internal installation) are owned by the operator. Fee-for-service operators often receive capital cost subsidies from the government to lower their connection charges to customers (and in some cases ongoing operating and maintenance expenses). Under the fee-for-service model, the SHS operators often operate under a concession or license that grants an exclusive right and obligation to provide service within specified geographic region for a specified period (usually 15–20 years).⁷¹ It is useful to think of such concessions as involving a *quid pro quo*. Specifically, the concessionaire is granted a legal monopoly (and a capital subsidy) in return for a specified obligation to serve. The subsidy grant is often bid out, so that there is competition “for the market.” This model resembles the traditional utility model for grid-connected customers.

⁶⁷ The only apparent conflict was that the license issued by the regulator was for 7 years, and the power supply contract between the community and the developer was for 15 years. The staff of the regulator said that when the first seven-year term ends, it is likely that the license will be automatically renewed for an additional seven or more years if the private developer performs well (that is, makes continued investments and improves operating efficiency). However, some have argued that the regulatory system could be improved if the regulator were willing to give longer licenses and specify more clearly the criteria used in deciding the duration of licenses.

⁶⁸ The Cambodian Council of Ministers took this approach in a 2005 sub-decree, which stated that the regulator “[m]ay apply different principles to different licensees, to the extent that these are necessary to take account of their different sizes, locations, and other objective circumstances.” Royal Government of Cambodia 2005.

⁶⁹ See Barnes 1996; Reiche, Martinot, and Covarrubias 2000; Martinot, Cabraal, and Mathur 2000. When we use the term *business model*, we are referring to the business arrangement by which the services are delivered.

⁷⁰ A third hybrid model is the medium-term service contract that has been proposed in Bolivia. Under this approach, the SHS provider is granted an exclusive franchise for four years (starting from the date of the installation of the last SHS in the specified area) in return for commitments on installation, post-installation servicing, and local market development. Once the three-year period ends, so does the exclusive franchise.

⁷¹ Therefore, the terms *fee-for-service model* and *concession model* are often used synonymously, which is not strictly correct. Both modalities can be implemented without the other: operators who have been granted exclusivity can decide to transfer SHS ownership at a certain point—for example, Bolivia and Brazil—just as companies without a formal concession contract by a government entity or regulator can opt for an operate leasing contract with some or all of their customers—which is the same as fee-for-service).

In contrast, a SHS provider who is a dealer operates under a very different business model. The dealer may receive a nonexclusive franchise from the government under the expectation is that the dealer will be one of several dealers, all of whom are (hopefully) competing “in the market” to provide SHS to potential customers, usually at fixed subsidies. Typically, the dealer-provider will sell the equipment and ideally installation (with or without financing) to a customer. It will have no ongoing obligation to that customer, unless the dealer is willing to offer an extended warranty or ongoing service agreement. Once the equipment is purchased, it is owned by the customer.

The Bolivia IDTR project is implementing a new SHS business model that tries to combine the strengths of the fee-for-service and dealer models. Under this hybrid approach, known as Medium Term Service Contracts, subsidies are provided in return for five- to seven-year year obligations to develop and serve small local markets. The winners of the medium-term service contracts will have the obligation to install a minimum number of SHSs over a period of less than three years, to service systems during an additional four years (starting from the date of installation), to develop the local SHS markets on the demand and supply side by educating users about SHSs and training future local spare parts suppliers), to report on their own performance, and to conduct user interviews for project evaluation.⁷² Since the operators are free to choose between cash sales, microcredit, and a finance or operate lease, they have considerable freedom to find the best business plan for their geographic areas.⁷³

Should fee-for-service operators and dealers be regulated in the same way? We think not. Under the fee-for-service model, one would expect that the regulator, or some other entity that is acting as its agent, would need to regulate both price and quality of service. The rationale is that the SHS operator has been granted a legal monopoly and therefore consumers need to be protected from possible monopoly abuses in the form of high prices or inferior service. The regulator, however, will not be the only government entity with an interest in the SHS operator’s price and quality of service. If some other entity within the government has provided the subsidies, this government entity will clearly also have an interest

in ensuring that the government is getting “good value” for the subsidies it has granted. In other words, both the regulatory and the subsidy-granting entity will want the same outcome, although for different reasons. There is room for delegation—and a necessity for cooperation—in such cases.

Less regulation is required for the SHS provider that is operating as dealer. Specifically, there is a presumption that price regulation is not needed because competition among dealers will protect consumers from monopoly pricing. However, this assumes that the markets will be workably competitive, which is likely to occur only in relatively mature markets where customers can choose from more than one supplier. In addition, it is sometimes also argued that the regulator (or its agent) does not need to regulate quality of service under the dealer model. Those who take this position contend that any licensing of dealerships should simply be limited to minimum financial requirements, technical competencies, and perhaps a commitment to some specified form of dispute resolution, but with no need for quality-of-service regulation. Under this “minimalist” regulatory approach, the presumption is that dealers will compete on both price and quality, and therefore potential purchasers of SHS do not need protection from a regulator or a ministry over maximum prices and minimum quality of service. Those who argue for this approach view the purchase of an SHS as being no different from the purchase of a TV or a radio.

In our view, this approach is based on a somewhat idealized view of consumer competencies. It assumes a level of knowledge and sophistication on the part of poor and sometimes illiterate consumers that is not realistic, especially since the purchase of an SHS is often likely to be a “once in a lifetime” purchase. Therefore, we see merit in the argument that it is more efficient for the government to establish minimum quality-of-service standards for SHS equipment. This conclusion has even greater justification if the government is also providing subsidies to the SHS dealers or their purchasers. A government clearly does not want allegations that it provided subsidies to dealers of SHSs without ensuring that the dealers’ customers get value for the government’s subsidies.

⁷² The delegation of basic monitoring tasks to the providers will save money because fewer visits will be needed to remote households. but it will need to be complemented with independent evaluation and auditing to check on the operators’ reporting.
⁷³ ESMAP 2005a.

EXAMPLE 7: Minigrids: Private Operator or Community Owned

The nature of regulation should also be allowed to vary depending on the type of entity that owns the facilities that are being regulated. Consider, for example, the case of an isolated minigrid combined with some form of generation (say, diesel or hydro). Such a system could be owned and operated by a private company, a cooperative, or some other community-based organization.⁷⁴ In both instances, the technology is the same and the legal document issued by the regulator (for example, a license or concession) may be the same, but should the process of regulatory review, especially with respect to price, be the same?

We think that the answer is “probably not.” The private minigrid operator, like all private monopolists, will be trying to maximize profits by charging the highest prices that it believes that its customers can pay. Therefore, if it has been given a license, concession, or contract that provides a de facto or de jure monopoly, there is a need for the regulator or the subsidy granting entity to be concerned about monopoly pricing. The situation is different for a cooperative. In a cooperative, the owners are also the consumers. In addition, under the Seven Principles of Rochdale, the universal principles that govern most cooperatives around the world, each owner-consumer has one vote in all matters. Therefore, if the member owners of the cooperative decide to raise prices, they themselves will pay the higher prices because they are also the customers. In effect, they would be taking money from one pocket and putting it into another pocket. Since there is no obvious incentive to do this, when a community-based organization is self-supplying electricity, it is reasonable for the regulator to accept considerable degrees of “self-regulation.”

This has been the regulatory approach taken for the Energy Services Delivery (ESD) project’s off-grid village hydro systems that operate in Sri Lanka. The systems are owned and operated by community-based cooperative societies. Although the government exerts some control over technical specifications and safety in its role as a

provider of subsidies, the prices charged for the electricity are determined by each cooperative’s board of directors and not by any government ministry. In fact, the charges are not even called tariffs, but instead are referred to as membership fees.

Our general recommendation is that there should be a presumption of “self-regulation” for cooperative and other community-based organizations. However, this does not mean that the regulator should take a completely “hands-off” approach. It would be naive to believe that community-based organizations will always have good governance. Like any other local organization, they are susceptible to corruption and capture by local politicians for political purposes. This has been a major issue for the rural electric cooperatives in the Philippines.⁷⁵ A recent in-depth analysis of the Philippine cooperative movement concluded that Philippine “cooperative managements tend to be relatively fragile and isolated, making them susceptible to local corrupting influences.”⁷⁶ This is a polite way of saying that the Philippine cooperatives have been vulnerable to takeover by local politicians. Once local politicians gained control, many of the cooperatives were “run into the ground” through economically unjustified grid extensions, padding of cooperative payrolls with supporters of the politicians, a general reluctance to raise tariffs, an unwillingness to pursue collections, and sometimes even outright theft of funds.⁷⁷ A 1989 World Bank report found that only 22 of 117 Philippine electricity cooperatives were commercially viable. One consequence of the prevailing financial weakness of most Philippine cooperatives is that they are often unable to extend service to new users.

Even if there is a presumption of self-regulation by cooperatives or other community-based organizations, the regulator (or its designate) must have the ability, incentive, and obligation to “step in” when there is evidence that “self regulation” is no longer working. But even if the regulator has the legal authority and obligation, the regulator can do very little when there is pervasive corruption. Corruption in community-based rural electrification organizations can only be overcome

⁷⁴ In most countries, a cooperative is a nonstock, nonprofit membership that operates under the Seven Principles of Rochdale. Perhaps, the most important principle is that each member has one vote. See <http://www.coop.org/coop/principles.html> for a full description of the Rochdale principles.

⁷⁵ Barnes 2005.

⁷⁶ Barnes 2005, p. 9.

⁷⁷ The problems of politicization appear to have been largely avoided in Bangladesh where the statute prohibited any officer in a political party from serving on the board of directors of electricity cooperatives.

if the central government is able to support a strong central entity—whether it is a government ministry or umbrella organization of the community organizations—that is willing to impose serious economic and governance standards on the community organizations in return for subsidies.

Finally, it is important to recognize that the nature of tariff regulation is likely to be quite different for privately owned operators and community-owned operators. For a privately owned operator, the regulator will almost always be trying to reduce tariffs. In contrast, the situation will usually be the opposite for community-based organizations and government-run enterprises. In these cases, the regulator will often find itself trying to increase tariffs. Therefore, in the former case, the regulator will be establishing price ceilings, whereas in the latter case, the regulator will be establishing price floors.

Principle 4: Establish Realistic and Affordable Quality Standards

Quality-of-service standards must be realistic, affordable, monitorable, and enforceable.

It is counterproductive to try to impose quality-of-service standards that cannot be met.⁷⁸ However, this does not imply that quality of service should be ignored. Unfortunately, although everyone talks about improving quality of service, in practice quality of service often gets very little attention. This probably happens because it is easier to specify (and to monitor) tariff levels than quality-of-service standards. Tariffs are uni-dimensional and can be readily observed in customer bills. In contrast, quality of service is multi-dimensional, and compliance is often difficult and costly to monitor, especially for off-grid systems. Moreover, when quality falls short of expectations, disputes often arise, particularly in SHSs, about what happened and who was responsible. Because it is harder to regulate, quality of service usually receives less attention from regulators. The danger in ignoring quality of service is that whatever goodwill may have been generated by an electrification program can quickly disappear if quality of service falls short of what customers were expecting. From a customer’s perspective, electricity that is of poor quality (or never arrives) has little value.

A good regulatory framework for quality-of-service regulation should be based on the following operational standards:

- Quality-of-service standards can be established on an input basis, output basis, or a combination of the two. Quality-of-service standards should be established for those dimensions of service that are important to consumers, controllable by the operator, and capable of being measured on a reasonably objective basis.
- Quality-of-service standards need *not* be uniform across all customer categories or geographic areas. Instead, standards should be based on customers’ preferences and their willingness to pay for the costs of providing the specified level of quality. All other things being equal, customers prefer higher quality to lower quality. However, all other things are not equal—higher quality almost always costs more money.
- In the absence of subsidies, the regulator or government ministry, which is acting as an agent for customers, should not impose quality-of-service standards on an operator unless customers would be willing and able to pay for the costs associated with meeting the standards. This is especially important in remote off-grid markets, where users’ requirements can vary greatly and many households will be satisfied with a lower service level (for example, frequency of short system failures) for less money—as long as that lower service level is clearly defined in advance. In general, consumers should be given no more than two or three choices. With too many choices, the process of making a selection may become confusing to consumers and expensive to administer.⁷⁹
- Quality-of-service standards should be established for both technical and commercial dimensions of service (see the next section). The quality-of-service standards may be (a) guaranteed standards where the standard must be achieved for every specified customer and (b) overall standards where the standard must be achieved on average over a stated period across a specified customer category, but need not be satisfied for all customers at all times in the category. The operator must publicize the standards to its customers.

⁷⁸ The discussion in this chapter draws from IDTR transaction advice (IDTR 2004b), as well as from Bakovic, Tenenbaum, and Woolf 2003, pp. 46–47 and appendix C. See also Foster 2002.

⁷⁹ Although it is fashionable (especially among economists) to emphasize the desirability of maximizing customer choice, this ignores the fact that there are genuine costs associated with the time and effort to make choices. For a discussion of the transaction costs involved in making choices, see Schwartz 2004.

- Quality-of-service and associated penalties and rewards should be phased in over a reasonable period. Any penalties should be proportionate to the extent of noncompliance and the costs likely to be incurred by the operator in meeting the standards.
 - Where it is feasible and efficient, penalties should be paid to individual consumers. Otherwise, penalties should be used to provide subsidies to poor customers. Penalties should not be used to support the budget of the regulator or any other government entity. In general, penalties and rewards should be capped so that they do not exceed more than 2–4 percent of the operator’s overall revenues.
 - Any changes in quality-of-service standards should be synchronized with a regulatory proceeding to update tariffs for a new tariff-setting period.
 - The regulatory entity should have the legal authority to delegate or contract out quality-of-service monitoring and imposition of penalties to a third party subject to appropriate oversight and a dispute resolution process.
 - The regulatory entity should establish a reliable, objective, and publicly available monitoring system that compares the quality of service provided by different operators.
- Commercial quality
 - Connection time for new customers
 - Accuracy in meter reading
 - Accuracy in billing
 - Response time to customer complaints

EXAMPLE 8: Quality of Service for Solar Home Systems: The Case of Bolivia

Standards

The quality-of-service standards for SHSs installed under Bolivia’s IDTR program are summarized in table 4.⁸⁰ The standards were specified in the bidding documents for the simultaneous bidding of 14 areas that were awarded in 2005. In addition to the quality-of-service parameters, maximum prices for each SHS size were also specified in the bidding documents. Therefore, when the 11 prequalified potential operators in the Bolivia SHS bid competed for the right to provide service with an exclusive right to subsidies for four years in one or more of the 14 areas, they had complete information on two key regulatory parameters: maximum prices and minimum quality-of-service standards.⁸¹ In addition, bidders were informed of the maximum aggregate subsidy that would be provided for the each of the 14 areas, if the performance targets were met. Bidders competed against each other based on the number of SHSs that they would commit to install in the specified area.

The basic regulatory parameters were fixed by the VMEEA, which established the program and will provide output-based subsidies to the successful bidders. The national electricity regulator (Superintendent of Electricity) will have no direct involvement in specifying either maximum prices or quality-of-service standards during the 3-phase, 10-year IDTR program.⁸² However, the regulator was invited to evaluate the monitoring process of the program’s first phase—with the option of assuming regulatory oversight in Phase Two of the program.

This is one of the first SHS programs that set performance targets for quality-of-service standards. The quality-of-service standards are mostly output-based, although some standards in the bidding documents are based

Quality of Service Standards for Electricity

Quality-of-service standards for electricity service, whether grid or off-grid, fall into three general categories:

- Product quality
 - Stability of voltage relative to targeted levels
 - Stability of frequency relative to targeted levels
- Service quality
 - Targeted hours of service
 - Number of interruptions, both planned and unplanned
 - Duration of interruptions, both planned and unplanned
 - The safety of the system

⁸⁰ Two of the standards are less stringent than the standards for EJEDSA, the SHS concessionaire that is a fee-for-service operator in the Argentine province of Jujuy. EJEDSA must respond to complaints in five workdays if the user is reachable by motorized vehicle and nine days if the user can be reached only by foot or donkey. The corresponding numbers in Bolivia are 10 and 15 days, respectively.

⁸¹ Winning bidders have the flexibility of providing the service on a traditional fee-for-service basis as a concessionaire for three years or on a sale basis (cash or credit) where the customer will own outright all of the SHS facilities right from the beginning.

⁸² The SHS bid is the core component of the ongoing Bolivia IDTR project, which runs until 2008 and is part of a three-phase adaptable program credit designed by the World Bank. The programmatic approach allows for long-term market development: if Phase One targets are met, funding for Phase Two will be triggered. See IDTR 2003b.

Table 4. Quality-of-Service Standards for Solar Home Systems in Bolivia’s IDTR Program

| | STANDARD | PENALTY OR INCENTIVE |
|---------------------------|--|---|
| PRODUCT QUALITY | <ul style="list-style-type: none"> • Components and system must meet technical input specifications. For instance, PV module output must be at least 90% of name plate. • Standards are measured (a) for the prototype of each system size and (b) in random in situ samples. | Operator needs to fix or exchange all systems that do not meet minimum requirements, and pay a penalty to the user. |
| SERVICE QUALITY | <ul style="list-style-type: none"> • Minimum energy (defined as Ah at given voltage level) provided by the system must meet minimum specified for each system size. This translates into minimum hours of appliance use. • Must make the mandated annual visit to customers during years 1–4, including user training. | 17% of total subsidies will be paid (a) upon completion of each of the 4 visits (3% per visit) and (b) in a final payment upon satisfactory service up to year 4 (5%). |
| COMMERCIAL QUALITY | Must respond within 30 days to a request for new service. | Will be fined US\$2 for each day of delay. |
| | Must respond to customer complaints within 10 days if reachable by road and 15 days if not reachable by road. | Will be fined the number of days without service times the equivalent daily tariff times a penalty factor (about one US\$1 per day). No penalty if it was the customer’s fault; customer pays visit. |
| | Must employ one local technician with spare parts for every 300 users. | Payment of subsidies will require the establishment and training of independent and certified local technicians with spare part shops. |
| Source: IDTR 2004. | | |

on input specifications. The rationale for input specifications was that it was necessary to protect winning operators and customers from costly mistakes. Because off-grid markets are new phenomena in most developing countries, it was concluded that there was considerable risk that the winner of a minimum subsidy bidding might be underinformed and might bid too small a required subsidy. The problem in such cases is that these bidders would win, but then be unable to perform as required (sometimes referred to as winner’s curse). If this happens, the winners would probably fail financially, but consumers would also get hurt in the process, and SHSs would get a bad reputation in Bolivia. To avoid such an outcome, all bidders were required to offer SHSs that met certain minimum equipment specifications based on several national and international standards for PV systems.⁸³

Monitoring

The monitoring of quality-of-service performance will use a hybrid form of contracting out arrangements. A Technical Control Unit (TCU) within the VMEEA, will be responsible for monitoring compliance with the prespecified quality-of-service standards and imposing penalties when operators fail to meet the standards. Two draft reporting forms have been created for monitoring purposes—a complaint form and an annual visit form. When a customer has a complaint about the performance of the system, he or she must initially contact the operator. If communication problems exist, the user can also make contact through the municipal government authority. The operator will then be required to log in the complaint and put it in a Management Information System that can be audited for accuracy by the VMEEA or a contractor

⁸³ Norma Boliviana NB1056; IEC61215+60811; IEEE1262; PV-GAP PVR5-8; EC-DGXVII THERMIE-B SUP 995-96.funding for Phase Two will be triggered. See IDTR 2003b.

hired by the VMEEA. These audits can be contracted out to a private contractor who “will witness what he sees.”⁸⁴ To reduce costs, the contractor will perform the audit on a sample basis (20 out of 1,000 customers). If the audit finds that the operator failed to meet the specified quality-of-service standards, a larger sample may be taken, and penalties would apply to the full 1,000 customers in that sample.

Who Is Responsible?

The feasibility of implementing quality-of-service standards for SHSs depends critically on determining who was responsible for a given failure of the system. If the customer is responsible, the operator does not pay any penalty. In off-grid systems, however, it is not always easy to make this determination. Unlike other electrification technologies, the components of the system that produce electricity are located within the customer’s premises. In contrast, for most other forms of electricity production, the electricity is produced at facilities that are far from the customer’s house, and the facilities are solely under the operator’s physical control.

The three most common problems in operating an SHS are discharged or aged batteries, missing battery water (except for sealed batteries), and blown fuses. All three problems are frequently caused by user behavior. One solution is to put the PV module, the charge controller, and the battery completely outside the user’s direct control.⁸⁵ This solution, however, raises installation costs. Prepaid meters are sometimes installed in combination with such tamper-proof systems.⁸⁶ A second alternative is to transfer ownership of the battery completely to the user, so that the user bears the consequences of poor maintenance.⁸⁷ A third option is to create a bonus system for users with long-lasting batteries. Such a bonus system creates financial incentives for the user to take good care of the battery (for example, fill it with water at regular intervals and not discharge it completely by shunting the charge controller). The Bolivian IDTR project has chosen a variant of option three (for all systems) with operators being allowed to decide about options one and two. In the future, the battery charge controllers may include a memory device to record user behavior. This should help to resolve disputes over who was responsible for battery failures.

⁸⁴ The use of private contractors to monitor compliance with quality-of-service standards is not uncommon for connected and isolated utility systems. See Trémolet, Shukla, and Venton 2004.

⁸⁵ Applied, for instance, in Morocco by a fee-for-service operator.

⁸⁶ Although prepayment meters and “energy dispensers” for SHS and village PV systems have recently been applied in several pilot projects, documentation of early lessons and costs is scarce. In the case of prepayment meters, the cost of establishing and maintaining the infrastructure for charging can be substantial. Quoted costs range from about US\$30 to US\$60 per prepayment meter, depending on sophistication and production size. See Fraunhofer Institute 2004 and Vallve 2000.

⁸⁷ This is obviously the case in all dealer models, but also in some fee-for-service models.

3. A MODEL LAW TO PROMOTE ELECTRIFICATION

Most electricity laws are not opposed to the principles presented in this paper. However, early electricity reform laws are usually silent about electrification or, if electrification is mentioned at all, the law might include a general statement that increased electrification is a worthwhile goal. Some recent electricity laws have gone somewhat further. These “second generation” electricity reform laws often create new rural electrification agencies that are tasked with giving technical assistance and administering a “rural electrification fund” to subsidize connection costs.⁸⁸ However, even these second-generation laws usually pay little or no attention to how the rural electrification agency should interact with the electricity regulator to avoid duplication and delays. Nor is there any guidance on whether the core regulatory tasks of setting maximum prices and minimum quality-of-service standard should be performed differently or by entities other than the designated regulator. Quite often even basic rules for financing these funds and disbursing the subsidies are not defined. As a consequence, implementation of the law is often slow and confused.

Electrification—the Forgotten Child of Power Sector Reform

Electrification is the “forgotten child of power sector reform” because most power sector reform laws focus on improving the performance of existing state-owned utilities through restructuring, privatization, or a combination of the two, and the regulatory system needed to accomplish these outcomes. This emphasis on reforming existing or new “main power grid” enterprises is neither surprising nor inappropriate. When existing state-owned enterprises are inefficient and poorly run, there is little that they can do to promote electrification, especially if the electrification strategy assumes that these enterprises will provide a major source of cross-subsidies for connecting new customers.

Going from Principles to Practices

The lesson to be learned from past power sector reforms is that good intentions (increasing electricity access) do not necessarily lead to good outcomes. *Regulatory principles need to be embedded in legal instruments.* Therefore, a fundamental premise of this paper is that more explicit legal guidance needs to be given to national regulators and energy ministers on how to promote electrification, whether it is grid or off-grid, or rural or urban. Ideally, such guidance should be given ex ante in the new electricity reform law. If is too late, however, because the law already exists and would be difficult to amend, the next best solution is for the government to issue a decree that provides guidance to the regulator on how to promote electrification. Such guidance is necessary because most regulators will be reluctant to pursue nontraditional regulatory approaches to promote electrification, unless they receive clear signals that such approaches are consistent with the government’s electrification policies and are permissible under law.

Given the many forms of electrification, it would be dangerous to be overly specific, either in law or in decree, because too much specificity can easily lead to unintended consequences. But if guidance is to be of any practical value, it needs to go at least one level down from the general principles discussed so far in this paper. Therefore, we propose a set of seven “regulatory standards” designed to provide more detailed guidance to the regulator and other government officials on what they should and should not do in implementing the general principles.⁸⁹ The standards are intended to serve as a starting point for developing specific language that could be used in a primary law, a secondary law, or a degree.

The approach embodied in the standards is enabling rather than prescriptive. Although the standards, which deal with issues of both regulatory governance and regulatory substance, are more specific than the four principles discussed in this paper, the standards are still sufficiently general to apply across all forms of electrification. The standards are designed so that a regulator can “particularize” them for the different forms of electrification shown in table 1.

⁸⁸ Federal Republic of Nigeria, Energy Power Sector Reform Law, 2005, Part IX.

⁸⁹ The standards presented in this chapter are incomplete in three ways. First, as noted earlier (footnote 16), a number of regulatory design issues still need to be addressed in future research. Second, a model law would also need to cover the functions of any rural electrification agency and fund. Third, the standards would need to be converted to formal, legal language by a lawyer who is familiar with the legal system of a particular country. It is dangerous to assume that the legal language that works in a civil law country would work equally well in a common law country.

Legal Standards for a Regulatory System That Will Promote Grid and Off-Grid Electrification

1. Flexibility to allow other entities to act on its behalf

- a. In the interest of maximizing the use of limited government and regulatory resources to promote electrification, the regulator is explicitly authorized to allow other entities, both governmental and nongovernmental, to act on its behalf in performing various regulatory tasks, such as (but not limited to) setting maximum tariffs and minimum quality-of-service standards.
- b. The regulator has the authority to contract out (fully or partly) regulatory functions if it believes that this will lead to more efficient and timely electrification. If the regulator chooses to designate other entities to act on its behalf, the regulator still has the ultimate legal responsibility to ensure that these entities are performing regulatory functions in a manner that is consistent with the law.
- c. The regulator is authorized to use other government entities (including, but not limited to, ministries, electrification funds, subnational governmental bodies) and other nongovernmental organizations (including, but not limited to, community and cooperative organizations and associations of suppliers) to perform its regulatory functions.
- d. The regulator can enter into agreements with other governmental and nongovernmental entities to perform functions, such as gathering information and data, establishing rules, monitoring implementation of existing rules, and enforcing decisions.
- e. To ensure that efficient sharing options are considered, the regulator is required to make a specific proposal for sharing of regulatory responsibilities that affect electrification to the [energy] minister [or some other specified official or entity within the executive branch] no later than 18 months after the issuance of this law. The minister must accept, reject, or modify the proposal within 90 days after it has been received. If the minister takes no action within 90 days, the proposal is deemed to be accepted. Every two years the regulator is required to make a new proposal to modify or retain the existing sharing arrangements.
- f. The regulator, or any entity acting on behalf of the regulator, must render a decision to any petition within a specified period. If the regulator, or the entity acting on its behalf, fails to render a decision within the specified time, the petition is deemed to be accepted.

- g. There should be specified procedures for appealing the regulator's decisions. These procedures should identify the entity or entities that can receive appeals and the grounds for reviewing the regulator's decisions.

2. Flexibility in regulatory methods

- a. The regulator has the authority to vary its methods of regulation depending on the form of electrification and the type of entity that is providing the electrical service, as long as the categories and methods are transparent.
- b. The regulator can allow for some degree of self-regulation where a community or cooperative organization is providing the electrical service.
- c. The regulator should encourage associations of electricity providers to develop technical and commercial standards of performance.
- d. The regulator should encourage suppliers and individual or groups of consumers to negotiate direct agreements that cover the term and conditions of electrical service with the presumption that the regulator will give considerable deference to these negotiated agreements if the agreements are consistent with the regulator's general principles and standards.
- e. The regulator should adopt the minimum necessary amount of regulation to protect both consumers and investors. Light-handed and simplified regulatory requirements should be employed in deciding the nature and number of approvals that are required and the type and amount of information that must be supplied.
- f. As a general rule, smaller entities should have fewer and simpler regulatory requirements.
- g. The regulator has the authority to grant temporary or permanent exemptions or waivers from regulatory requirements if the regulator concludes that the costs of regulation (both direct and indirect) would exceed its benefits.

3. Eligibility and authorizations

- a. An electricity supplier can be a company, a partnership, an individual, a cooperative, or a subnational government body.
- b. In granting authorization to provide electrical service, the regulatory authority should provide authorizations of sufficient duration and exclusivity to provide incentives to the supplier to make investments that will lead to improvements in the number and quality of connections.

- c. The authorization should specify conditions that must be satisfied so that some or all of the rights to supply service can be transferred to other entities.
- d. If there is an involuntary takeover of service (for example, replacing one supplier with another), the regulator should specify the principles that will be used in deciding whether the current supplier is entitled to compensation and at what level.

4. Tariff setting

- a. The regulator has the authority to use different tariff-setting methods for different types of entities. For example, tariffs can be set using cost-of-service studies, price or revenue caps, tariff tables for groups of similarly situated electricity providers, and negotiated agreements between suppliers and individual consumers or groups of consumers (such as a village, a municipality, or a province). In addition, the regulator has the authority to accept tariffs or tariff formulas that result from a bidding process where there has been adequate competition. The regulator also has the authority to use benchmarks in setting tariffs.
- b. In setting tariffs, the regulator should take account of grants or contributions received from government ministries, national or subnational electrification funds, international donor organizations, or monetary or in-kind contributions from customers. As a general rule, the level of tariffs should be reduced to take account of grants or contributions of labor while recognizing that tariffs must recover the cost of future replacements of any capital equipment that is acquired, either partially or completely, through grants or contributions.
- c. The regulator should encourage technologies or billing arrangements that will allow consumers to control the amount and timing of their expenditures on electricity.
- d. Whenever possible, the regulator should encourage the use of meters for consumption. If a meter is not technically or economically feasible, the regulator should take steps to ensure that the absence of metering does not lead to wasteful consumption or operating problems on the supply system (for example, too much consumption during periods of constrained supply).
- e. Where there are variations in the costs of supply, the regulator is not obligated to impose uniform tariffs unless publicly instructed to do so by the government. If the government concludes, as a matter of policy, that uniform tariffs are necessary and desirable, the

government must publicly notify the regulator as to how cost shortfalls are to be funded (for example, cross-subsidies or government-provided subsidies).

5. Providing subsidies

- a. The government, rather than the regulator, has primary responsibility for deciding the level of subsidies, the form of subsidies (subsidies to the enterprise, subsidies to some or all consumers, or both) and the mechanism for funding subsidies (external budget transfers, grants or loans, or cross-subsidies). The regulator has primary responsibility for periodically informing the government as to how much the electricity service would cost with and without subsidies.
- b. The regulator should coordinate efficiently and transparently with any entity providing subsidies (for example, an electrification agency or electrification fund) to reduce subsidy delivery and regulatory compliance costs and to ensure that the subsidies reach their intended beneficiaries.
- c. If the government fails to deliver its promised subsidies, the regulator is authorized to raise the price of electricity to reflect the shortfall after it attempts to resolve conflicts between the provider, users, and government.
- d. One-time connection subsidies that reduce connection costs for the poor should be favored over ongoing consumption subsidies.
- e. Targeted subsidies for particular classes of customers (for example, poor customers) are generally preferable to untargeted subsidies that benefit all customers.
- f. The regulator should publicize the level, sources, and beneficiaries of subsidies.
- g. Where tariffs for electricity consumption are significantly subsidized (directly or indirectly through cross-subsidies or external subsidies), the regulator should try to encourage actions (for example, subsidizing energy conservation or placing physical limits on users' peak loads or energy consumption) to minimize the efficiency losses that result from charging prices that do not reflect the costs of supply.
- h. The electrification agency should favor subsidies that are given in return for performance (for example, new connections by the supplier and payment of bills by consumers). The regulator and the electrification agency should coordinate the definition of appropriate performance indicators and align regulatory reporting requirements and auditing procedures with the corresponding rules for subsidy disbursement.

- i. Even when consumption is subsidized, consumers should always pay more for higher levels of electricity service, such as more kilowatt-hours received and better quality of service. If consumption subsidies are given, they should be limited to the amounts needed for basic human needs.

6. Quality of service

- a. The regulator should establish quality-of-service standards for product quality, service quality, and commercial quality. Product quality includes stability of voltage relative to targeted levels and stability of frequency relative to targeted levels. Service quality includes targeted hours of service, number of interruptions (planned and unplanned) and duration of interruptions (planned and unplanned), and safety of the system. Commercial quality includes connection time for new customers, accuracy in meter reading (for customers whose service requires meter reading), accuracy in billing, and response time to resolve customer complaints.
- b. The regulator has the discretion to establish quality-of-service standards on an input and/or output (that is, performance) basis. Whatever standards are established should be important to consumers, controllable by the operator, and capable of being measured on a reasonably objective basis.
- c. The regulator has the discretion to phase in quality-of-supply standards over time, with reasonable grace periods.
- d. Quality-of-service standards need not be uniform across all customer categories, geographic areas, or forms of electrification. Whenever possible, the regulator should encourage lower costs of construction. However, the regulator should recognize that lower costs of construction may lead to lower quality of service.
- e. In establishing quality-of-service standards, the regulator must recognize that it is acting as an agent for consumers. In general, the regulator should not impose input or output quality-of-service standards on a supplier unless customers are willing and able to pay for at least some portion of the costs associated with meeting the standards and unless the standards are capable of being monitored.
- f. Fewer standards that can be effectively monitored are preferable to many standards that are poorly monitored.
- g. Whenever possible, consumers should be presented with a menu of service options ranging from the less costly to the more costly.

- h. Any penalties should be proportionate to the extent of noncompliance and the costs likely to be incurred by the operator in meeting the standards.
- i. Required improvements in quality of service should be synchronized, whenever possible, with proceedings to change tariffs.
- j. If quality-of-service standards are established and monitored by another entity within the government, the regulator should have the right to make recommendations on these matters to this other entity.
- k. Given the dispersed and often isolated location of electrification projects, the regulator is encouraged to use other government and nongovernment entities to monitor a supplier's performance relative to these standards.

6. Coordination with other government entities

- a. The regulator should enter into memorandums of understanding (MOUs) with other entities that are promoting electrification, such as ministries and electrification funds. Such MOUs should clarify respective roles and responsibilities and the sequence of needed approvals. The overall goal should be to streamline the regulatory process by minimizing unnecessary duplication and delays.
- b. Any MOUs should be publicly available documents so that consumers and potential suppliers of electrical service will have clear understanding of the responsibilities and processes of the regulator and other entities that are promoting electrification.
- c. Two to three years after these standards are adopted, the government should require an independent and publicly available evaluation of its electrification program, which should include an assessment of the regulatory system as it affects electrification.

7. Model documents

- a. The regulator should encourage and assist in the creation and use of model documents by communities or organizations that seek to initiate or expand electrification. Such documents could include, for example, model power supply agreements, model subsidy contracts, and model bidding documents.
- b. Such documents should be used to particularize national regulatory policies for the circumstances and needs of individual communities. Whenever feasible, the regulator should encourage and assist in the creation of model documents that will allow other

- entities to perform one or more regulatory functions on its behalf. This will have the benefit of economizing on the use of the government's limited resources.
- c. The regulator should also employ such model documents to streamline the regulatory process.

4. CONCLUSION

Our goal in writing this paper was to consider how economic regulatory systems could be designed to help rather than hurt government and nongovernment initiatives to promote electrification. Electrification can be achieved with a variety of technologies and forms of ownership. Within the many possible forms of electrification, our focus has been on electrification by small, decentralized entities. Given this emphasis (and the fact that it has received little attention in the literature of regulation), much of the paper is devoted to addressing a single question: Are the regulatory approaches that are traditionally used in regulating large central utilities equally appropriate in regulating small, decentralized electricity providers?

The answer is that some regulatory approaches are common to large and small enterprises, whereas other regulatory approaches clearly need to be modified to accommodate the characteristics of small enterprises. For example, the principle that “quality-of-service standards must be realistic, affordable, monitorable and enforceable” is equally relevant for large centralized utilities and small decentralized providers (even if the principle leads to different regulatory answers when applied to these different suppliers). Similarly, the principle that a “regulator should be allowed to vary the nature of its regulation depending on the entity that is being regulated” is a sensible principle whether the entity that is being regulated is large or small, or connected or not connected to the main grid. However, the two other principles—the need for “light-handed regulation” and the ability to “delegate or contract out regulatory functions to other governmental or nongovernmental entities”—are clearly more relevant for small, decentralized providers than for large centralized providers.

General regulatory principles are important because they provide direction for where one should be going. Principles are of little or no use, however, unless they can be operationalized. Translating principles into action requires that the principles be both legally and politically feasible. Legal feasibility requires supportive laws and decrees. The elements of the proposed model law represent an attempt to translate the general principles into more detailed regulatory standards. These standards would need to be modified for the specific requirements of a country's legal system. We did not attempt to create specific standards to achieve political feasibility, even

though political feasibility is clearly important. Nothing will happen if a proposal is politically infeasible. However, the requirements for political feasibility are country specific, so they are much less amenable to general principles and standards.

This paper does *not* pretend to provide all the answers on designing a complete regulatory system to promote electrification. For instance, our focus has been largely limited to off-grid electrification, which is typically associated with rural electrification of a remote or dispersed population. Further work needs to be undertaken on workable regulatory approaches to support electrification in periurban areas. In addition, a number of other general regulatory questions are not addressed in this paper. They include tariff levels and structures, coordination of tariffs with subsidies, regulation when there are different forms of bidding (for example, for minimum subsidies, minimum customer connection charges or minimum tariffs), “regularization” of informal service providers, and “handoff” arrangements when the main grid connects to a minigrid. We hope to address these questions in future research.

We conclude with one final word of caution. Even if all the principles and standards are satisfied, this in itself will not guarantee the success of an electrification program. *Regulation is not a “magic bullet.”* As we noted earlier, regulation is a necessary condition, but not a sufficient one for the success of electrification initiatives. An electrification initiative will be sustainable in the long term only if costs are covered by a transparent combination of revenues and subsidies. No regulatory system—no matter how well designed or implemented—will produce sustainable electrification if this fundamental requirement of commercial viability is not satisfied.

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