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Principles of Successful Expansion of Rural Electrification Programs

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EXECUTIVE SUMMARY

This paper presents an overview of the contributing factors to the design, implementation, and sustainability of successful rural electrification programs.

Main Argument

Rural electrification programs require a number of conditions in the institutional environment to ensure successful and sustainable program expansion. Due to the specific challenges posed by low population density, low energy demand, and undeveloped rural economies, these programs require special financing conditions, design and construction standards specifically formulated to address rural power-supply characteristics, and a program management agency with the expertise required to adapt to country-specific realities. This paper will examine both the conditions and requirements for designing successful rural electrification programs that achieve high rural electrification penetration rates and the issues that may challenge long-term success during program implementation. It will further explore lessons learned from selected successful rural electrification programs.

Policy Implications

- Well-designed electrification programs contribute significantly to rural economic development, but only if the resulting electric service is reliable, affordable, and accessible to a significant proportion of the communities served.
- Ensuring that infrastructure costs are reasonable has a direct impact on not only the affordability of electric service, but also on the potential impact of the program in terms of cost per household or business served. Moreover, given the need for other essential public services that require electricity, such as healthcare, primary education, safe water supply, and transportation, ensuring that program implementation is economically efficient directly benefits both the government and the communities served.
- Given the potential economic benefits of affordable and reliable electric service, long-term institutional and financial sustainability is essential.

Large-scale electrification programs date back to the early twentieth century when urbanized electric distribution utilities began to consider expansion of service from urban centers to peri-urban and rural areas in Europe and the Americas. These distribution utilities faced many of the same challenges that confront rural electrification programs today. In both cases, commercializing electric service depends on selling enough energy to balance out the costs related to infrastructure and non-energy services. In general, the lower the population density per kilometer of distribution line, the more challenging it is to achieve financial returns for electric service providers.

Although the first rural electric utilities were established in the mid-1930s, rural electrification programs still face significant challenges. That is, load projections for rural areas are much lower than they are for urban centers where income levels and demand density are generally higher. Willingness and ability to pay for both service connections and monthly service is generally much lower in rural areas, meaning that even where population density may be reasonably high, penetration rates can still be quite low. Moreover, finding and retaining qualified and dedicated personnel can be extremely challenging; many well-educated young people may simply prefer to relocate to urban areas where opportunities for financial advancement are much higher.[1]

Yet while many rural electrification programs face significant technical, financial, and political challenges, a number of highly successful programs have been designed and implemented, employing a diverse set of program designs. These successful programs, while using divergent ownership, operating, and decisionmaking mechanisms, share common characteristics that have significantly contributed to success—measured in terms of their ability to both expand at a rapid rate and concurrently achieve financial sustainability.

How is it that some programs have been successful while others have stagnated or essentially failed to achieve their goals? What common attributes are necessary to facilitate rational infrastructure development, reasonable tariffs, and the long-term financial sustainability of service providers? Why is it that some seemingly successful

[1] Douglas F. Barnes, "Challenge of Rural Electrification," in *The Challenge of Rural Electrification: Strategies for Developing Countries*, ed. Douglas F. Barnes (Resources for the Future, 2007).

programs fall short of the expectation of universal coverage after encouraging beginnings?

This paper will explore these issues while drawing from a review of successful rural electrification programs completed by the World Bank in the early 2000s. In addition, it will report on program management challenges arising in two programs in South and Southeast Asia that have continued to expand access in recent years.

Rural Electrification Program Challenges

Rural electric market conditions are quite distinct from those in urban areas. By definition, rural areas have significantly lower population density than urban centers, and they are often characterized by lower incomes; less access to primary education, health services, and clean water; and either minimal or no existing commercial electric service. Given limited financial resources to satisfy national demand for public services, government agencies have historically allocated significantly lower levels of financial resources towards development of rural public services, including investment in electric transmission and distribution infrastructure.[2]

The financial viability of electric distribution utilities is governed by the balance of costs and revenues generated from sales of energy and the cost of providing service. Due to lower population density, often lower income, and concurrently lower specific energy consumption for rural communities, rural distribution systems realize far lower revenue per kilometer of rural distribution line than their urban counterparts. Moreover, rural distribution service providers are also faced with higher operating expenses per household or commercial consumer served, given their lower energy density. Additionally, rural electric service providers must recruit management and staff resources from communities that often have fewer trained engineers, accountants, financial specialists, and customer service specialists due to lower levels of professional and practical skills training. In short, the business of rural electrification provides few

[2] Barnes, "Meeting the Challenge of Rural Electrification."

financial incentives for distribution service providers, while presenting significantly higher risks than those faced by urban distribution service providers.[3]

These conditions are common concerns for rural electrification programs worldwide. Some programs have faced greater challenges with respect to human resources, while others face greater challenges with respect to cost recovery from lower population densities. While the degree of the challenges vary from country to country, the nature of the technical, administrative, financial, and management challenges are common.

To address these challenges, rural electrification programs require special financing conditions, and design and construction standards specifically formulated to address rural power-supply characteristics while lowering capital costs associated with power systems. The programs must define operating policies and procedures that normalize service provider operations to ensure internal cost controls, while concurrently focusing on expanding service to the maximum number of customers and promoting service to commercial and small industrial clients. Given that many programs rely on newly formed rural service providers, the program management agency responsible for financing and often supervising construction of rural infrastructure is frequently also the entity chosen to take responsibility for establishing the guiding principles for new or expanding rural electrification programs. This means that successful programs will also require a program management agency with electrification expertise and the ability to adapt to the country-specific realities present in individual cases.

Foundations of Sustainable Rural Electrification Programs

As mentioned above, rural electrification programs must overcome a series of technical, financial, and programmatic challenges to achieve long-term institutional viability and the high access rates that constitute program success. Given the difficulty of the markets they serve, the programs need to focus on the means to minimize capital and operating costs, while concurrently ensuring a high quality of electric service.

[3] Barnes, "Meeting the Challenge of Rural Electrification."

Perhaps the first decision point in establishing successful programs is to determine the modality of rural electric service provision. Up until the 1990s, rural electrification had a very specific meaning; rural electrification programs have historically been implemented by the provision of commercial electric service through electric generation-distribution infrastructure. Remote communities have historically been served through distributed generation, combined with islanded distribution grids. Rural communities in closer proximity to urban population centers have been served via extension of grid electric systems, with energy provided through central station power plants.

More recently, however, rural electric service can include remote renewable energy technologies, including micro-hydroelectric systems, solar photovoltaic (PV) systems, wind-hybrid systems, and even biomass gasification systems. While wind-hybrid and biomass conversion systems are not as common as solar PV and micro-hydroelectric systems, they are technologies that have grown in use in recent years.

Most rural electrification programs now employ a combination of technologies. Conventional generation-distribution systems are employed for higher population density communities that may have existing or potential for industrial load growth. Renewable energy systems are employed for those situations where extension of grid electric power is too costly due to the remote nature of the communities, or where the population density is so low or dispersed that grid extension is not cost-effective. Micro-hydroelectric systems are also popular in countries where there may be a vibrant network of irrigation canals that lend themselves to conjunctive use of micro-hydroelectric generation and irrigation supply. Solar PV systems have been ubiquitous in many parts of Latin America, Africa, and South and Southeast Asia. Generally, this technology choice is a function of cost and resource availability; technology selection should be accomplished on the basis of the least costly power supply, influenced by the reliability and availability of the power-supply option.

Therefore, as a policy decision, agencies managing rural electrification programs must decide how to invest program resources, usually allocating some portion of funds for electric service to a selection of remote communities and designating the balance to expand service through grid extension to communities that can be more readily connected to grid-electric power supply.

The guiding principle for most rural electrification programs is to expand service at the lowest cost to the highest number of community members. This means that whether the program employs conventional or renewable electrification service options, there will nonetheless be an emphasis on cost minimization and revenue recovery. With this in mind, the following program guidelines have been employed by many successful electrification programs.[4]

Establish design and construction standards that, on the one hand, minimize capital cost, while allowing for high quality of service to all connected consumers. Many rural electrification programs employ urban construction standards that serve much higher load densities and thus use larger conductors and larger distribution transformers, require larger and more pole-top structures, and employ relatively long low-voltage distribution circuits. Using urban design and construction standards can result in construction costs that are two or even three times the cost in comparison to standards that take into consideration lower population density and the resulting lower rural distribution loads. Specialized construction standards translate into lower capital costs, which in turn results in lower depreciation costs to the consumer.

Rural electrification planning that focuses on expansion of coverage to rural areas with the highest potential energy demand and highest financial viability. Rural electrification programs are designed to provide electric service to as many rural communities as possible—to eventually provide universal coverage. However, the process of achieving universal coverage may take two or more decades. The path to achieving this goal is quite important; if the expansion program is designed in such a way that rural service providers serve very low population density areas in the early years of the program, program costs may exceed program revenues, which can result in highly unstable service providers. It is essential to establish master plans for each service provider that focus on a well-defined expansion plan that serves the largest and most economically viable communities first and systematically expands service to outlying communities over time. Sacrificing financial viability for political expediency is a challenge that many programs have experienced at a high cost to program sustainability.

[4] Barnes, "Meeting the Challenge of Rural Electrification."

Electric coverage that expands at an organic rate, serving the highest population density areas first (with the concurrently highest potential consumption) is the most economically efficient means of achieving long-term sustainability. Moreover, programs that are designed against the primary objective of serving communities at the lowest cost concurrently result in the highest impact.

Ensure that program financing is provided over time to facilitate gradual but sustained service provider expansion. Electric distribution utilities need to expand as communities expand. Doing so requires not only encouraging economic efficiency in existing structures, but actively planning for expanding infrastructure in served communities and extending service as the population grows in outlying areas. Thus, ensuring that program funding can be provided continually to both the population served and for greenfield construction is of fundamental importance.

Establish and maintain sound business management. Electric distribution service requires the mastery of a number of core capacities, but none is more important than commercialization of electric service. That is, distribution service providers must be very proficient at the process of recording monthly electric sales, billing consumers, collecting bills, and disconnecting services of customers who are delinquent in bill payment. Failure in any part of this commercial cycle will dramatically weaken the financial sustainability of an electric service provider. While this seems like a simple and obvious requirement, it is interesting to note that many rural electrification programs suffer from high commercial losses stemming from poor commercial management on the part of the rural electric service providers.

Focusing on providing high quality of service. In order to ensure high collection rates, customers must believe that they are being treated fairly; they must receive good value for the money they pay. If the quality of service is low, customers will be less inclined to pay electric bills on time, if at all. The electric distribution service provider must do all in their control to maintain high quality of service by maintaining the distribution system adequately, and by investing in system upgrades as they become necessary.

Investing in human resources. Many rural electrification programs are challenged with attracting and retaining high quality managers, engineers, accountants, commercial managers, and linemen. Successful rural electrification programs most often create training programs to build capacities of personnel from the communities they serve—investing in the communities rather than trying to bring in personnel from outside of the community. From the point of view of sustainability, training programs are critical to the long-term success of rural service providers.

Establishing rational tariffs that allow full cost recovery. This is perhaps the most critical and problematic issue for most rural electrification programs. Very often, tariffs are kept artificially low. Failure to achieve full cost recovery, and in some cases failure to recover even just the operating costs of the utility, directly threatens financial sustainability. Rural electric systems that cannot recover the investment and operating costs cannot afford to reinvest in system expansion due to growing loads, or population growth.

Increasing Access: Common Challenges and Solutions

The goal of most rural electrification programs is to design a program that will surely and steadily expand access to electric service to all villages, households, businesses, and institutions in the entire country. While this process is often conceptualized as one that expands outward to the outermost region of the country, in fact the process works in two directions. Grid and off-grid systems do need to expand outward, but because the initial penetration rate of connected consumers is often quite low, it is important to provide access to service through "backfill" or densification programs. These programs increase the density of customers in an area that already has electric infrastructure by identifying and addressing barriers to access. Very often, access statistics are more affected at a lower cost by backfill projects than expansion projects.

First, however, it is important to understand the principal obstacles that deter rural consumers from accepting a service connection, whether it is a grid-electric connection or a renewable energy system. Not surprisingly, the primary obstacle is the initial cost of the service.[5] Electric service in the form of grid electric service, a solar home system, micro-hydroelectric service, or some other form of energy delivery requires a capital investment

[5] Waddle, 2006.

by the energy company. To help defray the capital cost of the investment, service providers most often require that each consumer pay for some portion of the cost of the connection from the medium voltage line to the household or some portion of the system cost in the case of a solar PV system.[6] The higher the connection fee, the lower the penetration rate for most projects.

Another significant impediment has to do with effectively communicating likely monthly or weekly energy costs to the served population, and how these costs compare with traditional energy costs. While almost everyone acquires energy services through commercial exchange for fuel (even fuel wood), people living in marginal areas may not realize what they spend on a monthly basis. Therefore, it is often extremely important to engage in an information campaign to ensure that potential consumers understand the costs that they can expect to pay for service and how that cost compares to what they are already paying for traditional energy supplies.

With respect to connection fees and other first-time costs, successful rural electrification programs have historically identified methods to reduce the initial financial barrier to potential consumers in one or more programs. First, all materials costs for service materials, meters, and installation costs can be capitalized into the initial project cost.[7] Since most electric utilities own the service materials, meter, and meter box (if used), including these materials and the labor associated with installation is simply good business practice anyway. The question becomes how to capitalize services that are installed after the initial construction period has been completed. Toward this end, many electrification programs purchase excess meters and service materials, disbursing them to participating service providers on an as-needed basis. Since increasing the number of connected consumers is in the joint interest of the service provider and the rural electrification program management agency, this is a rational practice.

Another associated cost and subsequent barrier is the cost of internal household wiring. Most rural electrification programs require that the consumer pay for internal wiring costs or find the means to finance it from their own resources. A number of rural

[6] Martinot and Cabraal, 2000.

[7] Best Practices, 2008.

electrification programs have taken the additional steps to (1) define a low-cost wiring standard that complies with consumer and utility safety requirements, (2) train and certify local electricians to install the wiring package for participating households, and (3) arrange for financial resources to make loans to the homeowners and/or commercial enterprises to finance the cost of internal wiring required by the utility.

A similar approach has been used in solar home system programs, albeit with many variations.[8] The most common program design is to work with a rural credit agency to qualify community members to borrow funds through the bank that can be repaid on an established repayment schedule. The homeowner is responsible for an initial payment (often on the order of $100), with the balance payable to the rural credit agency over a period of 12–24 months. In some cases, when these programs are financed through a donor agency, the credit may include a capital subsidy—just as conventional electrification programs often include capital subsidies. The program design seeks to minimize the initial cash outlay by the consumer in order to achieve a higher penetration rate of served customers.

Again, it is important to emphasize the importance of providing incentives not only to residents in newly electrified areas, but also to provide incentives to potential customers in areas that have already received service. Post-project construction monitoring can help inform the program management agency where increased emphasis can be applied for the purpose of increasing access to electric service—whether this occurs in areas served by grid electric systems or renewable energy systems.

Balancing Tariffs with Cost Recovery

It goes without saying that government agencies that are established to serve the public often promote tariffs that are below the full cost of service, especially to low-income consumers. Low-income consumers are often in the majority of all electric consumers; over 80% of electric consumers in Bangladesh qualify, consuming less than

[8] Eric Martinot and Anil Cabraal, "World Bank Solar Home Systems Projects: Experiences and Lessons Learned 1993-2000," World Bank, 2000.

50 kWh per month. Thus, providing tariffs that are below the real cost of service to low-income consumers can create a huge distortion in the ability of the distribution service provider to balance cost of service with adequate revenues.

The methodology for balancing revenues most often employed is to cross-subsidize low-income consumers by increasing tariffs for commercial and industrial consumers. While this formula may work in service territories where there are significant commercial and industrial sales, it often fails to balance costs and revenues in more remote, rural-service territories. Moreover, it is unfortunately at cross-purposes with one of the principal goals of electric power supply. Cross subsidies impede economic productivity by disproportionately taxing the most productive part of the economy.[9]

Subsidies also ignore the fact that, in most cases, electric service provides energy at a lower cost than traditional sources of energy service. Even for higher-cost solar home systems, the cost of lighting and entertainment service is less expensive than small generators, candles, flashlights, and dry cell batteries.

Most importantly, if the goal is to build infrastructure that can be self-sustaining, tariffs must be designed to recover all operating costs and capital recovery costs. Electric power systems require ongoing investment to expand capacity and to expand coverage. If tariffs are not designed to facilitate capital recovery, the consumers who are connected during the initial construction phase of the project will essentially mine the capital value of the investment, and will not pay a high enough rate to finance future expansion, repair, and improvements that will be needed as the community grows and consequently increases its energy consumption.

Electrification programs need to focus not only on maximizing service connections, but also supporting sustainable institutions. Rural service providers need to achieve sufficient geographic scope and connected consumers to reach a sustainable revenue

[9] Daniel Waddle and James Van Coevering, "Bangladesh Rural Electrification Program at the Crossroads: An Analysis of Barriers, Threats, and Opportunities to Enhance Program Sustainability," Rural Power for Poverty Reduction Report to USAID, 2005.

plateau, but to do so, the tariff design must provide adequate revenue recovery to allow the service providers to recover the real cost of service.[10]

Short of providing cash subsidies to the service providers, there are some options open to rural electrification program management agencies. These include:

1. *Focusing on capital cost control by establishing and employing low-cost electrification standards*. Single-phase distribution systems have been used for decades with success in Australia, Brazil, Chile, Peru, Mexico, and Bolivia. Of course, where grid costs are high, employing off-grid renewable systems can result in significant capital and operating cost savings.
2. *Considering long-term loan financing as opposed to capital subsidy programs*. Long-term loans with low interest rates have worked extremely well in Costa Rica, Bangladesh, the Philippines, and other rural electrification programs. Administering loan programs ensures capital recovery such that over time, the program can sustain itself by using reflows to continue the process of expansion.
3. *If subsidies are unavoidable, employing subsidies for capital costs administered by the rural electrification program*. Capital subsidies, whether applied for grid expansion systems or renewable energy systems, should be minimized by evaluating the need for subsidies objectively in an analysis that is devoid of political bias.
4. *Considering allocating the lowest cost generation resources for use by the rural electrification program*. Bulk power costs can vary tremendously, and one way to avoid the inclusion of subsidies is to give rural electric service providers first right of refusal for low-cost generation resources, such as low-cost hydroelectric power.
5. *In all cases, ensuring that consumers are well-informed regarding the nature of the relationship between the consumer and the service provider*. The service provider is responsible to the consumer for the quality of power, and to expand access as much as possible to all members of the community. The consumer, in

[10] Daniel Waddle, Eric Gibbs, and Paul Clark, "National Rural Electrification Strategy for Yemen," World Bank Report, Yemen, 2006.

turn, needs to understand that if the service provider cannot recover costs, the quality of service and the long-term reliability of the electric system will be put at risk. This relationship is fundamental and needs to be understood by all parties.

Long-Term Risks to Program Sustainability

It is interesting to note that some rural electrification programs that experienced success in the early years ran into difficulties during later years, as they began to expand rapidly to realize the large-scale coverage that these programs strive to achieve. Given that there are natural changes in program leadership at all levels of program-implementing institutions, it should not be surprising that problems have arisen at various stages of program implementation.

For purposes of this discussion, it would be useful to review two programs in South and Southeast Asia that are generally accepted to be successful, but have presented uneven financial performance across rural distribution service providers. The two programs are financed and managed by the Philippine National Electrification Administration (NEA) and the Bangladesh Rural Electrification Board (REB), respectively.

Philippine Rural Electrification Program[11]

The Philippine rural electrification program had its start in the early 1960s, when the Philippine government declared its commitment to universal electrification coverage. It established the Electrification Administration, which quickly began financing over 200 small-scale generation-distribution systems. In 1967, the Philippine government reached an agreement with the newly formed USAID to initiate two pilot rural electric cooperatives, one situated in Mindanao and the other in Negros Island in the Visayas region of the Philippines. Prior to completion of these two pilot projects, the government decided to launch a national-scale electrification program, promulgating the National Rural Electrification Act in 1969. USAID again agreed to co-finance the expansion

[11] Gerald Foley and Jose Logarta Jr., “Power and Politics in the Philippines,” in Barnes, *Challenge of Rural Electrification*.

program, and in 1972 the construction of 36 rural electric cooperatives was launched on the basis of eventually achieving up to 100,000 members in each service territory. The program was founded on the basis of area rural electrification access, relying on careful planning and objective criteria for expansion-planning purposes.

An evaluation of the program in the late 1970s determined that the cooperatives that were monitored were achieving cost recovery, realizing high rates of new consumers, and moving toward financial sustainability. NEA was responsible for all planning and construction functions, as well as training and provision of technical assistance to the newly formed rural electric cooperatives. The cooperatives in turn signed long-term mortgages to NEA, repaying loans over extended payment periods at below-market interest rates. The formula for quality control in selection of service territories, procurement, and construction management seemed to be well in hand within NEA; institutional development and oversight for the rural electric cooperatives seemed to be functioning well.

However, while these achievements were typical for the original 36 cooperatives financed by USAID and the Philippine government, expansion to the next phase of cooperatives did not meet with the same level of success. Many of the safeguards instilled through the USAID-sponsored technical assistance program were ignored, and the careful selection and planning functions were set aside. The result was a full-scale program crisis by the mid-1980s; many of the newly formed electric cooperatives failed to follow strict cost-recovery criteria employed for expansion planning and were running significant financial deficits.

Efforts to define the road to recovery were financed by a combination of donor agencies, including USAID, the World Bank, and the Japanese Overseas Investment Agency. These donor agencies financed a stabilization program that evaluated the changes in program management, governance, and commercial management of rural electric cooperatives, as well as program management within NEA. A financial and institutional evaluation was undertaken for all participating cooperatives to determine the degree to which governance, management decision-making, and investment planning complied with the original NEA policies and procedures. The results indicated that many fundamental policies and procedures had been ignored, resulting in a dramatic downturn in financial performance by many of the cooperatives, and a dramatic downturn in loan repayments to NEA.

The other significant finding of the series of studies was that, in addition to very poor collection rates, tariff levels had dipped to levels that did not allow recovery of the cost of service even if the cooperatives were successful in achieving acceptable collection rates. The program had succumbed to political influence, first at the level of NEA, and thereafter within the cooperatives themselves.

Over the years since implementation of the recovery program, the NEA program has demonstrated improved financial results, and the cooperatives have more closely followed the policies and procedures embedded in the loan covenants with NEA. The majority of the NEA cooperatives now show positive financial returns and continue to make progress toward full coverage within their distribution service territories. While there remain significant investment requirements to respond to growing demand and expansion of service, the cooperatives have generally turned the corner from the precarious situation in which they found themselves in the late 1980s. That said, a significant number of the cooperatives continue to experience financial challenges, mostly due to the fact that, as islanded generation-distribution systems purchasing energy from liquid-fuel power plants, the cost of power purchased is quite high, which in turn limits growth to low-income consumers. However, this situation is due more to the nature of providing service in an archipelago that requires distributed generation solutions, and not to a failure of the program model.

Bangladesh Rural Electrification Program[12]

Separately, in 1977, the Government of Bangladesh (with assistance from USAID) commissioned a feasibility study to evaluate options to design and implement a national rural electrification program. The study recommended establishing 13 rural electric cooperatives located in close proximity to population centers, deriving power from the national generation-transmission system. The original thirteen cooperatives started with

[12] This section draws from Waddle and Van Coevering, "Bangladesh Rural Electrification."

less than 10,000 members and were financed through long-term loan agreements managed by the newly established Rural Electrification Board (REB).

The initial stages of the REB program were highly successful. Over time, REB attracted loan and grant capital from a group of 14 donor agencies totaling more than $1.6 billion in value, establishing seventy electric cooperatives that now serve more than 8.5 million residential, commercial, and industrial consumers. The expansion program was strictly based on a revenue recovery model that required sufficient energy sales to ensure cost recovery from all feeders and laterals, even those serving increasingly remote villages. A cross-subsidy tariff model was employed, but it was based on the principle of full cost recovery within each independent service territory. REB was established as an independent government agency but was led by a brigadier assigned to manage REB from the Bangladesh military. This decision led to a high degree of political autonomy for REB; civil servants owe their loyalty to the political apparatus, so assigning the program leadership position to a military professional provided another important degree of freedom for program planning and expansion purposes.

As of the late 1990s, the program had expanded at a rapid rate, achieving more than three million service connections and providing electric service to more than 20% of rural Bangladesh. The cooperatives that had been established were meeting loan repayments on schedule, and taken as a whole, were financially viable. They achieved extremely high collection rates and relatively low losses (approximately 97% collection rates and 12% losses).

By the mid-2000s, however, the donor community noted a decline in program performance. While losses and collection rates held more or less constant, a change in leadership from a brigadier to an appointed civil servant resulted in a loss of program autonomy. Tariffs were held flat for several years while bulk power rates were increased. The number of financially sound cooperatives declined rapidly, and loan repayments to REB also declined. While several of the largest cooperatives boasted significant industrial sales, the tariffs were for all intents and purposes the same as those with insignificant industrial and commercial sales. This resulted in windfall profits for the more industrialized cooperatives and crippling losses for the more remote cooperatives with few low commercial and industrial sales. While program expansion was by and large managed with a similar level of discipline to that followed in the early stages of program implementation, the shift in tariff policy, combined with widespread load shedding, have threatened the long-term viability of the electric cooperatives around which the program has been designed. Thus, the linkage between the welfare of the service providers and the long-term well-being of the program that was acknowledged and respected during the first two decades of program implementation has been largely ignored in recent years.

Results

These two programs have made remarkable contributions to rural economic development in each of the rural markets that they serve. Both NEA and REB management and staff have outstanding experience and dedication, and understand the missions of their respective institutions. The NEA and REB programs, even with the challenges that have arisen, are still highly successful rural electrification programs. These two programs demonstrate, however, that rural electrification programs evolve through many stages, and at each stage the programs must adjust to the changing realities of the markets they serve, while retaining program discipline to ensure program sustainability.

Conclusion

Rural electrification programs endeavor to provide electric service to the most problematic market segment of the power sector at prices that are affordable to even the lowest-income groups. Programs are often designed to extend electric service through grid electric systems, isolated conventional energy systems, and through renewable remote power systems to the most remote areas of the country with similar levels of service to those offered in large population centers. Thus the challenges that rural electrification programs face are multiple and in some cases, daunting.

Be that as it may, if rural electrification planners establish carefully defined technical standards that allow cost minimization while providing high quality of service and safety, and if robust planning discipline is carefully followed, rural electrification programs can be established to extend service to the majority of rural communities on a financially sustainable basis, steadily expanding service coverage over time. Concurrently, it is essential for rural electrification program managers to adjust program-implementing principles to meet the changing needs of the communities they serve, while staying the course with respect to financial management and program expansion. It is of paramount importance to ensure that the programs themselves do not fall prey to political influence that may undermine project selection and unduly influence tariff-setting methodologies. Most importantly, it is of utmost importance to recognize the vital role that successful rural electrification programs play in rural economic development. Rural communities depend on a reliable power supply to remain competitive in an increasingly globalized economy. Allowing rural electric utilities to be weakened through ignoring or deemphasizing essential management and implementation principles will, over time, result in declining power quality and reliability within the communities that rural distribution service providers serve.