

**PRODUCTIVE USES OF ELECTRICITY:
COUNTRY EXPERIENCES**

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1.0 INTRODUCTION

This paper was prepared for the Village Power '98 conference held in Washington, DC October 6-8, 1998. The author provides an overview of the productive uses work done by the National Rural Electric Cooperative Association (NRECA) in various countries with special emphasis on projects in Bolivia. A simple definition of the term "a productive use of electricity" is, "Any use of electricity that helps generate income for the end-user." The author describes both successes and failures and concludes with a section describing the five factors that he considers to be the most important for implementing successful productive uses programs.

2.0 BACKGROUND

Since its founding nearly 55 years ago, the National Rural Electric Cooperative Association (NRECA) has championed rural electrification (RE) in the USA. And, during the last 35 years it has played an active role in RE internationally. Though it does not create miracles, invariably, rural electrification has improved the quality of life for rural peoples around the world. Nevertheless, a line of reasoning exists that argues that most RE end-users simply consume electricity rather than use it productively. That line of reasoning assumes that if end-users would employ electricity productively it could benefit them much more. In conclusion, the reasoning goes, when productive uses proliferate everybody wins. The end user takes advantage of the electricity to generate income for himself and employment for others. The utility sells more electricity making the investment in electric generation, transmission, and distribution infrastructure more profitable.

As mentioned in the introduction, a simple definition of a productive use of electricity is, "Any use of electricity that helps generate income for the end-user." Some prefer a

broader definition that can encompass the use of electricity for such things as schools and community water-pumping systems. Those applications do not directly generate income for the end-user, but they can obviously contribute to quality of life and development. An expanded definition would be: "Any use of electricity which improves the financial situation of the end-user and/or contributes to the development of the community and the nation." Though this paper will concentrate on examples of the former, applications that fit the latter definition will also be included.

Some people tend to consider only micro-enterprises when thinking of productive uses. By definition, however, large industries also qualify and can sometimes be the key to financial viability for a project. Perhaps some have felt that the large investors have sufficient capital to invest in hiring experts of their own and that productive uses programs should limit their help to the poor and disadvantaged. In the experience of the author, however, it is important to address the entire range of productive uses. Large factories and mines, for example, also generate income and create jobs.

A discussion of the key components in a productive uses program is included after the "Country Experiences".

3.0 COUNTRY EXPERIENCES

NRECA has actively promoted productive uses for over 15 years. In Bangladesh, for example, literature on productive uses dates back to at least 1982 when a conference on productive uses was held there. In Guatemala under the Central America Rural Electrification Support program (CARES), managed by NRECA, productive uses were promoted with international seminars and specific interventions in the field. NRECA personnel worked with micro-credit organizations to get productive uses loan programs started and to enlist their help for training.

In El Salvador NRECA worked with the national utility, CEL, promoting productive uses with a demonstration trailer and later a van. These demo units were filled with all kinds of electric tools and equipment. The units were taken around El Salvador and served both to inform the villagers of the existence of certain tools and equipment and to demonstrate how the equipment was used and what it could do.

In the USA, NRECA-affiliated cooperatives have promoted economic growth in their communities by sponsoring "incubators". The concept of an incubator is to provide a setting with the appropriate support where a business can "incubate" before it launches out completely on its own. The support often includes physical space in which the busi-

ness can operate and access to central office equipment and a secretary offered at affordable rates. Readers interested in more information regarding incubators may contact Brian Crutchfield at BREMCO, the electric cooperative that serves the Blue Ridge area of North Carolina.

The efforts mentioned above have been documented in NRECA reports and other literature and will not be further elaborated on in this paper.

The author worked as the Productive Uses Specialist in Bolivia for five years and he continues to be stationed there as the Deputy Director. Therefore, the bulk of the country experiences and supporting data will be gleaned from selected Bolivia projects described below.

3.1 Vinto

The Vinto Densification Project was implemented as a pilot project to promote productive uses in the lower Cochabamba valley in the area in an around the town of Vinto. NRECA set aside \$237,000 for the project. Of the total, \$100,000 was to be used in conjunction with ELFEC, the local utility, to install productive uses service drops that the end users could pay for over time. The remaining \$137,000 was to be granted to PRODEM a micro-credit organization. Under the terms of the contract, PRODEM was to use \$100,000 to provide loans to at least 50 productive uses and \$37,000 were to cover administration and operation costs.

At the conclusion of the project, \$95,166 had been invested in service drops and line extensions with 73% of that amount used in the Vinto area and 23% used to electrify the community of K'aspi Kancha Alta in another province of Cocabamba. A total of 217 service drops were installed: 183 in the Vinto project area and the other 34 in K'aspi Kancha Alta. Of the 183 in the Vinto area, only 28 were for productive uses.

Because of problems with disbursement of Bolivia governments funds, PRODEM received only \$112,000: \$75,000 for loans and \$37,000 for administration and operation. PRODEM used some of its own money to complete the loan portfolio and made 101 loans worth \$103,026. In all, 83 productive uses were benefited since 14 of them qualified for two loans and 2 qualified for 3 loans. Loan amounts varied from \$66 to \$6,500 and 77 of the loans were for less than \$1,000. Of the 101 loans, 63 were used to purchase raw materials and 38 for electric equipment.

When PRODEM had fulfilled its contractual obligations with NRECA it sold its entire loan portfolio in the project area to Banco Sol and unexpectedly returned all the loan portfolio money, plus 6% interest, to NRECA. Therefore, Banco Sol continued providing

loans throughout the project area and NRECA had additional money to invest in another productive uses project.

A financial analysis projected out to 20 years for the service drop component of the project showed a loss. The main reasons for the deficit were: 1) the low consumption of the end-user of only 36 kWh/month as an average per end-user, and 2) the high administrative costs (nearly 50% of the total) that ELFEC charged to the densification project.

Of the 83 productive uses that benefited from loans, 18 were surveyed in a final evaluation of the loan component of the project. All but one showed an increase in production. Similarly, all but one showed an increase in profit, though, paradoxically, it was not the one that had reduced production. A majority also showed an increase in the number of employees. Most of the participating productive uses were tiny shops or businesses with only 4 to 7 employees. Nevertheless, the 18 productive uses surveyed generated a total of 25 new jobs.

In the three tables below, one can see a summary of the loan program results. Of special interest is the effect on the production and profits of the 18 productive uses that were surveyed.

Table 1. Changes in production and profit or productive uses benefited with loans

	Production Level			Profit/Month (Bs)		
	Without	With		Without	With	
Production	Loan	Loan	Change	Loan	Loan	Change
Unit	Program	Program	%	Program	Program	%
Dresses, hats	1104	264	-76%	8549	13619	59%
Trousers	384	480	25%	3719	2291	-38%
Women's shoes (pair)	96	144	50%	2060	2830	37%
Tables and chests	30	60	100%	915	2175	138%
Shoes (pair)	18	36	100%	628	1857	196%
Bedsread	24	48	100%	2555	4570	79%
Tables, chairs, doors, windows, beds	72	148	106%	167	3191	1811%
Guitars, charangos	21	44	110%	2353	4224	80%
Clothes chest	50	120	140%	496	2522	408%
Trousers	480	1200	150%	2291	8225	259%
Trousers	250	700	180%	2225	6896	210%
Traditional skirt	72	216	200%	-149	367	346%
Bedsread	12	48	300%	271	2809	937%
Doors, windows	36	144	300%	1520	8242	442%
Closet, showcase, dining set, nightstand	30	186	520%	1880	3062	63%
Meat and vegetable pastry	6000	45000	650%	1485	5262	254%
Exchange Rate: approx. Bs 4.80 to US\$ 1.00 during 1995						

Table 2. Number of loans listed by ranges of amount of loan

Amount (US\$)	Qty of Loans
4,001 - 6,500	3
3,501 - 4,000	2
3,001 - 3,500	3
2,501 - 3,000	1
2,001 - 2,500	2
1,501 - 2,000	5
1,001 - 1,500	8
501 - 1,000	32
66 - 500	45
Total	101

Table 3. Quantity of loans given listed by activity of the productive use

Productive Use Activity	Quantity
Potato Chip Makers	2
Market sales stalls	2
Juice Stands	2
Blacksmiths	5
Metal-working Shops	5
Shoemakers	7
Carpenter Shops	16
Clothing Makers	21
Others	23
Total	83

3.2 *Valles Cruceños*

Using USAID funds, NRECA helped to finance the Valles Cruceños project in conjunction with the regional government and CRE, the rural electric cooperative that has the concession for the city of Santa Cruz. The project cost about \$5.5 million and connected approximately 5,500 end-users in over 40 villages and small towns. NRECA provided technical assistance to CRE for launching and promoting a productive uses program. Based on the positive experience with stores opened by electric cooperatives in Chile, CRE opened a productive uses store called CREAGRO in the project area. Certain electric cooperatives in Chile began by selling goods directly related with electricity then expanded to the point of selling everything from toothpaste to automobiles.

Obviously, it is no small task to launch into a new activity. It required significant investment on the part of CRE to buy a house in the town of Mairana, outfit it as a store, stock the store, hire and train personnel, and cover the losses associated with start-up. At the end of September 1998, the author learned that CRE had decided to close the productive uses store in the Valles Cruceños (and the other stores that CRE had opened elsewhere). Subsequently, in a conversation with the General Manager of CRE, the author was informed that CRE decided to shut down the stores for legal reasons. A clause in the New Electricity Law states that utilities can use the electric bill to charge only things directly related with providing electricity and garbage collection services. The productive uses stores had been successful, but the law undermined the best leverage they had for having people pay back their loans – cutting off their electricity if they did not pay.

Another component of the productive uses work in the Valles Cruceños consisted of electrifying sugar cane crushing machinery. There were at least 50 small cane-crushing operations in an area known as El Chilon. They depended on internal combustion engines for to move the crushing equipment and on firewood to boil the cane juice to transform it into dense brown sugar blocks. The internal combustion engines were obvious sources of pollution and the use of the firewood was an even more sensitive ecological issue. The cane crushers bought firewood that was coming from a unique protected rain forest area. Therefore, a project was designed to have the internal combustion engines converted to electricity and to take advantage of the natural gas pipeline that came through the area for boiling the juice.

For the project, NRECA granted the productive uses money (about \$85,000) that PRODEM had returned from the successful Vinto loan program. That money permitted CRE to build the line extensions and service drops that would allow the cane crushers to convert from internal combustion engines to electric motors. To the author's knowledge, the component of substituting gas for firewood has not been concluded yet.

3.3 Chapare

The Chapare has become infamous because of its reputation as a coca growing and drug processing area. The United States Agency for International Development (USAID) in collaboration with the Government of Bolivia has designed a program intended to create an alternative economy in the region. NRECA success in rural electrification projects has been tapped to carry out three stages of identifying and connecting area industries and communities to the grid.

Under Chapare I, NRECA built over 19 km of line and installed service drops with transformers ranging from 10 to 250 kVA to connect 41 industries. Under Chapare II 21 connections were made including both industries and communities. Transformers ranged from 5 to 50 kVA. The Chapare II project included technical assistance to small dairy farmers. NRECA personnel met with the farmers on various occasions and visited some of their small farms, their milk collection and cooling facilities, and the dairy processing plant to which they sell their milk. An experimental extension farm in the area was also visited. Based on the information obtained, detailed spreadsheets of costs and potential profits were prepared and explained to the farmers. Based on priorities identified by the farmers, NRECA also supplied cost information for tractors and electric milking equipment with ideas regarding how they could contact suppliers and purchase the equipment on credit. Chapare III is now in progress and is scheduled to conclude by the end of 1998.

3.4 *Licoma – Mina Chilaya*

The Licoma – Mina Chilaya project is an example of how one large productive use made an entire project financially viable. The productive use was a gold and antimony mine, Mina Chilaya. NRECA did the prefeasibility study for the project to determine the viability of electrifying three remote rural villages and the mine (Kittelson, et al, 1995). The results made it obvious that it was not financially viable to electrify only the villages. The mine, however, used diesel generators and a least cost useful life cycle analysis showed that the mine was much better off paying for a line extension from the grid. The mine and the electric utility reached an agreement on how much the mine would contribute and NRECA contributed the money that made it possible to tap into the three phase line to the mine to connect the villages.

3.5 *Renewable Energy Projects*

NRECA has implemented various renewables projects around the world. One of the most recent examples is the work in Chile under contract with NREL to implement hybrid wind projects that have benefited schools and health posts, besides the village households. In Bolivia, projects have included solar, wind and biomass technologies. The biomass plant in Riberalta, which is a 1 MW unit fueled by brazil nut shells and waste wood, has permitted the greatest productive activities. The electric cooperative in Riberalta has a significant industrial and micro-enterprise load. The wind project was exclusively for pumping water for a village water supply system. Solar energy has been used for village water systems, powering a satellite TV dish (the owners of which charge an entrance fee to viewers), school systems for lighting, audio-visuals, and learning-at-a-distance programs. Though there are many who will argue for the long-term benefits of renewable energy, the fact is that its current cost per kW installed drives large productive users to find alternative energy sources with lower initial capital costs.

4.0 KEY FACTORS FOR PRODUCTIVE USES PROGRAMS

In this section the author summarizes the lessons learned from the productive uses programs described above. An effort is made to make the conclusions internationally applicable.

Successful productive uses of electricity programs depend on a combination of key factors. If any particular factor is weak or missing the program will either fail or be significantly less successful. Those factors are: 1) reliable and affordable electricity, 2) available and reliable electric tools and equipment, 3) available and affordable financing, 4) available and qualified human resources, and 5) sufficient demand for the product or service. Obviously, other factors such as the legal framework, government stability, and the national economy affect the success of these programs, but those issues are more country-specific and will not be addressed in this section.

1) Because the tendency has been to emphasize the end-user in productive uses programs, the author also wishes to point out the importance of considering the utilities. Bear in mind that reliable and affordable electricity is a key element. Yes, the profit of utilities must be kept within reasonable limits, but they also have a right to make a profit and one must remember that if the utility is not financially healthy, sooner or later there will be problems with the reliability of the service. Moreover, it does not take much imagination to think about how extended outages impact on productive uses that have frozen chicken or ice cream in storage.

NRECA has worked extensively with electric cooperatives and utilities to help them provide reliable service to productive uses. In general, the utilities like to attract and retain large, stable industries that consume thousands of kilowatt-hours monthly. They can also be convinced to participate in productive uses programs where end-users have smaller consumption, as discussed below. Nevertheless, they have to keep the bottom line in mind. Utilities cannot be philanthropic beyond their means and still stay in business to provide reliable power.

2) Reliable electric equipment is not always readily available in remote areas. Equipment can be brought in to jump-start a productive uses program, but that does not solve the ongoing need for adequate maintenance and repair services with readily available spare parts.

3) In many cases credit exists, but there have been annoying and discouraging obstacles to actually having access to it. Large enterprises with the proper clout and assets for guarantees have more alternatives available to them. In recent years, micro-credit programs have been widely implemented with varying degrees of success. In Bo-

livia, PRODEM has been one of the most successful, but even it has not gotten out into remote rural areas.

4) The author considers the need for qualified human resources to be the paramount factor in the success of a productive uses program.

5) One of the most difficult things to address is demand for the products and services of the productive uses. It is impossible to control, much less guarantee, a market. Nevertheless, one can at least avoid making overly optimistic projections. It usually does not take much market research to determine if projections are reasonable.

5.0 CONCLUSIONS

A productive use is any use of electricity that generates income for the end-user. It may be a huge cement factory or a tiny juice stand with an electric blender. Electric cooperatives and utilities must watch their bottom line. They are obviously interested in attracting and retaining those productive uses that consume thousands of kWh per month. While they can be convinced to participate in programs that cater to micro-enterprises, their philanthropic efforts must remain within reasonable limits if they are to continue to provide reliable electric service.

Five key factors must exist in order for productive use programs to be successful: 1) reliable and affordable electricity, 2) available and reliable electric tools and equipment, 3) available and affordable financing, 4) available and qualified human resources, and 5) sufficient demand for the product or service. Many productive uses programs have concentrated on only one of the five factors mentioned above, but for the program to succeed the other four have to exist. It does not mean that a program must build all five from scratch, but program implementers must ensure that the other components already exist in the target area or that the appropriate linkages can be forged with other actors that can make them available. The author considers that of the five, qualified human resources is the most important.

Finally, no matter how carefully something has been planned, there are inevitably unforeseen issues that arise. One must learn to be flexible and be prepared to make timely adjustments in order for the program to generate the greatest benefits.

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