

Comparing Urban and Rural Telecenters Costs

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Abstract

If deployed in both urban and rural areas, telecenters can decrease the gap in social services and economic opportunities that often exist between the two. However, establishing and operating rural telecenters is perceived to be more costly than urban ones. This paper presents a cost comparison of establishing urban and rural telecenter in Costa Rica. It shows that telecenter operations in rural areas disconnected from the power and telecommunication grids may not be significantly more expensive than those of an urban telecenter. Utilization of stand-alone communication and power systems, combined with low-power equipment can bring rural operating costs within range of those of a typical urban telecenter. The analysis is based on the Little Intelligent Communities (LINCOS) telecenter project, an initiative of the Foundation for Sustainable Development of Costa Rica.

Introduction

Over the past several years, a diverse range of facilities providing access to information and communication technologies has been established in the developing world. Telecenters offering phone, Internet and community services can now be found in some of the least-developed countries. If established in both urban and rural areas, telecenters can decrease the gap in social services and economic opportunities that often exist between the two.

The geographic spread of telecenters, however, has not been uniform. They are primarily located in major cities, where the required infrastructure exists and potential client base is large. For the countless rural communities without power and phone lines, significant obstacles can stand in the way of access¹:

- Scarcity of technical personnel
- Severe climatic conditions that make critical demands of the equipment.
- Low population density
- Low per capita incomes

¹ *Preparation of Handbooks for Developing Countries: New Developments in Rural Telecommunications*. (Geneva: ITU, 1999) 6.

- Lack of communications and power infrastructure

Establishing a rural telecenter is perceived as being more costly and risky than an urban one. As urban areas increasingly connect to global communication networks, the gap in opportunities between urban and rural regions will further increase. It is already the case in many developing countries that all Internet users reside in major cities².

Given the significant social and economic benefits rural telecenters can provide, a closer look at their costs is warranted. This paper presents a cost analysis of a telecenter deployment in urban and rural Costa Rica. It shows that operation in rural areas that lack access to power and telecommunication grids may not be significantly more expensive than urban areas. Utilization of stand-alone communication and power systems, combined with low-power equipment can bring rural operating costs within range of those of a typical urban telecenter. The analysis is based on the Little Intelligent Communities (LINCOS) telecenter project, an initiative of the Foundation for Sustainable Development of Costa Rica.

The paper begins with an introduction to the LINCOS project, and a description of a LINCOS deployment in a rural agricultural community in the Dominican Republic. Two configurations of the telecenter are presented, one each for urban and rural locations. Alternative power and telecommunication systems are proposed and their costs determined. Finally, estimates of the total initial and ongoing costs of both telecenters are discussed.

Little Intelligent Communities

The LINCOS project is an initiative of the Foundation for Sustainable Development of Costa Rica. Founded by the former president of the country, Jose Maria Figueres, the Foundation aims to promote social, cultural and economic development. Through a number of innovative projects, it works with communities to improve their immediate conditions and facilitate a transition towards rich and sustainable community life.

LINCOS is one of the Foundation's key initiatives, and seeks to redefine community life in the 21st century. The project has been developed in collaboration with a wide range of educational and private sector institutions including:

- The Media Laboratory at MIT
- Instituto Tecnológico de Costa Rica
- University of Rochester
- Universidad Estatal a Distancia
- Universidad Autónoma de Santo Domingo
- Universidad Nacional
- Denver University
- University of West Florida
- Grupo AVINA
- Microsoft
- Hewlett Packard
- Becton Dickinson

² *Challenges to the Network. Internet for Development.* (Geneva: ITU, 1999) 26.

LINCOS is an innovative multi-purpose community telecenter that integrates a variety of services and multimedia applications to empower community development. It is configurable for both wired and wireless operation, allowing it to be deployed in any part of the world.

The telecenter is housed in a standard 20-foot shipping container and protected by a tension structure from storms and hurricanes. The container serves the dual purpose of protecting the equipment and allowing for easy transport to rural locations.



LINCOS telecenter in Bohechio

Deployment sites are chosen based on an analysis of the potential community's infrastructure and needs. Meetings with local leaders and community members are held to explain the project and determine their level of interest and commitment. Communities work with the Foundation to determine which services should be available in the telecenter. The choice of services include:

- a six-terminal computer lab with office applications and internet connectivity
- a local wireless telephone network connection
- a business center with a printer, scanner and fax
- a telemedicine laboratory offering electrocardiogram and blood pressure testing
- soil and water testing equipment to support local agricultural activities
- community television, public phones, local radio and videoconferencing

Currently, one LINCOS unit is in operation in Costa Rica and three in the Dominican Republic. Over the next several years the Foundation hopes to deploy a further thirty units in the Dominican Republic, one in each province. They are also working with the Inter-American Development Bank to install five in each Central American country.

LINCOS Bohechio

One of the first operational LINCOS sites is in Bohechio, an agricultural community in the Dominican Republic. The town, consisting of 600 households, is located 40 kilometers from the regional capital San Juan and 220 kilometers from the national capital Santo Domingo.

In a recent study of the community, the following issues were raised as critical to local development:

1. An improved water pump. Currently, water is pumped into the town for two hours every morning between roughly 8 and 10 a.m., and one hour in the afternoon at some time between 3 and 5 p.m.
2. A stable power supply. Short but frequent blackouts occur in Bohechio, as in the rest of the country. Every evening the power level drops.

3. More productive land. Government expropriation of land near Bohechio to build a hydroelectric dam together with recent hurricanes has decreased the quantity and quality of land available to farmers.
4. Finished road to Guanito. The road to Bohechio intersects one of the main east-west highways at the town of Guanito. Parts of this 20-kilometer stretch of road are unpaved and difficult to drive.
5. New sources of employment. The town has experienced an increase in migration to the cities in the past few years.

Expectations are high in the community that LINCOS will substantially improve their opportunities and standard of living. The residents are very enthusiastic and many believe it to be the best thing to happen in Bohechio for several years. Below this enthusiasm, however, there is a strong demand for education and awareness. Few of the adults in Bohechio have visited the site for reasons other than making a phone call. Most do not understand how to operate the computers, Internet or fax, or the benefits that could derive from their use.

In operation since mid-June, LINCOS receives 150 people per day, of which 75 use the phone, 45 the computers, and 30 other services such as the copier or scanner. The majority of the computer users are students, although the town council is organizing a campaign to attract people from other segments of the community. Interest in the telecenter has spread beyond the town to the Bohechio region and into the capital of San Juan. In a rare reversal of traffic, a farmer from the regional capital visited Bohechio to conduct soil tests since no similar equipment was available in San Juan.

Prior to installation of the telecenter, a local business was the exclusive provider of phone and cable television service in the town. LINCOS has introduced significant price competition for outgoing calls. Calls to Santo Domingo can be made for 3ps/minute (17ps = \$1 US) at the LINCOS box, compared to 5ps/minute at the phone shop. Employees of the phone shop have estimated that the number of outgoing calls they serve has been halved because of LINCOS. Demand for the new telephone service has surprised many. Tricom, a local exchange carrier who operates the phone line, has not been able to supply phone cards fast enough to meet local demand. The town has already begun to lobby for more phone lines, and eventually the mayor hopes LINCOS will bring residential phone service to all houses in Bohechio.

Local Infrastructure in Bohechio

The telecenter in Bohechio is connected to the local power grid, uses a satellite connection for data communications and a cellular connection for voice telephony. Currently, both power and data services are fully subsidized by the government.

LINCOS operates seven days a week from 8 a.m. to 6 p.m. Every evening the power level in Bohechio begins to fall. In order to continue operation of the telecenter past this time, its manager must start-up a diesel power generator. This costs 100ps to operate for four hours, beyond the current operating budget of the telecenter. As a result, evening use of the telecenter is limited to weekends.

Discussions have begun among the community leaders to determine appropriate prices to charge for the telecenter services. The council agrees that prices must be affordable to all in the community. However, there is concern that if subsidization of the power and data connections ends, prices will be forced unreasonably high.

Estimating the Cost of Urban and Rural Telecenter Deployment

A model is presented to compare the cost of operating LINCOS units on and off the power and telecommunication grids. The on-grid configuration assumes that power and communication lines are accessible and can support a sufficient level and quality of service. The off-grid configuration utilizes a satellite connection and a solar energy system. While the paper focuses on these two extreme cases, results from intermediate configurations are provided in the Appendix.

Base Telecenter Cost

The base cost of the telecenter reflects all expenses from assembly to installation in the host community.

Key elements include:

Equipment

- LAN equipment
- Desktop computers
- Monitors
- Telemedicine equipment
- Teleconferencing equipment
- Scanner/fax/printer
- Satellite Dish
- Soil/water test kits

Configuration and Installation

- Community assessment
- Feasibility analysis
- Software/hardware installation
- Unit construction/packaging
- Unit transportation and installation
- Final test and quality control

Labor and Miscellany

- Training
- Project personnel
- Office supplies
- Research and development

For a LINCOS configured to provide all available services, the base cost is estimated to be \$102,100.

Estimating Power Consumption

Understanding the power consumption needs of the telecenter is critical for configuration planning. Unless a stable and reliable grid connection is available, both primary and backup power systems must be carefully selected. This is already an issue in Bohechio, the community cannot lengthen the operating hours of the telecenter without exceeding their budget.

The power consumption estimate for the telecenter is a function of the power requirements of each piece of equipment and the expected length of operation each day. In an eight-hour day, a 25-watt light bulb consumes 200 watt-hours of power (25 watts X 8 hours), and a single LINCOS desktop and monitor 1,840 watt-hours. In total, the telecenter requires 14,700 watt-hours of power per day.

Results show that the bulk of this amount is consumed by the computers and monitors:

	Daily Use in Watt-Hours
Computers	7,400
Monitors	3,800
Network	1,800
Other Equipment	1,700
<i>Total</i>	<i>14,700 WH</i>

Power Consumption with Computers and Monitors

In rural areas, where stand-alone power systems may be required, it is useful to consider low-power computer equipment. A 70% decrease in total power consumption can be achieved by replacing desktops and monitors with laptop computers. Laptops are designed to be energy efficient and can run for hours from rechargeable batteries. A further power savings is gained by using an inkjet printer rather than a laser printer.

	Daily Use in Watt-Hours
Laptop Computers	1,300
Network	1,800
Other Equipment	1,000
<i>Total</i>	<i>4,100 WH</i>

Power Consumption with Laptops and an Inkjet printer

With this configuration, the total base cost of the telecenter increases to \$104,400. The following analysis will show, however, that the higher cost is more than offset by savings in stand-alone power systems.

Power Supply Alternatives

For operation both on and off the grid, LINCOS units need a steady and reliable power supply.

On the Grid

Where available, connection to the power grid is the least expensive source of power. In Costa Rica, the government offers LINCOS the same rate for electricity paid by educational institutions, four cents per kilowatt-hour consumed. Based on the power consumption estimated above, the annual power cost is \$60. In many developing countries, however, both urban and rural areas connected to the power grid experience frequent power fluctuations and blackouts. LINCOS is equipped with an Uninterruptible Power Supply system that regulates the flow of power to the equipment and acts as a short-term power backup. However, this is not sufficient protection for all environments. In the town of Bohechio, for example, a diesel generator is used since the power level drops for hours on end. Therefore, the costs of a small diesel generator and a supply of fuel are included in the total grid cost.

	Cost
Generator Cost	\$1,800
Annual Fuel Cost	\$200
Annual Electricity Cost	\$60
<i>Total Initial Cost</i>	<i>\$1,800</i>
<i>Total Annual Cost</i>	<i>\$260</i>

Power Grid Costs

Off the Grid

Where the grid is not accessible, a range of stand-alone power sources must be considered. Photovoltaic cells, wind generators, diesel generators and hydro turbines are all potential solutions for rural power generation. In selecting between these, cost, maintenance, local geography and environmental impact must be taken into consideration. Accordingly, the following proposed alternatives were eliminated:

- Wind generators were determined to be too large and prohibitively expensive. Additionally a constant wind flow is not found in all regions of Costa Rica.
- Diesel generators are both reliable and inexpensive, but require that additional fuel be supplied on a continuous basis. They also create both noise and gaseous pollution.
- Hydro turbines, small hydro-power plants, are limited by the topography and rainfall of their given location. Given the geographic diversity of Costa Rica it is not appropriate in many areas.

A solar photovoltaic (PV) system is preferred as it best balances cost and functionality. Solar panels are extremely durable and require little or no maintenance. Unlike generators, they do

not create noise or gaseous emissions. They work by directly converting the sun's energy into usable electricity. The number of panels needed depends on the availability of sun in the region and on the amount of power required by the telecenter. A full PV system consists of:

- Solar panels to capture the sun's rays and convert them to electricity
- Inverters to convert the current into a form usable by appliances
- Rechargeable batteries to power the telecenter when the sun is down
- An optional natural-gas generator to provide backup power in case of prolonged overcast or rainy days

When deployed for a sophisticated telecenter such as LINCOS, a PV system will significantly increase the initial investment cost. However, by choosing low-power equipment, the cost of the PV system itself can be minimized.

Furthermore, given the long lifespan of solar panels, ongoing costs for the system are negligible.

	Cost
PV Panels	\$8,000
Batteries	\$6,300
Inverter	\$6,000
Generator	\$1,800
Annual Fuel Cost	\$200
Annual Electricity Cost	\$0
<i>Total Initial Cost</i>	<i>\$22,100</i>
<i>Total Annual Cost</i>	<i>\$200</i>

PV System Costs

Telecommunication Costs

Communications is the most significant recurring cost for telecenters, whether they are located on or off the grid. Determining the bandwidth needs for a telecenter requires consideration of the number of computers connected to the network, the services provided, and the quality of service acceptable to the community. While people surfing the Internet may not mind waiting for images to form on the screen, rural doctors videoconferencing with experts will want continuous audio and video.

The application in LINCOS that requires the fastest communication speed is videoconferencing. In Costa Rica they have tried videoconferencing at 300 bit-per-second (bps) and have found the results unacceptably slow. Accordingly, we base our cost estimate on a 2 megabit-per-second (Mbps) connection, sufficient to support a reasonably continuous flow of text and images. For both on and off the grid connectivity, the price of a dedicated data connection is estimated. This connection can support voice traffic, but requires that it be bridged onto the telephone network. The alternative is to operate separate lines for data and voice traffic, with the data line linked to the Internet and voice to the telephone network.

On the Grid

Where available, a leased line data connection to the telecommunications grid is a viable means of data connectivity. A leased line will provide a direct connection between the telecenter site and the Internet through an Internet Service Provider (ISP). Initial costs are often high due to the labor required to configure the connection. If supplied through Radiografica Costarricense, the primary ISP in Costa Rica, the cost of a 2 Mbps leased line is as follows:

	Cost
Installation	\$1,100
Annual Usage	\$20,400

Telecommunication Grid Costs

Additional lines to service voice calls costs \$50 to install and \$2400 per year, assuming 100 local calls are made every day.

Off the Grid

Leased line service is typically only available in urban areas. Where this is the case the wait time required for installation is prohibitive, alternate forms of telecommunications access must be considered. Options include radio, cellular and satellite networks. Selection between these depends on the services available in the telecenter location.

It is currently the case that in many rural areas of the world satellite is the only available service. For economical off-the-grid connectivity in Costa Rica, a very-small aperture terminal (VSAT) connection through Tachyon is considered. Tachyon is a low-cost reseller of unused satellite bandwidth. Connection to their network requires a small satellite dish to send and receive data, a coaxial cable between the satellite and telecenter, and a computer and satellite modem connected to the telecenter computer network. Tachyon routes data traffic directly from the telecenter to their satellite and on to a high-speed connection point on the Internet. Because the Tachyon network is designed specifically to deliver Internet data, it offers high-speed data communications in the range of 6 to 8 Mbps, with a maximum speed of 45 Mbps. The variability depends on the total utilization of their network at a given time.

	Cost
Installation	\$500
Satellite Dish	\$5,300
Computer	\$900
Annual Usage	\$18,000
<i>Total Initial</i>	<i>\$6,700</i>
<i>Total Ongoing</i>	<i>\$18,000</i>

VSAT Costs

While initial costs are significantly higher for a VSAT connection than a grid connection, annual usage costs are lower. For timeframes greater than two years, the satellite system is less expensive than a leased line. If separate voice and data service is preferred, other satellite service providers must be considered.

Comparing the Cost of the Two Configurations

The following tables summarize the costs associated with the deployment and maintenance of a single LINCOS unit outfitted with laptops and a high bandwidth data connection. Figures reflect the base, energy and telecommunication costs, including a 20% replacement rate for all equipment.

On the Grid

	Initial Cost	Ongoing Cost
Base	\$104,400	\$11,400
Telecommunications	\$1,100	\$22,800
Power	\$1,800	\$300
Total	\$107,300	\$34,500

The initial cost of a connected LINCOS box is \$107,300, and the annual costs \$34,500, or \$2,900 per month. One clear benefit of an urban location is savings on installing power and telecommunications service, little initial investment is required. Ongoing costs are dominated by the bandwidth usage fee, and less so by the maintenance cost of the equipment.

Off the Grid

	Initial Cost	Ongoing Cost
Base	\$104,400	\$11,400
Telecommunications	\$6,700	\$18,000
Power	\$22,100	\$200
Total	\$133,200	\$29,600

Initial costs for the stand-alone LINCOS is \$133,200, 25% higher than the connected one, due to the cost of the VSAT and PV equipment and installation. Ongoing costs, \$29,600 per year or \$2,500 per month, are slightly lower, primarily because the satellite service is less expensive than the leased line.

5-Year Cost Projection

Configuration	5-Year Projected Cost
On the Grid LINCOS	\$238,200
Off the Grid LINCOS	\$245,600

For a five-year operating timeframe calculated at a 10% discount rate, the stand-alone telecenter is marginally more expensive than a connected one. This is due to the high cost of the photovoltaic cells, 17% of the initial cost. As the Tachyon satellite connection is less expensive on an annual basis than a leased telephone line, the total difference in cost decreases over time.

Impact of Equipment Choice

	Off the Grid - Laptops		Off the Grid - Desktops	
	Initial	Ongoing	Initial	Ongoing
Base	\$104,400	\$11,400	\$102,000	\$11,000
Telecommunications	6,700	18,000	6,700	18,000
Power	22,100	200	49,000	200
<i>Total</i>	<i>\$133,200</i>	<i>\$29,600</i>	<i>\$157,800</i>	<i>\$29,200</i>

Replacing the eight desktops and monitors in the telecenter with laptops has reduced the PV system cost by over half. However, as the laptops are slightly more expensive, equipment and maintenance costs are higher. Some disadvantages of laptops over desktops are that they are harder to expand, upgrade and repair. Thus, laptops may not be a feasible solution in communities far distanced from technical support.

Impact of Bandwidth Choice

	On the Grid		Off the Grid	
	Initial	Ongoing	Initial	Ongoing
Base	\$104,400	\$11,400	\$104,400	\$11,400
Telecommunications	300	6,600	6,700	5,600
Power	1,800	300	22,100	200
<i>Total</i>	<i>\$106,500</i>	<i>\$18,300</i>	<i>\$133,200</i>	<i>\$17,300</i>

The cost of the telecenter can be significantly reduced for both on and off the grid operations if a slower data connection is chosen. A 300 bps connection is considered, one-eighth the speed of the original choice. The annual difference in costs is \$12,400 for a VSAT connection, and \$16,200 for a grid connection. However, selecting a slower connection may exclude applications such as videoconferencing.

Conclusions

Implementation of stand-alone power and communication technologies can make telecenter expansion into rural areas affordable. Use of photovoltaic systems and low-power computer hardware minimizes the cost of powering telecenters. Low cost VSAT services can provide an economical alternative to wireline data connections. As rural telecenters are established

exploiting such stand-alone solutions, the benefits of the network society will increasingly extend to those who can most benefit.

Appendix

Complete Results

The following tables summarize the results of the cost analysis. Standard configuration denotes a telecenter equipped with desktops and monitors, and lean configuration one equipped with laptops. Low bandwidth is a 300 bps connection, and high bandwidth a 2 Mbps connection.

Standard Configuration – Low Bandwidth			
		Telecommunications	
		Telco Grid	VSAT
Power	Power Grid	\$173,200	\$176,200
	PV	\$210,200	\$221,600

Standard Configuration – High Bandwidth			
		Telecommunications	
		Telco Grid	VSAT
Power	Power Grid	\$235,500	\$223,000
	PV	\$272,500	\$268,500

Lean Configuration – Low Bandwidth			
		Telecommunications	
		Telco Grid	VSAT
Power	Power Grid	\$176,000	\$179,000
	PV	\$187,800	\$198,700

Lean Configuration – High Bandwidth			
		Telecommunications	
		Telco Grid	VSAT
Power	Power Grid	\$238,200	\$225,800
	PV	\$250,000	\$245,600

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