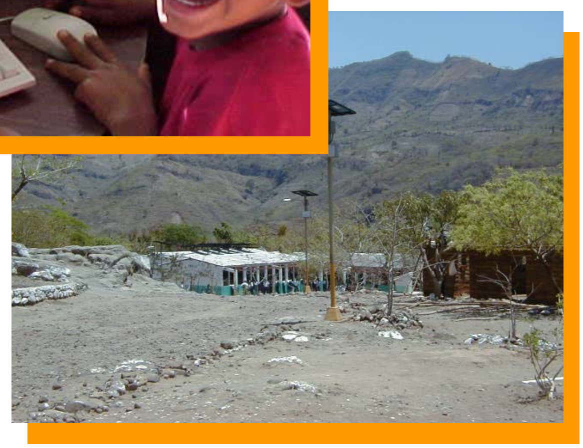

RURAL CONNECTIVITY AND ENERGY INITIATIVE
Program Design Phase

DRAFT REPORT – FOR COMMENTS
April 4, 2002

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Submitted to

Inter-American Agency for Cooperation and Development
Organization of American States

by

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Cover photo: Public school in San Ramón de Lempira, Honduras. Photo: Honduran Council of Science and Technology (COHCIT)

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EXECUTIVE SUMMARY

The Executive Secretariat for Integral Development of the Inter-American Agency for Cooperation and Development (SEDI/IACD), in collaboration with the Renewable Energy in the Americas (REIA) Initiative of the Organization of American States (OAS), is establishing a Rural Connectivity and Energy Initiative with the aim of supporting the use of information and communication technologies (ICTs) in rural communities in OAS Member States, thereby facilitating the provision of high value community services. The Initiative will work to identify, test, demonstrate, transfer and replicated "best practices" in the areas of energy, communications, and information technology systems, program and project design, high value applications of ICTs, and training packages for teachers and other personnel using or supporting rural ICT facilities. Collectively this "best practices" approach will enable Latin American countries to significantly advance the quality of community services in rural villages.

Winrock International is providing technical assistance to the IACD and the OAS Unit for Sustainable Development and Environment/REIA during the Initiative's Program Design Phase. Winrock has assisted with accomplishing two critical tasks leading to the launch of this Initiative: assessing the market conditions for the Initiative, and characterizing typical energy, telecommunication and information technology packages that meet the community service needs in the target communities. As a result of this effort, pilot projects will be designed and developed in one or more of the countries participating in this study; and a broad program description will be prepared and distributed to OAS Member States, highlighting the opportunities that exist throughout the region for the implementation of similar projects.

ICTs are a key enabler of access to knowledge and information, and are increasingly central in the effort to foster economic and social development. The positive benefits of ICTs generally fall into the categories of distance education and virtual research, health and wellness, increased access to information for economic development (e-commerce) and improved quality of life, agricultural development, e-governance, improved environmental information, and cultural and indigenous knowledge preservation. The OAS/IACD recognizes that ICTs can make unique contributions to rural economic and social development, while at the same time numerous factors render rural use of ICT more challenging. The OAS/IACD Rural Connectivity and Energy Initiative is designed to address the unique barriers to the rural application of ICTs. These applications are especially needed in rural areas, which often are without access to adequate or reliable electricity. In many cases, the use of environmentally sustainable renewable energy technologies—such as solar photovoltaics (PV)—are appropriate in facilitating these ICT-related services.

Chapter 3 reviews some of the key issues surrounding the application of ICTs for telecenters, distance education, agriculture and telemedicine/health. Telecenters have emerged in the last ten years as the primary means for providing public access to a range of telecommunications services and particularly the Internet. Various policy and program issues can advance or constrain the deployment of ICTs and telecenters in rural areas. Particularly important are the "universal access" policies of national governments and telecommunication regulators. Increasing evidence is mounting for the role of the telephone as a primary revenue driver in rural telecenters and other ICT applications. Rural populations continue to identify telephone service as their primary ICT-related need, and it has been shown that telecentres without phones are less likely to achieve financial sustainability. Policy measures such as liberalization, tariff reform and fair interconnection agreements are fundamental to achieving universal access.

Ten elements are identified as common among successful rural ICT interventions, including: 1) conducting preliminary participatory communication and information needs assessments with intended users; 2) ensuring ICT applications are demand-driven; 3) employing a strong awareness building campaign; 4) identifying and supporting local “champions;” 5) building strong strategic partnerships to ensure all project objectives are met; 6) ensuring sustainable operation and management of telecenters; 7) providing capacity-building for telecenter staff and clients; 8) employing appropriate and user-friendly technology and putting in place a sound technical support system; 9) promoting sustainability; 10) and monitoring, evaluating and sharing experiences.

In recent years a great number of ICTs have been developed for and applied to the improvement of rural education programs, completely changing the foci and increasing the efficiency of traditional distance education models. This has given way to a greater number of and better educational tools to meet the educational needs of child and adult students at a variety of different levels in rural areas. There are several models of distance education and other rural education programs that make use ICTs to improve the delivery of rural education, including: a) interactive radio instruction (IRI), b) Internet use in schools, c) School Linking, d) Virtual Schools, and e) Telesecundarias. A wealth of materials has been developed to support these programs.

Information is an important input to the business of agriculture. The growing pressure of competition in the global market has created a growing need for farmers to access local, national and international market information, to interpret this information for making informed business decisions, to diversify their products and find new ways to market them. ICTs can be powerful tools for accessing this critical market and technical information, and broadcast media, the Internet and other ICT tools can be used very effectively by and for farmers in developing countries.

Recent developments in ICT have raised the hopes and expectations related to broader use of telehealth and telemedicine. Continuous advancements in the ICT sector, associated with the lowering of costs for ICT services and the integration of such technologies have made possible the introduction and use of telemedicine in an increasing number of rural and remote communities all over the world. Today, telemedicine applications range from the use of telephones to high-speed specialized data and video communication networks. Use of ICTs for real-time diagnosis and treatment is still expensive, particularly compared to the limited funding available for rural health programs, due to cost of doctors’ time and high bandwidth connectivity. ICT can support more efficient and effective management and operation of rural health services, however, in a number of “telehealth” applications that are less ambitious and expensive than telemedicine per se.

Chapter 4 outlines the process of selecting ICT and energy equipment packages—including wireless communications technology—for rural settings, highlighting the importance of conducting a thorough analysis of application requirements and site characteristics in order to determine a suitable wireless solution. This chapter also offers models of possible rural telecenter solutions that might be applied in Latin America, including ICT equipment, connectivity options and appropriately sized photovoltaic power systems, and gives cost estimates for the various options. The telecenter types modeled differ in the type and number of PCs (e.g., desktop vs. laptop, more energy efficient vs. less efficient) and telephone lines and the resulting magnitude of their bandwidth requirements.

Chapter 5 describes in some detail the rural electrification and rural telephony environments in the four target countries—Bolivia, Columbia, Guatemala and Honduras—as well as a brief examination of these sectors in Belize. The countries' current and proposed rural ICT initiatives are reviewed, with special attention paid to rural distance education programs, telecenters, development efforts and programs harnessing ICT tools for rural economic development. Rural ICT opportunities in the various sectors are identified, and broader policy and institutional issues are explored.

Conclusions and recommendations are provided in Chapter 6, and include:

1. There is a high demand for rural connectivity and energy.
2. There is an indirect relationship between the overall market conditions in a given country and the prospects for near-term activities under the Rural Connectivity and Energy Initiative.
3. Education programs play a key role in the application of ICTs to rural programs.
4. Voice telephony is critical in ensuring sustainability.
5. Content is also critical.
6. The impact of investments in rural ICT facilities and services will be maximized if this infrastructure can support multiple sectors.
7. The OAS/IACD should identify and pursue its specific niches in rural ICT development.
8. Developing country rural ICT activities are at a very early stage of development.

1. INTRODUCTION

The Executive Secretariat for Integral Development of the Inter-American Agency for Cooperation and Development (SEDI/IACD) in collaboration with the Renewable Energy in the Americas (REIA) Initiative of the Organization of American States (OAS) is establishing a Rural Connectivity and Energy Initiative with the aim of supporting the use of information and communications technologies (ICT) in rural communities in OAS Member States, thereby facilitating the provision of high-value community services.

The Initiative recognizes the following characteristics of this emerging market, which serve as the motivating forces behind the effort:

- There is a significant unserved rural population, whose economic development is limited by the absence of this basic infrastructure.
- Advanced wireless technologies offer commercial solutions for infrastructure development without building new telephone and electricity grids.
- OAS Member Government agencies demonstrate significant interest in developing rural ICT projects and programs, but recognize that their resources are severely constrained, and that they are at an early stage in effectively applying ICT to rural economic and social development.
- Several leading technology and service providers have expressed interest in catalyzing commercial business opportunities associated with this market.

This Initiative will support use of appropriate advanced energy generation and storage systems, telecommunication systems and information technology packages including computers with Internet connection. The Initiative will work to identify, test, demonstrate, transfer and replicate "best practices" in the areas of energy, communications, and information technology systems, program and project design, high value applications of ICTs in areas such as education and enterprise development, and training packages for teachers and other personnel using or supporting rural ICT facilities. Collectively this "best practices" approach will enable Latin American countries to significantly advance the quality of community services in rural villages.

The OAS has collaborated with UNESCO in the development of two pilot projects intended to demonstrate the potential application of these technologies in remote regions of Honduras. These projects clearly illustrate the tremendous impact that the delivery of modern electricity and communications services can have on isolated villages, and have catalyzed larger investments in Honduras currently in the planning stage. It is the intention of the OAS to establish an initiative which makes such services broadly available in the hemisphere, while addressing the key concerns associated with system cost, operation, delivery, and other key factors associated with program and project sustainability.

This initiative is also designed to help enable the IACD to achieve it's objective to become a leading supplier of technical cooperation and training in the region to accelerate the pace of economic development and to address the issues of poverty reduction and social imbalances, and that it seeks to achieve that mandate by developing projects that attract private sector experience and financing so as to expand beyond traditional grants and thus leverage available project funding.

Objectives

This initial design phase for the establishment of the *Rural Connectivity and Energy Initiative* has sought to accomplish two critical tasks leading to the launch of this Initiative:

1. Assessment of the market conditions for the Initiative. This includes an analysis of the total unmet need in the target countries for rural electrification and telephony services, identification of high value applications and projects consistent with national priorities and programs, a preliminary review of the interest among the relevant government ministries (Ministers of Education, Health, Energy, etc.) to initiate national or pilot programs and to work with the OAS/IACD, and recommendations regarding cost recovery strategies and mechanisms designed to enhance the sustainability of the projects. It also includes a review of efforts being undertaken by other international organizations and national agencies and organizations, in order to identify potential collaboration opportunities and in order to better identify the most useful areas of niches for IACD support and possible overlaps with other agencies' efforts.

2. Characterize typical energy, telecommunication and information technology packages that meet the community service needs in the target communities. This includes a description of various systems components and configurations, which may be selected as appropriate for different communities and applications. Typical equipment packages and related power systems are defined, including satellite (VSAT) and wireless technologies. Complete rural energy/telecommunications packages are described, along with infrastructure, operation, maintenance, and other data inputs. Equipment costs are identified, and broad range estimates for service costs, including space segment costs, are provided. One of the key issues addressed is the importance of selecting appropriate ICT equipment for rural facilities, and the severe cost impact of selecting inappropriate ICT equipment resulting in unnecessarily large and expensive power systems.

This study focuses primarily on four countries—Guatemala, Honduras, Bolivia, and Colombia—and also includes information on Belize. OAS/IACD intends to utilize the data from five countries as a model for engaging other OAS Member States in this initiative.

This study is critical to advancing the development of this Hemispheric Initiative at the OAS. As a result of this effort, two key activities will follow: 1) The design and development of approximately 10 pilot projects to be built in one or more of the countries participating in this study; and 2) The preparation of a broad program description intended for distribution to all of the OAS Member States, highlighting the opportunities that exist throughout the region for the implementation of similar projects.

The Executive Secretariat for Integral Development of the Inter-American Agency for Cooperation and Development ("SEDI/IACD") entered into a cooperative agreement with Winrock International, under which Winrock worked with the IACD and the OAS Unit for Sustainable

Development and Environment/Renewable Energy in the Americas (REIA) on the Program Design Phase of the Rural Connectivity and Energy Initiative. Winrock is an independent non-profit organization with extensive experience in rural economic development, including rural renewable energy development, and assessment and planning of rural development and investment programs. The Telecommons Development Group, a Canadian consulting firm, also assisted in the preparation of this report. Winrock made an in-kind contribution equivalent for the implementation of the Program, consisting of staff time, travel expenses, and consultant fees and/or subcontract expenses incurred in the implementation of the Program. Sandia National Laboratories, a U.S. Department of Energy National Laboratory, also provided support for this investigation.

2. INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) FOR DEVELOPMENT

The level and pace of global flows of knowledge, information, and financial resources have been dramatically increased by the ability to connect vast networks of individuals and organizations across geographic boundaries. Industrialized nations with high levels of wealth and human development also boast a high degree of information and communication technology (ICT) penetration. ICTs are increasingly seen as a key factor in positive aspects of "globalization," and increasingly central in the effort to foster economic and social development. The poor themselves recognize this; studies have shown that if given the option, they are willing to spend over two percent of their income on telecommunications alone.[1] There has been significant activity and brainstorming over the past two years on issues related to ICT for development, including among the G-8 countries Digital Opportunities Task Force (DotForce) and related country-level dialogues, and the Digital Opportunity Initiative led by Accenture, the Markle Foundation, and the United Nations Development Programme (UNDP). While there is still considerable uncertainty about the nature of this relationship between ICTs and development, there is a general recognition among development professionals and practitioners of the development-related benefits ICTs have to offer, and the need to harness ICTs to contribute to the achievement of development goals.

ICTs can contribute to development goals at both the micro and national levels by increasing the effectiveness and reach of development interventions, enhancing good governance and lowering the costs of service delivery. Moreover, the right complement of targeted ICT interventions has the potential to play an even more substantial role in accelerating a sustainable dynamic of social and economic development in developing countries. ICTs can be a powerful enabler of development goals because its unique characteristics dramatically improve communication and the exchange of information to strengthen and create new economic and social networks (Box 2-1). These characteristics suggest that ICTs have the potential, if conceived as a means and not an end in itself, to be a powerful enabler of development. For example, allowing for income per capita (which is highly correlated with most measures of development, including telephones per capita), a highly significant positive relationship remains between the number of telephones per capita and both literacy rates and life expectancy.[2] Even people living in the poorest developing countries also have significant access to television.

However, access by the poor to ICTs—both "low tech," such as radios and telephones, and more advanced, such as computers and the Internet—remains limited, particularly in rural areas of developing countries, where more approximately 2 billion people lack access to reliable, affordable electricity. ICT development in rural areas will face a number of challenges related to scarce human resources (i.e., ICT-adept people located in rural areas), lack of electricity, and limited Internet connectivity, which, when it exists at all will often tend to be slow, unreliable, and expensive. Furthermore, ICTs should not be seen as a substitute for other development efforts. Rather, ICTs can be seen as a tool for strengthening complementing overall development

[1] deMelo (2000), as cited in Kenny et al. (2001), p. 20.
[2] Grace et al. (2001), as cited in Kenny et al. (2001), p. 21.

strategies by widening access to products and services, enhancing development efforts, and allowing for greater facilitating more efficient project implementation and impact monitoring.

Because information exchange is part of nearly every element of an economy, the impact of improvements in the capacity for information exchange will depend critically on how the rest of the economy functions. This suggests the centrality of a holistic approach in evaluating the impact of ICT development. This lesson should be of particular concern to policy-makers in the government services sector, as increased ICT use in government can only be successful as part of a larger reform effort.[3]

There are three primary ways to organize a discussion of ICT opportunities in sustainable development work, each useful and appropriate to a particular audience. First, when engaging private sector actors such as technology companies, it is useful to break down ICTs into specific technologies (e.g. personal computers, cell phones, PDAs, database-driven websites, etc.) and describe relevant development applications possible with each. Second, when discussing ICT opportunities with political actors responsible for specific localities (e.g. mayors, governors, local organizations) we can describe the ICT technologies plausible at particular levels of physical and human infrastructure (e.g. unwired, off-grid villages; wireless, on-grid villages; low, medium, high literacy; near/far town center). Third, when discussing ICT use with appointed officials or international organizations, one can break down ICT applications by "themes" in development (health, education, income, etc.), and suggest a variety of technologies and applications which can improve development prospects within each theme. This chapter will take the third approach, defining categories of development themes and identifying useful ICT applications in each. However, there are some critical cross-cutting issues to consider when implementing ICTs for development, and these will be discussed further below.

The positive benefits of ICTs generally fall into the categories of distance education and virtual research, health and wellness, increased access to information for economic development (e-commerce) and improved quality of life, agricultural development, e-governance, improved environmental information, and cultural and indigenous knowledge preservation. In this assessment of the high-value applications for telecommunication services, experiences will be grouped under these headings, although telecenters tend to be multi-purpose, and serve community needs across any number of categories.

[3] Kenny et al. (2001), p. 20-21.

Box 2-1: The Unique Characteristics of ICT

- ICT is *pervasive and cross-cutting*. ICT can be applied to the full range of human activity from personal use to business and government. It is multifunctional and flexible, allowing for tailored solutions—based on personalization and localization—to meet diverse needs.
- ICT is a key enabler in the *creation of networks* and thus allows those with access to benefit from exponentially increasing returns as usage increases (i.e. network externalities).
- ICT fosters the *dissemination of information and knowledge* by separating content from its physical location. This flow of information is largely impervious to geographic boundaries—allowing remote communities to become integrated into global networks and making information, knowledge and culture accessible, in theory, to anyone.
- The "digital" and "virtual" nature of many ICT products and services allows for *zero or declining marginal costs*. Replication of content is virtually free regardless of its volume, and marginal costs for distribution and communication are near zero. As a result, ICT can radically reduce *transaction costs*.
- ICT's power to store, retrieve, sort, filter, distribute and share information seamlessly can lead to substantial *efficiency gains* in production, distribution and markets. ICT streamlines supply and production chains and makes many business processes and transactions leaner and more effective.
- The increase in efficiency and subsequent reduction of costs brought about by ICT is leading to the creation of new products, services and distribution channels within traditional industries, as well as *innovative business models and whole new industries*. Intangible assets like intellectual capital are increasingly becoming the key source of value.
- ICT facilitates *disintermediation*, as it makes it possible for users to acquire products and services directly from the original provider, reducing the need for intermediaries. This can be a considerable source of efficiency, and is one of the primary factors leading to the creation of so-called "markets of one," leveraging ICT's potential to cater to the needs or preferences of users and consumers on an individual basis.
- ICT is *global*. Through the creation and expansion of networks, ICT can transcend physical barriers by providing individuals and groups the ability to live and work anywhere, allowing local communities to become part of the global network economy without regard to nationality, and challenging current policy, legal and regulatory structures within and between nations.

Source: Adapted from Accenture et al. (2001).

2.1. Improved Educational Services and Distance Education

Perhaps the most widely known application of ICTs for development is in education. The use of ICTs to improve education takes two main forms. First, ICTs can enhance the quality and efficiency of education available in existing schools by expanding teachers' and students' access to resources via radio, video, TV, computers, the Internet and so on. Second, ICTs can be applied to facilitate "distance education" in areas where desired educational facilities are either insufficient or non-existent, such as in remote areas or in situations in which the student does not live near the educational facility she/he desires to attend. In poor, remote areas, affordability and geography have been real barriers to access to quality education. Combining ICTs with broadcast technologies and thoughtfully designed content can be an extremely efficient and cost effective way to address the problem of shortages of teachers and physical materials. In some cases, this is more cost-effective than building new physical structures and infrastructures.

Technical and vocational training benefit similarly from thoughtful ICT design and delivery. Because ICTs can facilitate sophisticated and customized performance simulation at low marginal cost, ICTs are being employed by many organizations and vocational training facilities to train employees in a variety of subjects.[4] At the macroeconomic level, providing skills to develop a technologically competent work force facilitates a country's ability to compete in the global economy.

ICTs can benefit teachers and students in remote areas by giving teachers access to a menu of instructional materials and items for teacher training and professionalization. Many teachers in remote areas seek training in subjects outside of their traditional areas of expertise. Adequate connectivity to curricula repositories and teacher training sessions can allow remote teachers to cover topics and serve students better than they could without access to dynamically produced content. Teacher training and networked support groups deliver a high value per ICT investment and should be promoted early on in any educational connectivity initiative. Internet can be a valuable pedagogical tool. It is common now for teachers and students to interact via e-mail, and for students to use e-mail to interact with researchers, practitioners and other students around the globe.

Advanced ICT-enabled education has a particularly important role in empowering poor people with disabilities. Disabled people have, on average, lower enrollment and literacy levels than the rest of the population. Even standard ICTs can make it possible for disabled people to utilize mainstream educational opportunities, provided that they are designed to be more accessible to people with functional limitations. Assistive devices have opened up all kinds of new learning opportunities for people with visual or hearing impairments and for those with dexterity problems.[5] This may be especially important in war-torn areas of the developing world.

ICT-enabled educational programs are no substitute for quality teachers or educational materials, or safe and adequate school facilities. They require situations with adequate financing and technical support to ensure sustainability. Money spent on advanced ICTs should not displace money spent on textbooks, more teachers, building repair or more basic ICT-based education such as interactive radio instruction. While ICTs may be the most cost-efficient delivery tool for certain educational programs, it is likely that these cases will be rarer in poorer countries.[6]

2.2. Increased Access to Information for Economic Development

The introduction of new information and communication technologies (ICTs) such as telephones and the Internet provides rural people with tools, skills and information needed to compete on an economic level with others in their own country and around the world. These tools and skills can include everything from learning computer skills for employment eligibility to acquiring telephone, fax or email information on market prices in the capital city, other regional centers, or around the world. In developing areas, the savviest users of e-commerce applications in business often began as "social" Internet users who later adapted their skills to serve more economically practical and/or immediate needs.[7]

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[4] Accenture et al. (2001).
[5] Kenny et al. (2001), p. 31.
[6] Ibid, p. 31-32.
[7] Young et al. (2001).

ICT can help facilitate greater economic opportunities for people and enterprises by widening access to and efficiency of markets, allowing greater access to expanded economic networks, and creating new opportunities for employment. ICT can enhance rural productivity in a number of ways:

- By providing access to practical information on, for example, small business accounting, weather trends and farming best practices;
- By providing timely access to market information via communications networks to allow small entrepreneurs to make more informed decisions about where to do business, where to sell their products and at what prices, and where to get the best prices for inputs;[8] and
- By providing increased access to rural finance.

ICT use frequently improves business process efficiency and productivity. Business can reduce operational costs by decreasing material, procurement and transaction costs, resulting in lower prices for intermediaries and finished goods, and they can also use more and better information to improve the value of their output. ICT further facilitates global connectivity, resulting in new ways of creating and delivering products and services on a global scale. New business models and market configurations enabled by ICT, including business process outsourcing, value chain integration and disintermediation, provide developing countries with access to new markets and new sources of competitive advantage from which to drive income growth.

Radio remains a key source of trusted information for people in rural communities in Latin America and elsewhere. Community radio in particular, which often serves as an combination broadcast source, information center, and meeting place, and broadcasts in local languages, can play an important role in overcoming access barriers for rural people who have neither the language nor technical skills to be able to use the Internet effectively. Rural broadcasters with Internet access can search the Web for solutions to local problems, integrate the information into broadcasts which can be communicated in local languages. These broadcasters can also access pre-produced programs from a number of on-line sources.

A project in Bolivia called “Libre Ondas” integrates radio and Internet to enhance the impact and coverage of local radio programs produced by NGOs in Bolivia. Initially the network included one radio station in Eastern Bolivia and four NGOs, but it is expected to grow to include more radio stations, and reach an audience of 130,000 people. The project is in preliminary stages, so it remains to be seen whether it can be sustainable, given that it depends on annual funding of US$39,000 for the next four years. It is currently funded by the International Institute for Communication in Development (IICD).[9]

Community radio is key resource in developing countries for two reasons. First, radio operators and their stations represent critical concentrations of human capital and communications infrastructure in rural areas. ICT, while different, is not qualitatively dissimilar in requirements or complexity to the equipment these organizations already operate. In short, successful community radio sites present “best chance” locations for successful adaptation and use of ICT equipment. Moreover, community radio sites offer potential locations for village studios, where local organizations, artists, or others can produce digital content for the Internet and other media.

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[8] See www.pinoyfarmer.com for a sample of farming best practices, market trends, and price information.

[9] www.iicd.org.

In some cases, locally produced cultural content distributed digitally can signify new income sources for hitherto isolated communities.[10]

Recent advances in ICT also provide people with sensory disabilities an effective channel to access information and communicate with the rest of society. As a result, more disabled persons can become economically productive to their families, increasing disposable family income and improving their sense of dignity.

Finally, ICT accessibility can connect rural families more closely with overseas or migrant relatives. Monthly or semi-annual remittances already provide substantial income for some families and villages. Improved and lest costly communication can help coordinate better, reduce transaction costs, reduce family vulnerability to fraud, and offer increased security to migrants.

2.3. Agricultural Development

Although rural communities in developing countries remain disadvantaged in terms of access to fast and dependable connectivity, national telecom policies and programs, infusion of donor funds, and lower cost information technologies are creating new opportunities for rural people to join the information society. Information is an important input to the business of agriculture, and communication systems have been used very effectively by and for farmers even before the advent of the Internet. In fact, the use of radio to provide market information, extension service support, weather reports and other timely information is nothing new, and rural radio in Latin America has been a powerful tool.

However, the growing pressure of competition in the global market has created a growing need for farmers to access international market information, to interpret this information for making informed business decisions, to diversify their products and find new ways to market them. The Internet is a powerful tool for accessing this critical market and technical information, and because this is recognized throughout the agricultural sector, a significant demand has been created for improved telecom services in rural areas. Also, other challenges to accessing on-line information, not the least of which are language barriers, lack of training, cost of equipment and service, and illiteracy have stimulated a variety of innovative responses.

Broadcast media, particularly radio, has proven an extremely useful tool for agricultural development. For example, a survey of some of the 21,000 farmers enrolled in radio-backed farm forums in Zambia found that 90% found programs relevant, and more than 50% credited the programs and forums with increasing their crop yields.[11]

Examples of Agricultural Information Portals

In Ecuador, a World Bank funded agricultural portal has been developed to provide a variety of information services to producers. This project includes a service called Microinformativo Agropecuario, which provides radio broadcasts on cassette for a network of over 70 radio stations. The broadcasts, provided free of charge in both Spanish and Quecha, include

[10] For example, Greenstar.
[11] Dodds (1999), as cited in Kenny et al. (2001), p. 24.

information on commodity prices, farming tips, and weather, and are geared to two separate audiences—the coastal and Andean producers.[12]

Another agricultural information portal exists in Costa Rica. This, however, is only one part of a broader agricultural information system, supported by the Consejo Nacional de Produccion (CNP). Aimed at small and medium producers, INFOAGRO provides services through Internet, email, and GIS; training and awareness-raising in order to create an "information culture"; technology, to facilitate Internet access; and extension of information delivery through other media such as radio, television, print and extension services. INFOAGRO services are aimed to benefit farmers, agricultural institutions and organizations, local governments, civil society, research and teaching centers, agribusiness, national and private banks, exporters and importers, and organizations and businesses that support the agriculture sector.[13]

In Brazil, the Ministry of Science and Technology, National Research Council, and Institute of Information on Communications and Technology have teamed with local agricultural producers to produce "Verticalizing Portals" (vortals) designed to link producers, suppliers, and markets along entire agricultural production chains. The first vortal produced focused on cashew producers, and receives about 1000 visits per month.[14] The Brazilian vortal construction process is noteworthy for its extensive efforts to include all relevant stakeholders in the design and ownership of the site.

2.4. E-governance

ICT can help foster greater participation and political empowerment of the populace, and can help make government processes more efficient and transparent. Basic applications of ICT in the governance area break down roughly into a) citizen empowerment and rights, particularly for minorities, and b) improved administration.

Empowerment and rights

ICTs can play a major role in amplifying the voices of marginalized populations or those living in remote areas. E-governance is aimed at ensuring that common citizens have equal right to be a part of decision-making processes which affect them directly or indirectly, and influence them in a manner which best improves their conditions and the quality of lives. Experiences and experiments with this new form of governance work to ensure that citizens are no longer passive consumers of services offered to them, but rather allow them to play a decisive role in deciding the kind of services they want and the relative priorities of each.

Citizens are encouraged to participate in the democratic process through ICT mechanisms, such as electronic forums and bulletin boards, which enable participation in public discussions. This is especially relevant for marginalized communities and groups such as women, youth and ethnic minorities; they can share and exchange information of mutual interest, strengthen their collective power and help influence political and institutional decision-making processes.

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[12] www.sica.g.v.ec.
[13] www.infoagro.go.cr.
[14] www5.prossiga.br/caju/index.html.

Internet sites with material made available through multiple channels, including voice, paging, PDA and other mechanisms, can be essential for helping citizens understand their rights vis-à-vis government, police, employers, and banks. Early uses of the Internet by Amnesty International were highly cost-effective at raising awareness about human rights abuses. In the global push to promote democratic means of governance, much greater use is being made of websites, help lines, and other "modern" mechanisms to inform citizens of their new rights and to secure these rights.

Privacy will become an increasingly critical issue if ICT development in the Americas is to benefit communities effectively. In the rush to deliver equipment and launch websites, privacy policies and the protection of citizen information is frequently left "for later" and never revisited. Just as local corruption can divert financial flows from their intended purposes and protect the interests of the locally powerful, privacy corruption can channel sensitive information about citizens to those who would use it unlawfully. Carefully designed privacy policies and intellectual property protection will be critical aspects of successful e-governance. As local and regional organizations grapple with privacy issues, a pan-American "privacy resource center" to assist with models and best practices of privacy administration could prove highly effective.

Community portals can serve as a comprehensive and organized menu of services, directories, news, events, chat forums, and sometimes decision-making forums. A good example of a Community Portal is the Red de Informacion Comunitaria (RIC).[15] La Red de Informacion Comunitario (RIC) provides Internet access through community telecenters, but also provides locally relevant information, including government, social and commercial services, through well-developed and presented Web portals. The telecenters, located in public centers such as libraries, are linked to local municipalities, which provide resources, personnel and operational support. Each of the communities—all in the Region of La Araucania—can create an individual web portal, providing information on their local services, news, events, forums and resources, but with links to others in the network.

Administration

ICTs are also being used by local, regional and national governments for improving the delivery of government services. A good example of is the Projeto Alvorada initiated by the Brazilian government and implemented with help from Winrock International. Projeto Alvorada links the establishment of municipal access centers with the development of state and national portals to offer access to information and services—such as agricultural assistance and social security—which would ordinarily be accessible only miles away. An Alvorada website is expected to be launched shortly.

The main types of formal information areas for which ICTs can assist governance include:

- Information to support internal management, including staffing and budgeting accounts.
- Information to support policy and regulatory decision-making, including population, economic, financial and other data.
- Information made publicly available, including laws, statistics and health information.

[15] www.redcomunitaria.cl.

- Information to support public services, such as education, health and transport.[16]
- Information regarding effective governance processes, such as how to manage participatory planning and stakeholder meetings.

It should be noted that state and local governments may benefit particularly from professionalization programs and local government information distributed via internet. Local and state governments frequently represent concentrations of resources and skills sufficient to support ICT connectivity and use. At the same time, local and state government leaders are seldom flown around the world to conferences discussing the latest policy and governance techniques for achieving sustainable development. On-line material developed and targeted for this audience can deliver a powerful development resource to this otherwise neglected constituency.

Moreover, democratic transitions, fiscal decentralization, and increasing exposure to globalized markets and culture place new responsibilities on state and local government. Governors, mayors, and local legislators may not understand how to exercise their new powers, with what emphasis, on what priorities, while, at the same time, traditional management practices no longer apply.

While e-governance offers many benefits, there are also potential drawbacks that should be avoided. Introducing stand-alone and networked ICTs into local government systems can be very complex and expensive. Perhaps most seriously, ICT-based governance reforms backfire if those who need services are excluded by the technology due—as is usually the case in poor areas—to lack of access to the technology altogether, or if the technologies required to access the services are prohibitively sophisticated.

2.5. Improved Environmental Information

ICT can be used to collect, process and disseminate information between distributed locations, enabling a better understanding of issues such as climate change and biodiversity, and helping to monitor ecological conditions so that prevention and mitigation measure can be activated. ICTs are also being deployed to monitor and respond to natural disasters, thereby reducing developing countries' vulnerability to these events. ICT is also heavily used as an information and networking medium, informing citizens about important and timely environmental issues such as drought, and offering them a readily accessible way to make their views known to decision-makers. As discussed above, ICT can also be used to reduce the consumption of energy, water and other natural resources through more efficient agriculture and industrial procedures.

Particular opportunities are presented by the integration of ICT with community environmental monitoring, perhaps through relatively inexpensive ICT devices such as GPS, personal digital assistants, or cell phones. In many contexts, access to such devices confers an air of professionalism and modernity on the users, which instills a desire to utilize the devices to maximum effectiveness. The use of ICT monitoring and recording equipment by communities themselves can serve as a mechanism to educate and raise awareness about environmental interconnections and how degraded environments affect daily life and individual futures, as well

[16] Heeks (1998), as cited in Kenny et al. (2001), p. 27.

as facilitate a relatively inexpensive method for populating environmental databases for project and baseline evaluations.

ICT can assist environmental planning and simulation, particularly where the environmental science is well understood and relatively easily modeled, such as water management. For example, community water users groups in Ceará, Brazil used spreadsheets and other simulation mechanisms to design annual water use plans, assign responsibilities and build contracts with the state water resources agency (COGERH). Again, this assists in local awareness building and can prevent or resolve potential conflicts over resources use.

In environmental education, planning, and simulation, the multimedia aspects of ICT can play a critical role in understanding environmental degradation. GIS, time-lapse digital photography, and animated visualization can communicate the state of multivariate environmental pressures and indicate the relative threats posed by each. For example, human beings are notoriously ineffective at estimating the pace of exponential processes, but effective visualization can communicate such conclusions effectively.

For localities with limited processing power or connectivity, distributed or server-side computing can offer solutions which still allow communities the benefits of more intensive processes such as visualization.

Finally, it should be noted that environmental simulations and planning must take careful consideration of the veneer of "infallibility" which ICTs can impart. To be used effectively, simulation applications must be weighted by consideration of the risks of "false positive" and "false negative" predictions. Additionally, simulations seldom generate consensus unless those who receive the results of simulations have a chance to adjust the parameters of the simulation in conformity with their own experience and estimations of real-world conditions.

2.6. Cultural and Indigenous Knowledge Preservation

Some indigenous populations have embraced ICT as a tool for recording and preserving their culture and traditions, and for educating the rest of the world about the importance of protecting indigenous values and ways of life. The development of scientific research networks is also helping to empower indigenous research and development programs around the world.[17]

A good example of connectivity for a remote indigenous community is Casa Cultura Asháninka.[18] The Asháninka do not see the Internet as the beachhead of a cultural invasion from the North. Rather, they have seized it as a tool to reinforce and perpetuate their own culture, to build a larger sense of community purpose among the 400-odd Asháninka villages scattered across South America, and to tell their own story to the world. In the process, they bypass outside news media and governments, which they think tend to marginalize them. The community plans to use the Internet to build and structure their own study program and create an Asháninka school, compatible with the Peruvian education system, for sharing experiences with other communities. In many respects, the Asháninka continue to do the same things they've

[17] Accenture et al. (2001).
[18] http://www.rcp.net.pe/ashaninka/.

always done. Their new communication tools just make them more efficient. For instance, they find the Internet useful for choosing the best time to take their produce to market in Lima. They now know if market prices are good before they even set foot out of their villages, and their economic standing has already improved as a result.

In the course of embracing the Internet, the Asháninka are moving from an oral to a written culture. Parents hope their children will be able to learn new things that the Asháninka have not known before.

It is important to emphasize that no culture necessarily “owns” the Internet. The Internet is frequently perceived as American or Western European because these were the first global regions to adopt Internet use widely, and the Internet has evolved to accommodate many of their needs. In a few years, Chinese is predicted to be the widest language in use on the Internet. Thus, most, if not all cultures can have a digital counterpart on the internet without necessarily devaluing them, but not all cultures will spontaneously produce a digital presence and may, under certain conditions, merit special assistance to secure a digital space in the global medium.

2.7. Health and Wellness

By mid-2001, the world population was estimated at over 6 billion people, and most predictions indicate growth to between 7.9 (low estimate) and 10.9 (high estimate) billion by the year 2050. Some 4.9 billion people were living in less developed countries by mid-2000, and this number is expected to reach 8.2 billion by the year 2050. At the same time, life expectancy in developed countries will likely increase from 75 years (in 1995 – 2000) to 82 years in 2050, while life expectancy in less developed countries will increase from 63 years (in 1995-2000 period) to 75 years by 2050.[19] Even without this predicted increase in the population figures, the less developed countries face problems in the provision of medical service and health-care, including a shortage of funds, expertise, resources, doctors and other health-care professionals. Of more than 52 million deaths in 1996, about 40 million occurred in developing countries, more that 12 million of them children under five dead from preventable causes.[20] To make matters worse, roads, transportation, and communication are inadequate and make it difficult to provide health-care in remote and rural areas. A great number of villages and rural areas lack even the basic medical and health facilities, and people in these areas have no access to medical advice, even in emergency cases.

Under these circumstances, the health system in these countries faces a series of needs, some of which are:

a) Improved access to health services in rural and remote areas;
b) Improved access to health information in rural and remote areas;
c) Improved efficiency and quality of health related services;
d) Reduced costs for providing health services to rural and remote areas,
e) Improved equity of access to health services and information;
f) More effective education campaigns to promote behavior change in critical health areas;
g) Improved access to specialized expertise;

[19] UN Population Division (2001).
[20] Wright (1997).

h) Improved continuity of health services (especially for post-intervention);
i) Reduced isolation of practitioners working in rural and remote areas; and
j) Access to updated medical resources for rural practitioners.

To these ends, ICT is being used in many developing countries and communities to:

- Facilitate remote consultation, diagnosis and treatment;
- Facilitate Collaboration and medical research among physicians;
- Provide relevant medical training, such as "teach and test" modules;
- Facilitate improved disease prevention and epidemic response efforts;
- Disseminate public health messages and disease prevention techniques;
- Enable more effective monitoring and response mechanisms; and
- Improve the administrative efficiency of public health systems and medical facilities.[21]

Although telemedicine has been used since the early 1960s as a tool to provide health services and information from a distance, because of technological and financial constraints it was available mainly in urban areas in developed countries. Recent and continuous advancements in information and communication technologies (ICTs), and reductions in cost for an increasing number of ICT tools, is making telemedicine a reality for an increasing number of rural and remote communities both in developed and developing countries. At the same time, the number of telemedicine applications is increasing very rapidly, and many different technological solutions are available for a variety of situations.

Telemedicine is no magic bullet that will resolve all health problems for rural and remote areas around the world. It can be expensive, and may not be the most appropriate way to address many of the biggest health problems facing the developing world, which might better be addressed through, for example, improved drinking water and sanitation facilities. Still, if introduced and implemented properly, it has the potential to resolve a number of problems currently facing these communities. Some of these problems are the demand for improved efficiency and quality of health services for an increasing number of people; reduction of the cost of health services per capita without reducing the quality of the services; improving the access to health services and information for people living in rural and remote areas; and reducing the isolation of health practitioners working in the rural and remote areas. In many cases, the most cost-effective applications of ICT will not involve telemedicine per se, but rather more modest "telehealth" applications related to information dissemination, information retrieval, and improved management of rural health programs facilitated by ICT.

AIDS, Information, ICTs, and Privacy

The AIDS pandemic is a global problem already predicted to reach the proportions of Europe's medieval Bubonic Plague, unless a vaccine or cure is discovered and distributed quickly. For this reason, it deserves special attention under this health discussion. AIDS is presently most serious in Africa and increasingly so Asia, but its effect on the Americas should not be underestimated, particularly along river tributaries such as the Amazon basin and newly populated remote regions. Periurban zones are also strikingly vulnerable.

[21] Accenture et al. (2001).

In more impoverished and/or remote zones, AIDS can virtually wipe out accumulated human capital, because the more educated and mobile classes of impoverished regions tend to be primary disease vectors. To a certain extent, ICT integration into aspects of rural life may reduce the degree of urban-rural travel required for daily life and in itself contribute to reducing rural vulnerability. Nevertheless, the main contribution of ICTs to combating HIV has to do with raising awareness of prevention and treatment options, including the non-medical aspects of treatment, finance, and support groups.

In general, AIDS strategies focus on awareness and prevention, and ICT has important roles to play in preventative approaches, but information about treatment and post-diagnostic care is critical for maintaining livelihoods for those who are HIV-positive and their families. Information and knowledge about AIDS is a far cry from a cure, and there are realistic limits to its ability to constrain addictive and sexual behaviors. Still, awareness and information about prevention and life options for the infected are critical for reducing and ameliorating the already devastating aspects of the condition.

ICT has a special role to play in the struggle to manage soropostive communities, because HIV spreads easily in low-information environments. Moreover, because those who seek out information about AIDS are frequently stigmatized or ostracized, many people choose to remain ignorant about their condition or palliative options for reasons that are “locally rational.” ICTs can help reduce the effects of “rational ignorance” by providing an essential modicum of privacy for those who seek information but fear stigmatism from being seen at a local facilities known to help those with AIDS. The benefits of an improved knowledge environment with respect to AIDS are likely to spread beyond those who seek knowledge to include family, friends, and the community as a whole.

2.8. Cross-Cutting ICT and Development Issues

Up to now, this chapter has discussed ICT applications in development based on overall themes and issue areas in development work. There are, however, a number of cross-cutting issues that arise in nearly any development-oriented application of ICTs, and these will be discussed here. Briefly, these issues have to do with equity in access to and use of ICTs, the flexibility of ICTs and capacity to reorient the technology to multiple uses, the need to ensure information flows across the “connective” or digital/non-digital frontier, and the question of information content production for ICT use. This section draws highly upon independent research conducted at Winrock in the course of planning ICT applications in Winrock’s Knowledge Technologies for Sustainable Development program.[22]

Equity

To a certain extent, equity is itself an important development theme, insofar as development programs seek to reduce the degree of social inequality, their importance, or their impact. In “ICT and development” contexts, equity can insert itself as an issue either in 1) assuring equal access to and use of ICTs, or 2) reducing the degree, importance, or impact of inequalities in the

[22] Chadwick (2000-2001).

target community of an ICT project. These two objectives are frequently in tension, albeit not exclusively so. For example, equal access approaches may permit larger, more educated farmers in a community to use increased business intelligence to eliminate smaller competitors. Although this might raise their incomes, if that rise comes at the expense of less connected businesses and their market share, then overall inequality in the community has risen. On the other hand, targeting ICT programs to direct use by the "absolute poorest of the poor" risks setting the expectations too high and compounding implementation difficulties.

Gender equity is an important theme in ICT use and has rightfully received considerable attention in word and some attention in practice. Many characteristics of ICTs lead them to be appropriated disproportionately for use by male community members. Male members should have access to ICTs and associated technologies, but careful attention should be placed on ensuring that women and girls also benefit from ICT availability and training. If improvements in community information are exclusively available to men, then ICT interventions can end up increasing the dependence of women on male community members, disempowering them, and potentially increasing family strife.

A significant component to gender sensitive ICT deployment involves including women and girls in ICT training and/or use. These activities are absolutely essential, but the creation and development of ICT content and services that attend specifically female needs are equally important if women and girls are to find reasons to employ these newfound skills. The scarcity of female-centered development materials (and their digital versions) has complex roots. Because women often provide unpaid labor, female-oriented services frequently fail to raise family incomes as rapidly as male-oriented interventions, and are thus mistakenly considered sub-optimal uses of scarce development funds. For similar reasons, female oriented uses of ICT can be mistakenly considered "less serious" applications of expensive equipment. For example, ICT linked "cooking clubs" for women may superficially appear to be a less "serious" use of ICT, but the exchanges can lead to lower food costs, the use of ecologically efficient stoves, and improved rural health and nutrition.

As a result, producing female-oriented content through participatory methods should be a high priority in any gender sensitive approach to ICT deployment in development contexts.

Other critical equity considerations include content for and access by minority groups, indigenous people, interfaces and mechanisms (such as multimedia audio in local languages) for semi-literate populations. Income and asset inequalities are often a prime motivation for pursuing development projects in the first place, but the importance of considering income and assets as an equity criterion should not be forgotten.

One equity consideration merits special attention: youth. The world over, observers and social scientists have noted how young people gravitate toward ICTs and appear to learn its use and application with relative ease. Although one should be careful not to lock older community members out of ICT use, programs which target young people for ICT use and training are appropriate for several reasons. Firstly, many young people end up teaching older members of their communities how to use computers effectively. Secondly, young people may stand the best chance of building skill sets that set the course of their entire lives. Thirdly, successful youth in

Latin American and developing countries frequently share their success with the remainder of their families, and so the benefits will be shared more widely. Finally, young people frequently have a particular gift of imagination, and can help guide future opportunities for ICT deployment

Multiple Use Efficiencies

Most ICTs (e.g. personal computers, cell phones) are highly flexible devices suitable to multiple use and applications. For example, a PC laboratory designed to enable distance education a local school can also serve to connect local farmers to important market and agricultural information, even if these farmers graduated from school long ago and would not otherwise go there. The reusability of many ICTs for multiple objectives is a primary reason for their perceived cost-effectiveness in many development contexts. A single investment can efficiently serve multiple development objectives.

Capitalizing on these efficiencies can be a challenge in development projects, due to the departmental and/or bureaucratic nature of project design. Multiple use of ICT often places additional stress on equipment and raises questions of who will be responsible for its maintenance. For example, a project centering on distance education will not take kindly to equipment repair costs needed as a result of non-project uses of their equipment. As a result, projects over time tend to restrict ICT use to the purposes outlined in the initial program mandate. While understandable from a management perspective, this tendency makes it difficult to realize the potential efficiencies of ICT and makes it difficult for beneficiaries to identify and adapt to the most effective use of their new capabilities. In the long run, this dynamic can threaten the sustainability (financial or otherwise) of ICT deployment in local contexts.

These difficulties represent serious challenges to realizing the efficient use of ICT and have no easy answers. Effective partnering between development projects and funding agencies can reduce these tensions, share burdens and responsibilities, and maximize the efficient use of ICT investments in a given community. In addition, allowing entrepreneurial use of excess ICT resources, such as opening after-school cyber-cafés or community telephone centers along the Grameen model can help promote multiple use efficiencies.

Communicating Across the Connective (Digital/Non-digital) Frontier

ICT and development activities typically target disadvantaged communities with little or no existing access to digital content. The “connective frontier” refers to the boundary between digital and non-digital worlds. Whereas the “digital divide” refers to the gap separating those with access to those without, the “connective frontier” describes a boundary that individuals cross when moving from connected to unconnected environments. Individuals and organizations do not necessarily sit on one side of a digital divide, but frequently move back and forth across the connective frontier to environments of greater and lesser digital connectivity.

Much of ICT deployment centers on knowledge management, facilitating information circulation, and improving the “information environment” in which communities operate and make day-to-day decisions. From the perspective of development goals, it is important to think of ICT as a component in a larger system of knowledge exchange and, in particular, that effective ICT deployment does not end at the most peripheral digital device. Good ICT development design includes consideration of how digital information interfaces with the analog world, and how to make communication across the digital frontier easy and efficient in both directions.

Examples of "connective frontier" thinking include rural radio as a mechanism to push digitally archived knowledge out through existing analog media, careful printer support to ensure that digital materials can be circulated beyond technology centers, pictorial descriptions of new-technology use, ask-at-home questionnaires to ensure that ICT users share knowledge and learning with non-ICT users around them. More difficult to design, but equally important are mechanisms and procedures to allow questions and knowledge from the analog environment to cross into digital media. Voice-over-IP and voice-to-text offer a few examples, but more research is required to identify the most effective modes of ensuring effective information flows across the connective frontier.

Relevant Content Production

The three basic pillars of effective ICT deployment for development are connectivity, capacity building, and content development. In rural and marginalized areas, promoting basic connectivity is generally the first and most apparent challenge, soon followed by capacity building to maintain and support new ICT infrastructure. Ultimately, locally relevant, meaningful, and accessible content or services will determine whether ICT connectivity investments generate the benefits attributed to them.

Digital content production for developing communities—preferably with significant components designed through facilitated and/or participatory techniques—is therefore a critical aspect of any ICT-based development strategy and needs explicit consideration. Over the long run, content development is likely to generate high development returns-on-investment, depending on the design and medium chosen, because while specific technologies and delivery mechanisms may change rapidly, the essential health, agricultural, educational, and other materials needed by most communities will evolve more slowly. Specific equipment may change from day-to-day in response to production costs and new technologies, but the Internet, digital transmission, and digital storage can be expected to remain for the foreseeable future. Investments in digital content designed for (and by) local communities are likely to retain their value even after specific delivery technologies have changed.

3. RURAL ICT FACILITIES AND HIGH-VALUE SERVICES

Chapter 2 outlined the various ways ICTs can be applied to help meet development goals by improving communication, widening access to information, facilitating skill building, strengthening civil society participation, etc. This chapter explores the key issues affecting the successful development of rural ICT initiatives—including common success factors, the critical role of rural telephony, and impediments and challenges to rural ICT deployment—and discusses in more detail four key types of development-related ICT applications: telecenters, ICT for agricultural applications, ICTs for rural education and telemedicine/telehealth programs.

3.1. ICT System Fundamentals for Success

Eight common elements can be identified among successful ICT initiatives:[23]

1. They are based on a good understanding of the market and demand-driven;
2. They employ strong awareness building campaign;
3. They identify and support local "champions;"
4. They build strong strategic partnerships to ensure all project objectives are met;
5. They promote sustainability;
6. They provide capacity-building for telecenter staff and clients;
7. They employ appropriate and user-friendly technology and put in place a sound technical support system; and
8. They monitor, evaluate and share experiences.

1. Understanding the Market and Measuring Demand

Fundamental to the success of any ICT project is an initial assessment of the communication and information needs of the intended users. Equally important is the need to engage community members in a participatory planning process. This will help identify key stakeholders and community leaders, as well as existing organizations and information systems, upon which any ICT project must be based. Demand-driven projects based on the needs and input of the user communities stand a much greater chance of success. Unless ICT initiatives are established to satisfy the information and communication needs of the intended users, technologies will remain underutilized and thus have an even smaller chance of achieving sustainable developmental results. Simply put, initiatives that do not meet the needs or demands of the communities they purport to serve, nor involve their target communities in the project planning process, will not survive and will not contribute to sustainable development.

One common theme that arises from many community needs assessments around the world is the criticality of telephony. Demands identified frequently include:

- The main demand for communication services in rural and remote areas is for phone calls between small local communities and larger centers.
- Most calls are placed to communicate with community members who have moved to urban centers or overseas. In many cases phone calls play an important role in facilitating

[23] Richardson, Don (1997).

the transfer of financial remittances to family members residing in the rural communities. For example, a study of Grameen Telecom's Village Phone Program in Bangladesh indicated that the single most important variable in relation to phone use is whether or not a household has a family member working overseas.[24]

- Calls are also important for conducting business; accessing agricultural pricing information; communicating matters of illness or death; arranging travel and visas; and making educational arrangements.

It is clear that planning for ICT applications requires a specific understanding of the target community's distinctive nature of rural telecommunication operation and service usage patterns. Unless ICT initiatives are established to satisfy the telephony needs of the intended users, services are likely to remain underutilized and thus the program will be less likely to survive.

As part of this initiative, Winrock International and Telecommons Development Group conducted a Demand Analysis for Telecommunication Services in Santivanez, Bolivia, in November 2001 to assess the development-related ICT needs of the community. The demand analysis highlighted the need for telephone service among respondents, and expressed the important role of the telephone as a primary revenue driver. This may have important implications for the development of telecenters in the area—i.e. in terms of financial sustainability of telecenters without phones—and the potential role of voice telephony for information access applications—e.g. agricultural extension voice information service, telehealth information service, etc. (Annex 1 gives a detailed description of the Demand Analysis and its findings.) The criticality of telephony will be discussed at greater length in section 3.2 below.

Another critical issue in understanding the market for ICT services is that of gender. Understanding the ICT needs of both the men and women of the community is integral to gaining a full understanding of the market. Women are often significant—and in many cases, the main—users of telephony and other ICT services. For example, in Santivanez, Bolivia, females use the phone on average between 2.6 and 3.3 times per month (compared to between 4 and 5.2 times per month for males), and make more international calls than males (see Annex 1). It is also important to recognize the central role that women can play in promoting and implementing ICT initiatives. Women are often the primary drivers of ICT development in their communities, and in many cases make up the majority of the sellers of the ICT services. For example, an evaluation of the Grameen Phone Village Phone program in Bangladesh found that by placing phones in the hands of village women, Grameen Telecom is able to increase its revenues by up to 100% by ensuring that women have equal access to telephones for placing and receiving calls. The same phones in the hands of men are shown to have few, if any, female customers.

Furthermore, promoting the involvement of women microentrepreneurs in ICT initiatives can have significant development benefits. Grameen Village Phone operators were found to have gained increased social status within their own villages as a result of their increased income and the fact that the woman's house now became the center of local activity in the village.[25] Holmes (1999) notes that the South African Universal Service Agency (USA) has also recognized the importance of women's activity in telecenters, going so far as to implement a policy which

[24] Richardson et al. (2000).
[25] Ibid.

requires one member of each trained telecenter team to be a woman.[26] Holmes emphasizes that the women who are selected for employment within the telecenters must be more than just token positions, and must have the necessary skills to deliver results.[27]

2. Building Awareness

Awareness building at all stages of ICT planning is critical for success. This needs to be directed to potential users of the services, but also to decision-makers who may not be aware of the possible uses of Internet services. Without local political support, the barriers to achieving community buy-in will more than likely remain in place. Achieving the support of local politicians who support and understand the potential of the technology is vital to the spread and success of ICTs.[28] Also, successful marketing is vital to ensure that a telecenter, or other ICT service is an integral part of the community. The telecenter will not produce the desired results, if the people in the community are skeptical of the value of the new services. To overcome this potential barrier to use, a continuous awareness and promotion campaign should be conducted. This awareness campaign could include information regarding different issues specific to the area, as well as information about the possible benefits offered by the telecenter.

3. Identifying Local Champions

In order to facilitate the introduction of ICTs as smoothly and as quickly as possible, local champions who believe in the project objectives and methodology need to be incorporated in the process from the start.[29] This includes the use of intermediary organizations which are capable of acting as the link between the technologies and rural people.[30]

4. Developing Partnerships

Rural ICT project proponents should continue to explore multi-sector partnership possibilities in order to generate strong, collaborative efforts and ensure project objectives can be met. Through the formation of local private and public sector collaborations, projects can be better equipped with the human, technical and financial resources needed to produce sustainable results. Partnerships may include project proponents, donors, private sector representatives, government, NGOs and community groups.

The importance of partnerships involving both the public and private sectors of society for rural ICT initiatives is presented in a number of documents.[31] Chanya,[32] in an excellent guide intended for USAID programs and projects, outlines the process required to foster and sustain multi-sector partnerships. Richardson[33] goes further to suggest that the requirements for sustainability in ICT projects go beyond simply requiring partnerships in rural ICT initiatives, and that they must also

[26] Holmes (1999), p. 6.
[27] Ibid.
[28] Robinson (1998a).
[29] McConnell (2000); Anderson et al. (1999); Fuchs (1997).
[30] Richardson (1996).
[31] Richardson (1999); Chanya et al. (1998); Ehrenberg (1998); Fuchs (1998); Robinson (1998b); IDRC et al. (1997).
[32] Chanya et al. (1998).
[33] Richardson (1999).

include the components of "delivery of service and knowledge accessibility" and "the provision of electronic connectivity" to enable the transfer and sharing of information and knowledge to take place.

5. Promoting Sustainability

Sustainability is one of the most critical factors in establishing a telecenter initiative for the long term. While sustainability cannot be achieved without long-term commitment from national and local politicians and decision-makers, each community should be encouraged to explore and find new ways to sustain these services without compromising the delivery of the services. A telecenter initiative can became sustainable and maintain its sustainability if it meets the needs of community; if it is based on cost effective networks and applications; if the network and applications are easily upgradeable so that more services could be added with little extra cost; and if the demand for connectivity is aggregated with other business/organizations that operate in the same community.

Well-developed business plans built on demand studies, and measurement of ongoing costs and revenues, once donor funding is used up, are fundamental to ICT project sustainability. In the case of a telecenter, there must be a critical mass of community members keen to have Internet access, a local ISP connection and conscientious coordinators.

The sustainable implementation and operation of ICT initiatives, especially telecenters, is dependent on a number of inter-related factors. These include:

- *Technical* – telephone lines, electricity supply and servers
- *Cultural* – consideration of social and historical characteristics; pressing needs; cultural outlook; physical space; levels of education and literacy; and gender dimensions
- *Economic* – consideration of income levels and people's ability to pay;
- *Political* – consideration of participatory mechanisms; political networking; and local power
- *Training* – including "information literacy" training to transfer computer and "info-culture" knowledge to the users so that they can make better use of the center and its services
- *Information Support* – the assistance that the center can offer to clients in terms of knowing and advising where to look for the information they need; might also include engaging with known information providers to make content available; and
- *Technical Support* – which may be provided in-house, through shared community resources, or through a sufficiently responsive private service.

Community access facilities built into existing community centers, and ongoing projects, integrated with existing management structures, and ideally sharing lines, tech support, and costs are more likely to succeed. An interesting example of such an arrangement can be found in Cotahuasi, in a remote region in Peru. La Asociacion para el Desarrollo Sostenible (AEDES) has been working there supporting local efforts to export high-value organically produced local products. In 1997, when the first satellite phone was installed, AEDES personnel began to use email and the Internet to communicate and gather information. Soon, rural leaders and public officials, especially those working in health and education, began to request use of the new ICTS. AEDES complied, but soon found that the demands for use of the computers grew, the financial burden became excessive. In response, AEDES opened up the Cabina de Internet Cotahuisi, which offered use of its computer for the general public. Now it is being used by farmers, women's groups, local schools, and community leaders. Rates vary from US $0.43 per hour for students, to $0.86 for professionals, and $0.58 for farmers. Leaders pay nothing when engaged in community work, thanks to a subsidy from a Canadian project. Special rates are charged when the equipment is used for courses run by the school.

6. Building Capacity

Project proponents and planners must concern themselves not only with ICT hardware and software, but also with capacity-building activities. Such activities are necessary to ensure that both staff and clients will be in a position to utilize the technology and thereby have a stake in its future success and development.

In order to increase the effectiveness and efficiency of this equipment, it is important that a basic local capacity for maintaining this equipment be created. The creation of this local capacity will have three main benefits for the community: a) create employment, b) reduce the cost of operating the telemedicine network, and c) create and increase self-confidence and self-reliance in the community.

7. Employing Appropriate Technology and Proving for Technical Support

In order for the proposed technologies to be easily understood and implemented, the applications should be appropriate to the context of the region where it is to be utilized. At the same time, the ICTs should be as user-friendly as possible. Community members need to be comfortable with whatever technologies are proposed for them, and understand the extent to which such technologies can reasonably meet their needs. Telecenters need employees and volunteers who are qualified, professional, well-trained, enthusiastic, as well as skilled technical support personnel. Often university students have provided technical support, as well as training and research.

8. Monitoring, Evaluating and Sharing Experiences

People in different communities will have different experiences using telemedicine, and not all these will be positive. It is important that continuous monitoring and evaluation (M and E) of the telemedicine initiatives take place. Through the monitoring of the initiative, those in charge will receive information on how the initiative is being implemented, the utilization of different resources, and how the objectives have been met, while the evaluation will measure, among other things, the level of satisfaction of both the users and the providers. The positive experiences identified through the evaluation process and shared with other communities will serve as guidelines for the other initiatives, while the negative ones show what to avoid.

3.2. The Critical Role of Rural Telephony

The policies and programs implemented in support of rural telephony services are a critical part of the supporting environment for other rural ICT initiatives. In most cases rural connectivity can best piggyback on infrastructure also intended to support rural telephony. Among rural populations voice communications will usually be the most immediately useful and easily accessible service (application). In addition, experience generally shows that for telecenters that serve as the primary means of access to rural telephony, voice communications (i.e. phone calls) will provide the overwhelming majority of telecenter revenues. For these reasons, it is important to examine in detail the rural telephony policy and programmatic issues that form part of the operating environment for broader rural ICT/connectivity initiatives.

Rural Telephony Policy and Programmatic Issues

This section provides background on policy and program issues that can constrain or advance the deployment of ICT initiatives in rural areas.

The use of ICTs for rural and remote communities generally fall within the scope of "universal access" policies of national governments and telecommunication regulators. The provision of universal access is an important objective of telecommunication policy and legislation in many emerging market countries. Even now in Latin America, it is common for there to be fewer than ten telephones per 100 people, compared to over 64 lines per 100 people in the United States.[34] The concept of universal access, its content and the implementation of policy may vary depending on a country's specific needs, and indeed, to be effective, the concept and policy must be sufficiently flexible to adapt to the changing needs of the country concerned. There does not seem to be one common prescription for insuring universal access.

The objectives of universal access policies and programs focus on social and economic development of rural and remote areas. The provision of telephone lines and Internet services is a means to accelerate and support social and economic development. Objectives may also be tied directly to government goals for decentralization of governance to regional and district levels in order to provide more effective social service delivery and more effective local decision-making. Decentralization requires that front line service delivery agents and local government officials have access to affordable and effective communication and information sharing tools.

It is important for national governments to play an active role to ensure that the provision of universal access is successful. However, it is also necessary for such governments to examine how responsibilities can be appropriately allocated to telecommunication operators and local authorities, particularly in a competitive multi-operator environment.

Defining Universal Access

Many telecommunication analysts prefer the term "universal access" over the term "universal service" because it more accurately reflects the provision of a group of lines at locations

[34] ITU (2000b).

convenient to rural and remote residents.[35] Universal service is a term used to refer to the policy of providing telephone service to all community members and is based on the North American concept of a telephone in every home. It is generally recognized that universal service, in terms of a telephone in every home will not be achievable (or desirable from the perspective of a commercial operator) in most emerging market countries. A more realistic goal is universal access where a working, affordable telephone is within reach of the whole population of a country.

More specifically, universal access requires establishing a certain level of telephone service to meet the needs of communities where the existing telephone penetration is low or non-existent. Typical access targets are one public telephone per 500 people, or four to five telephones (one payphone plus three to four business or institutional lines) per village.[36] In some circumstances where populations are particularly dispersed, universal access policy may require only that people in rural and remote have access to telephone service within a certain distance from their community. This is typically measured by the length of time required for a community member to walk to a telephone two to five kilometers outside their community (e.g. 30 minutes). For example, the goal of Grameen Telecom in Bangladesh is to have one telephone accessible within a ten-minute walk for every rural villager.

The process of determining measurable targets for universal access is an important role for regulators. In order for universal access targets to accurately reflect the needs of rural and remote people, regulators must engage rural and remote stakeholders in meaningful dialogue to establish jointly agreed upon targets. The latter point cannot be stressed enough. Too often, universal access targets and policies are developed with the distinct absence of the rural and remote stakeholders those targets and policies are meant to benefit. Their absence results in services that do not meet their needs and therefore generate low revenues: a problem that perpetuates the belief that rural and remote telecommunication is unprofitable. As telecom analyst David Barr is fond of saying, "you get what you measure," and it is important to create measurements with the direct involvement of the people who would benefit from universal access.[37]

If regulators seek only to measure universal access in terms of tele-density (the number of lines per 100 people) operators may be encouraged to deploy lines, regardless of location, people's access, affordability or ease of use. Targets created in the absence of multi-stakeholder dialogue about the development results which can be obtained through universal access, are unlikely to assist in catalyzing the social and economic development for which universal access policies are ultimately intended. Benjamin and Dahms (1999) draw regulators' attention to the importance of creating clear national understandings of the terms universal service and universal access when they note:

> "Developing a definition of universal service and universal access can be mechanisms for agreeing national targets with the many stakeholders involved, which must then be monitored to ensure compliance. Universal access and service definitions should be seen as 'moving targets'—when one level is achieved, a higher goal should be set."

[35] Barr (2000).
[36] Dymond (1998).
[37] Personal communication.

The Myth of Unprofitable Service

It is frequently assumed that universal access policies must be based on the "fact" that rural and remote service is expensive and therefore unprofitable. Despite extensive evidence to the contrary, many regulators continue to believe in the myth of universally unprofitable rural and remote service. Hence, universal access policies are often designed only as means to extend service in order to achieve socio-economic development benefits for rural and remote communities. While socio-economic benefits are certainly desirable, basing policies only on political desires to be benevolent can actually deprive rural and remote residents of the quality and location of service for which they are actually willing and able to pay.

Commercially managed telecom services in competitive contexts tend to provide users with the most affordable prices and highest quality of service. Without a commercial imperative, operators of rural and remote services frequently lack the incentives to continuously improve service to anticipate and respond to user needs. Anecdotes about locked public calling offices, unreliable lines, and abysmal customer service are common in regions where universal access policies force incumbent operators to provide lines. In these cases, the goal of having telecom service generate socio-economic development benefits cannot be obtained, despite the existence of universal access policies and regulations.

The argument that governments must financially support the provision of rural and remote telecom services only as a benevolent way to achieve socio-economic benefits is a common one. Investigations of the commercial viability of rural and remote telecom services are neglected for many reasons, including:

- Regulators may lack the resources to conduct independent and accurate assessments of commercial viability in rural and remote areas.
- Regulators may lack the broader policy imperatives that provide the motivation to accurately assess commercial viability before yielding to the myth of unprofitable rural service.
- Regulators may lack the in-house skill sets necessary for conducting or managing independent market research and demand analysis within the unique environments of rural and remote communities.
- Regulators have not examined evidence and experiences from other countries where rural and remote telecom services are commercially viable.
- Incumbent operators that do not want to face competition or lose territory (and do not want to be bothered with universal access commitments) may provide compelling and convincing stories and data about rural and remote ventures that have been costly and "unprofitable."
- Stakeholders in rural and remote communities, including private sector agencies that provide services for these communities, are often not involved in collaborative planning to construct universal access policies.

To consider what the possibilities are for universal service, we must look at economic factors of providing service. In many countries of the developing world, the telephone company was run as a state monopoly. Prices were often set at levels below costs for policy reasons, especially for local telephone services. These were often cross-subsidized by prices for international calls being charged for over cost. This system is starting to break down through greater competition reducing the possibility of cross-subsidy, in addition to the attack on the international accounting rate system from the United States Federal Communications Commission (FCC), which has reduced international call transfer costs to developing countries considerably. This trend for telephone prices to move closer to real costs is seen throughout the globe and is usually referred to as “tariff rebalancing.” This trend makes local and low cost services more expensive. Also the transparency requirements that often come with a liberalized telecommunications environment make it harder (and sometimes illegal) to have hidden cross-subsidies within pricing structures. Most developed countries, which currently have over 90% household telephone service, achieved this even while cross-subsidies existed.

Without accurate and independent market research, the financial revenues and profitability of rural and remote services are typically assumed to be limited at best. Regulators should thoroughly examine the commercial viability of rural and remote telecom service before buying into the myth that rural and remote telecom services cannot be profitable. Subscribing to this myth without due diligence can seriously distort universal access policies and deprive rural and remote communities of high quality service.

Stated simply, universal access policies should not be implemented without accurate and independent market appraisals and parallel involvement of rural and remote stakeholders in the design of universal access policies.

One simple method of calculating the affordability and return-on-investment for rural telecommunications is based on the ITU’s very general assumption that people generally spend 1.5% to 2% of GDP per capita on telecommunication services. It must be stressed that using this simple formula should in no way replace detailed demand assessments for rural telecommunication ventures. However, this simple calculation method can provide an indicative picture of the viability of rural ventures, and can help identify rural communities that are deserving of more intensive demand studies. The ITU estimates the median cost of providing a phone line as US$ 2,060 (with a very efficient operator the cost could be brought down to US$ 1,340). Whether or not a community can support a single telephone line can be roughly estimated by multiplying the community’s population by 1.5% or 2% of the GDP per capita of that community. For example, given a community with 2,000 people and a GDP per capita of US $200, one could conservatively estimate that those 2,000 people might spend $6,000 per year on telecommunication services, if those services were available. Such a community could theoretically support an investment for three telephone lines operated as payphones, or within a telecenter.

Andrew Dymond (1998) and many other telecom analysts argue that socio-economic benefits, financial revenues, and the commercial viability of rural and remote telecom services are closely linked. Evidence strongly indicates that when managed in a commercial manner, telecom service can be a profitable business in poor rural and remote regions. Again, this potential can only be realized through when regulators have accurate and rigorous data on rural/remote market demand.

Armed with meaningful market demand data, regulators can design universal access policies to attract private investors, providing them with a fair operating environment, and enabling them to serve market demand. Such policies will have the objectives of making rural and remote telecommunication services financially attractive investments, and of making the developed services fully available to their users. The demand for telecommunication services in rural and remote areas is often much higher than many people believe, and within an appropriate policy environment this sector can capitalize on that demand to achieve maximum commercial and socio-economic benefits.

Funding Universal Service

There are different approaches to financing universal service programs, some of which are:

- *Conditional Licenses*: The telecommunication operator must provide service to rural and remote areas as a condition of its license. In Peru, for example, the telecom provider is required to contribute 1% of gross revenues to a rural telecommunication fund as a license condition.[38] In South Africa, the national provider is obliged to roll out 1.7 million lines in disadvantaged areas during its five-year exclusivity period.
- *Fee for Connection to the Backbone*: New competitors may be required to pay certain charges to interconnect with the dominant telecommunication operator, with some or all of the charges being used to provide service to rural areas.
- *Incentives*: Provision of incentives to encourage operators to provide telecommunications in less profitable areas. Some incentives may be:
    - Tax concessions;
    - Removal of duties on telecommunication equipment targeted to rural and remote areas; and
    - Lifting of foreign exchange restrictions.
- *Rural Development Funds*: One approach to addressing the universal access challenge in under-served and high-cost areas is the creation of special rural telecommunication funds, typically obtained from the telecom sector. Normally, these funds provide resources for one-time programs and have very defined coverage goals.
- *Micro-credit Programs*: Linking existing and successful micro-credit organizations with rural telecom operators to expand "public calling office" (PCO) coverage in rural areas can relieve operators of many of the barriers associated with rural telecom operation. Small loans to rural entrepreneurs, such as those established by GrameenPhone in Bangladesh, can effectively enable new ICT operators to establish PCOs which provide a variety of services including telephone, fax, email, the Internet, photocopying and word-processing services.
- *Build Operate and Transfer Arrangements*: The government can sanction concessions for equipment vendors, integrators and/or operators who deploy infrastructure in rural areas and operate a system for a fixed period of time before transferring the operation to an incumbent national operator, or other investors.
- *Cooperatives and Community-owned Systems*: Cooperative organizations active in rural areas (e.g. electrical cooperatives, agricultural cooperatives, etc.) are provided with incentives, such as periods of exclusive operation, to encourage provision of service in poor rural areas. For example, Bolivia passed a new telecommunications law in 1995, which affords

[38] Dymond (1998).

cooperatives six years of exclusivity to operate in their markets provided certain conditions are met.

From a regulatory perspective, if subsidies are used to promote universal access, the amount of subsidies and their specific application should be measurable, identifiable and transparent to ensure that they are not regarded as anti-competitive.

Key Regulatory Issues

There is an urgent need for specific universal access and rural telecommunication policy strategies at the national level, strategies that include strong roles for independent regulators working to attract new entrants and encourage fair competition. There is also a related need for wider dialogue and agreement on regulation, interconnection and tariff-sharing among nations.[39] This is particularly clear to a number of authors[40] who highlight the complexities that are surfacing among telecom operators in dealing with Internet telephony issues, resulting in rising revenues for the Internet telephony industry, and mounting losses for the current telecom operators in their existing regulatory environments.

1. Reform Means Liberalization and Privatization

Virtually all of the recent documentation on national ICT policy agrees that policy measures such as liberalization, tariff reform and fair interconnection agreements are fundamental to achieving universal access. Evagora[41] summarizes the arguments of many when he writes, "Increased competition and liberalization of telecommunications encourages infrastructure development, draws inbound investment, and assists in meeting universal service objectives." A number of authors draw attention to the fact that reforming the national regulatory body helps to promote liberalization and privatization within the sector.[42]

The keys to achieving universal access are highlighted by a number of authors[43] who argue that the provision of universal ICT access includes the formation of independent regulatory bodies which promote competition, the encouragement of private investment to expand rural telecom networks, the process of deregulation, and the provision of telecom opportunities for under-served populations. Singh[44] and Intelecon[45] report that fair interconnection agreements and tariff reform are the keys to establishing competition, while the World Bank[46] summarizes the components required to attract outside investment, including a clear and predictable regulatory framework, independent regulatory authority, government non-interference as a provider, and the establishment of a finance mechanism for telecom projects in rural areas. Recent documents also

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[39] Adhar and Hafkin (1999).
[40] See, for example, Braga et al. (1999) and Intven et al. (1998).
[41] Evagora (1996).
[42] See, for example, ADF (1999); ITU (1999b); Kenny (1999); Melody (1999a); and Melody (1999b).
[43] See, for example, Kennerd (1999); Dorfman (1998); Evagora (1996).
[44] Singh (1997).
[45] Intelecon (1999).
[46] World Bank (1999).

highlight the need for government to step back from their participation as providers of general telecommunication and ICT services, which are more efficiently run by the private sector.[47]

Although the literature presents the case that rural connectivity is furthered with telecom sector reform, Panos[48] addresses the issue of diminished national ownership of the sector through the increasing number of foreign investors entering the market. While the benefits to the sector and to rural network expansion are clear, Panos' points are important to consider when proceeding with market liberalization and privatization.

The most accessible documentation currently available on telecom sector policy reform and deregulation concerns Latin America, a region which, along with Asia, has telecom and energy sectors boasting the largest worldwide success in attracting private sector investment.[49] A review of existing literature makes it clear that if donors and international financial institutions are to learn about new and innovative approaches to telecom policy, much more on-the-ground reporting and documentation is needed.

Gray's 1997 Colombian case study calls for a clear distinction of sector roles and responsibilities and the promotion of joint venture partnerships involving both the private and public sectors.[50] This report also makes the linkage between Colombia's past successes at liberalizing the telecom sector and its introduction of new policies, which gave full responsibility for telecom ventures to the private sector.

The example of Chile's success with rural telecom ventures[51] highlights why it is a role model for other countries attempting to manage their rural telecommunication initiatives. Chile raised new capital and implemented competition through deregulation and privatization policies, which led to the deployment of telephone lines to 6,000 rural villages throughout the country. Chile's approach included the establishment of a rural telecom fund which offers subsidies to operators committed to delivering rural telecom services, an approach which has since been replicated in Peru, Venezuela and other countries around the world. Wellenius[52] reports on Chile's success with the rural fund program; in 1996 just 48% of its available funds were used to implement 90% of the planned deployment, and "competitive entry was the main factor which drove down the subsidy." Cahmbouleyron[53] reports that policies such as unrestricted competition, cross subsidies, tariffs linked to costs, required (not-for-profit) investments, and objectives aimed at increasing access have left Chile's rural connectivity program in a much stronger position than Argentina's, which undertook rural telecom initiatives and reform at the same time.

According to Wellenius[54] the Chilean experience suggests a number of lessons that may be broadly applicable in other emerging economies:

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[47] See for example World Bank (1999); Wellenius (1997a) and Wellenius (1997b).
[48] Panos (1997).
[49] Roger (1999).
[50] Gray (1997).
[51] Maturana (1999).
[52] Wellenius (1997b).
[53] Cahmbouleyron (1999).
[54] Wellenius (1997b).

1. The key to accelerating rural telecommunications development is competition. An environment that encourages new entry and competition can go a long way toward meeting basic telecommunications needs in rural areas on commercial terms.

2. Given the right policy environment, limited government subsidies suffice to close gaps between the commercial and social objectives of rural telecommunications development. The fund's 1995 commitment was less than 0.5 percent countrywide.

3. Market forces can determine which projects really need subsidies and how much. Competitive bidding following established administrative procedures and subject to independent judicial review can keep political pressures largely at bay. The Chilean bidding process left little room for discretion in the awards. Cost-benefit analysis was used only for the initial screening of projects, to determine roughly what subsidies the government should be prepared to pay and which projects should go first. However, limited competition for the projects meant that in many cases the subsidy awarded was the maximum available set by the study, not the market.

4. In a competitive environment, small subsidies can give tremendous leverage. The fund's US $2.1 million commitment of public money for the 1995 program triggered private telecommunications investments of about US $40 million. These investments included additional facilities offered by the bidders, more than twice what was required by the projects. The US $2.1 million will result in 1,285 rural public telephones, averaging US $1,634 per telephone. By contrast, in the1980s, the government paid the incumbent operators US $6 million to install only 300 rural public telephones, averaging US $20,000 per phone.

If those working in telecom are to be capable of managing change, more sharing of information needs to take place among policy makers, regulators and operators working in rural ICT projects throughout the developing world. Key aspects of telecom work which need more exposure in the telecom community include understanding how regulators can establish multi-national networks, and how operators can begin to develop and implement a rural ICT business strategy. Although this information is becoming more and more available from Latin American countries, it requires increased effort on the part of those active in rural ICT initiatives to stay current with evolving contexts. Unless those within the telecom sector share the knowledge gained from their experience in this ever-changing market, new entrants will continue to be severely challenged in their efforts to stimulate activity in rural regions of the continent.

2. Interconnection

In order for a new telecom operator to provide rural telephone service, that operator must be able to interconnect with the local incumbent operator, and all other operators. Too often, new telecom operators do not receive the regulatory support necessary to negotiate fair interconnection agreements with incumbents. The impact can be substantial. In the case of the two licensed rural operators in Bangladesh, for example, the inability and apparent lack of desire of the incumbent operator to provide interconnection has stifled capital investments that would help meet the demand for rural telecommunication in the country. If new rural telecenters are established using the services of operators other than the incumbent, addressing interconnection agreements is imperative.

3. Unbalanced tariffs

In liberalized and liberalizing markets, telecommunication tariffs are rebalancing; however, progress is slow, and rural operators require faster action because of their unique business circumstances. Most telephone calls within a rural network are calls that originate in urban areas or other countries and terminate at the rural network. For the rural operator, this kind of traffic pattern requires a tariff scheme that insures that the operator receives a portion of the revenues from calls that terminate at the rural network.

Rural network operators *and* independent operators of telecenters need to be able to charge fees that may be higher than those in urban areas. As telecom analyst Andy Dymond notes, “It is important to recognize that a properly priced service that recovers costs and makes good progress into the countryside is far better for rural communities than no service at all at legislated low tariffs.” Grameen Telecom in Bangladesh provides an example of a service for which rural users pay higher tariffs than users of the fixed-line network in the capital city of Dhaka. Despite these higher tariffs, Grameen Telecom services are profitable; village phone operators make reasonable profits which allows them to stay in business, and users have access to telephones that they otherwise would not have.

If the national government or regulator legislates uniform tariffs, regardless of service area, rural and remote communities may be denied service if operators cannot afford to provide service.

4. Entrepreneurial Public Calling Offices – Re-selling

Small commercial telecom entrepreneurs have emerged in many developing countries. The number of such Public Call Offices has hugely increased in the last few years, usually with no external financing from governments or external donors. These companies usually offer one or a small number of telephones and sometimes a fax machine. More and more offer other services, such as photocopying and even Internet access.

Examples of this include the franchised call offices “wartels” in Indonesia, and the 5,000 “telecenters prives” in Senegal that have blossomed throughout Dakar and now also in rural areas. In Bangladesh, Grameen Telecom is working to establish 40,000 Village Pay Phones (VPP) using cellular technology that will provide access to over 100 million rural inhabitants. The cost of US$450 per VPP is being financed by the Grameen Bank Small and Medium Enterprise (SME) loans, and so far the program has been very successful. Grameen targets women operators, who are more likely to be successful entrepreneurs and responsible in using their money for improving the well-being of their families.

In Brazil, Telebahia has instituted a service in which people can subscribe to receive a telephone number attached to an automatic answering service (without a separate telephone line). Received calls can be retrieved by phoning the service’s number and entering a security code—akin to cellular voicemail service. This has proven very successful, and has provided an incoming call service, which other universal access systems do not do so well. This also is a relatively cheap way to increase the telephone network in a way that promotes added growth with minimal capital investment.

In many countries it is illegal to re-sell telephone service in such manners, despite the fact that this is an efficient way to move toward universal access. Entrepreneurial telecenter and PCO operators continue to bypass rules that work against them, but any initiative that involves government and/or donor involvement will need to look closely at inhibiting regulations of this nature.

5. Incentives for the Operators

Kayani and Dymond's report[55] recommends a number of approaches which can be implemented by telecom regulators to strengthen national telecom policy: a focus on national, rural telecom strategies; integrating telecom with other sectors; imposing rural service obligations on operators; protecting rural service providers from those in larger, urban centers; tariff reform linked with interconnection agreements which favor small rural operators; and providing financial incentives for rural service provision. Intelecon[56] notes that "many 'loss-making' investments can be made profitable with careful optimization of policy variables (interconnect and tariffs) and financial instruments (e.g. development funds or special low interest credit lines)." Melody[57] sees the key to the provision of rural services resting with privatization of the market, and states that "the more barriers to market privatization can be removed or reduced, the greater will be the network extension." Lawyer[58] points out the importance of subsidies in providing incentives for the delivery of rural services, as exemplified by the case of the United States, where the major operators have no incentives to comply with rural upgrading regulations.

Policy makers need to explore a range of alternative incentive packages for the provision of rural service, and select those that are most appropriate to the local context and national development objectives. These incentives can include universal service funds, public-private joint ventures, rural concessionary licenses, build-operate-transfer schemes with international investors, cost-based tariff reform tied to interconnection agreements that favor rural operators, and special incentives for indigenous investments that support universal service.[59] Wellenius[60] points to the Chilean experience to show the minimal levels of subsidies which are needed for operators to successfully pursue rural telecommunication access.

6. IP Telephony and Technological Convergence

There is increasing concern related to issues revolving around the convergence of new technologies which greatly expand the roles and responsibilities of national regulatory bodies.[61]

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[55] Kayani and Dymond (1997).
[56] Intelecon (1999).
[57] Melody 2000.
[58] Lawyer (1998).
[59] Intelecon (1997) and (1999).
[60] Wellenius (1997b).
[61] ECA (1999).

Among the issues being discussed is the integration of Internet Protocol (IP) telephony, a technology which bypasses traditional telecom operators in favor of Internet gateways which utilize satellite technology for transmission and connectivity. The consequence of this for national telecom operators is that their long-standing telephone revenue streams are being reduced more and more. These issues are reflected in Intven et al.'s 1998 report[62] on the pressures facing countries to deregulate and simplify regulation governing new technologies; and in the International Telecommunication Union's 1999 report[63] on the threat that IP telephony might pose for future rural service provision due to the loss of capital by the operators. Primo Braga et al.'s1999 paper[64] presents the World Bank's strategies for assisting developing nations as they grapple with accounting rate regime (ARR) issues and the need to reform regulatory policies in the future. The increasing importance of regulatory policies related to the issues of technology convergence in the developing world is witnessed in China's recent licensing of IP and Botswana's difficulties in negotiating with local ISPs to determine rights of technologies.[65]

7. Internet and Applications

The role that ISPs have, and must be enabled to have, in the future figures largely in the rural ICT access debate. Kayani and Dymond[66] discuss the importance of protecting ISPs to promote diversity in the sector. Such protection could include decreasing Internet costs while at the same time ensuring liberalization is combined with the growth of local ISPs;[67] and introducing special tariffs to promote Internet usage, thus enabling users to make local calls to their ISP.[68] The World Trade Organization[69] discusses the role that e-commerce can play, but emphasizes the need to cooperate with ISP operators in the provision of low-priced telephone access, and make telecom equipment available to ISPs at internationally competitive prices. Singh's 1999 proposal[70] for a single tariff zone in Asia, and Adhar and Hafkin's call[71] for continent-wide telecom regulations and standards addresses the importance of making telephone and Internet use easier and less costly.

8. Civil Society Participation and Gender in Policy Development

Policy needs to be developed with much greater participation from civil society and non-governmental organizations so that rural ICT access programs truly meet nationally recognized, sustainable development objectives. The participation of women and youth must also be included if telecom policies are to have any relevance for the populations they serve. The role that gender plays in policy reform and policy-making is recognized in a number of reports.[72] These documents underlie the importance of ensuring that both men and women are involved in

[62] Intven et al. (1998).
[63] ITU (1999b).
[64] Braga et al. (1999).
[65] Intelecon (2000).
[66] Kayani and Dymond (1997).
[67] UNDP (1997).
[68] ITU (1999b).
[69] WTO (1999).
[70] Singh (1999).
[71] Adhar and Hafkin (1999).
[72] See, for example, Marcelle (1998) and UNU/INTECH (1998).

consultations and discussions concerning telecom policy, recognizing the distinct needs and attentions which must be considered when deploying rural and urban telecom networks. (Gender's role in ICT development is discussed at greater length in section 3.1.1 above.)

Box 3-1: Five Recommended Documents Related to ICTs and Policy and Regulation

1. Rogati Kayani and Andrew Dymond, *Options for Rural Telecommunications Development*. Available at http://www.worldbank.org/html/extpb/abshtml/13948.htm.
2. William E. Kennerd, *Connecting the Globe: A Regulator's Guide to Building A Global Information Community*. Available at http://www.fcc.gov/connectglobe/.
3. Economic Commission for Africa, *National Information and Communication Infrastructure Policies, Plans and Strategies: The Why and How*. Available at http://www.bellanet.org/partners/aisi/nici/NICIinAfrica.htm.
4. Jorge Bascor Maturana, *The Positive Impact of Universal Access on the Rural Population: Chile, Two Years On*. Available at http://www7.itu.int/itudfg7/fg7/CaseLibrary/documents/gvt001.doc.
5. Bjorn Wellenius, *Extending Telecommunications Beyond the Market: Toward Universal Service in CompetitiveEnvironments*. Available at http://www.regulate.org/references/ExtendingTelecommunicationsbeyondtheMarket.pdf.

3.3. Impediments and Challenges to Rural ICT Development

Physical isolation, low income levels and lack of ability to pay, and underdeveloped infrastructure in rural areas all combine to jeopardize the sustainability of information and communication services. The ITU has identified several characteristics of rural areas, summarized in Figure 3-2, that have a powerful cumulative impact on the provision of rural telecommunication services.[73] Extreme climates, harsh topographies, and the lack of physical and technical infrastructure tend to raise rural telecommunication costs in two ways: (1) by increasing up-front capital investment and installation costs, and (2) by adding to the cost of operating and maintaining service over the lifetime of the network equipment.

[73] ITU (1998).

Table 3-2: Some Obstacles and Approaches to Rural Communications

Obstacles to Rural Communications	Mitigating Approaches
Scarcity or absence of public facilities such as reliable electricity supply, water, access roads and regular transport.	Use of low-power, low-maintenance technologies and off-grid energy systems.
Scarcity of technical personnel.	Remote network management over communication lines.
Difficult topographical conditions, e.g. lakes, rivers, hills, mountains or deserts, which render the construction of wireline telecommunication networks very costly.	Satellite or terrestrial wireless infrastructure.
Severe climatic conditions that make critical demands on the equipment.	Ruggedized or tropicalized equipment and equipment shelters.
Low income per capita; Low population density; Low level of economic activity mainly based on agriculture, fishing, handicrafts, etc.	Providing universal access prior to universal service.
Underdeveloped social infrastructures (health, education, etc.).	Training for local staff and users.

Source: ITU (1998).

Low income levels and lack of ability to pay are a major barrier to the deployment of ICTs that can improve income-generating opportunities and enhance quality of life among the rural poor. The rural poor face significant constraints in terms of their ability to pay for ICTs and associated services. Further, ICT investments in poor communities must compete with other pressing development priorities, such as the provision of clean water supply, building housing structures and roads, providing access to health facilities and quality education, and so on. Deploying ICT demonstration projects is valuable in certain circumstances to raise public awareness, demonstrate feasibility, and build local capacity. However, if ICT interventions are to ultimately be available to and serve the needs of the rural poor, they must look beyond high-visibility demonstration projects, and examine how to design ICT applications that reasonably match people's needs with development and implementation costs.

Scarcity of public facilities and infrastructure, difficult topographical conditions and severe climates have historically increased the initial costs of installing telecommunications equipment. Installing power generating systems in areas without access to mains electricity is one of the largest up-front costs associated with the lack of infrastructure in rural areas. Additionally, civil works to lay cables underground and establish aerial wires can be prohibitively expensive over long distances, particularly when the target population is small and geographically dispersed. Careful selection of equipment is essential in order to ensure sustainable operation and affordability. In off-grid areas it will generally not be cost-effective to use temperature and humidity control systems which may be desirable for maintaining the appropriate operating environment for electronic equipment and batteries in areas where temperatures routinely lie above 40°C or below 0°C [74].

[74] ITU (2001a), p.23. In areas with grid-based electricity, climate-controlled structures will often be feasible, and climate control systems may be justified for extremely valuable off-grid ICT systems such as telecom repeaters. It will generally not be feasible to provide climate-control for off-grid telecenters or schools, except in cases of inexpensive power sources, such as micro-hydro.

Moreover, the costs of sending technicians to remote areas for routine maintenance and repair of wire plant can be high, a situation which has often resulted in the long-term neglect and deterioration of the quality and reliability of rural telephone service.

When multimedia services such as Internet access, video-based educational programs and telemedicine are added, the difficulties of maintaining rural networks are compounded. Real-time multimedia applications can also increase bandwidth requirements significantly—particularly in the "downstream" direction from the network core to the rural user. As illustrated in Table 3-3, distance learning applications may require a connection of 1.5 to 3 Mbps to effectively serve a classroom of students downloading large files and interacting with graphics and video content. This example illustrates one of the most important factors when choosing a cost-effective connectivity solution for Internet applications: the flow of traffic for many Web-based applications is asymmetric—greater in one direction than the other.

Table 3-3: Typical Bandwidth Requirements of Multimedia Applications

Application	Typical Bandwidth Requirements (downstream / upstream)
Email (text only)	2.4 Kbps
Low-graphics WWW browsing	9.6 Kbps
Streaming audio/video (low quality)	14.4 – 56 Kbps
Distance learning (2-way video)	1.5 – 3 Mbps / 64 Kbps
Video conferencing	384 Kbps – 1.5 Mbps / 384 Kbps – 1.5 Mbps
Broadcast TV	6 – 8 Mbps / 64 Kbps

Sources: (Author unknown), Red Herring (2000); eMarketer (2001); and Winrock estimates.

A desktop PC and standard CRT monitor used for two hours per day can add a load of between 1500 and 2000 Watt-hours[75] to the weekly energy consumption of a rural installation. Information technology devices require a reliable, high quality stream of electricity since the integrated circuits within can be easily damaged by energy surges and spikes. Data loss can occur as a result of sudden power outages, leading users to purchase both UPS systems and backup storage media. Finally, the operators of the PC equipment must continue training over time in order to keep the systems up to date with software upgrades and new features.

Thus, the challenge of providing communications services to rural communities does not end once the first telephone connection is installed. Ensuring sustainable lifetime operation of rural installations is vital to protect both the initial investment as well as the desired social benefits.

The following are some general factors to consider when selecting technologies and applications for rural areas:[76]

Infrastructure

- Ease of Installation
- Ease of Operation & Maintenance
- Tolerance of environmental extremes

[75] Based on a rough estimate of weekly energy consumption of 1743.7Wh based on average computer and monitor consumption. Assumed two hours of usage per day, 80% hard drive idle / 20% HD active, no standby time.
[76] ITU (2001a), p. 18.

Energy
- Level of power consumption
- Compatibility with off- grid energy solutions

Social Benefit
- Variety and flexibility of service applications
- Support for local language(s)
- Skills and/or training required by end users

Cost
- Modularity and scalability
- Compliance with recognized standards
- Initial and lifetime costs
- "Future proof" technology evolution

Even under ideal conditions, telecommunication networks require very large up-front capital investments. The additional up-front investment required to compensate for underdeveloped infrastructure in rural areas makes it even more difficult to attract the necessary capital.

As Chapter 2 described, ICTs can be deployed to meet a number of rural development needs, ranging from improved education and health services, providing greater access to income generating and enhancing opportunities, increasing access to information, and so on. In the rural development context, ICTs can be a means of promoting *improved services*. It is with this perspective that the OAS/IACD Rural Connectivity and Energy Initiative is being implemented. The following sections describe some of the ways ICTs can be applied to promote improved services for rural areas. The first describes community ICT centers which provide a myriad of ICT-related services, which we have lumped here under the general term, "telecenters." Subsequent sections focus more narrowly on ICT applications for improving services within specific development sectors, including education, agriculture and health.

3.4. Telecenters[77]

Telecenters (also known as Community Communication Centers, Infoshops, Telecottages, Community Access Centers, and in Latin America as Telecentros, Infocentros, Cabinas Publicas, etc.) have emerged in the last ten years as the primary means for providing public access to a range of telecommunications services and particularly the Internet. Beginning in Northern Europe, the approach has spread quickly throughout the world with current estimates as to total numbers ranging (depending on the definition) into the tens if not low hundreds of thousands.[78]

Telecenters are currently being developed as community hubs for linking a range of opportunities presented by Information and Communications Technologies (ICTs) with economic and social development efforts at the local level. As telecenters do not depend on the model of individual access to ICTs that predominates in the developed world, they are especially relevant to the needs of developing countries.

[77] In much of the literature, the term is spelled "telecentres," reflecting the fact that much of the groundbreaking work in this field has been supported by the Canadian Government and involved numerous British Commonwealth countries.
[78] www.is.cityu.edu.hk/ejisdc/vol4.htm.

Telecenters are providing solutions to a host of development problems concerned with the digital divide: community access to information; health and wellness initiatives; e-democracy and e-government; cultural and indigenous knowledge preservation; rural and agricultural development; and electronic commerce. Although this is commonly accepted to be true, an exploration of specific relevant experiences of telecenters in Latin America is critical to reach an understanding of their actual development potential.

Telecenter Services

Telecenters may offer a broad range of services, from basic telephony to a variety of enhanced specialized services as sophisticated as video conferencing and on-line banking. Based on the community needs identified in the planning stages, it is advisable for a Telecenter to develop an initial focus, starting small, and building on services as community needs and awareness grow. In most cases telecenters will charge for services that may include:

- Telephone calls – incoming and outgoing;
- E-mail and Internet access;
- Desktop publishing, including graphic design, scanning, printing, binding;
- Computer use for word processing, spreadsheets, etc.;
- Education and training – access to distance education programs, tele-learning;
- Computer training – in use of telecenter facilities;
- Web Page design and hosting;
- Photocopying;
- Fax communication;
- Business and secretarial services, including professional writing (grant applications, funding submissions, etc.);
- Information services – phone directories, compilation of local service access points, employment opportunities, government information, news;
- Video conferencing;
- Video or still camera hire;
- Internet searches – by Telecenter staff or volunteers; and
- On-line banking facilities.[79]

Classification of Telecenter Types

Telecenters can be classified based on two main aspects: a) size, and b) management type. Based on their size, telecenters can be divided into four groups:

- *Micro telecenter* – These telecenters are located in a shop or other business. These provide pay phone service, built-in web browser and possibly a smart card reader, and receipt printer.

[79] Note: There has been discussion of the potential of telecenters to serve as intermediaries in the provision of remittance transfer services between local people and family members working abroad. Source: Robinson (2000).

- *Mini telecenter* – The mini telecenter is equipped with a phone line, a fax machine, a PC connected with Internet, a printer, a printer/scanner/photocopier, and a call meter.
- *Basic telecenters* – A basic telecenter has a number of phone lines, a call management system, fax machine, photocopier, computers, Internet connection, printer, and a scanner.
- *Multi-purpose telecenter* – In addition to the equipment available at a basic telecenter, in a multi-purpose telecenter there may be access to multi-media equipment, digital camera(s), video camera, TV, overhead projector, laminator, video-conferencing facilities, and other enhanced services.

Telecenters can be divided into the following categories based on their management type: a) commercial, b) franchise, c) civic, d) NGO sponsored, and f) municipal (Table 3-4).

Table 3-4: Telecenters by Management Types

Management Type	Advantages	Disadvantages	Proponent	Example
Commercial	• Demand driven • More sustainable • More flexible • Offer quality service Promotion done by owners	• Marginalized poor and disadvantaged • Establish only where there is disposable income • Initial financial requirements might be prohibitive	Private sector	Rural Information Technology Alliance (Newfoundland, Canada) - www.futureworks.ca/rita/rita.html&e=650
Franchise	• More sustainable • Set of quality standards and controls • Offer quality service • Owners interested in expanding network • Training of franchisees is continuous	• Risk limiting competition • Initial financial requirements might be prohibitive	Private sector	Cabinas Publicas (Peru) - ekeko.rcp.net.pe/rcp/servicios/cabina/
Civic (located in public centers like libraries, schools, etc.)	• Free or low-fee services • Serve as community social meeting point	• Not self sustained • Limited services • Promotion limited within the community	Public sector / donor agencies	• Amic@s (Paraguay - www.amicas.gov.py • Centro Polivalente de Teleservicios Comunitarios www.santalucia.hn • Cabina de Internet Cotahuisi - Peru
NGO sponsored	• Free or low-fee services • Provide services to marginalized groups	• Depend on donor funding • Accessibility might be an issue (for non-NGO members)	Public sector / donor agencies	• INFORCauca (Colombia) • Audio Visual Alternative (South Africa) www.communitysa.org.za/
Municipal – located in government facilities	Open to all people in the community	• Depend on public funds • Depend on local/national political support	Public sector	Technicon SA East London (South Africa) - www.communitysa.org.za/

Sources: Gómez et al. (1999a); SangoNet; and Jensen and Esterhuysen (2001).

During the course of the research conducted for this study, the quantity of useful information available through Web resources grew faster than the researchers' ability to process the information. One factor influencing this surge of on-line information is a commitment made by national leaders at the Summit of the Americas in Quebec in April 2001 to support universal access to ICTs throughout the hemisphere as a means to strengthening democracy and the full participation of Latin America in the Knowledge-based Economy.[80] In addition, commitment by donor agencies like the International Development Resource Center (IDRC)[81] to support telecenter applications and research in the Americas, as well as their documentation and dissemination of success stories, has stimulated the telecenter movement. A conference in Ecuador in August 2001, I Encuentro Regional de Telecentros de America Latina y el Caribe, brought together ICT champions from throughout the Americas, and resulted in the formation of somos@telecentros, a virtual community committed to sharing lessons learned in telecenter experiences with an end to applying ICTs for promoting equity, democracy and development (www.tele-centros.org). Somos@telecentros is a project of TELELAC (Red de Telecentros de Latinoamerica y el Caribe), coordinated by the Chasquinet Foundation of Ecuador,[82] with support from IDRC. The Web site www.tele-centros.org is a clearinghouse for information on telecenter activities throughout Latin America, as well as resources to support these activities, current news, and proceedings of the El Encuentro Conference.

This accelerated information networking has created a vehicle for allowing telecenter proponents to identify best practices, replicate models of success, and avoid operating practices destined for failure. Much literature has now been generated on telecenter experiences and links between ICTs and rural economic development, though until recently much of this has come from donor agency studies and academe. Forums like I Encuentro, and virtual communities like somos@telecentros have created new channels for documentation of real-life experiences and agreement on some fundamentals for success, reached through communication among telecenter practitioners. In addition, many telecenters and networks of telecenters have created their own informative web pages that document ongoing activities and often provide practical advice for installing and managing a telecenter, and examples of useful ICT applications.

Guidelines for Telecenter Development

Getting Started - The Community Audit

An audit of community needs must form the basis of the business plan that is essential to ensure sustainability. *The Community Telecenter Cookbook for Africa: Recipes for Self-sustainability* [83] provides guidelines for conducting a community audit to allow for the matching of Telecenter operations with community needs. The community audit is needed to:

- Determine the size and needs of the telecenter's target market;

[80] Americascanada.org (2001).
[81] IDRC (1999).
[82] www.chasquinet.org.
[83] Jensen and Esterhuysen (2001).

- Create awareness and involve the target market in the process of building local ownership;
- Identify competing or related initiatives;
- Establish who are the key people, institutions or projects in the community that can participate in the development of the Telecenter;
- Establish which development and educational projects exist that can benefit from information and communication services;
- Find out if there are any local investors or other sources of funding.

Selection of Telecenter Sites

Experience has proven that it is important to select sites that are known by the community as stable institutions, such as libraries, schools, community centers, etc. This has been a model of success demonstrated in Canada through the national Community Access Program, which provides public access to Internet in rural communities through terminals located in libraries and schools. It is also recommended that telecenters be located close to organizations or champions of the technology to encourage their use of the telecenter. In certain circumstances it is critical that these sites remain politically neutral, such as through selecting a library or cultural center; secure, in terms of data and physical safety; and under the management of a local authority or citizens' group that is willing and able to support the programs of the center.

Gender is also a consideration in the selection of a location for a telecenter. An evaluation of the Grameen VillagePhone system in rural Bangladesh by TeleCommons[84] identified a need to consider gender in selecting access points for village telephones which encourage universal access by both men and women, rather than in locations which discourage women's access to the service.

Other studies have shown that considerable cost savings can result from integrating telecenters with existing services. A study of telecenters in Tasmania, Australia that were established in association with existing facilities such as schools or libraries, identified a cost savings of between US$7,800 and $10,400 per year.[85] These savings resulted from shared costs for rent, telephone lines, electricity, equipment and network support.
Often overlooked in telecenter studies are initiatives taken by entrepreneurs who build telephone, fax or Internet services into their existing business, such as a corner store, café, or photo shop, and increase the level of service gradually, in response to demand and cash flow.

Selection of Operator/Management Groups

Telecenter practitioners and researchers tend to agree on certain key points with respect to selecting the managers and operators of telecenters. The success and sustainability of individual telecenters is closely linked to the competence of these managers and operators, their ability to clearly identify the information and communication needs of the clients, and their ability to adapt the services offered to meet those needs. Young et al. (2001) emphasize the importance of combining volunteers with paid staff, and note that volunteers were "pivotal" to the success of

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[84] Richardson, et al. (2000).
[85] Young et al. (2001).

telecenters in Tasmania.[86] Hunt (2001) recommends acquiring employees and volunteers who are qualified, professional, well-trained, enthusiastic, and skilled in technical support.[87] Harris (1999) emphasizes that telecenter staff must be able to relate to the clients and be user oriented, rather than being technically skilled individuals who lack the ability to empathize with the users.[88] Other authors[89] emphasize the importance of including women in management positions and in daily activities to ensure sustainable operations.

Creating a Forum for Operators and Managers

One useful option is to create a forum through which operators and managers can share experiences and learn from one another. In many telecenter evaluation reports the isolation of one telecenter from others in the region or country is cited as a major hindrance to the operators. The Escuela Virtual in Colombia integrated an ongoing web-based training program into its operation, which links 450 teachers in 45 communities.

Equipment Used in the Telecenters

The hardware and software contained in the telecenter initiatives studied for this report is wide ranging. Telecenters can range from telephone service only, to those which offer access to telephones and other ICT tools. The list of potential services can include, but is not limited to:

- Televisions with VCR;
- Computers with software, printers and scanners;
- Fax machines;
- Telephones;
- Photocopying machines;
- Off-grid power systems for unelectrified locations; and
- Uninterruptible power source (UPS) to counter power outages.

In areas underserved by any telecom access, any new interventions point to the telephone as the main information and communication tool to be implemented.

The initial challenges associated with establishing rural telecenters concerns the provision of connectivity to telephone, electricity and Internet services. On the issue of telephone connectivity, Shakeel et al (2000) compared the costs involved with equipping Costa Rican telecenters with leased line telephony service versus implementing very small aperture terminal (VSAT) service. The study determined that, while initial costs are significantly higher for a VSAT connection than a leased line (grid) connection, the annual usage costs for VSAT are lower than leased line connections.[90] The same study also examined the choices to be made when dealing with telecenters that depend on photovoltaic (solar) energy sources for power. The authors found that by replacing desktop computers and monitors with lap top computers they could reduce energy consumption by as much as 70%; the particular telecenter in the study

[86] Young et al. (2001), p. 5.
[87] Hunt (2001), p. 10.
[88] Harris (1999), p. 3.
[89] See, for example, Richardson et al. (2000); and Holmes (1999).
[90] Shakeel et al. (2000), p. 11.

reduced its consumption by half.[91] However, the study cautions that lap top computers are not always appropriate for use in telecenters, as they are harder to expand, upgrade and repair than their bulkier, energy consuming alternatives.[92]

Challenges to Telecenter Programs

There remain many challenges to telecenter operations. Some include:

- *The need to build the independence of the community* without becoming too dependant on external agents.
- *Introducing new technologies such as the Internet and the telephone to rural areas*, when they may not be regarded as permanent or regular sources of information.
- *Overcoming illiteracy as a barrier to telephone and computer use*, especially in cases involving computers and rural farmers.
- *Providing adequate information on and promotion of telecenters throughout the community.*
- *The need for local content*, especially contending with the unmet demand for information material in the local language.
- *Adapting to and meeting the community's training needs*, so as to take into account the different cultural aspects of the community.
- *Developing appropriate pricing levels* that meet the abilities of low-income users.
- *Staffing telecenters*, in terms of identifying the needs of staff; addressing lack of training and resource issues; and retaining skilled staff.

3.5 ICTs for Rural Education

Given that effective education requires the communication of information between teachers and learners, there are many obvious and important ICT applications for education in general and for rural education in particular. ICTs can play important roles both "behind the scenes" in teacher or curriculum support, or "up front and center" as the primary medium of student interaction. The most appropriate use of ICTs in education and rural education are highly context-dependent, both in terms of locally available infrastructure, physical and human, and in terms of the specific goals of an educational effort—be it primary, secondary, tertiary scientific, tertiary "letters," or vocational.

ICT applications in education fall into the following categories, listed here in ascending order by the degree to which the technology dominates student interactions. They include:

- ICT providing teacher materials and curriculum support for the classroom;
- ICT use as an additional skill or subject matter for students to master;
- ICT as enrichment for existing courses, offering new pedagogical approaches; and
- ICT for distance education in unserved subject or geographical areas.

[91] Ibid, p. 13.
[92] Ibid.

ICT use in education predates current interest in the topic and the computer revolution by some time. Correspondence courses were invented in the mid-to-late 1800s, and spawned radio-based education activities in the 1920s and after. Both closed-circuit and broadcast television education were used in the United States and the United Kingdom by the 1960s, and videocassette, audiotape, and videodisk technologies were widely employed for pedagogy in both developed and developing countries by the 1980s. Each of these technologies could and did fall into the four use categories described above.

The current generation of ICTs differs from its predecessors in two distinct areas. First, much of the content currently available is digital, which allows for extreme flexibility in reconfiguring content to specific uses, and allows for text, graphics, audio, and video to travel through the same communication channel to be received by any one of a variety of devices. To maximize the flexibility of digital content, it is invaluable to concentrate on creating reusable information objects (RIOs) from the start. Secondly, the development of synchronous digital communication means that text, audio, video, and feedback can all pass through the same communications channel simultaneously. Combined, these features offer an unprecedented potential for interactivity and "learning on demand," although the optimal management systems for creating and using learning-on-demand are still being developed and perfected

Approaches to ICT in Rural Education

ICTs Providing Teacher Materials and Curriculum Support

For communities with extremely limited physical and human infrastructure, this "behind the scenes" approach to ICT in education can deliver a substantial return-on-investment. Due to stretched resources and limited personnel, teachers in rural areas are frequently asked to cover unfamiliar subjects and lack the opportunities to update or improve their competence in various fields. ICTs can offer teachers vast libraries of lesson plans, course materials, teacher training courseware targeted at different study levels and experience. All of these can improve the quality of the education teachers provide to their students and increase teacher confidence and self-esteem. Where telecommunications connectivity is difficult, much can still be distributed by CD-ROM and non-volatile flash memory. More reliable telecommunications can add teacher support and discussion groups and generate a set of local knowledge bases to improve teacher effectiveness and peer support.

In addition, providing schools computing equipment for teacher use generally requires a smaller hardware investment than targeting machines for student use, and leaves the equipment for use in the hands of responsible adults. As a result, equipment provisioning, maintenance and support costs, albeit necessary, are significantly reduced.

Frequently, teacher support ICT strategies precede more intensive student ICT use and form part of a phasing strategy. The goal is to familiarize teachers with the technology and its use before asking them to supervise student use of the technologies, and can assist in planning to assure that the more substantial investments required for direct student use go to communities with capable and involved teachers.

Merely supplying equipment, training, and connectivity to remote communities will not help teachers significantly without substantial concomitant efforts to generate course content and support materials and keep them in the public domain. Teachers and schools do need equipment and training, but they also need content to which to connect and which connects to their needs. Key aspects of successful content accumulation will include the definition of course RIOs , the use of teacher user groups to generate content, and creating an incentive structure that rewards information sharing and useful content contributions.

ICT Use as an Additional Skill or Subject Matter for Students to Master

Even in remote areas, most communities are at least somewhat aware of the transformations that ICTs are making to daily and economic life. In its work with rural communities, Winrock International frequently encounters cooperatives and farmers in remote areas who are deeply concerned that their children receive training in ICT use, particularly computer use. These communities may be remote, and their experience with ICTs limited, but they clearly see ICT and computer use as a critical economic and life skill, and want their children to be competent in computer use. In many cases, there is fear of being "left behind" in a changing and globalizing world, an understanding that children and adolescents are particularly capable of learning the new equipment, and they see ICT training in rural schools as a family survival strategy, not merely an aspect of individual improvement.

Some important ICT skills include: point-and-click interfaces, using a word processor, moving and deleting files on a computer, connecting to the internet, sending e-mail, surfing the world wide web, learning effective search techniques, and instant messaging (including messaging to cell phones). More advanced topics include: making presentations with software such as PowerPoint, usenet, spreadsheets (usually requires solid understanding of arithmetic or elementary algebra), database construction (sometimes an outflow of spreadsheet work), computer networking, and software programming. Important "soft" subjects to consider include: Internet etiquette or "netiquette," protecting your privacy, common Internet scams, and other aspects of an "informed digital culture." Exposing previously isolated communities to the Internet responsibly requires ensuring that they understand the rules of the game and their potential vulnerabilities in the new environment.

Teaching ICT skills usually requires investing in computer laboratory where students can interact with the machines in an environment where they can be observed and tutored. In rural areas, this may or may not be located in the school itself, but can be neighboring telecenter at an NGO, church, or other organization. As mentioned earlier, designing "multiple-use" telecenters is crucial for ensuring sustainability. If computer labs are located in schools, this generally implies a substantial investment of resources in equipment, connectivity, training, and maintenance. However, as mentioned above, there is substantial demand for ICT training by rural communities.

Appropriately designed computer games can be valuable in helping users acquire basic skills. Games need not refer exclusively to the arcade-style games associated with teenage boys; for girls and adults of both genders, internet and computer card games played singly or with remote players can also motivate players to acquire the skills necessary to operate the equipment for other uses.

Finally, ICT skills acquisition is generally more successful if it is linked to solving local problems, presented as “how ICT X can solve problem Y” as opposed to “how to operate equipment X.” For example, communities with large migrant populations look to email as a method to keep in touch with dispersed relatives. Agricultural communities will want to research prices in local markets or pest control advice. Email and the web can be important tools in regions where human rights continue to be problematic, helping inform users of their rights in an environment where the concept of rights might seem precarious. Each of these situations offers an example of how to link ICT use to the daily needs of a rural community.

ICT as Enrichment for Existing Courses, Offering New Pedagogical Approaches

Beyond ICT use as its own subject for student mastery, ICTs in the classroom can present teachers with new methods to teach old subjects. As a practical matter, ICT-enriched courses generally require a pre-existing familiarity with ICT equipment and its capabilities, and consequently are typically phased in either a) after “ICT as independent subject matter” is successful and/or stable, or b) in cases where basic ICT competence and familiarity can be safely assumed. If not, time allotted for an ICT-enriched science course can, for example, end up as time used learning to maintain ICT equipment. While ICT maintenance is indeed a useful skill, such interruptions typically disrupt the learning process, take time away from important subject matter, and tend to create financial and educational inefficiencies.

Nonetheless, ICT enriched courses—where appropriate—offer the double advantage of newer and potentially more engaging teaching options, along with greater practice in ICT skills building. The most obvious applications for course enrichment lie in mathematics and the sciences, where simulation, drills, and virtual laboratories take advantage of the mathematical, visualization, and graphical power embedded in most ICTs to teach science and math concepts. However, social science and humanities can also benefit from graphical and multimedia presentations of history, music and art.

It should be emphasized that for science instruction, virtual laboratories cannot replace real laboratories for teaching the scientific method and the role of experiment in reaching scientific conclusions. Students who cannot run genuine experiments can only talk about science; they cannot practice it. However, given that many rural schools lack laboratory facilities of any sort, virtual laboratories offered by ICTs and computer labs represent an improvement over nothing at all.

Where telecommunications and the Internet are accessible, ICTs offer the option of collaborative learning between schools and classrooms. In these scenarios, two geographically separated classrooms engage similar learning material and exchange results. A biology course might monitor the growth of similar plant species over time under different climatic conditions. A social studies course could compare daily news or daily experiences between a rural school and a migrant community in the United States or elsewhere. Collaborative learning techniques linking geographically dispersed schools require extra care in coordinating and facilitating appropriate interpersonal networks, but they can generate great interest in the outside world, develop important ICT skills, and potentially build long lasting linkages between two communities. It is not unknown that linkages between rich and poor classrooms result in mentoring and other aid benefits to the needier school, its teachers, students, and larger community.

ICT for Distance Education

The most often discussed and dramatic use of modern ICTs in education focuses on in distance education, where in many cases the technology either significantly supplements or entirely replaces a human teacher. In many areas, the emphasis on distance education as the "killer ICT-education application" is so strong that "course enrichment" applications of ICT are billed as "distance education" because a) computers mediate part of the teaching processes, b) course content is created and distributed at a distance, c) there is some connection to a distant resource. For example, Mexico's Telesecundaria program, discussed below, uses primarily "course enrichment" strategies, but defines itself as a "distance education" program.

Distance education itself is not new. "Open education" or distance education offers students a way to study on a flexible schedule, far from the author or instructor of the pedagogical material, thereby in many ways reducing education costs. Different distance education models have been developed based on the needs of the student and on the type of technology available, beginning decades ago with classes by mail, which afforded students opportunities to learn skills not otherwise accessible for those living far from specialized schools or universities or unable to leave their home or place of business for extended periods of study. In the past 20 years, "open education" and distance education programs have spread around the world and have become an integral part of the majority of modern education systems.

For rural zones, the lure of distance education arises in part in response to the difficulty of retaining quality teachers and teaching materials in rural areas. In true distance education, a local teacher may act more as a technical facilitator of a learning telecenter and less as a classic pedagogue. This approach builds on the perception that a facilitator can function effectively with fewer skills than a full teacher. In practice, this may or may not be the case. Facilitators need to excel in specific skill sets to be effective, whereas teachers require a broader array of more general skills.

It is important to emphasize that schools in the developed world and in wealthier areas of the developing world are all evolving toward a model of education which combines classical pedagogy with ICT-enriched courses and distance-education approaches. Most schools—particularly secondary and tertiary institutions—find that they are better equipped to teach certain subjects and less equipped to cover others. Distance education is seen as an option for increasing overall teaching capacity in underserved subject areas, but not a single solution for all their students in all subject areas.

Distance education and inter-school linkages may uncover hidden comparative advantages to rural areas. City-bound students may have little or no experience with rural life and rural schools may well find that demand and appreciation for their participation is greater than expected.

Finally, distance education is likely to have the greatest impact in lifelong learning, vocational training, skills maintenance and skills upgrading. These are all areas in which "on-demand-training" and flexible learning schedules are required and play to the strengths of ICT/distance education methodologies. In general, distance education is very easy to do, but very difficult to do well. A key issue is keeping students focused and motivated, which can be difficult in compulsory education.[93] However, students in vocational and skills maintenance or improvement courses often come with the motivation required to perform with the tools available.

Models in ICT-enhanced and Distance Education

There are several models of ICT-enhanced and distance education that are presently in use. This section explores some of the primary models in greater detail. As mentioned earlier, the optimal mix of ICTs in any pedagogical program depends greatly on the specific context of a community and its development, as well as the available human and material infrastructure. It is important to remember that ICTs include technologies beyond the computer. The models discussed here include a) interactive radio, b) Internet use, c) School Linking, d) Virtual Schools, and e) video-based instruction.

Interactive Radio

After the correspondence course, radio and interactive radio is the oldest and longest documented distance education model. It is also the first model that unmistakably utilizes a modern communications technology. For extremely poor and remote areas, radio-based education can disseminate critical information inexpensively, since radio stations can generate a relatively wide coverage and receiving equipment is also inexpensive and low-power. An ordinary transistor radio can run on solar or hand-cranked mechanical power (e.g. Freeplay Radios) in areas that lack reliable power. Although having two transmitting radios is one model of interactive radio education, there are other models available, such as having a radio station respond to write in or respond to surveys of educational needs over time.

USAID has supported interactive radio programs since the 1970s in over twenty countries in Latin America, Africa, and Asia. Generally, such programs are tailored to individual countries, but there are also some regionalized efforts, such as the joint efforts in pooling interactive radio instruction (IRI) curriculum materials for mathematics and Portuguese in lusophone Africa. These efforts have been financed with assistance from UNESCO, the Dutch government and USAID.

Given the poverty and infrastructure profile of Africa, interactive radio is still a very popular and sensible approach to ICT-enhanced education, but it is also appropriate for many parts of the Americas. Some of the lessons learned from interactive radio are appropriate for emerging technologies such as WorldSpace's AmeriStar satellite, which broadcasts digital data in much the same manner as a radio station. WorldSpace's platform allows a sizable pipe for digital

[93] It is also important that students come with some basic ICT skills familiarity, or a distance education course on "automobile maintenance" can become a course on "how to use distance education software." Any site that uses distance education methodologies needs to include the capacity to deliver "ICT literacy," preferably delivered on-site and in person.

educational information accessible in remote regions with relatively modest power requirements. At the same time, the platform encounters many of the same constraints as traditional broadcast radio and video in that the pipe is one-way. If combined appropriately with traditional mail and survey techniques to provide a feedback loop for remote users, technologies such as AmeriStar can expand the interactive radio model to new media over all of Latin America.

Internet Use

As the Internet expanded in the United States, one of the first initiatives of the Clinton administration was to connect all US schools to the Internet. Other OAS member states will undoubtedly and rightly pursue this strategy as a key public policy for the Internet age, even as some face greater financial and technological challenges than the United States. Internet use will be a key feature of 21st century education.

Currently, children in schools with access to the Internet take advantage of it in a variety of ways. Discussion groups, curriculum resources for download and use in the classroom, and other internet-based educational services present inexpensive methods to improve education and connect children to a technological world in which they must learn to operate to survive. Internet curriculum sources frequently concentrate on particular areas such as the environment (e.g. The Globe Programme), conservation (e.g. The Wild Ones, or mathematics and science (TERC). Some of the most exciting examples of Internet use in education center on children's own creativity and contributions to digital life, such as the DRIK Picture Library in Bangladesh, where children themselves create resources to use and show. The concept of a web page on the Internet that anyone in the entire world can visit is a powerful incentive to student creativity, particularly when a child's daily life may feel restricted to a small and remote village.

Internet connections open up the possibility of virtual courses, or even "virtual schools," which are described below. The approaches are again varied depending on the onboard teaching capacity, bandwidth, processing and electrical power available. Ideally, virtual courses allow students to study some courses on a face-to-face basis and others on an open-learning basis, or simply as a supplement or "chapter" in a traditional face-to-face course. As this evolves, schools can provide a full program is offering both face-to-face learning and distance learning as appropriate, but each supervised by the school.

In special circumstances, particularly in wealthier but remote regions, some schools have begun to offer on-line private tutoring for home-based education, designed for use outside the regular school curriculum and employing parent supervision. These categories and those above are not mutually exclusive; in practice, schools will employ a mix of strategies and capitalize on the available opportunities. For example, schools which develop computer-aided instruction for their face-to-face students will frequently try to use the same materials for instruction in a distance model.

School Linking

An exciting development in Internet is "School Linking" (twinning), which use the Internet's ubiquity to establish long- or short-term links between geographically separate schools. These linkages may connect students in classes, cross connect pupils with remote teachers, help mentor new teachers with older, more experienced ones, and permit school managers to learn from shared experiences. The opportunities presented stem from the richness of potential linkages, which allow both north-south and south-south configurations, as well as the traditional north-north version. Even more exciting are the opportunities to establish meaningful linkages across the rural-urban divide and between disparate ethnic groups. Presently, most school linking takes place at or near the secondary level, wherein ICT skills are more readily established, but primary educators are also expanding the technique, driven particularly by the introduction of ICTs at an earlier and earlier stage in developed countries and the industrialized regions of developing regions.

School Linking helps teach students social and information sharing skills which have always been important, but which will be even more critical in an internet-present age: new learning communities, email pen pals, resource exchange and development, collaborative writing, web page development, and global classrooms. The exposure to distant communities at an early age can help to reduce social and/or racial prejudices and teach cultural ethics, reducing the power of stereotype and hopefully encouraging horizontal relationships in society that strengthens the ability of communities to tolerate differences while appreciating their own characteristics. School linking is particularly powerful amongst minority and isolated communities such as the Jewish and African Diasporas, Innuit and Native American communities, and Latin American migrants with their communities of origin.[94]

Virtual Schools

Schools in wealthier regions have developed computer-based virtual classrooms for out-of-school adolescents. Most often, these classrooms have evolved out of material designed for in-school learners redeployed in a distance-education mode. Virtual Schools can either focus on specific content and subject areas, or offer a computer laboratory and staff resources as a method to access remote virtual learning material. For example, the John D. Bracco School in Alberta, Canada operates as a dual-mode school: it offers a mainstream schooling curriculum, but has added a full “alternative” junior high school program, Learn Net, for remote adolescents or parents who wish to educate their children at home. Learn Net offers course content and uses a computer conferencing system to guide students and their parents through the curriculum. The Bracco LearnNet program even allows students to mix the online and face-to-face formats within a single course, so that students may occasionally come to the school to socialize, meet their teachers, and attend class

As mentioned above, the variations on the interactive teaching model are extensive and take advantage of available resources. An Internet variation on the interactive radio model includes strategies where satellites deliver the teaching and questions for the teacher arrive by fax, e-mail, chat, or instant message. In Mexico, Monterrey Technological Institute for Higher Education (Instituto Tecnológico de Estudios Superiores de Monterrey) is an example of an institution that has made significant progress with this model for different levels of higher education, including masters and post-graduate studies.

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[94] As an example, Mexico began its experience with school networks through the Red Escolar (School Network) and Secundaria siglo 21 (21st Century High School) models.

Video-based Instruction

Video and television-based education offers a middle technological ground between interactive radio and Internet and/or full blown virtual schools. For much of rural Latin America (and also parts of non-Latin North America), video-based instruction offers the most reliable and cost-effective method of ICT-enhanced education. In particular, Mexico has established itself as a regional leader through its investment in the Telesecundaria program, which has been providing direct television-based teaching to rural learners and has been steadily increasing its coverage over time.

<u>Mexico's Telesecundaria Program</u>

The Telesecundaria program offers video education of the same secondary school curriculum presented in ordinary schools, centrally produced, and beamed via satellite throughout the country for reception by Telesecundaria school. The broadcasts arrive on a scheduled basis and in two shifts (morning: 08:00-14:00; afternoon 14:00-20:00). Each hour focuses on a specific subject area and teaches at different levels. Typically, these courses are designed with 15 minutes of instruction to be followed by book and or teacher mediated activities. Staggering the teaching levels throughout the hour allows more advanced students to engage the books and live teacher while the basic skills students receive video instruction. The program design sees that each student has a "home teacher" that oversees all learning, even though the child encounters various teachers on television. The Telesecundaria teacher corps consist of roughly 60% fully qualified teachers and 40% university graduates but without previous teacher training. For these 40%, the Telesecundaria program provides induction training, as well as in-service training broadcast on off hours or on the weekend.

Castro et al. report that the introduction of satellite transmission helped increase those exposed to televised education from 512,700 in 1993 to 817,200 by the end of 1997-98, and project an enrolment of 1,100,000 by 2004. By the end of 1997-98 there were 13,054 schools and 38,698 teachers.[95] Moreover, Telesecundaria's performance is encouraging: Telesecundaria dropout rates are slightly lower than those of general secondary schools and significantly better than technical schools. Students may start off significantly behind other students, but catch up entirely in math and make significant progress in language. The cost of maintaining a Telesecundaria school[96] turns out to be higher than that of an equivalent urban secondary school, but lower than the cost of establishing a rural secondary school of similar quality.

For cases where signal reception equipment is not available in each school, the Telesecundaria model calls for copying the signal onto videocassette (VHS) an education center or location which can receive a signal for distribution to schools for their use.

The Telesecundaria model has been so successful that several Central American countries (e.g. Guatemala and Honduras) have signed agreements with the Government of Mexico to replicate the model and have been able to bring intermediate education to isolated rural communities.

[95] Castro et al. (1999), p. 29.

[96] Including teaching and administrative costs, physical facilities, televised programs and books.

Telesecundarias have also influenced much video-education in other parts of the world, such as the TV Educativa efforts in Brazil.

Educational Portal of the Americas

The Educational Portal of the Americas (http://www.educoea.org/) is a new multi-lingual (English-Spanish-Portugese-French) Internet resource that brings distance learning opportunities to students and scholars throughout the Americas. The Educational Portal is an initiative of the OAS Inter-American Agency for Cooperation and Development (IACD), and was launched in September 2001 during a meeting of the Hemishphere's education ministers in Uruguay. The Portal provides access to more than 4,000 distance learning courses by more than 1,000 accredited universities in a wide variety of academic disciplines, with all universities and courses of study carefully screened and pre-qualified. The participating universities include institutions from the United States, Canada, Spain, Latin America, and the Caribbean. While there is a fee for many of the courses, the IACD offers a large number of fellowships through the Portal for students from OAS-member countries, enabling many students and professionals to take courses at low or no cost. The courses include offerings aimed at in-service training or strengthening of teaching professionals. The Portal also provides links to digital libraries, educational foundations, and other relevant sites.

Technologies Employed in Rural Education Initiatives

In recent years a greater number of information and communication technologies have been developed for and applied to the improvement of rural education programs, completely changing the foci and increasing the efficiency of traditional distance education models. This has given way to a greater number of and better educational tools to meet the educational needs of child and adult students at a variety of different levels in rural areas.

A variety of technologies can be used to facilitate teacher-student, student-student and teacher-teacher communications, or to distribute educational materials between remote locations. They range from "low tech" to "high tech" and vary greatly in function, applicability and expense. They include: audio and video cassettes, cable and satellite television, computer audio-graphic systems, Viewdata, videotext, videodisks, interactive CDs, audio and video conferencing, e-mail, computer conferencing, Internet, computer Multimedia, and interactive computer databases. No one technology is appropriate for every situation; in many cases, a combination of technologies will produce better results than using one single technology. Ultimately, though, the quality of the education depends more on the quality of course design and instruction than on the technology itself.

Digital systems, which transmit all information as bits (Binary digits), can send different types of information (text, numerical data, sound, images) down the same channel at the same time, or across networks that use several different communication channels. (In order of increasing bandwidth, or "pipe size," these channels include ISDN, fiber optics, cable, and communications satellites.) As communications between computers grow, so does the role of the Internet—the backbone of the worldwide computer communications network, with signals passing through several of these channels. The Internet's role is growing no less in distance education. Box 3-5 describes some of the technologies commonly applied in rural education programs.

Box 3-5: Some Technologies Commonly Applied in Rural Education Programs

Microwave
High-frequency microwave transmission has been the standard mode of terrestrial communication used by telephone companies and broadcasters (FM) for many years. Microwave signals are transmitted by highly directional dish-shaped antennae, in both terrestrial and satellite communication. Microwave transmissions can be modulated to carry both analogue and digital signals for voice, video, or data communication. Instructional television fixed service (ITFS) uses microwave transmission for narrow casting.

Integrated Services Digital Network (ISDN)
ISDN is a set of international digital telephone switching standards. ISDN networks, which can be used to transmit voice, data, and video, offer the advantages of error-free connections, fast call setup times, predictable performance, and faster data transmission than possible using modems over traditional analogue telephone networks. Basic ISDN services combine voice and data, while broadband services add video and higher-speed data transmission. As telephone companies have progressively installed ISDN services, there has been much experimentation with distance education applications, notably for audio-graphic conferencing and multimedia desktop conferencing.

Coaxial Cable
Coaxial cable is widely used in many countries for distributing cable television and telephone services. The cable has a central copper-conducting core sheathed in insulation, then another ring of conductor and an outer core of insulation. Cable circuits take either a tree and branch form or a switched star form, and need to have signal amplifiers installed at points along the network. The amplifiers can be one-way or two-way; the two-way amplifiers permit the provision of interactive services over the network, allowing consumers to select from a menu of services (for example, home shopping, videos on demand, or educational services). Cable networks are often fed services and programs by satellite communications systems for local redistribution.

Communications Satellites
Satellites orbiting the earth are used to receive and retransmit signals for telephone, television, radio, and data communication. The basic relay device in satellites, the transponder, has seen tremendous increases in efficiency thanks to advances in compression technology. A communications satellite system comprises the satellites and the ground stations for transmitting and receiving the signals. Direct broadcasting satellites, which are geo-stationary, transmit radio and TV services that consumers can receive through a cable redistribution network or a personal domestic disc antenna. Recently a digital satellite radio system was inaugurated using satellites over Africa, the Middle East, Asia, and Latin America. Signals from these satellites—including distance education programs that are planned—will be able to be received directly on special portable radio receivers.

Fiber Optics
Optical fiber systems provide high-capacity bandwidth (up to 3.4 gigabits per second) with high transmission quality, no electrical interference (because the signals use light waves rather than electrical transmission), and minimal loss of signal strength over distance, thus necessitating fewer repeaters than coaxial cable. Wider use of optical fiber systems—and realization of their full potential—will depend on the speed at which telecommunications and cable providers replace their copper wire systems.

Internet
The Internet is the world's computer network backbone—a vast network that connects independent networks spanning more than 170 countries. It links computers of many different types, sizes, and operating systems, all sharing the Internet Transmission Control Protocol (TCP/IP), which allows computers of different types to communicate. Internet users can communicate with one another by email, file transfer, computer conferencing, bulletin boards, and newsgroups. Using Telnet, they can log onto computers elsewhere to access databases, on-line libraries, or even computer games. They can explore the World Wide Web, with links to the same resources and to graphics, sound, and video material. And they can have real-time interaction with other users through the keyboard (Internet relay chat) or through audio and video links. No organization or government "owns" the Internet; instead, many people and organizations participate voluntarily on task forces to develop standards and monitor its technical operation.

Source: World Bank, http:wbweb4.worldbankorg/DistEd/Technology.

Material and Content

Mexico's Telesecundaria Materials

Mexico's Telesecundaria program has developed a wealth of materials to support teachers in remote classrooms—from material for transmission through its Edusat Network, to educational

CDs that can be used by the student to both learn the curricula and develop computer skills. This material is highlighted here for two reasons: to show the breadth of content that can be addressed via video-based instruction; and to characterize one existing source of Spanish-language content available for use elsewhere in the hemisphere.

For all of the initiatives undertaken by Mexico's Secretary of Public Education (SEP), different materials can be accessed directly from the Internet or acquired through the Latin American Institute of Educational Communications (ILCE) or the General Management for Educational Television (DGTVE). DGTVE recently produced 48 programs for Telesecundaria grades one and two, implemented during the 2000-2001 school year. ILCE has made available to schools and the general public educational materials that support curricula from the primary education level to the professional level, much of which is dedicated to secondary education. Materials created by various universities and commercial television channels at the national level can also be acquired through the National Catalogue of TV Programs and Video Productions, which has generated more than 17,000 titles on subjects targeted primarily for the basic high school level, but on other subjects as well.

The Satellite Network for Educational Televisión (Red Satelital de Television Educativa – Edusat) is the Telesecundaria program's programming and digital satellite network, which transmits educational programming throughout Mexico and to some Central American countries (including Honduras) over ten channels[97] via a Satmex 5 satellite. During the 1997-1998 school year, Edusat produced 3,090 programs, plus 412 summer school programs, 860 "Development Activities" and 103 general programs. To receive Edusat programming, a Telesecundaria school must meet certain established equipment requirements, such having a classroom equipped with computers with Multimedia capacity, Internet access, etc., and software packages that include Windows, Explorer, Netscape, and Realplayer. When a school does not have some of the necessary software—or recent versions of the necessary software—it can access it for free through links found on the web pages of the national educational video-library, through ILCE and DGTVE. Edusat provides the satellite equipment to receive the signal (antenna and decoder).

The schools that receive educational material on CDs (mainly through Mexico's' Red Escolar and Secundaria Siglo 21 programs) receive a package of about 20 educational CDs which contain multimedia encyclopedias. As of yet, no basic package has been established. The educational CDs require the installation of easy-to-use software which is provided to the schools.

Brazil's Alvorada Approach and TV Escola

Mexico's Telesecundaria program is pioneering in the scale of its offerings and the potential to cross-fertilize other Spanish-speaking efforts, but other regions are also instituting programs based on improving education via ICT. In Brazil, Winrock International is an implementing partner of an ICT assistance component of the government's Alvorada program.[98] This key activity in the larger Alvorada program, targets small towns and villages in Brazil's northeast region to receive what amounts to a local ICT-enabled library, including a videocassette library, television, VCR, and computer with internet connection (where adequate). The main objective is

[97] Edusat currently transmits over ten channels but has capacity for six more.
[98] See http://www.presidencia.gov.br/projetoalvorada/alvorada.htm.

to enable remote access to internet-enabled government services, but video and CD components include educational materials about basic health including AIDS, human rights, gender issues, and selections from Brazil's "TV Educativa," which helps students around the country prepare for examinations up to and including college entrance examinations.

Given the nature of the target communities, it is expected that local teachers will make greater use of videos oriented toward more basic and primary skills, but the Alvorada program envisages that appropriate distribution of video materials to these communities will increase their capacity to respond to local problems. Over time, the accompaniment of local demand will identify the optimal materials required for Alvorada's community centers to maximize local problem-solving capacity and their ability to capitalize on opportunities.

The Alvorada project is based on the larger "TV Escola" (Television School) program, started in 1996, where every school in the country with more than 100 students receives the resources to purchase a "basic technology kit," which consists of a VCR, satellite receiver, television, and a small videocassette library. In addition, for the poorer regions of the country (north, northeast, and centerwest), schools with less than 100 students receive a television, VCR, and videocassettes. According to the Ministry of Education and Culture, over 50,000 schools have benefited from the program since its inception.[99]

In Berilo, Minas Gerais, the ministry reports that many students encounter television for the first time through the schools participating in the program. Under such conditions, even rudimentary information such as basic hygiene can make dramatic differences in local quality of life. The school serves children in the daytime, but adults come to learn to read and write at night. Both children and adults have regular interactions with a local teacher, who helps facilitate and contextualize what they have seen from the television.

Other Regional, US and Canadian Materials

The use of internet technologies can allow some rural locations to take advantage of online course resources prepared by Latin-America focused organizations in the more developed areas of the region, including the United States, Canada, México, and the Southern Cone. For example, the Latin American Studies department at the University of Texas at Austin has compiled and maintains an outstanding set of Internet resources relevant to Latin America, including significant education and distance education links broken down by country, region, thematic area, and medium.[100] Lanic offers an excellent source for comparing regional approaches to and programs in distance and ICT-enhanced education.

The resources Lanic offers are too detailed to describe here. However, the main point is that for centuries, individuals and families in remote areas have had to travel to (often urban) knowledge centers to obtain the education, knowledge, or technical assistance they need to improve their productivity and solve the problems of daily existence. In many cases and for many problems, the journey was simply to costly or too inconvenient to undertake, perpetuating a culture in

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[99] See http://www.mec.gov.br/seed/tvescola/default.shtm and http://www.presidencia.gov.br/publi_04/colecao/2acao9.htm.

[100] See: http://lanic.utexas.edu/la/region/distance/.

which seeking immediate answers to problems or attempting to solve issues through innovation was too risky to consider. Similarly, the distance between knowledge center and the rural knowledge user led to a disconnect in understanding what rural communities really need. As a result, poor communities did not know what questions to ask, and knowledge providers such as teachers and extensionists did not necessarily have the right answers.

A key opportunity in ICT-enhanced rural education, whether using a distance or other approach, is to shorten the gap between rural knowledge and the rural knowledge consumer. The carefully planned and appropriate use of ICTs will shorten that travel and gap considerably and help promote a culture in which even marginalized communities learn how to ask questions and how and where to seek answers. Perhaps most important in the vocational and technical assistance applications of programs like Telesecundarias, TV Escola, and Alvorada is to ensure that the "content" provided through videocassette, internet, or other medium is updated in response to the changing needs of communities as they learn to access new information resources and develop new questions. There is much more opportunity in ICT-enhanced education than mere cost savings. The real opportunity is to make content meaningful to these communities, so that the overall knowledge environment in which they operate helps them live more meaningful, productive, and healthier lives.

3.6 ICTs for Agriculture

Various manifestations of agricultural applications of ICTs exist in developed countries and are emerging in developing countries. They include, but are not limited to:

- Dynamic information, communication and learning tools, such as World Wide Web databases, electronic mail networks, electronic newsletters and bulletins, and distance education programs that are facilitated via the Internet and telecommunication networks;
- Applications of voice telephone systems for communication and information sharing tools that provide agricultural information hotlines and research directories;
- Creative marriages between Internet tools and other media such as rural radio and print media;
- Linkages between electronic media and face-to-face workshops, discussion forums, and "kitchen table" meetings;
- Geographically distributed video and audio conferencing systems via telecommunication networks and satellite systems;
- Publicly accessible geographic information system tools; and
- Linkages with community communication centres and community organizations for improved information dissemination and feedback.

Developed countries have a legacy of single-purpose agricultural software tools and limited-access agricultural networks. Prior to 1990, the Internet was largely outside of the realm of agriculture. Communication among agricultural stakeholders involved in creating and managing electronic tools was thus quite limited. Electronic tools tended to be geographically limited, or used by a select group of subject-matter specialists. The explosive growth of the Internet during the 1990s stimulated an intense period of collaboration, linkage, standardization, and development of distributed applications that can essentially be used by anyone connected to the Internet, anywhere and at any time.

During the latter years of the 1990s the distributed, multi-user nature of these new applications catalyzed the development of tools (particularly Internet database tools) that were not simply limited to distributed use. This latest generation of networked electronic tools could also be developed, enhanced and collaboratively managed by people who might work across time zones around the world: people who might never meet face-to-face.

While individual tools may be maintained by different organizations, users can mix and match whichever tools meet their specific needs. If their needs are not met, they have the option of creating their own tools and adding them to the network of tools available to all. Planned or happenstance consultation among users helps to identify imperatives for linking these tools, ways of reducing duplication of services and ways of creating partnerships among organizations offering the tools. In Canada, for example, agricultural stakeholders have begun to take stock of the variety of networked electronic tools available. Canadian agriculture's honeymoon with electronic technology for technology's sake is over, and there is much greater interest in realistic and practical applications of information and communication technologies (ICTs) to meet pressing needs. Decreasing government funding for agricultural research and extension is one key factor driving this interest in practical tools that are individually supported by one organization, but accessible to all.

Organizations providing the tools in Canada are now meeting with one another, and with client groups, in order to provide better value and better information, improve communication relationships, and create synergistic partnerships among tool providers. Thus, we are seeing new and interesting strategic alliances between telephone system operators, agricultural ministries, rural development organizations, agricultural businesses, universities, farmer organizations, Internet service providers, and marketing organizations. Each organization takes responsibility for supporting the components of the ICT applications that best fit that organization's capabilities.

For example, the central directory of Canadian agricultural information on the Internet, the Canadian Agriculture, Farm and Food Extension Information Network and Exchange (CAFFEINE), was once maintained by the University of Guelph. University budgetary cuts and increasing management time for maintaining a rapidly growing database resulted in a strategic alliance with a private sector agriculture consulting firm specializing in Internet applications. CAFFEINE was purchased by a private sector consortium and is now called Farms.com (www.farms.com). The service now covers all of North America and has been strengthened to include numerous e-commerce agricultural trading tools.

Today a user can link to Farms.com on the World Wide Web and instantly access information about market prices, weather, agricultural research, extension services, government programs, inputs and agricultural news. Users can also buy and sell agricultural commodities directly through the Internet. Farms.com also includes a vast chat section through which users can discuss any topic they wish, a free classified advertising section for users to buy and sell things from one another, and a calendar database through which organizations can post information about upcoming events occurring throughout the country.

Creative marriages to other media are exemplified by the Ontario AgRadio Network (http://agradio.ciaccess.com/) in the Province of Ontario. The Ontario AgRadio Network produces, syndicates and distributes daily farm market audio programming for a network of rural radio stations. Daily news items that are broadcast on radio are mirrored on the Ontario AgRadio Network Internet site, together with programming schedules and broadcast frequencies across the Province. Daily farm market information (e.g. daily prices for corn, soybeans and feed) that is broadcast on the radio is available to farmers through a subscription and pay-per use system via telephone, fax, electronic mail, or regular postal mail.

Another example of collaborative information and communication partnership is Farmcentre.com (www.farmcentre.com). Farmcentre.com is owned by the Canadian Farm Business Management Council (CFBMC) and is the result of partnerships between CFBMC, agriculture industry players, commodity groups, farm organizations, provincial government ministries of agriculture, and Agriculture Canada. Farmcentre.com provides a variety of farm management information on the World Wide Web and in print format, together with farm management software tools and an automated electronic mail delivery of market reports, news, and weather forecasts. The information on Farmcentre.com appeals to a broad range of users, including farmers from across Canada, extension personnel, agricultural media, government agriculture specialists, university researchers, agribusiness consultants, and international users from all the above categories.

Examples of similar information, communication and learning partnerships that illustrate the power of agricultural applications of new ICTs include:

- The United States Department of Agriculture's Cooperative State Research Education and Extension Service[101] in partnership with university research and extension divisions across the United States, and with U.S. farmer organizations.
- AgNIC, the USDA's Agriculture Network Information Center, which is currently expanding the global reach of its web-based information network.[102] The site maintains information on and links to more than 800 agricultural databases, a contact list of agricultural specialists and a calendar of agricultural conferences. In the works are on-line libraries with in-depth content and personalized assistance.
- Agricultural stakeholders in developing countries can take advantage of the research and development of agricultural ICT applications occurring in developed countries. They may also benefit from the fact that, unlike many in the developed world, they have not made costly investments in non-networked electronic tools and thus do not feel obligations to support and maintain out-dated tools. A planned approach to stakeholder collaboration in agricultural ICT development and strategic application of networked electronic tools could enable some developing countries to leapfrog over developed countries in terms of return-on-investment and application to critical agricultural issues.

[101] http://www.reeusda.gov.
[102] http://www.agnic.org.

Developing Country Examples

There are a number of emerging examples of agricultural applications of information and communication technologies that hold significant promise for replication in developing countries, a few of which are described in this section. Each of the examples discussed below highlight the importance of organizations' orientations toward effective information and knowledge sharing. Organizations that hoard knowledge and have management cultures that penalize or do not reward staff for sharing information and knowledge, are unlikely to benefit from the acquisition of new ICTs.

FarmNet

FAO, in partnership with UNFA, undertook to design and develop a Farmer Information Network for Agricultural and Rural Development (FarmNet) in Uganda in 2000. A FarmNet is a network of rural people using communication tools and processes to facilitate the generating, gathering and exchanging of knowledge and information among themselves and the intermediary organizations that work with them. Coordinated through the Communication for Development Unit at the FAO and developed with assistance from the TeleCommons Development Group, the purpose of the FarmNet is to empower farmers through participatory communication networks managed by them to access, generate, share and utilize information and knowledge for improved livelihoods. A FarmNet enhances horizontal communication—information and knowledge sharing—among agricultural stakeholders, and relies more on communication planning and agreement about information and knowledge sharing protocols among various participants than it does on technologies. A FarmNet also relies on participants accessing and using existing ICTs rather than creating new technical solutions. In essence, a FarmNet focuses on the planned and organized use of existing ICTs, combined with traditional media and communication processes such as rural radio or face-to-face meetings, to help farmers exchange experiences, find common ground for collaboration and actively participate and manage agricultural and rural development activities.

Operated by farmers and their organizations, the Uganda FarmNet links farmers to each other and to the resources and services that they need to improve their livelihoods through agricultural productivity, profitability and food security. The FarmNet uses existing organizational and social groupings of rural people and incorporates grassroots communication networks (often informal and face-to-face) such as farmer-to-farmer exchanges and traditional media. It combines the organizational and communication networks of rural people with conventional media, such as rural radio, and with the planned and appropriate use of the new ICTs such as mobile cellular phones and email.

The Uganda FarmNet focuses on the following activities:

- *Participatory information audits and needs assessments* to understand the differentiated constraints, opportunities, resources and skills of farm groups;
- *Rural networking* using farmers' own communication channels combined with conventional communication media and the new ICTs;

- *Capacity building* with all FarmNet partners to strengthen their abilities to generate, access and manage knowledge and information for better farming and improved livelihoods; and
- *Participatory monitoring and evaluation* to update FarmNet activities and information services and to document and share successful experiences and best practices with other farming communities and development partners.

Many types of farmers benefit from the Uganda FarmNet—small scale, limited resource farmers, semi-commercial family farms, and producers of high-value export commodities. FarmNet partners such as extension advisory services (public and private), research institutions, NGOs, input suppliers, local media and local community information centres also benefit as both providers and users of knowledge and information. FAO is examining opportunities to replicate the FarmNet concept in several other countries. Most recently it has supported a FarmNet planning exercise in Bolivia (January 2001).

PinoyFarmer

Another example of innovative ICT deployment for agriculture is the PinoyFarmer program financed by the Philippine Department of Agriculture and implemented by Winrock International. Informed by positive experiences in Guinea and Mexico using low-tech methods to distribute regional and international price information, PinoyFarmer brings ICT to bear through web-based databases distributing price and market information to upland farmers in five Philippine macro regions.

Designed as a method of improving rural information environments and strengthening agricultural extension support, the PinoyFarmer website (www.pinoyfarmer.com) lists historical and current market prices for the dominant agricultural products in the region. Human samplers go out on a regular basis to markets in Manila and other areas to record current prices by crop and quality. Winrock is training local extension workers to use local connectivity points to sample and distribute this information to local producers so that they can coordinate planting, harvesting, and shipping activities accordingly.

In addition to price information, the PinoyFarmer website educates cooperatives, extensionists, and farmers about quality distinctions for their products, so that local farmers can improve incomes through a closer connection to international quality standards and international markets. PinoyFarmer's "business tools" section offers template spreadsheets for calculating the costs and benefits of a variety of tasks commonly used by local farmers, with step-by-step instructions on how to proceed. Moreover, the PinoyFarmer program is rolling out a "virtual mentoring" service to their site wherein farmers, extensionists, and cooperatives can consult world quality specialists on agricultural problems in their area.

Part of the PinoyFarmer implementation plan sees the use of personal digital assistants (PDAs) such as Palm Pilots as extension support tools, so that extensionists can carry price, quality, weather, and pest information with them in visits to clients and field locations. Agricultural extension agencies were already experimenting with laptop computers for this use, but the PDA approach cuts the cost by roughly 80%, with improved portability and battery life as additional advantages.

In the future, PinoyFarmer will have customizable sites where users can log in and track price, mentor, news, and best practices information for crop varieties that interest them, using a personalized portal design. Moreover, since the PinoyFarmer site is driven by server-side software, even relatively inexpensive equipment such as WebTV, kitchen top console computers (such as 3com's Audrey), and potentially WAP or text pagers.

VERCON

Coordinated through the FAO and developed with assistance from the TeleCommons Development Group, the Egyptian Virtual Extension-Research Communication Network (VERCON) is currently being piloted in Egypt through the Central Administration for Agricultural Extension Services (CAAES) and the Agricultural Research Centre (ARC). VERCON aims at improving linkages between and within agricultural research and extension institutions through two fully integrated and co-dependent components: the human component and the technological component. The human component is a network (e.g. staff of research and extension institutions, faculties of agricultural education, NGO workers and in some cases agricultural producers themselves) committed to strengthening collaboration, communicating, sharing information and supporting improved agricultural production. The boundaries of the network are flexible and can expand to include more stakeholders or can contract to focus more closely on specific actors and their information or communication requirements and functions.

The Egyptian VERCON is currently a pilot project to improve linkages between research and extension in four pilot centres as the basis for creating a national electronic agricultural knowledge and information network. The project uses Internet-based ICTs to strengthen the national agricultural research and extension systems, and in particular to close the gap between researchers and extension agents by improving the generation, flow, sharing and collaborative use of agricultural knowledge and information. The network helps overcome the physical, administrative, knowledge and communication barriers that hinder interactions between researchers and extension agents, limit their ability to share technical competence, and ultimately reduce their impact on improving agricultural productivity and increasing farm incomes. The project is directed to human capacity building through improved and expanded access to agricultural knowledge and information.

The technical foundation of the VERCON is a networked computer database tool that enables distributed and decentralized data entry and data access in the form of text, images, audio and video. Creative marriages with other media, such as print, fax and rural radio extend the reach of the information resources, learning opportunities and communication processes to farmers and extension workers in rural communities. Technical design, maintenance and training are coordinated by one office within the Ministry of Agriculture. The tasks of organizing and updating the content of the network, and developing discussion and communication functions, are part of a collaborative exercise among a diverse set of Ministry of Agriculture personnel and departments. The Network focuses attention on the necessity of collaborative linkages between personnel and departments, enables good managers to enhance those linkages and identify opportunities for knowledge sharing, activity partnerships and avoidance of service duplication.

CONCADE

The Counter-Narcotics Consolidation of Alternative Development Effort (CONCADE) provides technical assistance to USAID, Bolivian government agencies and the private sector to support the creation of viable legal alternatives to growing illegal coca in the Chapare region of Bolivia's Cochabamba Department. Coordinated by DAI, with technical support from Winrock International, CONCADE promotes the production of alternate crops, such as bananas, pineapple, heart of palm, passion fruit and black pepper, through agricultural technology transfer, agribusiness marketing, private sector investment promotion, strengthening of alternative development organizations and alternative development policy. Project technicians are trained in the use of ICTs to help them provide critical outreach services, such as facilitating the delivery of market information to local farmers, families and producer groups. ICTs are also used to provide training information to project technicians, and to help track project impacts and costs.

CONCADE is a prime example of the significant impact the enhanced use of ICTs can have on alternative agricultural development programs. Local farmers' interest in producing legal alternatives to illegal crops is dependent on their ability to produce the alternate crops in a safe and commercially viable manner. Alternative development projects must get information out about the relative attractiveness of producing alternative crops to the majority of farmers in the target area. In the case of the CONCADE project, there are 17,000 families in the Chapare region. By using ICTs, each project extensionist now serves 200 rural families, with a total of approximately 7,000 families currently being served. The CONCADE project incorporates GIS-based applications into its project Performance Monitoring Information System to facilitate more timely and accurate information gathering and dissemination and more accurate evaluation and documentation. The project plans to enhance its use of ICTs, including integrated Geographic Information System applications and handheld devices, to facilitate technicians' wider coverage in order to ultimately reach all 17,000 families in the Chapare.

CAB International Compendia

CAB International (www.cabi.org) is an international non-profit organization which delivers "practical knowledge solutions" in the applied life sciences to benefit improved agricultural, trade and environmental practices worldwide. CAB International is headquartered in the UK and has affiliate centers in Kenya, Malaysia, Pakistan, Switzerland and the U.S. CAB has published a series of three encyclopedic, multimedia tools, called "compendia," which bring together a wide range of different types of science-based information sourced from a range of experts in agriculture, forestry and environment.[103] Published in the form of CD/ROMs and on the Internet, the Compendia provide practitioners and researchers with practical information on locally and regionally relevant topics in forestry, crop protection and animal health and production, including information tailored to particular environments and relevant to local conditions. The compendia are updated regularly, are available only in English, and are made available to

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[103] CAB International (2002b).

interested organizations, institutions and individuals from developing countries for $100/unit ($600 for developed country customers).

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Issues are presented as data sheets with text, illustrations and maps, covering taxonomy, distribution, environmental conditions, horticultural and silvicultural characteristics and practices, pests/diseases, uses and disadvantages. Other features include bibliographic search facilities, multilingual glossaries, personal and networked notepad facilities, statistics from key multilateral organizations, trade supplier directories, and key scientific texts.

The Forestry Compendium is a silvicultural reference tool which provides worldwide coverage on tropical, subtropical, temperate and boreal species of major economic importance and lesser known species of local importance. The Forestry Compendium also includes an interactive species selection module which identifies species with potential to be tested in trials on a particular site, and is of particular value during planning of forestry plantations and other land-use systems which utilize woody species. The user may enter specific criteria such as climate, latitude, soil type, silvicultural requirements and/or uses, and this *compendium* will list species which match these criteria. The Crop Protection Compendium provides full data sheets for over 1830 pests, diseases, weeds and natural enemies of worldwide or regional importance, each with text, illustrations and distribution map, with outline data available for an additional 10,000 species. The Animal Health and Production Compendium covers several hundred topics in food-animal production (cattle, buffaloes, sheep, goats, pigs, poultry), including husbandry, housing, handling, identification, transport, behavior, nutrition, genetics, reproduction, techniques, welfare, slaughter, meat, milk, eggs, products and legislation. It provides data on more than 150 livestock and poultry breeds, covers over 250 diseases, includes an international veterinary drugs and products database, and uses a Geographic Information System to display global and regional maps from underlying geographic databases, especially useful in international trade and quarantine.

Connect Rural Knowledge Venture

The Connect Rural Knowledge Venture—a joint undertaking of FAO, Volunteers in Technical Assistance (VITA), the TeleCommons Development Group, and the WorldSpace Foundation, with pilot activities in northern Africa underway through the WorldSpace Foundation—aims to increase access to appropriate and practical information among farm families, rural enterprises, and producer groups. It will build local capacity in information production and outreach and add value to existing networks, projects and communication initiatives. More effective information access will contribute to improving rural livelihoods, reducing hunger and strengthening food security. Support network partners/subscribers will include donors, IFIs, INGOs, NGOs, the CGIAR system, governments, existing projects, NARs, private sector agribusiness, existing advisory services, producer organizations, and media & connectivity service providers.

Supporting multiple and diverse communication tools and existing media will be at the heart of the network. Tools and media will range from folk media and email to rural radio and posters. The Connect Rural Knowledge Venture is not "another web portal" or an attempt to have technologies drive development solutions. While the Internet is a necessary element of the support network, only cost-effective and existing connectivity solutions will be contracted from service providers that understand the challenges of rural contexts.

Current pilot activities are centered on the WorldSpace Foundation's Africa Learning Channel. The Africa Learning Channel (ALC) is a collective audio channel of "first voice" programming collected from African NGOs, media groups and other content providers.[104] It provides the means for these groups to reach much larger audiences than was previously possible. The ALC is a forum for Africans to exchange ideas and share solutions to common problems with other Africans. It gives voice to populations that have not been heard, and empowers them with the knowledge they need to participate in the new global village. Special radio receivers are required to capture Channel content through a satellite signal from the AfriStar™ satellite. The receivers run on batteries or an external power source, and can be adapted to run on solar energy. They have data ports, that when connected to a computer via multimedia adapter cards, enable users to download web-based text and images, thus expanding the receivers' capabilities beyond audio to digital multimedia transmissions. Web-based multimedia data (text, images, video clips, and audio) are transmitted via the satellite to the computers' hard drive without phone lines.

In the future, programs produced by community radio stations in Africa will be broadcast to the rest of Africa from AfriStar™, and throughout the Asia-Pacific region from AsiaStar™, the second satellite in the WorldSpace system, launched in March 2000. As WorldSpace Foundation expands and develops the learning channel concept in Asia-Pacific in 2001, and in Latin America and the Caribbean beginning in 2002 (AmeriStar™, the third WorldSpace satellite, will be launched later in 2002), a truly global exchange of information between communities in developing countries will then be possible.

In later sections of this report, we discuss analogous efforts in Colombia and Guatemala.

3.7 Telemedicine/Telehealth

Telemedicine is not a new concept. Although cases of telemedicine have been recorded since the early 1900s,[105] the first full scale telemedicine projects date back to the early 60s when the National Aeronautics and Space Administration (NASA) started its programs of space exploration by humans.[106] A number of telemedicine projects were implemented during the late 60s and the 70s, but most of them did not succeed. The main reasons for their failure were the limited advancements in the related technology, the cost of the technology and administrative and staff issues.

The recent developments in ICTs have revived the hopes and expectations related to telemedicine. Continuous advancements in the ICT sector, associated with the lowering of costs for ICT services and the integration of such technologies have made possible the introduction and use of telemedicine in an increasing number of rural and remote communities all over the world. Today, telemedicine applications range from the use of telephones to high-speed

[104] World Space Foundation (2001).
[105] Wright (1997).
[106] Brown (1995).

specialized data and video communication networks. In 1997, 188 active telemedicine projects world-wide were reported.[107]

Definition of Telemedicine

In order to simplify the definition of telemedicine, one needs to distinguish between telemedicine and telehealth. For the purpose of this report, telehealth will be defined as the provision of health services to those who are at a distance from the service provider, but are not in need of a diagnosis. The services these people are looking are information on how to stay healthy and conduct a safe and healthy life.[108] Telemedicine, on the other hand includes the delivery of health information and the delivery of health services. Some of definitions related to telemedicine are:

> "The practice of exchanging clinical information in electronic format between remote locations to facilitate clinical diagnosis, treatment, consultation or referral for the purpose of delivering health services."[109]
>
> "Telemedicine is the use of medical information exchanged from one site to another via electronic communications for the health and education of the patient or healthcare provider and for the purpose of improving patient care."[110]
>
> "Telemedicine is the investigation, monitoring and management of patients and the education of patients and medical staff, which allows easy access to expert advice and patient information, no matter where the patient or relevant information is located."[111]
>
> "The use of electronic information and communications technologies to provide and support health care when distance separates the participants."[112]
>
> "The use of telecommunications to provide medical information and services."[113]

Although these definitions, vary to a certain degree in the scope and dimensions they attribute to telemedicine, there are a number of commonalities in all the definitions. These commonalities are: a) the delivery of health services, and b) the delivery of health information, c) the use of ICT tools.

For the purpose of this report, telemedicine will be defined as:

> "[T]he delivery of health care services, where distance is a critical factor, by health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, and for

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[107] Greenstar (2001).
[108] Greenstar (2001).
[109] Naval Telemedicine Business Office (2001).
[110] Linkous (2001).
[111] Norwegian Centre for Telemedicine (2001).
[112] Greenstar (2001).
[113] Telemedicine Research Center (2000b).

> the continuing education of health care providers, as well as research and evaluation, all in the interest of advancing the health of individuals and their communities."[114]

Telemedicine can help increase the efficiency of health care systems in three main areas: a) provision of quality and effective heath services to an increasing number of people; b) education of both practitioners and the general population; and c) the management and administrative aspects of a health care system. As such, telemedicine can be as simple as a patient and a health professional discussing a health-related issue over the phone, or a practitioner having access to a medical database, to advanced and sophisticated applications such as using videoconferencing to made possible real-time consultation between a number of health professional located in different countries.

Types of Telemedicine Systems

Depending on the communication speed, and the type of ICT tools used for communication, telemedicine applications can be divided into two main systems: a) store and forward (SandF) applications, and b) real time (RT) applications.

In the SandF applications, the information is first captured or created without intervention, and then transmitted. These types of applications are used mainly for non-emergency situations, and the whole procedure (store-and-forward) could be as long as 24 to 48 hours.[115] The different ICT tools utilized under these types of applications include still images (taken with a digital camera, or X-rays), text messages (e-mail), voice messages (voice mail), and video-clips. The SandF application can be undertaken through small or limited bandwidth. The SandF has been successfully used in dermatology, pathology, and gross medical photography.

On the other hand, real-time applications are used mainly when a face-to-face consultation is seen as necessary, and in emergencies. The two main ICT tools used in RT applications are video-conferencing and voice (both phone and radio). These kinds of applications require a much higher bandwidth than SandF applications, and are more costly. In addition to traditional video-conferencing sessions, there are an increasing number of devices that can be attached to a video-conferencing unit or a computer to enhance an interactive examination or consultation. RT applications are used in psychiatry, orthopedics, neurology, ophthalmology, etc.

Broadband Requirements for Telemedicine Systems

Bandwidth requirements depend on the types of applications that will be provided through the telemedicine initiative. In general, bandwidth required for applications based on an SandF system will be much lower in comparison with those needed for RT applications.

Store and Forward Systems

A good number of telemedicine applications are based on Store and Forward (SandF) systems, which in most cases do not require broadband connectivity. Most of the telemedicine

[114] Wright (1997).
[115] Telemedicine Research Center (2000b).

applications that are based on a SandF system require compression of the images that are being transmitted. While advancements in compression technologies have made possible compression of large images, there is still a risk of quality loss. As such the compression technology used in SandF is crucial, as even a very limited loss in the quality of the image could lead to misdiagnosis. Other factors that affect the quality of SandF applications are the reliability of the network over which the data and images are being transmitted, and the time it will take to send the data and images to the recipient. The solutions provided for these three major issues influence the amount of bandwidth required to implement different SandF based applications.

Telemedicine Initiatives Based on SandF System[116]

The Labrador Telemedicine Project was implemented in the community of Black Tickle (with a population of 210), situated in Northern Canada. Through this initiative the community clinic was linked with a regional hospital in Goose Bay (Labrador). Between April 1, 1998 and March 31, 1999, the nurse in the community clinic, with the help of a personal computer (266 MHz processor, 128 megabytes of RAM, and 56 Kbps modem), and a software (VisiTran-MD) assisted in 43 initial telemedicine consultations, and 40 follow-up telemedicine consultations. The nurse captured the information in different formats including video pictures, audio, and text, and stored them in an electronic file. The electronic file was then sent to the hospital in Goose Bay, where doctors were able to review the information. The transmission of the information was conducted through a dedicated phone line. The average connection speed was approximately 14.4 kbps.

Real Time System

Real time telemedicine applications require a much broader bandwidth than the ones based on a SandF system. For these types of applications, the quality of the images, the reliability of the network, and the timing of transmission have a much greater importance than in SandF applications. Based on the fact that approximately 10-20 frames per second[117] are required for a mental health tele-consultation (in order to differentiate facial expressions), and that 20 to 30 frames per second are needed to detect eye movement, the target for videoconferencing is set at 30 frames per second.

Networking

Networking within a single country – For the first stage of a national telemedicine initiative, a selected number of rural health centers will be connected with a health center in the main administrative unit. This will be the first-tier network, and will give health practitioners in the rural ands remote areas access to resources and expertise that they do not have available in the area where they work. At the same time, lateral connections between these rural health centers should be established. This will be the second-tier network. While the first-tier network will make possible mainly access to resources and expertise, the second-tier network will serve as a peer learning tool. The second-tier network will build the trust that will promote the quickest adoption, and subsequent expansion of telemedicine applications for both the health practitioners

[116] Jong et al. (no date).
[117] Wachter (2000).

and the population in rural and remote areas. Once both the health practitioners and the public gain experience and become familiar with the idea of telemedicine, more rural health centers can be linked with the network.

Networking between multiple countries – In order to achieve the greatest potential offered by the network between different hospitals and rural health centers in an individual country, direct connections can be established between a number of hospitals in each of several different countries in a region. In order to increase the resource base and the expertise available, the hospitals connected with the trans-national network could be specialized in different health areas.

Telemedicine Initiatives Around the World

Telemedicine in Latin America and the Caribbean

The population in Latin America and Caribbean has increased from 167 million in 1950 to more than half a billion in 2000.[118] A modest estimate for the year 2050 predicts that approximately 657 million people will be living in the region. A great variability in terms of income, infrastructure, health services, and access to ICT exists between different countries in the region and within each country. Some general data on the region are provided in Table 3-6.

Table 3-6: Data on Latin America and Caribbean[119]

Indicator	Average	Range
Rural population	24.7 %	7.1 – 68.4%
Physicians (per 10,000 people)	17.6	1.6 – 43
Nurses (per 10,000 people)	6.9	1.3 – 68
Dentists	4.9	
Hospital beds (per 1,000 people - 1996)	2.2	
National health expenditure as % of GDP (1996)	7.2 %	

This variability is reflected as well in the various telemedicine initiatives operating in the region. The number of telemedicine initiatives ranges from one in Bolivia, Colombia, and Uruguay, to two in Chile and Panama, five in Argentina and Brazil, and six in Mexico.[120] The first telemedicine initiative in the region began in 1994 (Visual Forum in Buenos Aires).[121]

In comparison with the rest of Latin America and the Caribbean, there are few telemedicine initiatives in the countries in the study area. Honduras and Guatemala do not have any telemedicine projects,[122] and the research identified only one telemedicine project in both Colombia and Bolivia (these telemedicine initiatives are discussed in the relevant country sections in Chapter X). Brief descriptions of some telemedicine initiatives from other parts of Latin America and the Caribbean are presented below.

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[118] UN Population Division (2001).
[119] Pan American Health Organization (2000).
[120] Telemedicine Research Center (2000a).
[121] Allen (no date).
[122] Communication with PAHO offices in each country.

Visual Forum – Buenos Aires (Argentina)[123] – The Visual Forum was the first telemedicine initiative in Latin America. It offers two main services to patients: a "second opinion consultation;" and a teleconferencing facility that offers medical education.[124] Through the "second opinion consultation," physicians based in six different locations can contact experts in various locations in the USA. The teleconferencing facility is mainly used by rural practitioners for consulting with their peers in urban areas. There have been approximately 15 international consultations and 20 hours of education programs per month.

Telemedicina CONAE (Cordoba, Argentina)[125] – This initiative, which began in 1998, deals mainly with health education and internal medicine. The initiative aims at improving the quality of health services and health care, especially in rural areas. The main types of medical services provided are pediatric, obstetric gynecologic, and general medicine. One central communication node, three reference hospitals (principal nodes) and telemedicine stations in peripheral points (ten rural hospitals at this time), such as regional hospitals, Antarctic settlements (remote notes) are linked together. The equipment in each node is accessible to the rural medical center. The central hospitals are connected to the network 24 hour a day, and the remote nodes log in through standard telephone lines with modems. The transmission mediums most commonly used are telephone lines, while the transmission speed most commonly used is POTS. Since 1998, more than 200 medical events have been carried out through this initiative.

INCC Telemedicine (Montevideo, Uruguay) – Through this initiative, which deals mainly with cardiology and internal medicine, selected angiograms are sent to specialist the same day that the study is done. Some 130 cardiologists refer patients living as far as 600 km from the center. This initiative began in 1997, and in 2000 there approximately 3500 patients had consultations.[126] Approximately 600 store-and-forward images are transmitted each month for educational and clinical purposes. The most commonly used transmission mediums are telephone lines, and the most commonly transmission speed used is 384 Kbps.

Telemedicine and Education (San Paulo, Brazil) – This initiative that started in 1998, deals mainly with the education and telemedicine education, and is based in the Faculty of Medicine at the University of San Paulo.

Costa Rica's Telemedicine Project – The center conducts approximately fifteen interactive tele-consultations per month, and provides several hours of educational programming.[127]

ISSSTE Telehealth Project (Mexico) – This project links seven states and conducts approximately 60 interactive consultations per month. The main applications are for infectious diseases and mental health. The most commonly used transmission mediums are telephone lines, while the most commonly used transmission speed is 384 kbps.

[123] Polycom Inc. (2001).
[124] Ibid.
[125] Telemedicine Research Center (2000a).
[126] Ibid.
[127] Allen (no date).

Telemedicine Projects in Other Areas of the World

Some telemedicine projects that have been implemented in other parts of the world include:

Health Project for the New Millennium (Ghana) – This telemedicine/telehealth development project at Dr. Martin Luther King Memorial (MLKM) Clinic in Accra, Ghana, West Africa, is intended to complement the already existing health delivery systems and particularly to serve the poor, disadvantaged and marginalized people living in the rural areas.

River Blindness Eradication Project (West Africa) – The World Health Organization has been implementing a program to eliminate the Onchoscerchiasis (River Blindness) vector from low elevation river valleys West Africa. Now the Black Fly vector is under control partly because of the use of health informatics and remote sensing.

Doctoranywhere.com (India) – Doctoranywhere.com is a service that allows doctors through an Internet-based software and hardware package to provide an affordable, efficient and time-sensitive platform for remote medical consultation. It is based on store-and-forward systems and uses telephone lines for the deployment of the services (56 kbps connection).

Transtelephonic Electro-cardiogram (ECG) Transmission (Jordan) – ECG diagnostics have traditionally been carried out at locations where the patient is physically attached to an ECG machine and the doctor present would diagnose his condition. Under the telemedicine project, a variety of trans-telephonic ECG acquisition and transmission products were developed. The project helps patients and practitioners with two types of services: the provision of diagnostic services and professional counseling to patients with suspected cardiac symptoms; and the provision of emergency-type services, primarily to patients with a heart condition who would subscribe to a service center for monitoring and emergency assistance.

Teleradiology Link between Two Hospitals (Mozambique) – Two hospitals were connected by a telemedicine link using the existing telecommunication infrastructure using terrestrial and satellite links. The link has the dual purpose of providing teleradiology and teleconsulting.

Telepsychiatry Pilot Project – Keewaytinook Okimakanak First Nations (Canada) – The main objectives of the project are to a) maximize access to professional services for isolated communities using video conferencing; b) minimize the disruption to the lives of clients; and c) utilize and enhance the capabilities and skills of community support persons in terms of the overall care of clients.

Lessons Learned from Telemedicine Projects

Based on the lessons learned from the implementation of telemedicine initiatives around the world, a number of common factors have been identified as important for the implementation of a successful telemedicine project. While each of these projects has individual characteristics related to the area of coverage, health issues in the area, social and cultural backgrounds, and many other factors, a number of common factors (in addition to the “fundamentals for success” outlined in section 3.1 above) have been identified as important for the implementation of a successful telemedicine project. These can be divided into the following areas:

Telemedicine initiatives as part of a wider strategy

Telemedicine initiatives will be more effective and provide the desired results only if they are part of a general health strategy. As telemedicine is not meant to replace the face-to-face communication with a health professional, the implementation of any telemedicine initiative will require that at least one health professional be present at the rural health center that will be involved in telemedicine. As such, telemedicine initiatives have the potential to enhance the national or regional health systems and expand its services, but they cannot replace it.

Specific solution for each community

From the outside, all communities in a region may appear to be the same, but each has its own formal and informal social structure and characteristics. These unique differences should be taken into consideration in the development of telemedicine services in different communities, while maintaining the same health standard for each of them. Some communities might be more receptive to a telemedicine initiative if it is located in a separate telemedicine clinic, while in other communities it might be part of a telecenter. For smaller communities a traveling health professional with a mobile phone and a laptop could be the best solution.

Start small and take a gradual step-by-step approach

Introduction of new ideas always challenges the status quo, and brings resistance. It is important to start with pilot projects in selected communities, to allow people time to become familiar with the new services. Once experience is gathered from these pilot projects, the telemedicine initiatives can be extended to more communities. At the same time, it is important to allow time for health practitioners to become familiar with the new technology and to avoid overloading them with information. This can be achieved by starting with some basic services, guiding the health professionals through the process, and building slowly on their acquired experience.

Involvement of decision makers and service providers

Telemedicine initiatives cannot be introduced successfully into rural and remote communities without the support and involvement of politicians, telecom service providers, and decision makers. It is important to ensure their involvement and support right from the early stages of the introduction of a telemedicine initiative, and maintain that support throughout the implementation process.

Emphasis on training health professionals

The benefits provided by the introduction of a telemedicine initiative in a community will be dependent on the ability of health professionals to effectively use the new technology. This capacity will increase through their direct experience in using the tools and instruments they will be working with, and through a continuous training program. The training program should be tailored to the specific learning needs of the health professional involved in the telemedicine initiatives.

Applications

- *Administrative needs of a telemedicine center* – Start by creating a medical record system for all the patients that come to the health center. Well-kept patient records will help health practitioners maintain patients' health history; provide better follow-up on each patient; and in the case of transferring a patient to a district or regional hospital, provide critical information to health professionals in the hospital.
- *Diagnosis* – A telemedicine initiative in a rural or remote area can start with even a limited number of tools. These tools can include a phone, a computer connected to the main hospital in the district and to the Internet, and a digital camera. Health professional at the telemedicine center would have access to CD-based resources which will help her/him to diagnose common diseases or health problems. If additional diagnostic support is needed from other health professionals he/she can contact them by e-mail and send digital pictures of visual symptoms. For the first stages of the telemedicine initiatives and with limited connectivity speed most of the applications should be based on a Store and Forward system.
- *Education* – Both the health professional and the general population in the area will need continuous health education. For community health education, educational materials related to the main health problems can be produced and stored in CDs, videos, and other forms. The health professional can organize monthly open houses, where different health issues could be discussed, and health education provided. For the health professional, ICTs will allow access to medical databases to provide updates on advancements in the field of medicine, and to information on experiences of other health professionals.

Table 3-7: A General Log Frame Analysis for a Telemedicine Initiative

Inputs	Outputs	Outcomes	Goal	Assumptions
• People • Funds • Hardware • Software • Buildings	• Needs assessment conducted • Connectivity established • Telemedicine centers identified and established • Promotion campaign is organized and conducted	• People receive heath services and information • Practitioners have access to their peers in urban areas and to other sources of information • Health services and information is provided to more people in rural and remote areas • Efficiency of the health system is improved • People are kept informed about the advantages of telemedicine	The overall quality of life in rural and remote communities is improved as the result of improvements in their health	• Local needs are identified and prioritized • Local champions are identified and involved in the project • Political and financial support is provided • The basis for creating a sustainable system is created • Training to practitioners is provided continuously • Local capacity building is ongoing • Ongoing needs assessment / M and E is conducted to stay in touch with the ever-changing needs of the population • Lessons learned during the pilot phase are shared with other communities

4. CHARACTERIZATION OF TYPICAL ICT AND ENERGY SYSTEMS

4.1 Energy Needs and Rural ICTs

As the process of globalization continues to spread into more remote corners of the world, the application and use of information and communication technologies are reaching communities and families in areas where basic services are often weak or nonexistent. For ICTs to have any utility in a rural setting, an adequate and reliable supply of electricity is essential. In this chapter, we present several possible equipment configurations for different levels of rural connectivity. While planning the implementation of such systems, it is imperative that energy considerations be included from the beginning of the design process. For this reason, the energy requirements and potential costs of energy systems are included in this discussion. While a variety of energy technologies can be used, the examples presented herein focus on solar photovoltaic applications, for reasons discussed below. (Although energy can come from many sources in rural areas, including wood for cooking and kerosene or oil for lamps, the use of the term "energy" in this discussion refers specifically to the provision of electricity on a sufficient scale to power rural ICT equipment.)

Although many rural areas in the world are connected to utility-level electric grids, there are still approximately 2 billion people in communities worldwide who do not have such access to reliable, relatively inexpensive electric power, the bulk of whom live in rural areas. In Latin America and the Caribbean, the percentage of the population without access to electricity is estimated at 14%, or 70 million people.[128] These people, however can benefit greatly from the use of ICTs. Although the coverage of electric grids is rapidly being extended throughout the world's developing countries, there still exist a vast number of communities that will either never receive grid electricity or will at least not receive it for a very long time. For these people, other energy options must be considered if they are to benefit from the use of rural ICTs. Fortunately, several energy options exist for rural areas, depending on a variety of factors.

A popular and growing means of providing rural electricity is the establishment of an isolated mini-grid that connects a central power source to all or most of the buildings in a community. This power source might be a diesel generator, a small hydro-electric system, or even a "hybrid" combination of renewable and fossil fuel-powered sources. In many cases, the implementation of a mini-grid is dependent on the natural resources available to a community. This is especially true in the case of hydro-electric systems, where a nearby stream must have a sufficient combination of flow rate and vertical drop, along with necessary terrain features, to power a small turbine and generate electricity to meet the needs of the community. In such cases, small hydro systems are often the lowest cost options for rural communities, and the installation can provide power to much more than just a rural telecenter.

Another common mini-grid power source is a diesel generator. Diesel systems are employed throughout the world, providing 24-hour power in many cases. Due to economic issues associated with the cost of fuel and maintenance of the generators, the more common approach is to use a diesel mini-grid to provide power to a community for 4 to 6 hours each day, most commonly in the evening. For example, this is the case in Columbia, where the government has

[128] IACD (2001), p. 2.

initiated a formal program through which more than 300 diesel mini-grids are being implemented to provide electricity for part of each day.[129] Although the fuel and maintenance costs of diesel mini-grids can be relatively high over the longer term, their short-term advantages still make them viable in many instances. In the case of rural ICTs, however, other considerations may make diesel systems less advantageous. For instance, the actual quality of the electric signals produced by the diesel generator can be low enough that they can damage the more sensitive components in an ICT system. Also, if a mini-grid is run for only a few hours each day, this can significantly inhibit the potential uses for a rural telecenter. These issues can be overcome through the implementation of power conditioning equipment, battery banks, and even possibly the inclusion of renewable energy components, but all of these will add to the cost and complexity of a system.

Renewable energy technologies (RETs), such as solar photovoltaics (PV), small wind-electric turbines, and micro-hydro systems, are often the best way to meet energy needs in rural areas in developing countries, especially as they relate to the use of ICTs. Although the initital purchase cost of a renewable energy system can be considerably higher than a small diesel or gas generator, the cost savings over the lifetime of the equipment, in terms of fuel, operation, and maintenance, can make RETs a much more economically viable option. In addition, RETs offer considerable environmental advantages, with essentially zero emissions of pollutants during their operation.

Of the options mentioned above, PV systems are the most widespread and often the easiest to implement. There are several reasons for this. First, the solar resource is rather well characterized throughout the globe, and thus less resource assessment work is needed to design PV systems for specific projects in specific sites than for other technologies. In addition, the supply chain for PV is better established in many countries than for other technologies, often leading to better designs, installations, and even improved maintenance for operating systems. Another advantage of PV is that it is a modular technology, meaning that as energy requirements grow, the system size can often be easily increased to meet these growing needs. This can be done with other technologies as well, but often with the need for greater infrastructure investments.

Solar photovoltaic cells and modules have been commercially available since the 1970s and are used in remote applications worldwide. A PV module is comprised of a number of smaller cells that are electrically connected together and mounted on a flat surface with a clear glass or plastic protective covering. Several different technologies are used to make PV cells, with the most common using some form of silicon—generally referred to as either monocrystalline, polycrystalline, or amorphous. As sunlight hits each cell within a module, the energy from the sunlight is transferred to electrons in the material (called the photo-electric effect), and a resultant voltage is created. By connecting the cells together within a module, and then connecting the module in an electric circuit, the module produces a current that can operate electrical equipment or charge batteries.

Photovoltaic systems have been used by the telecommunications industry for over 20 years, principally as a power source for remote repeater stations. Due to the need for high reliability (greater than 99% availability), PV systems for telecommunications repeater stations are often

[129] This program is discussed at greater length in section 5.2.

oversized, have large battery banks, and are coupled with a gas or propane generator for backup power in the event of a failure. These types of applications have helped PV technologies to develop a reputation as a reliable, but highly expensive, option for remote power. In the case of rural ICTs, however, simpler, smaller systems can be implemented on a significantly reduced cost basis. This is because the basic power requirements are often considerably lower than for a remote radio repeater. Also, with personnel on hand to manage and operate a rural telecenter, issues of reliability and availability of equipment are not as critical. Rural ICTs also offer a significant difference in terms of economy of scale: with a potentially huge market for rural telecenters, associated PV systems can offer the benefits of standard packages, knowledgeable providers, and readily-available networks of local technicians to conduct quick maintenance operations.

A typical PV system for use with rural ICTs will include several components in addition to the PV panels. These can include a battery charge controller; a bank of batteries; an inverter, safety disconnects, including switches and fuses; a grounding circuit; overall wiring; and mounting structures for some or all of the components. The batteries are used to store energy, allowing the use of equipment at night and on days without sunshine. The inverter converts the electricity from direct current, which is the operating mode of the PV modules and the batteries, to alternating current—the operating mode of most electrical loads related to ICTs, such as computers, radio equipment, etc. The charge controller monitors the flow of electricity into and out of the batteries, and disconnects the batteries from the circuit when they have reached a full charge. Many charge controllers also have a low voltage disconnect (LVD), which also disconnects the batteries when they have reached a preset low level of charge. These actions serve to optimize battery use and keep battery life at its maximum. Many inverters also contain integrated charge controllers and LVDs.

One of the most important factors in designing a PV system and in determining its cost is the proper identification and cataloguing of the electrical loads that it is to serve. In the design of the overall telecenter, it is important to consider the energy usage of the equipment that it will contain. This involves knowing both the energy consumption of the various components and their usage patterns. For example, if a center is designed with a laser printer rather than a much more efficient ink-jet printer, this can add thousands of dollars to the initial cost of the energy system. Similarly, if the energy system is designed to accommodate the use of six computers, but only four are actually used, the energy system can then be as much as 50% oversized. Although this may not have a large impact for a single telecenter, it can have an immense impact on the energy costs if a number of telecenters are based on the same design. Unnecessary oversizing of energy systems can also lead to negative perceptions about the actual costs of rural ICTs and thus impair the potential for replication of model or pilot projects. Therefore, careful consideration of the electric loads and related conservation measures are imperative to good design and implementation practices.

Since each component in any electrical system operates at some efficiency below 100%, the overall electrical efficiency of a PV system can be as low as 50-60%, depending on the components used and their operational modes. Proper design practices can ensure that the components within a system are adequately matched so that the system performs optimally. In addition, proper operation and maintenance of all of these components is essential to assuring quality operation and a long life for the energy system. Perhaps the most important aspect of overall system operation and maintenance involves the care of the batteries. Given the broad range of technologies and styles of batteries used in common photovoltaic systems, a detailed discussion is not provided here. Generally, however, many batteries require occasional (e.g., monthly) refills of distilled water, and all batteries perform better and have longer operational lives when they are stored in places where excessive temperatures (lower than five degrees or higher than 30 degrees Centigrade) are not reached.

In the implementation of renewable energy systems as part of a rural ICT project, several important considerations must be addressed to assure the quality and longevity of the energy system. These considerations principally involve assuring that the capacity of local suppliers is sufficient to adequately design, install, and maintain the system, and that the users receive adequate training in its proper operation. This, of course, is of equal importance in regard to the ICT equipment. In addition, component guarantees and an overall system warranty should be required of the equipment supplier and installer. All parties, including technicians and operators, should be trained in the proper use and maintenance of all related equipment.

4.2. Basics of Wireless Communications

This section outlines the process of selecting wireless communications technology for rural settings, highlighting the importance of conducting a thorough analysis of application requirements and site characteristics in order to determine a suitable wireless solution.[130]

All wireless communication systems transmit information by modulating—or varying—the characteristics of electromagnetic waves, which travel at the speed of light. Specialized devices called transceivers and antennae are used to transmit and receive modulated signals. The transmitting antenna converts the signal from electric current, produced by the transceiver, into electromagnetic waves broadcast through the atmosphere. The receiving antenna converts the electromagnetic waves back into electric current, which is then processed and "decoded" by the receiving electronic equipment. The devices on either end of a wireless link must use the same set of rules to process signals in order to successfully communicate information.

The principals underlying wireless communication require careful attention to two critical environmental factors: interference and obstacles in the path of the signal. When two signals occupy the same frequency at the same time and location, they interfere which each other and cause gaps or errors in the transmission of information. For this reason, the use of frequencies is regulated in each country and internationally. However, interference can be a problem if regulations are lacking or not enforced.

Just as light can be blocked or reflected by physical obstacles, wireless communication signals typically need an unblocked path between the transmitting and receiving apparatus. This principle, referred to as "line of sight," means that there should be no major obstacles in the direct path between the transmitting and receiving antennae. In addition, optimal performance

[130] For additional information on the wireless technology selection process, one of the many guides available on the Internet is a free, 9-step tutorial from the U.S.-based Cellular Telecommunications & Industry Association (CTIA). The tutorial is located at http://www.wow-com.com/industry/tutorials.

requires as much clearance as possible in horizontal and vertical directions around the antenna beam.

System configuration issues

Selecting wireless communications technology for rural settings requires a thorough analysis of application requirements and site characteristics. Perhaps the most important step in designing a robust, cost-effective wireless solution is defining the application and services for the end users who are expected to utilize them. Network designers need detailed information on the application requirements and physical location of the equipment in order to create a workable solution providing for the connectivity, bandwidth and quality of services required.

Among the factors affecting connectivity and bandwidth requirements are:

- Application (email, WWW browsing, telephony, video, etc.)
- Number of users (per site / total)
- Type of data generated by application (symmetric vs. asymmetric, bursty vs. continuous, real time vs. delay-tolerant)

Factors affecting wireless technology selection and configuration:

- Location characteristics: hilly, flat, amount of clearance, path obstacles, interference from nearby radio sources and electricity installations, potential antenna mount site, distance between antenna mast and end user terminals, geographic distribution of end users.

From the above discussion it should be clear that there is no "one size fits all" wireless solution. Many types of wireless systems are potentially useful for rural and peri-urban connectivity needs. The choice of one technology over another, and the selection of a particular system among competing options within each category, require a careful analysis of the economic, engineering and application requirements specific to each ICT project.

4.3. Wireless Connectivity Options

VSAT Networks

Very small aperture terminal (VSAT) satellite systems can be deployed in remote areas with no existing communications infrastructure. VSAT systems typically consist of three network components: 1) a hub station, which is a satellite earth station with an antenna and network management equipment; 2) a satellite in geostationary orbit above the earth, and 3) remote VSAT terminal stations located within the footprint (coverage area) of the satellite. Because the satellites are orbiting the earth, it is easy to point the VSAT dishes at the correct direction toward the sky and establish an unblocked path between the VSAT and the satellite, enabling a wireless communications link over thousands of miles with very low power requirements. However, the economics of VSAT systems require a fairly large scale of hundreds of terminals per hub station, which can cost anywhere from $400,000 to well over $1 million.

Ongoing costs include the space segment charges, electricity and maintenance costs. Space segment charges represent the cost of leasing all or part of a satellite transponder for use by the system. The space segment services are provided by a satellite network operator or service provider, either directly or through a local service distributor. The local distributor may be the national telecommunications operator, a private company or a service provider affiliated with the ground equipment supplier. For rural thin route applications with low traffic levels per remote VSAT, operators often use demand assigned multiple access (DAMA) techniques to share the costs of the space segment among a large base of users.

Remote VSAT terminals consist of 4-5 components and can cost in the range of $2,500 to $5,000 for 1-3 telephone lines (plus always-on Internet access) and $5,000 to $6,000 for 2-8 telephone lines, before customs duties, transport costs and local distributor price markups. The VSAT antenna is a dish ranging from 0.45m to 6m in diameter. Electronic transceiver equipment is connected to the dish, and a microprocessor-based computing device or modem provides the hardware and software interfaces to the end user equipment, such as a telephone, PC or local area network. Additional components may include a power supply, cables and mounting hardware.

Mobile Cellular Networks

First generation (analog) and second generation (digital) cellular networks use wireless base stations to provide mobile coverage of outdoor and indoor areas. Any cellular network, be it analog or digital, can be implemented as a last mile solution for rural connectivity by employing fixed receiving terminals and/or limiting handset mobility to the coverage area of a single base station.

The cost of implementing a cellular solution for rural connectivity can vary widely depending on the situation. However, it tends to be very expensive if only a few rural subscribers are being served. In some cases, analog cellular equipment that has been replaced by digital systems in urban areas can be reinstalled in rural areas as a low-cost connectivity option. In addition, the power consumption of cellular infrastructure is high compared to smaller-scale connectivity options. A GSM base transceiver station, for example, can consume between 1000 and 1800 watts.

In terms of data services, first and second generation cellular networks are typically limited in the bandwidth they can support to no more than 19.2 Kbps. Enhanced second generation systems and third generation systems support higher data rates. However, these systems typically have not yet achieved the economies of scale in the manufacturing process which would bring them into the range of affordability to serve most low-density rural communities.

Fixed Wireless Access

Through the mid-1990s, the main terrestrial wireless options for rural telephone connectivity were systems such as HF/UHF/VHF radio, TDMA-based multi-access radio (point to point and point to multipoint), and analog or digital cellular. As the worldwide explosion of mobile networks drove down the cost of cellular infrastructure, attention turned toward using this technology to serve less densely populated rural areas. By the latter half of the 1990s, fixed wireless local loop (WLL) systems based on cellular, cordless and military communications technologies were developed to serve the narrowband voice telephony needs of rural and peri-urban areas. The challenge for the early WLL systems was to reconfigure mobile cellular technology for fixed services at the lowest possible cost.

Fixed wireless access (FWA) systems use wireless technology to complete all or part of the link between a network access point and the subscriber's premises. The term FWA includes access systems formerly described as wireless local loop (WLL). Originally, WLL systems were developed primarily to support circuit-switched voice services using non-mobile applications of cellular technologies. As a general rule (although not without exceptions), the term WLL is typically used to describe systems optimzed for delivering telephone service, while FWA tends to describe newer convergence-oriented access systems. Many of the major global telecom equipment vendors are no longer actively marketing narrowband WLL or TDMA multi-access radio systems.

Dozens of manufacturers worldwide produce systems that fall in the FWA category. Some are wholly proprietary systems, others are based on standard air interfaces such as CDMA and TDMA, and yet others combine standardized and proprietary components to produce a variety of flexible and economical systems. Typically, FWA systems are used to serve subscribers within a 5 to 30 km radius.

Broadband Spread Spectrum FWA

Spread spectrum IP-based systems are the current offering for short-to-medium range broadband wireless access. The frequency bands used for spread spectrum/wireless LAN applications typically range from 2 GHz to 30 GHz. These include unlicensed bands, such as the ISM bands at 2.4 GHz, as well as licensed bands such as 3.5 GHz. Depending on the frequencies, configuration, terrain and desired data rates, the typical range of a single broadband spread spectrum FWA link can be as low as 3km but not much higher than 25-30km.

Spread spectrum technologies distribute wireless communications signals over multiple frequencies within a band, either by jumping from one frequency to another (frequency hopping) or cycling through them in sequence (direct sequence). In general, spread spectrum techniques are not limited to any particular set of frequency bands or applications. The spread spectrum systems this report focuses on for rural connectivity can be described as terrestrial, fixed wireless systems designed primarily for non-military data applications such as Internet access and wireless LANs.

IEEE 802.11b is an international standard for wireless LANs using direct sequence spread spectrum (DSSS). 802.11b specifies operation in the 2.4 GHz industrial, scientific and medical (ISM) band, which is a unlicensed band. In countries which have adopted FCC guidelines, the 2.4 Ghz ISM band comprises the frequencies from 2400.0 – 2483.5 MHz. Although the ability to use this band without a license (or license fee) is of great benefit for low-income communities, the downside of using unlicensed frequency bands is that there are no guarantees as to their availability. In urban centers such as Panama City and Managua, overuse of the unlicensed band has caused a deterioration in the quality of service experienced by companies using 2.4 GHz systems. Some companies have responded by increasing transmit power beyond the allowable limits, a measure which makes the frequency congestion problem even worse. In rural areas the common resource pool of unlicensed frequencies is much less likely to be depleted in this fashion.

Box 4-1 provides a concrete example of the large number of variables that can affect the performance of a wireless system in a given location. This example is provided both to describe one of the potential spread spectrum wireless solutions in more detail, and to clarify the need for a thorough and professional analysis of application requirements and site characteristics before selecting and designing a wireless connectivity solution.

Box 4-1: A Closer Look at an Outdoor Wireless Router System[131]

Agere Systems' Orinoco outdoor routers support wireless LAN applications at speeds ranging up to 11 Mbps. This system could be used to enable a rural telecenter with an existing Internet connection to act as a wireless ISP to another site or sites within a radius of 3.6 to 26.2 km.

Frequency Band: 2.4 GHz
Data Rates: 1, 2, 5 or 11 Mbps
Architecture: Point-to-point (PTP) or -multipoint (PMP) configurations supported. The central outdoor router (COR) can connect with up to 16 remote outdoor routers (ROR). Each ROR can transmit with one other unit, either another ROR (in a point to point configuration) or the COR. In addition, the router units can provide indoor wireless coverage for PCs equipped with an Orinoco 802.11b PC card, which has a built-in antenna.
Antenna options: The external antennae supplied and approved by Agere Systems for this system comprise two omnidirectionals (7 dBi and 10 dBi), one wide angle antenna (12 dBi), and two high gain directional antennae (14 and 24 dBi). For a multipoint configuration, the COR must be equipped with an omnidirectional or wide angle antenna. RORs are typically installed with either the14 dBi or 24 dBi antenna.
Modulation Technique: Direct Sequence Spread Spectrum (DSSS)
Standards: IEEE 802.11b (wireless LAN)
MSRP Pricing (list price in the U.S.):
COR $1695
ROR $1395
PC card $99
12 dBi antenna $295
24 dBi antenna $150 (discounted online)
Low loss cable $85-$125
Lightning arrestor $165
Pigtail $95
Configuration and Range:
There are many configuration options for the Orinoco system depending on the application. Each ROR and COR has two wireless interfaces (slots for transceiver cards) and an ethernet interface. It is possible to use one radio interface for PTP or PMP links and the other for indoor wireless LAN coverage. In this case, 802.11b PC cards supplied by Agere can be used with a laptop computer for wireless connection to the Internet or LAN. The maximum range of an Orinoco system reaches up to 26.2 km, depending on the antennas used and the configuration. The maximum ranges for a subset of configuration options are detailed below.[132]

Configuration	Data Rate			
	11 Mbps	**5.5 Mbps**	**2 Mbps**	**1 Mbps**
Multipoint[133]	11.2 km	13.1 km	15.4 km	17.3 km
Point to Point[134]	19.4 km	21.8 km	24.5 km	26.2 km

These range estimates are based on line of sight conditions with 10m clearance around the antenna beam. If actual clearance is less than 10m, for instance, due to terrain or buildings in the path of the signal, the achievable range will be reduced. In addition, the use of connecting cables of smaller diameter or longer length than the 6m cables assumed below can significantly reduce the range achieved. For example, using 15m cables at the central and remote sites will reduce the maximum ranges listed below by 34%. One can also use the ROR as a repeater in order to extend range or transmit around obstacles. If there is only one PC to connect at the remote location, it is possible to connect the PC directly to the receiving antenna through a device called a pigtail, which connects the PC card in the laptop or desktop computer to the antenna cable. In this case there is no need to purchase an outdoor router for the remote site.

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[131] Source: Interview with Rodrigo Rios, Sales Manager for Latin America, Agere Systems, 24 September 2001. Street prices for wireless spread spectrum LAN systems of the type described in this report have fallen since our initial analysis was done. As of March 2002, street prices were generally running at 50-70% of the list price for the Orinoco system discussed here.

[132] Based on Orinoco product specifications assuming clearance of 10m and low loss cables of 6m (10mm diameter).

Multi-Access Radio (MAR) Point-to-Point / Point-to-Multipoint Systems

Rural point-to-point (PTP) and point-to-multipoint (PMP) multi-access radio systems use a series of microwave stations and repeaters to link the local exchange and the subscribers over distances ranging from a few hundred to a thousand kilometers. Conventional PTP and PMP systems used copper wire to connect subscribers over the last few hundred feet to the wireless base station. Wireless local loop and cordless systems are used instead of copper wire to provide a completely wireless implementation between the exchange and the rural subscriber.

TDMA-based MAR is perceived as a technology which is no longer the most cost effective option for providing telephone and Internet access to remote communities of subscribers. Some equipment manufacturers have removed MAR systems from their actively marketed product lineup and limit their activity to maintaining clients' legacy systems.

MMDS

Multipoint Multichannel Distribution Service (MMDS) was originally designed as a broadcasting alternative to cable television. Operating in the 2.1 – 2.7 GHz band, MMDS technology was later adapted to support two-way broadband internet access, telephone and fax services. First generation systems transmitted signals over a 35 mile (56 km) radius with line of sight.

LMDS

Local multipoint distribution service (LMDS) is similar in the applications and services supported to MMDS, but it operates in a much higher band (over 20 GHz) with a maximum range of about 5 km. The frequency bands allocated vary by country. Honduras, for example, issued a resolution in February 2001 permitting the licensing of LMDS in the bands 25.35 – 28.35 GHz, 29.10 – 29.25 GHz and 31.00 – 31.30 GHz.[135]

Packet Radio

Packet radio is a form of data communication which breaks up text messages into "packets" of upto 256 characters and transmits them from one station to another. Packet radio links are generally suitable for store-and-forward applications like email, and low bandwidth applications such as low-graphics web browsing. Over a dozen frequency bands ranging from 28 MHz to 5.9 GHz are allocated for potential use by amateur radio in the Americas (ITU Region 2). The most common band used for packet radio applications is the 2-meter band from 144 – 148 MHz (so called because the wavelengths of signals in this frequency band are about 2m long). Although the range of a narrowband packet radio link can vary widely depending on factors such as line of

[133] Maximum ranges for the multipoint configuration are based on the use of a wide angle 12 dBi antenna at the COR and a 24 dBi antenna at the ROR.
[134] Maximum ranges for the point to point configuration are based on the use of 24 dBi antennae at both RORs.
[135] CONATEL Res. 002/01, 1 February 2001.

sight and propagation conditions, packet radio can typically achieve a range of 30-50km. Repeater nodes (called "digipeaters") can be installed to increase the distance.

Advantages of Packet Radio	Disadvantages of Packet Radio
• Medium range (30-50km)	• Subject to interference
• Low cost	• Technical expertise required to configure, install and operate

In a packet radio network, each user depends on other nodes in the network to forward its messages to their ultimate destination, which may be another packet radio user or a gateway to the Internet. For low-bandwidth applications such as email to be viable over a packet radio network on a large scale, there must be some organization or entity coordinating the maintenance of a packet radio "backbone" with sufficient capacity and diversity to relay messages consistently and operate at least one gateway between the packet radio network and the Internet. The maximum speed that can be achieved using a 12.5 KHz channel in the 2m band is 9600 baud—sufficient for email and textual web browsing, but not very efficient for downloading graphics or streaming audio/video.

4.4. Examples of Typical Systems

Definition of Telecenter Types and Service Levels

As described in Chapter 5 of this report, telecenters in Latin America vary widely in terms of size, services offered and population served. In order to provide meaningful ranges for the costs and energy requirements of rural telecenters in the region, this report defines three different telecenter sizes with associated levels of service: Type A, B and C. These characterizations are not standard in the industry and are simply used for the purpose of this report. Type A telecenters are the smallest and might be considered "mini-telecenters" or "micro-telecenters" in other contexts. Type B and C telecenters might be considered small- to medium-size telecenters in a typical urban or peri-urban context.

All of the telecenter types modeled for this study provide telephony, email, printing and at least minimal WWW browsing services to the end users in their service area (in some cases the web-browsing capabilities/bandwidth are significant). The telecenter types differ primarily in the number of PCs and telephone lines and the resulting magnitude of their bandwidth requirements. Type A telecenters contain one computer, Type B telecenters contain five, and Type C telecenters contain 10 (see Table 4-2).

Table 4-2: Telecenter Configurations by Type[136]

Telecenter A Connectivity Equipment	Telecenter B Connectivity Equipment	Telecenter C Connectivity Equipment
1 PC	5 PCs	10 PCs
1 Inkjet printer	1 8-port ethernet hub	1 16-port ethernet hub
1 Telephone	2 Inkjet printers	3 Inkjet printers
2 Indoor lights	2 Telephones	5 Telephones
1 Outdoor light	1 Fax machine	1 TV
	4 Indoor lights	1 VCR
	1 Outdoor light	1 Multifunction fax/printer/copier
		8 Indoor lights
		1 Outdoor light

In order to estimate power consumption for the telecenters it was necessary to make quantitative assumptions about the usage of each electronic device. In most cases, fairly heavy usage assumptions were chosen. Therefore in some cases the power consumption estimates may be biased upward to some degree compared to average telecenters in the field. Telecenter operating hours were defined as 12 hours per day, six days per week. The PC utilization rate was estimated at 65%[137], with online Internet access accounting for half of PC usage. Each telephone was assigned 1.5 hours of use per day.

The telecenter types were designed to model the power consumption and hardware costs of providing different levels of service to rural communities. No pricing assumptions, financial models or telecenter business plans were developed to address the financial sustainability of these telecenter types. The size of the communities to be served by each telecenter type is described in the following paragraphs so as to provide an intuitive explanation for the different telecenter sizes and configurations. Clearly, the desired level of service and numbers of computers in a given situation may be higher than assumed here. However, the sizes of the populations served are not part of the quantitative assumptions of the model and are not required by it. The level of service that can be sustained by specific communities varies widely depending on income, education levels, links to the outside world, and many other factors in addition to the size of the population.

Type A Telecenters

Type A telecenters represent the smallest telecenter unit with a simple configuration of one PC, one telephone and an inkjet printer. These telecenters are designed to serve a population of up to 500-700 individuals. Type A telecenters offer telephony, email, textual web browsing, and printing services. They may also offer offline use of the PC for services such as word processing and computer training. The telecenter requires one telephone (or voice) connection plus bandwidth for Internet access ranging from 9.6 Kbps to 64 Kbps.

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[136] Annex 2 provides detailed specifications on the equipment modeled for this study.

[137] Based on the profile of a basic telecenter "Cabina Publica Prototype" in Proenza et al (2001). The usage rate for computers in the telecenters described in the above source ranged from 60-70%. The target usage rate for rural telecenters in this study is 65%.

Type B Telecenters

Type B telecenters are expected to serve a population of up to 3500-5000 individuals. Type B telecenters are comprised of five PCs, an ethernet hub to network the PCs together, two inkjet printers, two telephones and a fax machine. Services provided include telephony, fax, email, web browsing, printing, occasional photocopying, offline PC usage and computer training courses.

The Type B telecenter requires three standard telephone lines plus Internet access bandwidth ranging from 48 Kbps to 256 Kbps. The absolute minimum bandwidth requirement of 48 Kbps was estimated based on the need to provide at least 9.6 Kbps per PC at any given time in order to support email and limited web browsing for five customers simultaneously (9.6 Kbps x 5 = 48 Kbps).

Type C Telecenters

Type C telecenters are the largest centers modeled in the study and they contain ten PCs, an ethernet hub, five telephones, three inkjet printers, a multifunction fax/printer/copier/scanner device, a 25” color television and a VCR. Type C telecenters are designed to serve a town of up to 7,000-15,000 people. Services offered include telephony, fax, email, printing, computer training courses, offline PC usage, web browsing, pre-recorded educational videos, scanning and copying. Bandwidth required for Type C telecenters ranges from 128 Kbps to 512 Kbps.

Overview of Results

The telecenters modeled for this study range in total cost[138] from approximately $6,000 for the “mini-telecenter” with low energy equipment and no connectivity, to about $78,000 for the larger, “type C” telecenter with VSAT connectivity and high energy-consumption equipment. Figure 4-3 provides an overview of the size and cost ranges resulting from this study.

It is important to note how the power system cost is influenced by the use of laptops versus desktops, due to the significant difference in their power consumption. For example, under Scenario 2 (telecenter Type C with VSAT), while the connectivity and computer equipment costs approximately $2,000 less when the 10 computers are PCs, the installed power system costs almost $30,000 more than for a system using laptops. Even with the assumption that approximately $10,000 of this cost is estimated for installation and vendor fees, the cost difference remains significant.

The following section discusses this issue in more detail, including reasons why desktops might be selected despite their much higher power consumption and resulting system costs. The four telecenter scenarios are then described and presented with a breakdown of their respective cost assumptions.

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[138] Total cost includes the connectivity equipment cost and the power system. These figures do not include local taxes and shipping charges, which vary by country. The power system cost does, however, include an estimate for installation and vendor fees.

Table 4-3: Overview of Results

Telecenter Type	Connectivity Component	ICT Equipment Cost	Power System Size	Installed Power System Cost[139]	Total Cost
Scenario 1: Single remote telecenter (no connectivity)					
A1 (laptop)	None	$1,432	150	$4,125	$5,557
A2 (desktop)	None	$1,250	400	$7,807	$9,057
B1 (laptop)	None	$6,832	600	$11,028	$17,860
B2 (desktop)	None	$5,922	1800	$29,634	$35,556
C1 (laptop)	None	$13,977	1050	$18,383	$32,360
C2 (desktop)	None	$12,157	3300	$56,099	$68,256
Scenario 2: Single remote telecenter with VSAT connectivity					
A1 (laptop)	VSAT	$4,432	300	$6,319	$10,751
A2 (desktop)	VSAT	$4,250	500	$9,462	$13,712
B1 (laptop)	VSAT	$9,832	750	$13,693	$23,525
B2 (desktop)	VSAT	$8,922	1800	$29,270	$38,192
C1 (laptop)	VSAT	$19,977	1200	$20,801	$40,778
C2 (desktop)	VSAT	$18,157	3400	$59,815	$77,971
Scenario 3(a): Wireless extension of connectivity from central telecenter to remote mini-telecenter (Packet Radio)					
C1 (laptop)	Packet Radio	$15,518	1050	$17,960	$33,478
A1 (laptop)	Packet Radio	$2,973	200	$4,850	$7,823
Combined C1+A1 (1)	Packet Radio	$18,491		$22,810	$41,301
Scenario 3(b)[140]: Wireless extension of connectivity from central telecenter to remote mini-telecenter (Spread Spec.)					
C1 (laptop)	Spread Spectrum	$15,871	1050	$20,992	$36,863
A1 (laptop)	Spread Spectrum	$3,326	200	$4,791	$8,117
Combined C1+A1 (1)	Spread Spectrum	$19,197		$25,783	$44,980
Scenario 4: Central wireless ISP telecenter linked to 5 mini-telecenters with Spread Spectrum					
B1 (laptop)	Spread Spectrum	$9,171	600	$11,028	$20,199
A1 (laptop) (5)	Spread Spectrum	$16,630	1000	$23,955	$40,585
Combined B1+A1 (5)	Spread Spectrum	$25,801		$34,983	$60,784

4.5. Costs: Factors Influencing Computer and Other Equipment Selection

PC Options: Notebooks vs. Desktops

The power consumption and cost ranges for telecenter Types A, B and C were calculated using the prices and power consumption levels of four different computer models: IBM Thinkpad i Series 1200 notebook, Acer TravelMate 200 notebook, HP ePC desktop with a CRT monitor, and IBM A20 Netvista desktop with a CRT monitor. These models were chosen for their combinations of moderate cost, energy efficiency and availability in Latin American countries. In figures 4-3 through 4-7, the IBM Thinkpad laptop is designated as computer "1", and the HP desktop as computer "2." The full data for all scenarios are available in Annex 2.

[139] Includes cost of power system (PV) equipment plus vendor/installation costs.
[140] Street prices for wireless spread spectrum LAN systems of the type described in this report have fallen since our initial analysis was done. As of March 2002, street prices were generally running at 50-70% of the list price for the Orinoco system discussed here.

Power consumption

The energy consequences of PC selection can be significant. This study estimates that a Type A telecenter with a standard desktop computer and CRT monitor consumes more than twice as much power as the same telecenter outfitted with a notebook—about 940 watt-hours per day compared to 370 watt-hours, respectively. This difference increases to a factor of three or more as the numbers of computers increases, representing a greater portion of the overall energy consumption. These relationships can be seen in Tables 4-4 through 4-7.

The desktop systems (including CRT monitor) reviewed for this study ranged from 80 to 200 watts consumed during normal activity—30 to 73 watts for the console and 50 to 120 watts for the monitors. The average desktop console consumes 50 to 55 watts during normal activity while the average monitor consumes 85 watts.[141] By contrast, the sample of notebook computers reviewed ranged from 9 to 18 watts of power consumption, including the display, once the internal batteries are fully charged. Average notebook consumption reported in the literature was 15 watts.

There are two main reasons why desktop systems consume much more power than notebook computers. First, notebook computers use energy-saving liquid crystal display (LCD) monitors as opposed to standard CRT monitors. Second, the CPU, software and components in a notebook are designed to conserve power so as to maximize battery operation times. A number of manufacturers offer desktop systems with lower than average power consumption, which are typically sold with LCD displays.

This issue of laptops versus desktops merits special attention given the impact it can have on energy consumption and therefore system size and cost. The choice of computer hardware is not, however, always a simple decision of cost, but is often complicated by such factors as: whether or not to accept hardware donations (new or used); the importance of field ruggedness; ease and cost of repairs, etc. These issues are discussed below.

Up-front hardware costs

Computers in Latin America are either imported from brand name manufacturers abroad or assembled from imported components by local companies. According to IDC, the top PC brands sold in Latin America are Compaq, HP, IBM and Dell[142]. Brand name desktop systems (including a CRT monitor) can be bought for as little as $650 in many countries of Latin America. A new notebook computer typically starts at $1000-$1200. Sales tax and destination charges vary by country and are in addition to the prices just mentioned.

Locally assembled clones or “white boxes” cost significantly less than imported models. In Guatemala, the U.S. commercial office estimates that clones account for 70% of all computers sold in the country[143]. It is difficult to obtain precise information on the power consumption of

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[141] Kawamoto et al. (2001).
[142] IDC (2001).
[143] Suchite (2001); U.S. & Foreign Commercial Service; and U.S. Department of State.

locally assembled computers, since the assemblers generally do not measure or publish these figures. Within a given country there may be dozens of local companies participating in the clone market. In the absence of local tests, it is difficult to say how the energy consumption of desktop clones compares to imported brands, which vary widely among themselves. Nevertheless, it is safe to say that desktops in general have much higher power requirements than laptops.

Lifetime system costs

Given the disparity in power consumption and the cost of PV systems, there would appear to be no justification to use desktop computers in off-grid telecenters. Each watt-hour of energy consumption in a PV system typically costs between $2.50 and $8.00. Therefore, the additional 1000 watt-hours per day consumed by a desktop system in the Type A telecenter described above necessitates an additional $2,500 to $8,000 investment in the PV system. This wipes out any cost savings associated with the purchase of a desktop rather than a notebook, a price difference typically less than $1,000.

However, some telecenter operators in Latin America are not convinced that notebook computers really save money for off-grid telecenters over the life of the equipment[144]. Selection of specific computer models for telecenter use is typically a decision made by the telecenter operator after balancing multiple factors, including:

- Price of hardware, software and peripherals
- Usability in a telecenter environment
- Energy consumption
- Warranty, maintenance and repair services
- Dealer incentives, such as bundled software packages

When it is time for a desktop system to be replaced, the owner can usually save $100 or more by continuing to use the old CRT monitor. Meanwhile, laptops tend to be more susceptible to damage in the rural environment. Anecdotal reports from the region include at least one case in which rough usage by peasants at a telecenter damaged a notebook computer after only two months[145].

Notebook computers are more difficult and costly to repair than desktop systems, partly a result of the technology involved and partly due to the much greater number of desktop systems in the marketplace. Special technology and expertise is required to repair an LCD display[146]. In some cases replacing the display is the only practical option. According to a U.S. notebook repair company, replacing the LCD display of a notebook computer typically costs $600 to $1400[147]. It is the single largest cost component of a notebook computer. In rural areas, the cost of replacement parts is compounded by the relative scarcity of notebook repair facilities. It takes longer to deliver, service and return a notebook computer than a desktop, translating into greater loss of service revenue for the telecenter operator.

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[144] Interview with Roberto Bastidas-Buch, ITU-D Zone Administrator for Central America, 30 October 2001.
[145] Interview with Roberto Bastidas-Buch, ITU-D Zone Administrator for Central America, 30 October 2001.
[146] Electronic Repair Services (Pty) Ltd, the largest PC repair company in South Africa, is the only company in the country which repairs LCDs. The company reported being in the process of building the expertise and inventories required to repair LCDs during a Feb. 2001 interview.
[147] Interview with a sales representative of Digital West, 2 November 2001.

In addition, some would dispute the contention that desktop systems in rural telecenters actually consume the amount of power estimated in studies like this one. There may be some weight to this argument, because power consumption by computing devices varies with the software used, the number of peripherals that are attached and functioning, and the requirements of the application. For example, the environmental product declaration for the IBM Netvista A20 desktop computer indicates that power consumption in a maximally configured unit can range from 73 watts to 207 watts! Professional computer testing labs that measure actual power consumption for manufacturers and trade magazines utilize software programs that mimic intended usage – down to the length of pauses between key strokes – to estimate battery life under actual usage conditions[148]. If telecenter applications do use less energy than the applications in developed countries for which the power consumption tests are designed, then the added PV costs of desktop systems may be less than what is estimated here.

The OAS/IACD and/or other partners should consider instrumenting a number of telecenters in order to accurately monitor and document actual usage patters and power consumption. Sandia National Laboratories will provide recommendations to the OAS/IACD on implementation of such a monitoring activity, including equipment and resource requirements.

Although the results of this study clearly emphasize the cost effectiveness of using notebook computers rather than desktop systems in off-grid telecenters powered by PV systems, the potential for well-founded differences of opinions on this subject among telecenter operators is duly acknowledged.

It is important to recognize that the current range of commercially available, off-the-shelf computer equipment is not ideal for deployment in off-grid locations where energy is expensive and environmental conditions (e.g. heat, humidity, dust) are difficult. Mainstream laptop computers are optimized for low power consumption, but have higher theft risk and reduced durability and higher repair costs. New desktop computers have increased power requirements due to use of faster power chips (e.g. Pentium 4, Althlon) not optimized for low power consumption. Ruggedized laptop computers (e.g. Panasonic Toughbook, Itronix) are available which can easily withdstand the rural environmental conditions, but these tend to be expensive ($3,000-$5,000) and still present theft risks.

Market forces are tending to squeeze out certain classes of products (larger handhelds with keyboards, web pads or Internet Appliances) that appear to be very appropriate for off-grid rural deployment.[149] There are some desktop computers available with lower consumption that might be mated with LCD monitors for rural deployment. It may be possible to convince at least one computer manufacturer to produce a limited number of desktop machines based on energy-effient (i.e. laptop) processors and other components. Certain used equipment, such as "off-lease" ruggedized laptops or normal laptops may be very appropriate for rural deployment,

[148] E.g. Business Winstone BatteryMark 2001, http://www.etestinglabs.com/benchmarks/battmark/battmark.asp.

[149] For example, Windows CE Handhelds in the HPC/Pro or Windows Handheld 2000 classes with 8"-10" screens and keyboards use very little power (<5 watts), are solid state devices with all software burned into ROM, can be used as thin clients or standalone machines, including for web browsing and e-mail, and these machines are rated for higher ambient temperatures (104 F). These machines are increasingly being squeezed out of the market, however, by the decreasing size and cost of laptop computers.

sufficiently powerful (200-300MHZ), and available at very low cost. This raises some interesting issues for the OAS/IACD in terms of equipment recommendations.

Other Equipment Options

Printers

Inkjet printers were selected over laser printers in all telecenter types because of their much lower energy consumption rates. For example, the average laser printer for commercial use consumes 77W in active mode and 25W in low power mode, whereas the average inkjet printer consumes only 17W in active mode.[150] Inkjets are also significantly less expensive than laser printers.

Lights

All telecenter scenarios assume compact fluorescents for both indoor and outdoor lighting, given their superior efficiency and longevity over incandescent lights. Compact fluorescents are increasingly available in Latin America, particularly where solar home systems have been installed in large quantities. Typical lamps available overseas include 9W, 11W and 15W, with lumen (illumination) equivalencies of 25W, 40W, 60W incandescent bulbs, respectively.

This study assumes 15W compact fluorescent lamps for indoor lighting, and 9W lamps for outdoor safety lighting, based on field experience that suggests these provide appropriate levels of illumination for their respective uses. While compact fluorescents are several times as expensive as incandescents, their lifetimes (typical rating is 10,000 hours) outweigh the cost differential. It is important, however, to ensure that the telecenter operators are conscious of the reasons for using efficient lighting, and are prepared to replace the fluorescent lamps appropriately.

4.6. Examples of Rural Energy and Connectivity Solutions

The examples in the following section describe complete rural telecenter solutions including ICT equipment, connectivity and appropriately sized photovoltaic power systems. The three connectivity options chosen for these examples are VSAT-based satellite connectivity, narrowband packet radio, and 802.11b spread spectrum fixed wireless access. These technologies represent the leading edge of current efforts to supply affordable connectivity in remote areas.

VSATs are used widely in all target countries to connect areas that are economically unjustifiable for wireline infrastructure. They offer advantages of low energy consumption, low maintenance, and distance-insensitive coverage. Packet radio is growing in usage for remote Internet access due to its low cost, coverage range and relative ease of acquisition and installation by private individuals. Broadband wireless access systems are beginning to be used for higher-bandwidth applications as they are also available at moderate cost and use a variety of licensed and unlicensed frequency bands. Further details on the equipment package specifications and assumptions are provided in the spreadsheets in Annex 2.

[150] Kawamoto, Kaoru, et al. (2001).

Scenario 1: Single remote telecenter (with no connectivity)

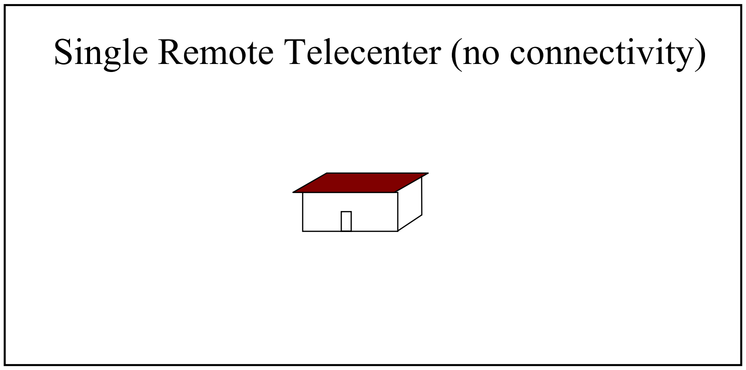


Table 4-4: Scenario 1: Single Remote Telecenter (with no connectivity)

Telecenter Type	ICT Equipment Costs[151]	Daily Watt-hours	Power System (PV) Size (W)	Power System Costs			Total Cost
				PV System Equipment[152]	*Vendor/ Installation*[153]	*Total power system cost*	
A1 (laptop)	$1,432	370	150	$2,558	$1,567	$4,125	$5,557
A3 (desktop)	$1,250	944	400	$5,390	$2,417	$7,807	$9,057
B1 (laptop)	$6,832	1418	600	$7,868	$3,160	$11,028	$17,860
B3 (desktop)	$5,922	4289	1800	$22,180	$7,454	$29,634	$35,556
C1 (laptop)	$13,977	2638	1050	$13,525	$4,858	$18,383	$32,360
C3 (desktop)	$12,157	8381	3300	$42,538	$13,561	$56,099	$68,256

[151] ICT equipment including computer(s), phone(s), printer(s), lights and other equipemt described above.
[152] Includes PV array (at $5.30/Watt), battery bank, inverter, charge controller, balance of system.
[153] Includes estimated vendor mark-up and fees for installation and guarantees.

Scenario 2: Single remote telecenter with VSAT connectivity

This scenario combines type A, B and C telecenters with a VSAT link to the public network and estimates a range of power requirements and costs for such solutions. The VSAT equipment chosen for this example adds between 240 and 425 watt-hours to the average daily power consumption of the telecenters. This type of solution is appropriate when the distance is large (more than 100km) and other terrestrial wired and wireless solutions have been ruled out as too expensive or difficult.

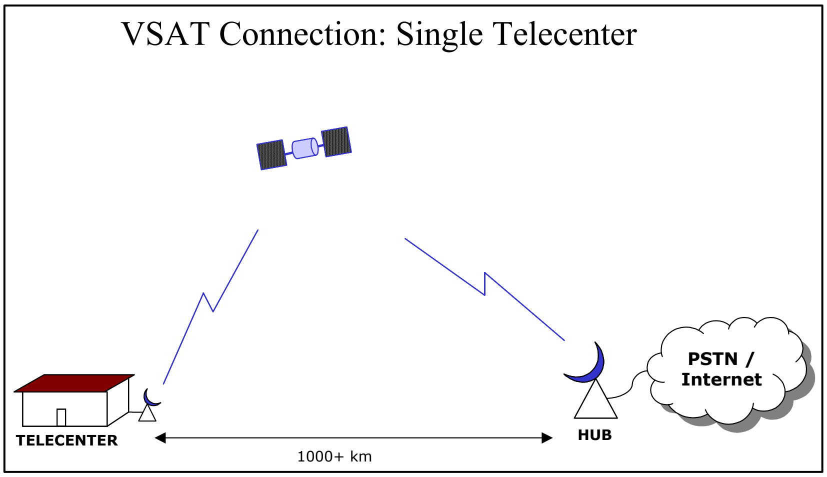


Table 4-5: Scenario 2: Power Consumption and Initial Cost Estimates for a Single Remote Type A, B and C Telecenter – Connectivity Technology: VSAT

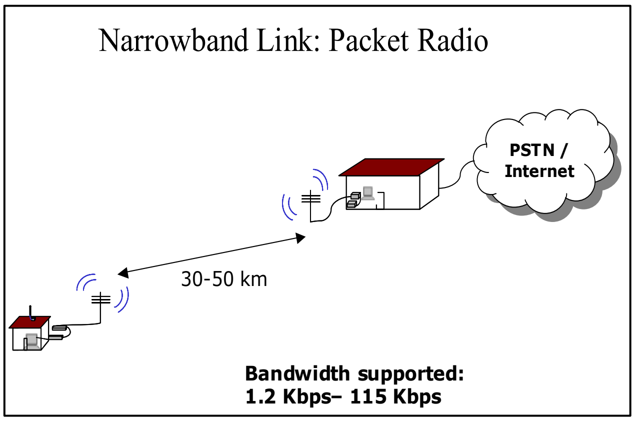
Telecenter Type	ICT Equipment Costs[154]			Daily Watt-hours	Power System (PV) Size (W)	Power System Costs[155]			Total Cost
	Non-connectivity equipment[156]	*Connectivity equipment*	*Total equipment cost*			*Equipment*	*Vendor/ Installation*	*Total power system cost*	
A1 (laptop)	$1,432	$3,000	$4,432	611	300	$4,245	$2,074	$6,319	$10,751
A2 (desktop)	$1,250	$3,000	$4,250	1186	500	$6,663	$2,799	$9,462	$13,711
B1 (laptop)	$6,832	$3,000	$9,832	1720	750	$9,918	$3,775	$13,693	$23,525
B2 (desktop)	$5,922	$3,000	$8,922	4591	1800	$21,900	$7,370	$29,270	$38,192
C1 (laptop)	$13,977	$6,000	$19,977	3061	1200	$15,385	$5,416	$20,801	$40,778
C2 (desktop)	$12,157	$6,000	$18,157	8803	3400	$45,396	$14,419	$59,815	$77,971

[154] Assumptions: Initial ICT equipment costs do not include local taxes, import duties, software (other than operating system and web browser included with hardware purchase), installation (other than power system installation) or network configuation services
[155] Includes PV system, vendor mark-up, installation and guarantees.
[156] Includes computers, printers, lights, etc.

Scenario 3: Wireless extension of connectivity from a town/village telecenter to a single remote telecenter

The applicability of a point-to-point connection extending access from a central telecenter to a remote subsidiary depends on the distance between the centers, line of sight conditions, and bandwidth requirements. Scenario 3a, below, describes a narrowband point-to-point link using packet radio stations. Scenario 3b uses spread spectrum fixed wireless access (FWA) to describe a broadband point-to-point connection.

3(a) Packet Radio Option



3(b) Spread Spectrum Option

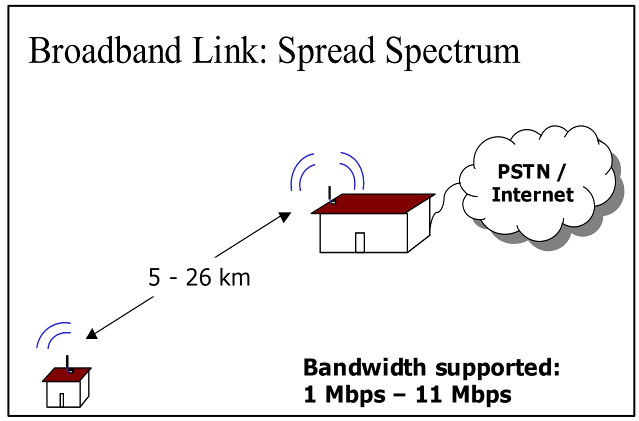


Table 4-6: Scenario 3: Wireless Extension of Connectivity from Town/Village Telecenter to a Single Remote Mini-telecenter – Connectivity Technologies: Point-to-Point Packet Radio and Point-to-Point Spread Spectrum FWA[157]

Telecenter Type	Equipment Costs			Daily Watt-hours	Power System (PV) Size (W)	Power System Costs[158]			Total Cost
	Non-connectivity equipment	*Connectivity equipment*	*Total equipment cost*			*PV System Equipment*	*Vendor/ Installation*	*Total power system cost*	
3(a) Packet Radio Option									
Central Telecenter (Type C1 - laptop)	$13,977	$1,541	$15,518	2791	1050	$13,200	$4,760	$17,960	$33,478
Remote Mini-telecenter (Type A1 - laptop)	$1,432	$1,541	$2,973	460	200	$3,115	$1,735	$4,850	$7,823
Combined C1+A1 (1)	$15,409	$3,082	$18,491			$16,315	$6,495	$22,810	$41,301
3(b) Spread Spectrum Option[159]									
Central Telecenter (Type C1 - laptop)	$13,977	$1,894	$15,871	2675	1050	$15,533	$5,460	$20,992	$36,863
Remote Mini-telecenter (Type A1 - laptop)	$1,432	$1,894	$3,326	398	200	$3,070	$1,721	$4,791	$8,117
Combined C1+A1 (1)	$15,409	$3,788	$19,197		1250	$18,603	$7,181	$25,783	$44,980

[157] Assumptions: The Type C telecenter has a wired leased line backhaul connection. Line of sight (LOS) conditions exist between the telecenters.
[158] Including PV system, vendor mark-up, installation and guarantees.
[159] Street prices for wireless spread spectrum LAN systems of the type described in this report have fallen since our initial analysis was done. As of March 2002, street prices were generally running at 50-70% of the list price for the Orinoco system discussed here.

Scenario 4: Central telecenter serving as wireless ISP (WISP) to mini-telecenters within a 17km radius

Scenario 4 consists of five Type A telecenters within the coverage area of a 12 dBi wide-angle antenna at the wireless internet service provider (WISP), and a maximum distance of 17km. Longer distances are acheivable using repeaters. Omnidirectional coverage is possible over a shorter range. The bandwidth delivered depends on the distance between the WISP and the remote site. At 17.3km, only 1 Mbps is supported (using this equipment and configuration). At 11.2km, up to 11 Mbps is possible. These figures were calculated using Agere equipment; however, many other systems and configurations are possible. There is no guarantee that the cost and energy parameters are representative. Equipment costs are based mainly on list prices; discounts are possible from local distributors and for large volume purchases.

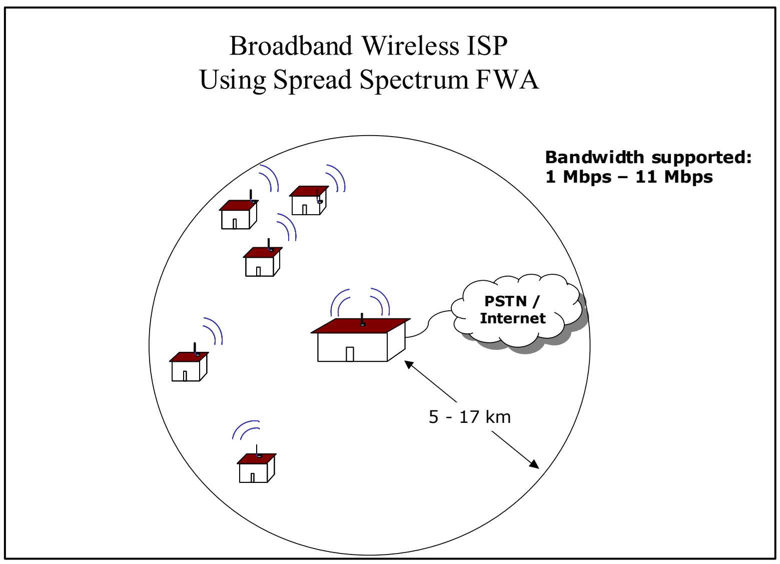


Table 4-7: Scenario 4: Wireless Extension of Broadband Connectivity from Town/Village Telecenter to 5 Mini-telecenters within a Radius of 17 km – Connectivity Technology: Spread Spectrum FWA[160]

Telecenter Type	**Equipment Costs**			**Daily Watt-hours**	**Power System (PV) Size (W)**	**Power System Costs**[161]			**Total Cost**
	Non-connectivity equipment	*Connectivity equipment*	*Total equipment cost*			*PV System Equipment*	*Vendor/ Installation*	*Total power system cost*	
Central Telecenter (Type B1 - laptop)	$6,832	$2,339	$9,171	1516	600	$7,868	$3,160	$9,171	$20,199
5 Remote Mini-telecenters (Type A1 - laptop)	$7,160	$9,470	$16,630	398 each	1000 total (200 each)	$15,350	$8,605	$16,630	$40,585
Combined B1+A1 (5)	$13,992	$11,809	$25,801			$23,218	$11,765	$25,801	$60,784

[160] Assumptions: The Type B telecenter has a wired leased line backhaul connection. Line of sight (LOS) conditions exist between the telecenters. Total network parameters (telecenter + 5 mini-telecenters) = $25,501 (max.), $21,011 (min.).
[161] Including PV system, vendor mark-up, installation and guarantees.

5. COUNTRY STUDIES

5.1. BOLIVIA

Bolivia General Country Data (1999, except where indicated):

- Surface area: 1.1 million km^2
- Population: 8.1 million
- Population Growth (annual %): 2.3%
- Rural population: 38.1%
- Illiteracy: 15%
- Poverty (1997 survey data):
  - Poor households: urban, 53%; rural, 38%
  - Destitute households: urban, 21 %; rural, 12%
- GDP: US$ 8.3 billion (at market prices, in current US Dollars)
- GDP Annual Growth Rate: 0.6%
- GDP average annual growth rate between 1989-1999: 4.2%
- Per capita income: US$ 990 (current Dollars); US$ 2,355 (PPA Dollars)
- Per capita income annual growth rate: -2.2%
- Human Development Index (UNDP): 0.648
- Per capita income average annual growth rate between 1989-1999: 1.8%

Sources: World Bank (2001b); CEPAL (2000); UNDP (2001).

Bolivia, one of two land-locked South-American countries, shares its borders with five countries: Brazil to the north and east, Paraguay to the southeast, Argentina to the south, Chile to the southwest and Peru to the west. Bolivia is divided into nine "departments:" Beni, Chuquisaca, Cochabamba, La Paz, Oruro, Pando, Potosi, Santa Cruz and Tarija.

Bolivia has a population of approximately 8.1 million of which an estimated 3 million, or 37%, live in rural areas. Of this 3 million, 32% live in communities populated with at least 2,000 habitants while the other 68% live in smaller and more dispersed communities characterized by extremely high levels of poverty and lack of access to basic services. In comparison with other South American countries, electrification in Bolivia is relatively low. Approximately 52% of the country and over 80% of the rural areas do not have access to electricity.

5.1.1. Rural Electrification

Electric Power Sector – Legal and Regulatory Structure

The 1994 Electricity Law established the National Superintendency as the regulatory body for the electric sector. In addition, the law divided the assets of the National Electricity Company, ENDE, separated the responsibilities for electric generation, transmission and distribution and stipulated that companies operating on the National Interconnected System (SIN) could only participate in one of those activities. Any company operating outside the SIN can be vertically integrated.

The Vice Ministry of Energy and Hydrocarbons (VMEH), under the Ministry of Economic Development, oversees the energy sector. The main unit related to rural electrification within the VMEH is the Energy Development Unit, which has the primary responsibility for promoting the National Rural Electrification Program, PRONER. The Superintendency of Electricity regulates the activities of the electricity sector, and the National Committee of Electricity Supply, created under Article 18 of the Electricity Law No.1604, coordinates the generation, transmission and dispatch of electricity within the SIN.

The Electricity Law, the Rural Electrification Rule, the Rural Electrification Information System and the Environmental Law make up the primary legal framework governing rural electrification in Bolivia. Rural electrification procedures are also subject to other related laws and regulations, such as the Popular Participation Law and the Poverty Reduction Strategy Paper (PRSP), as per HIPC agreement. (As one of the World Bank's Highly Indebted Poor Countries (HIPC), Bolivia is mandated to implement poverty-reduction programs with a focus on rural areas. Rural electrification has to compete for resources with other critical rural needs, including health, water supply, education, roads and other vital needs.

Electric System

The national electric supply system in Bolivia consists of the National Interconnected System (SIN), the Isolated System (SA), other isolated systems and self- producers. The SIN is an interconnected generation, transmission and distribution system, connected through the Interconnected Trunk System (STI). The National Grid reaches five of nine departments, providing forty percent of the population access to electricity.

The SIN accounts for about 83% of the installed capacity, 89% of the generation and approximately 40% of the whole population of Bolivia. Thirty-three percent of installed electric generation capacity is hydropower and the remainder is thermal. Eight hydroelectric plants power the SIN, with Coranee and Cobee supplying the bulk of the power. Bolivia still has significant hydropower potential to exploit.

There are four major generation companies within the SIN: Corani, Guaracachi, Valle Hermoso and Cobee. The first three are regional utilities that were a result of ENDE's división. They are now 50% privately-owned and 50% of shares in Bolivian pension funds. These generators must be connected to the STI and must comply with the regulations set up by the National Committee of Electric Supply and have to submit all the electricity to the Electricity Dispatching Center. The fourth generation company listed above, Cobee, operates in the La Paz and Oruro departments has always been private. It is now owned by US-based NRG and is subject to slightly different regulations.

Isolated Systems (SA) are those electricity supply systems that do not belong to the SIN. These are made up mostly of isolated systems with effective capacity of less than 1 MW and independent self-producers that generate electricity mainly to meet their own needs. A minimal percentage (ie: less than 1%) of renewable energy technologies, including solar PV and small wind, power small systems in the highlands. The Electricity Law defines that public concessions with a maximum duration of forty years are needed for the integrated generation, distribution and transmission of electricity in SA, however generator and distributors with installed capacity less than 300 kW do not require a concession. In the case of independent producers, they can operate systems up to 2 MW without concessions if the production is for their own consumption.

The Empresa Transportada de Electricidad (TDE) is the only transmission company in the country. There are six distribution companies within the wholesale market of the SIN. These include ELECTROPAZ, in La Paz; ELFEO in ORURO, ELFEC in Cochabamba, CRE in Santa Cruz, CESSA in Sucre y SEPSA in Pótosi. The voltages of the distribution lines are 44 kV, 24.9kV and 6.6 kV. The loest voltage is 230/115V in La Paz and 380/220V in the other areas.

Rural Electrification

Approximately 37% of Bolivia's population of 8.1 million live in rural areas. Of these rural inhabitants, over 80% lack modern electricity services. The central government has not participated in the implementation of energy projects since the new Electricity Law was passed in 1994, but the electrification program has been somewhat extensive. Between 1998 and 1999, for example, rural electrification increased from 13.7% to 20.5%, a total of 64,000 new connections. Despite these advances, however, around 700,000 homes—3 million people—still remain without access to modern energy and communications, and existing programs such as PRONER and the National Rural Telecommunications Development Program (PRONTER) do not adequately address the problem, in part due to the various pressing rural investment needs described above.

Nonetheless, there is an increasing realization that grid technologies are too expensive to serve in many of the more remote areas and given that universal access has been promised for Bolivians over within the next 15 years, this is becoming an increasingly important issue. For example, 78% of the municipal workshops held as part of the preparation of the national Poverty Reduction Strategy identified access to electricity in rural areas as the most important action to be given priority in combating poverty. Priority energy needs in rural areas include cooking, lighting, entertainment, communications, space heating (in the Altiplano Region), agricultural energy inputs, health care (for vaccine refrigeration etc) and lighting for homes, schools and health clinics.

Table 5-1: Rural Electrification (RE) Rate and Non-electrified Rural Homes: Geographic Distribution

Department	% RE 1997	% RE 2000	Non-electrified Homes	% of Total Not Electrified
Chuquisaca	8.2	15.1	64,059	9.3
La Paz	17.9	25.5	173,517	25.2
Cochabamba	21.0	31.1	136,464	19.8
Oruro	12.7	14.2	53,678	7.8
Potosi	4.8	11.1	123,836	18.0
Tarija	11.8	26.7	27,131	3.9
Santa Cruz	10.2	22.0	86,012	12.5
Beni	5.5	19.4	18,829	2.7
Pando	4.3	9.0	5,713	0.8
TOTAL	13.7	22.4	689,239	100

The departments with the largest percentage of non-electrified house are Pando and Potosi (91% and 89% respectively), although the number of unelectrified homes in Pando is under 6,000, making it less than 10% of the total unelectrified population of the country. Potosi, La Paz and Cochabamba represent the highest percentage of total unelectrified population in the country, with a total of 433,817 homes, representing a cumulative 63% of the total unelectrified population of the country.

Accurate information about the likelihood and timing of grid extension is pending the completion of three studies that are currently looking at the macro-level implications of grid expansion. The estimated investment requirement for universal electrification is $1 billion.

Table 5-2: Investments in Rural Electrification 1998-2001

Department	Projects No.	Technology Type						Home No.	Investment Thousand US$
		Grid	Photovoltaics	Hydro	Natural Gas	Diesel engines	Studies		
Chuquisaca	11	8	2		1			973	1,326
La Paz	54	50		3			1	25,000	7,748
Cochabamba	30	27	2	1				8,000	6,849
Oruro	31	28	2				1	4,000	5,822
Potosi	33	32		1				4,500	8,789
Tarija	37	29		4	4			4,074	3,825
Santa Cruz	28	25	1		1		1	15,000	21,536
Beni	13	8	1	1		2	1	4,084	1,823
Pando	4	2	1				1	1,385	257
Total	241	209	9	10	6	2	5	67,016	57,976

Sources: Del Castillo (no date); and VMEH.

National Rural Electrification Programs

The distribution of the rural population is as follows:

55% are between 15km and 25km from SIN transmission lines.
30% are dispersed and have annual income and savings of over US$1000.
15% are dispersed, isolated and have annual income of under US$ 800.

Based on these statistics, three basic models, to be implemented in parallel, have been developed for rural electrification. The objective of these models is to incentivize the participation of the private sector in terms of investment capital and human resources for implementation and management, to minimize subsidies and flexibilize public investment and avoid distortions in the market while providing widespread electrification.

The first model is based on increasing grid density in the concession areas. The goal is 50,000 new connections in three years with a total investment needed of US$35 million, of which $20 million is private investment and $15 million is subsidy.

The second model is based on the creation of a commercialization infrastructure in potential solar PV zones in which financing mechanisms would be adopted to users needs. The goal is 30,000 homes electrified with PV in four years with a total investment needed of US$ 14-19MM.

The third model is designed to attend the more dispersed and extremely poor rural communities with solar PV and micro-hydro. The goal is 20,000 homes electrified in four years in addition to providing support to education, health and productive uses of electricity. The total investment needed is estimated at US$15MM, of which $12MM would be subsidy.

These rural electrification models will be developed and financed through a host of national and international sources, described below, including PRONER, PRONTER, the World Bank, the Inter-American Development Bank, ESMAP/UNDP/GEF, possibly the Organization of American States (OAS) and aid agencies from the US (USAID), Spain, Germany (GTZ), Japan (JICA), Holand and the European Union.

The National Rural Electrification Program (PRONER)

In 1998 the VMEH started an ambitious five-year program to promote rural electrification called the National Rural Electrification Program (PRONER), with the primary objective of promoting socio-economic development in rural areas throughout the country. Through PRONER the VMEH plans to double the rural electrification rate from 13.7% to 28% by 2002, electrifying 110,000 households, or approximately 450,000 people. According to the VMEH in 2000, 197,239 out of a total of 885,454 total rural households (22.3%) now have access to electricity through the PRONER and an additional 76,000 households are expected by 2002.

National and international interest in PRONER is significant and a short list is being prepared for the next phase of the program, which will expand the network, build new hydroelectric plants and convert existing thermal plants to be powered by renewable energy sources. It is expected that through PRONER phase II, an additional 200,000 households will be electrified by 2006, increasing the coverage rate to 40%. The government has acknowledged the need to work more closely with the private sector to achieve service delivery and market penetration utilizing national subsidies and rural electricity supply concessions, although until the preliminary study is complete it is difficult to get a clear interpretation of exactly what this will entail.

Through PRONER, various organizations, cooperatives and agencies throughout the country are promoting different types of systems for electrification, including the electric grid, diesel mini-grids, micro-hydro systems and photovoltaic (PV) systems. The operation and maintenance (O&M) of the systems is determined by the various agencies, and tends to differ depending on the type of system, as follows:

Energy Source	O&M Agency
Electric grid	Distribution company; electricity cooperative
Diesel power	Municipality; electricity cooperative
Micro-hydro power	Electricity cooperative; rural electrification committee
PV system	Electrification cooperative; rural electrification committee; NGO and users

The most predominant problem facing the promotion of off-grid electricity services is in ensuring the sustainability of the systems and services. Most consumers lack the resources to replace batteries and other items, and communities lack the training and human resource infrastructure for conducting maintenance and repairs. A critical challenge is in developing a better understanding of the local needs for electrification of not only homes, but community services and of understanding resource requirements. The World Bank is currently financing a demand survey to obtain this information as part of the process of preparing a possible World Bank loan for PRONER, discussed in greater detail below.

External Aid to the Energy Sector

Over the past five years, Bolivia has received approximately US $70 million for energy sector development. An additional US $23 million from Germany and Spain is currently under negotiation, and IBRD plans to finance approximately US$35 million, of which about 60% will be earmarked for rural electrification.

The World Bank through the Vice Ministry of Energy and Hydrocarbons (VMEH) is preparing a rural connectivity and energy project which will build on both PRONER and PRONTER and have electrification and telecom/connectivity components. A number of market studies are underway to help in the project design and the Bank is preparing a Project Concept Document (PCD) focused on the development impact of the education, health, electricity and ICT infrastructure in small towns. The PCD should be ready by April of 2002.[162] The World Bank loan for the project is expected to total approximately $20 million.

The United Nations Development Programme (UNDP), in partnership with the Global Environment Facility (GEF), is also supporting microcredit institutions that provide loans for PV systems on a quasi-commercial basis. The World Bank's Energy Sector Management Assistance Program (ESMAP) will be financing part of its implementation, and is supporting a demand study to further analyze the financial mechanisms in place or in need of improvement to promote rural development.

Under the study of "Rural Electrification Implementation Plan by Renewable Energy in the Republic of Bolivia," the Japan International Cooperation Agency, JICA, has recently prepared studies for La Paz and Oruro including maps of existing transmission lines in 2001, projected grid extension by 2006 and 2011, and micro-hydro, solar PV and wind potential in the two departments.

[162] The World Bank PCD was not available at the time of publication. It is anticipated that the PCD will be available before this report is finalized, however, and the contents of the PCD will be summarized in the final report.

The Spanish Cooperation, with the support of the Instituto Catalán de Energía and the European Union, is promoting programs for the Beni and Pando regions, along with assistance from GTZ and the Dutch Mission. Most of the foreign aid funds earmarked for rural development are handled by the Integrated Unit of National Funds (DUF), in accordance with PRSP procedures. The DUF will be a major funding organization for a rural electrification project. In addition, some domestic funding organizations are expected to support rural electrification projects, including the PRONER Foundation, the Revolving Fund for UNDP projects and the Bolivian Rural Electrification Fund (BREF).

Finally, there have been numerous small renewable energy or distributed generation projects implemented in Bolivia by several different organizations, including significant activities by the U.S.-based National Rural Electric Cooperative Association (NRECA). Table 5-3 below lists a number of these projects.

Table 5-3: Distributed Generation projects in Bolivia

Project	Technology	Aplication	Installed Capacity	Home Connections No.	Investment US$	Parties	Year
COAINE Coffee Cooperative	Photovoltaics	Solar home systems	10 kW	200	130,000	NRECA, COAINE	1993
NRECA PV Water Pumping	Photovoltaics	Solar water pumping	9.4 kW	321	73,065	NRECA, CARE, CCH	1993
Brecha Casarabe (pilot program)	Photovoltaics	Solar home systems	5 kW	100	64,000	NRECA, CRE, PROPER	1993
CORDEOR Municipal PV Electrification	Photovoltaics	Solar home systems	5.3 kW	100	55,000	NRECA, CORDEOR	1995
CORDEBENI Municipal PV Electrification	Photovoltaics	Solar home systems	9.5 kW	180	93,600	NRECA, CORDEBENI	1995
Riberalta Biomass Plant	Biomass combustion	Mini grid system	1 MW	4.500	2,220,000	NRECA, E&Co, USAID, Riberalta Electric Cooperative	1996
Plan Internacional	Photovoltaics	Solar home systems	17.5 kW	350	182,000	NRECA, Plan Internacional	1996
Rural Solar Electrification in Bolivia	Photovoltaics	Solar home systems	20 kW	400	286,000	NRECA, EGSA, GPUI, CSDA, Prefectures of Oruro & Chuquisaca	1997
Rural Electrification in the San Ramon Area	Gas Turbine	Mini grid system	2.8 MW	2,715	6,961,000	CRE, Prefecture of Santa Cruz, Dutch Coop. Agency	2000
Santa Cruz PV Electrification	Photovoltaics	Solar home systems	500 kW	10,000	N/A	CRE, NRECA	2000

Source: Personal communication with Rafael Gastón Lemaître Leaño, January 2002.

5.1.2. Rural Telephony

Legal and Regulatory Aspects

In Bolivia, the telecommunications legal and regulatory system (and other public benefits) is based on the so-called SIRESE (Sectoral Regulation System), which is a collection of laws, regulations and institutions created in 1994 that restructured infrastructure services, including telecommunications. Also in 1994, the State companies' capitalization system was established, which allowed for the incorporation of private capital in different sectors.[163] The telecommunications sector is subject to additional legislation consisting of a basic law,[164] a general regulation,[165] and other special regulations.

SIRESE constitutes one of the most prominent examples of the Bolivian government's willingness to restructure the economy and the public sector. In the early 1990s, the government started an open incentive policy to promote private sector participation and competition. The SIRESE system is one of this policy's primary accomplishments, and has frequently been presented as a model at national and international conferences receiving support from multinational donors, such as the World Bank.

The telecommunications sector was one of the first to experience positive changes, with the capitalization of the national telecommunications company and the establishment of a regulatory body. Other sectors, such as water and sanitaiton, have been much less successful.

The telecommunications sector competition policy stipulated temporary exclusiveness for the national telecommunications provider for six years (until November 2001) for basic services, including local telephony and national and international long distance communications. However, in other areas, such as mobile communication and value added services, several competitive operators have been established. The privatization policy has allowed for the incorporation of private investment and management in the long distance sector—through capitalization of the old state company—and of other services (by establishing new companies).[166] The end of the exclusivity period for basic services will require modification of some regulations and concessions currently in force, but the precise form of these modifications is not yet known.

The nature of the fixed local telephone service companies has at times complicated the implementation of the sectoral policy. These companies act as service cooperatives (comprised of upto 15 entities, some of them very small). For this reason, they resisted the capitalization policy on many occasions, arguing that there was already private capital in the services (that of the cooperatives) even though these were not-for-profit companies. This kind of industrial organization for rendering goods and services, sometimes described in Bolivia by the motto "one city, one cooperative," was supported by the State since the 1950s, a period of heavy

[163] Bolivia Law No. 1544, Capitalization Law, 21 March 1994.
[164] Bolivia Law No. 1632, "Telecommunications Law," 5 July 1995.
[165] Bolivia Supreme Decree No. 24132, "Regulation for the Telecommunications Law," 27 September 1995.
[166] It must be stressed that some private companies, such as Telecel (the first cellular operator in Bolivia), had already been established since 1990, under the protection of exceptional spaces allowed by the preceding legislation.

cooperative/trade union sentimentality in the Government. In many cases these cooperatives have not had adequate incentive to improve efficiency, and/or their small size has prevented them from keeping up with rapid technological innovations or taking advantage of economies of scale.

The policy implemented in the 1990s tried to stimulate rural service development by establishing a special account for this purpose at the National Fund for Rural Development, to which certain resources coming from bids for new concessions, fines and other sources were contributed. Additionally, service obligations were established in some rural areas for local and long distance service operators. However, these measures were not very effective, and the special account mentioned above was never used.

At the institutional level, the policy distinguishes between telecommunications policy making, regulatory and provider entities.

The executive power, the Ministry of Economic Development (through the Vice Ministry for Transport, Communications and Civil Aviation), holds the overall power for sectoral policy and sector regulation. The Ministry has the legal power to "formulate, regulate, implement and control development policies" for telecommunications, and to "formulate, implement and control policies and regulations assigned to the development and installation of basic services".[167] Additionally, the Ministry has the power (when proposed by the regulatory body) to determine which services, for technical or economic reasons, will be open to an unlimited number of providers,[168] and which ones must limit the number of providers. (The legislation does define in detail these technical and economic reasons).

Regulatory duties are carried out by the Telecommunications Superintendence (SITTEL) as part of the SIRESE system. In this system, there are separate regulators for the different sectors, but there also is a General Superintendence (SG), with general power to supervise and decide administrative appeals on decisions made by the different sectoral regulatory bodies.

According to the law, SITTEL has its own legal status, and is technically, administratively and economically autonomous. The institution is financed via a mandatory rate paid by the providers, set at no more than 1% of their respective annual gross income.

The objective of this institutional structure is to guarantee sectoral stability and ensure objective decision-making for private investors, while insulating regulation from political contingencies and promoting technical excellence. The Superintendences have power both for regulating in the strict sense, and for promotion and defense of competition. The "two tiered" institutional structure (individual regulators for each sector, plus a general regulator) and corresponding procedures are rather unique at the regional level and are frequently held up as models.

Concessions are subject to compliance with various technical, economic and legal standards. All providers must comply with certain service quality regulations, and with technical regulations

[167] Bolivia Law No. 1788, Organization of Executive Power Law, 16 September 1997.
[168] Bolivia Law No. 1632, Telecommunications Law, Art. 4j); and DS 24132, Telecommunications Regulation, Art. 10.

issued by SITTEL, which in principle are intended to guarantee compatibility of the networks and the efficient use of resources, such as the spectrum.

Concessionaires have the right to use public resources for free, such as surfaces, subsoil and airspace; they also have the ability to impose rights over private properties to establish their networks, with the indemnities agreed to by the parties or by SITTEL.[169]

Licenses for use of spectrum segments are granted via public bids, for a maximum period of 20 years. Licenses are transferable, with SITTEL's authorization, and require payment of periodic rates for spectrum use (in addition to the amounts paid in the respective bids).

Interconnection of all functionally compatible networks is obligatory, based on the following principles:

- Timely attention to all interconnection requests;
- No discrimination between soliciting operators, according to technical regulations; and
- Timely delivery of necessary information regarding technical plans that modify the network and that could in the future affect interconnections.

According to the law, interconnection charges must be based on the following principles:

- May not be discriminatory with regards to their structure, level and application;
- Must reflect long term marginal costs of an efficient operator;
- Must be classified as non-recurring (covering interconnection costs) and recurring (covering interconnection use); and
- Must include an indexing according to the consumer price index.

The regulatory system for interconnection appears to work well in Bolivia, with an effective dispute resolution process. This will be important for facilitating entry of new service providers in rural areas.

The law indicates that rates must have the following characteristics:

- Apply the same structure to equal or similar services;
- Reflect the cost of each service rendered;
- Be based on rates defined consistently and itemized;
- Promote efficient use of services and not to include anticompetitive aspects; and
- Exclude cross-subsidies between different services.

For the effect of controlling rates, the policy establishes service classification between "competitive" and "non-competitive," a function that must be carried out by SITTEL, according to certain criteria. If a service is non-competitive, its charges must be regulated according to a price cap regime, with indexing every six months, and revision of the productivity factor every three years. Originally, it was established that local service, national and international long distance, circuit rental, cellular, public phones, and other minor services would be considered not competitive and regulated. This list can be modified by SITTEL when circumstances change (essentially, when the dominant operator reduces or exceeds the 60% market mark).

[169] This aspect is among the ones that could be legally modified with the opening of competition.

In practice, local companies make an important distinction between the rate structures of cooperative members and non-members (a category recently imposed by the regulator of cooperatives), strongly encouraging the incorporation of members. The main distinction is that members pay a significant fee for incorporation (the "contribution certificate"), in exchange for a minimal periodic fee. However, members receive attractive credit for paying this membership fee (usually, up to five years, with no interest in constant currency). Also, in many cases there are substantial differences between basic monthly charges for residential and commercial customers. In general, as a cooperative, it has been difficult for local companies to increase periodic rates, given that the users themselves are the ones that must approve these increases.

In the six years since its enactment, the policy has been reasonably successful in expanding services to urban areas, though penetration indexes are still modest. However, the policy has not been successful in terms of rates, which have remained relatively high. It also has not remedied the serious financial situation facing some local providers, nor has the expansion of services to rural and to low-income urban populations been successful.

The full transition to competition has been under preparation for a year; it is hoped that this will produce substantial improvements. According to the law, the Government, taking SITTEL's proposals into account, presented an Opening Plan in November 2000.[170] The law did not determine what level of detail this Plan should have; the Government decided to enact a document that is relatively detailed in certain aspects, but has left other matters, such as interconnections and, to a great extent rates, for later resolution.

In analyzing the most appropriate market characteristics, the Government and SITTEL, with support from external consultants, reached several conclusions in their initial diagnostic, including:

- Sector behavior is generally good relative to the average in South America, but household coverage is inferior to that of other basic services, and there are many small localities that do not have any type of telephone access.
- Local and long distance telephone service prices are very high, due to exclusivity.
- Providers demonstrate low internal efficiency and have made inefficient investments.
- Merger and acquisition control will be a very important tool in promoting a competitive market, as will service resale.

The following objectives have been established for the market-opening phase, though concrete goals or dates have not yet been established:

- Reach universal service in urban areas, and universal access in rural areas, up to at least the average of the South American region.[171]

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[170] (Author unknown), Official Bolivian Gazette (2000b).

[171] The Plan defines urban universal service as "the individual provision of available telecommunications services for the majority of the users or of those classified as of high social interests […] usually through the installation of a telephone line in the corresponding household or business, at an affordable price." Universal access is defined as "shared access to available telecommunications services for the majority of users or of those classified as of high social interest; this access would usually be made through the installation of at least one telephone line and terminal public access equipment, located at a reasonable distance or time and accessible price."

- Improve quality and decrease prices for all services and particularly for long distance ones, reaching the best practices in the region.
- Encourage convergence of services and increase access to information society, through the democratic use of the Internet web.

The Government and SITTEL have studied different market organization alternatives to pursue these objectives. The main concern to protect against potential monopolization or oligopolization.[172] Given this, the following has been taken into account:

- The effect of competition, with rates based on costs, on rural and low-income urban access. The disappearance of existing cross-subsidies could greatly hamper this access, and competition could acutely accentuate current inequities between the rich and poor populations, urban and rural, if support mechanisms for access to service for these rural and poor groups are not implemented.
- The possibility of developing an active competition market, attractive to national and foreign investment, the reduction of rates and expansion of services.
- The situation of the telephony cooperatives, several of which confront a very difficult internal situation, and must look for alliances to survive and consolidate with the opening.
- Entel's situation, which aspires to expand to other areas of telecommunications business (local service), but also recognizes that other providers are entering the long distance market. On the one hand, Entel's case is considered an indicator for the fate of foreign investment in the country, having been one of the first companies to be capitalized or privatized, with a considerable amount of resources contributed. On the other hand, the participation of pension funds in Entel's capital also links its fate to the private individual pension system, which has strong financial and political connotations.
- The possibility for implementing competition with few modifications to the legislation, regulation and existing contracts, given political and business uncertainties that this would bring, as well as the possibility for greater delays.
- The advantage of preparing for the convergence of telecommunications services. Here, it is useful to consider the social benefits of access to services such as Internet, as well as start developing technical and legal mechanisms for the operation of integrated services.

All things considered, the Government prefers to limit, at least partially, the formation of big, vertically integrated operators that have too much of a hold on the market. To address this, a plan has been outlined, which will allow Entel to acquire or control, at the most, one of the three big local cooperatives, for which a 40% cap in line concentration has been established, valid for the first four years from the opening of the plan.[173] This would also prevent any two of the three larger cooperatives from forming partnerships with one another. The plan will probably be conducive to a "tri-opoly," where one of the cooperatives can partner with Entel, and the other two would become partners with other foreign investors. The other smaller cooperatives would probably become part of one of these alliances. Recent developments confirm that, to a great degree, the Plan has accomplished its objective regarding the business structure of operators.

[172] In this aspect, the Peru experience has been closely analyzed, as have other national cases.
[173] This limitation would be controlled through the power of authorization of mergers, acquisitions and transfers held by SITTEL.

The plan contains few details regarding rates. Aside from confirming the no discrimination principle, the plan establishes that a local or long distance provider cannot charge different rates according to geographic conditions: in other words, each operator must have the same rates for each type of customer in its entire local service area or department. However, no other detail is given as to how rate regulation would be done, or mechanisms that would be used (even though the diagnostic criticizes the rate cap mechanism used during the exclusivity period). The plan also gives few details on interconnection policies, leaving this to be decided by an Interconnection Regulation, which has been devised in parallel and which substitutes almost entirely the current interconnection principles and procedures.[174] Clearly, one of the key opening elements will be the adequateness of the Interconnection Regulation, which still has not been fully tested.

The plan includes a proposal for the development of telecommunications in rural and urban social interest areas (described in more detail below).

The plan gives SITTEL the power to establish "technical, economic and procedural requirements" to grant concessions, including guarantees with adequate deposits.

There is no specific investment demand. With regard to long distance service, it is explicitly stated that the service can be rendered "with its own facilities or those of a third party," although at least one of the long distance switching centers must be owned. Resale services will be encouraged, although corresponding providers must obtain a concession in order to be able to offer such services.

Industry Organization

Until 1994, the traditional sector structure consisted of:

- 15 local cooperative companies, property of their respective members;
- One long distance company (Entel-Bolivia), government owned, which also rendered some services in certain rural areas; and
- One private cellular telephone service company (Millicom), established in 1990.

The restructuring program of 1995 led to the capitalization of Entel by Telecom Italia, which also assumed management of the company. Exclusivity was granted for a period of six years to Entel and to the 15 local cooperatives, subject to expansion commitments and service quality improvement. In other market segments (including cellular service) the Government accepted and promoted the entry of multiple providers. Entel, among others, started to offer cellular telephone service in 1996, and a third operator, Nuevatel, became part of this service at the end of 2000.

The largest telecom companies are ENTEL, COTAS, COTEL and COMTECO. It is possible that the structure of these providers will be modified significantly with the opening of competition. A North American company with a strong presence in the Latin American electricity sector, AES, has announced that it will form a partnership with COTEL to provide long distance and other services. At the same time, COTAS will partner with the German company Heilsberg to offer

[174] Bolivia DS 26011, 1 December 2000.

long distance, and with ITXC (USA) for information services. For its part, COMTECO is partnering with Western Wireless (USA) for mobile service, and with several smaller cooperatives for long distance service.

The evolution of services and other telecommunications issues in recent years are shown in the following table:

Table 5-4: Market Information for Telecommunications in Bolivia

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Land lines in service (thousand)	183	204	208	232	243	247	349	384	452	502
Density (lines/100 inhabits)	2.76	3.01	3.24	3.28	3.35	3.33	4.59	4.94	5.68	6.17
Waiting list (thousand)	...	98	73	50	...	...	...	...	...	8
Public phones (thousand)	...	...	...	...	...	...	4.8	7.9	11.1	11.4
Cellular mobile customers (thousand)	-	0.5	1.6	2.7	4.1	10.0	20.3	118.4	239.3	420.3
Mobile density (cust./100 inhabits)	-	0.01	0.02	0.04	0.06	0.13	0.27	1.52	3.01	5.16
Installation charges, residential	...	...	...	...	...	...	150	145	138	131
Installation charges, commercial	...	...	...	...	...	...	179	173	164	156
Monthly rate, residential	...	...	...	...	...	...	2	1,9	1,8	1,7
Monthly rate, commercial	...	...	...	...	...	...	18	17	16	15
Rate for 3 minute fixed local call	...	...	...	...	...	...	0.11	0.10	0.10	0.09
Connection fee, cellular phone	...	...	...	...	...	...	12	11	-	-
Monthly rate, cellular phone	...	...	...	...	...	...	4.54	4.38	1.81	1.72
Rate for 3 minute cellular call	...	...	...	...	...	...	1.21	1.16	0.87	1.21
Total sector revenue (US$ million)	72	75	95	104	118	187	223	258	357	415
Sector investment (US$ million)	23	22	25	16	15	9	158	137	110	...
TV Receivers (thousand)	750	755	775	800	825	850	875	900	930	960
Personal computers (thousand)	...	15	17	20	22	25	28	30	60	100
Internet Hosts (thousand)	-	-	-	-	-	0.07	0.43	0.55	0.63	0.95
Estimated Internet Users (thousand)	...	...	...	...	...	5	14	35	52	78

Notes: Rates are quoted in current US$, without taxes. Installation rates correspond to partners of a representative cooperative, but do not include the value of the "contribution certificate" that the partner must pay to the cooperative, equivalent to US $1,500. Cellular rates correspond to a representative plan of one of the major operators. Telecommunications revenue and investments are in millions of current US$, without taxes.
Source: ITU (2001b).

Beginning in 1996 the sector became more dynamic, with a strong increase in services and investment, headed by ENTEL and, to a lesser degree, COTAS. ENTEL's investment between 1996 and 1998 was assigned to mobile telephony (29%), the national long distance network (19%), general logistic and infrastructure investments (13%), public telephones and rural networks (12%) and local networks (11%). Between 1996 and 1999, ENTEL's investments (including the mobile network) totaled some US $433 million, constituting 27% of the total invested by capitalized companies in that period.

Investments have been concentrated in ENTEL and in cellular companies, and only secondarily, in local companies, which are in greatest need of resources to expand.

In addition, development data hide a notable geographic imbalance, as a very high proportion of services are offered in the so-called "main-axis" of the main cities (La Paz, Cochabamba, Santa Cruz), as the following table illustrates:

Table 5-5: Geographic Concentration of Fixed and Cellular Telephone Service Offer

Year	**Density of land lines (lines / 100 inhabits.)**		**Density of cellular telephony (lines / 100 inhabits.)**	
	Main axis	Rest of the country	Main axis	Rest of the country
1996	5.44	2.76	0.61	0.07
1997	5.77	3.15	1.98	0.54
1998	6.63	3.62	3.95	0.94
1999	7.28	3.73	6.79	1.57

Source: Bolivia SITTEL (2000), p. 99 and 103.

The difference in total density (land line and cellular) between the different regions is enormous: for example, the department of Santa Cruz has a density 5.6 times greater than that of Potosí. In cellular telephony, more than 90% of the total supply is concentrated in the main axis.

The relationship between the density of land and cellular telephone lines and the per capita GDP for the different departments in the country is shown in the following table:

Table 5-6: Telecommunications Services Availability and Per Capita GDP, Per Department (1999)

Department	**Population (thousand)**	**Per capita GDP (US$)**	**Land lines**	**Land line density (%)**	**Cellular lines**	**Cellular density (%)**
Chuquisaca	593	777	19,807	3.34	9,287	1.57
La Paz	2,314	828	165,719	7.16	159,016	6.87
Cochabamba	1,446	961	111,718	7.73	64,364	4.45
Oruro	387	942	23,602	6.10	9,869	2.55
Potosí	756	480	16,734	2.21	5,934	0.78
Tarija	380	956	21,156	5.57	9,435	2.48
Santa Cruz	1,704	1,232	130,534	7.66	157,247	9.23
Beni	346	965	11,790	3.41	4,557	1.32
Pando	54	1,114	1,423	2.64	635	1.18
Total	7,980	915	502,483	6.30	420,344	5.27

Sources: National Institute of Statistics and Coopers & Lybrand, as cited in quoted COTEL (1999); and Bolivia SITTEL, www.sittel.gov.bo/archivo/oprsrvtl02.xls.

The low penetration of service in the poorest departments is evident. SITTEL estimates that in 1999 rural telephone density reached only 0.4%, far below the national average of 6.17%.

Despite attempts to correct this in the last few years, there remains a strong disparity in rates. Prices have remained relatively constant in nominal terms during the length of the exclusivity period. The following table shows local rates of the three largest urban providers:

Table 5-7: Fixed Local Telephone Service Rates (in US$, without IVA-VAT)

	COTEL		COTAS		COMTECO	
	Member	**Non member**	**Member**	**Non member**	**Member**	**Non member**
Installation	-	150	-	45.45		126
Incorporation	1,500	-	1,250	-	1,800	
Monthly base charge	Res. A:0.83 Res. B:1.74 Com.:15.61	22.73	8	16.36	2.83	16.62
Free traffic included	Res. A: 100' Res. B: 200' Com: 200'	200'	60 imp*	60 imp*	90 calls	90 calls
Additional traffic	0.03 /min	0.03 / min	0.07/imp*	0.07/imp*	0.05/ 3min	0.05/ 3 min

*For COTAS, local impulses correspond to local calls of unlimited duration, and there is no difference between home and commercial customers.
Sources: Company interviews, September 2000; and ITU (2001c).

Local rates are remarkably high, especially considering the value of "incorporation" in the case of cooperative members. Long distance rates also remain very high; in 2000, national long distance rates were around US $0.44 per minute, and calls to the U.S. cost around US $1.10 per minute.

Support for Rural Services

After years of very superficial treatment of the rural telecommunications problem, the restructuring process of1994-95 finally defined two mechanisms to support rural development. The Telecommunications Law's Article 28 designated that funds from the sale of rights for frequency use, fines, revenues from bids, and the surpluses resulting from transfers would go into a special account in the National Fund for Regional Development (FNDR) to co-finance basic telecommunications service projects in rural areas. Articles 228 and 229 of the Regulations for the Telecommunications Law required local service concessionaires to address requests from the extended rural areas surrounding their respective local service areas. Long distance concessionaires were required to install at least one telephone in each area with 350 to 10,000 inhabitants in its concession area. These obligations were to be incorporated into the respective providers' concession documents.[175]

In practice, the results have been the following:

- Under the fee mandated by Article 28, US $25.86 million was transferred to FNDR between 1996 and 2000. However, there were no telecommunications projects implemented with those resources, because the operation of the system was not regulated until 2001. In 2000, the Government withdrew around US $18 million from this account to be assigned to "more urgent social objectives."
- Under the requirements of Articles 228 and 229, pledges were made to install public telephones in 1626 localities between 1996 and 2000.

[175] Though there are differences on whether or not these obligations are extended beyond the exclusivity period.

However, telephone penetration in rural areas only reached 0.4 [%] in December 1999. Penetration of other more sophisticated services, such as Internet, is practically non-existant.

These rural telecommunications obligations seem to be isolated within the Government's rural development programs, and are not coordinated with other infrastructure programs. (For example, it is very difficult and expensive to access these rural localities to install telephones, due to lack of electricity, adequate roads, and up-to-date demographic and economic date on rural areas.) It costs an average of US $8,700 per line installation, considerably higher than equivalent values in other countries in the region.

In order to address the rural telecommunications problem in the new competitive environment, the Government has developed a system that attempts to combine resources collected under Art. 28 of the Telecommunications Law with additional resources, and to use them in a more efficient way. The design of this system still requires some legal modifications, but in its present state, it calls for the following:

- To achieve universal service in urban areas, and universal access in rural areas, at levels at least matching the South American average.
- To support the accomplishment of these objectives through a new Fund for Universal Access and Service (FASU) established by law and by contractual obligations assigned to existing concessionaires in local and long distance service. If new demands were not established, the concessionaires would be required to at least maintain services in all localities included in the previous service expansion obligations.[176]

FASU would be financed via mandatory contributions from all telecommunications service providers (except broadcasting), in the amount of a certain percentage of their respective total gross revenue.[177] Concession resources from multinational agencies might also be assigned to FASU. Of the FASU resources, a maximum of 50% would be assigned to social interest projects in urban areas.

The allocation or reassignment of the funds already collected under Article 28 has not yet been considered, but it is assumed that these would be rolled into the FASU.

In the future, funds will be assigned not just to telephone access in rural areas, but also to telecommunications coverage in targeted urban areas, with an emphasis on providing Internet access to promote equitable access to improved information technologies. The way the resources are used will also be important to consider, in terms of providing competitive access among providers to the subsidies.

[176] This provision is still up for discussion, because the original expansion of obligations only mentions "installation" of services.

[177] The Government proposed to assign the FASU 3.5% of the revenue from operating companies, but Congress rejected this as excessive. In Peru and Venezuela the corresponding amount is 1% of the operators' revenue; in the Dominican Republic it is 2%. In Central America the tendency is to provide the Fund with a portion of the income from the spectrum bids, which at any rate renders amounts that are lower than what was proposed in Bolivia. In Chile the Fund is directly endowed from the public Treasury, and the contribution has been around US$ 4 million annually.

A serious problem is the lack of detailed information on rural areas with and without service, characteristics and needs.[178] The Ministry of Economic Development has developed the PRONTER (National Rural Telecommunications Development Program), including a very interesting program study, but the information included there is preliminary.[179] According to the PRONTER study, Bolivia has a population of 2 million in 9,000 localities with populations of 350 inhabitants or less. The study proposes to cover 5,200 of these localities—reaching a total of 1.4 million people—within five years, and assumes that this would also benefit the other 3,800 localities, though no concrete rationale is given for this. It is estimated that the telephone installations in the 5,200 localities would cost around US $68 million (some US $13,000 per locality). Additionally, the study estimates that the cost of other additional complementary investments in health, education and other programs that would be based on the telephone system would reach some US $35 million.[180]

In conclusion, it is clear that the sectoral authorities (Superintendence and Ministry of Economic Development) have detected that rural services are a necessity that need special support mechanisms that are currently being developed. The analyses conducted thus far are preliminary, and are entangled in parallel preparations for the next round of competition. The level of support that political entities will give for these initiatives is not clear. This will be key to the success of rural telecommunications programs, since the main instrument considered, the Fund for Universal Access and Service, requires implementation by law.

Rural Telecommunication Demand Analysis

As part of the OAS-supported investgation, a rural telecommunication demand analysis was undertaken to gain an understanding of the potential for establishing a financially sustainable rural telecentre in a representative region of Bolivia.[181] The results provide a perspective on the

[178] The recent National Census taken in Bolivia in September 2001 will provide valuable information, but probably some months will go by before concrete results are available.
[179] The data from the study are contradictory on this issue. The study of the General Communications Directorate entitled "National Rural Telecommunications Program (PRONTER)," dated May 2000, states that the total population is 2,013,935 and there are 9,276 localities with 350 or fewer inhabitants. This document proposes to cover 5,200 of these localities, or 1.4 million inhabitants, within five years.
[180] It is difficult to confirm these numbers, and they could be undervalued. On the one hand, installations made by Entel to date have had an average cost of less than U S$10,000 per line, which is rather high. However, the experience of other countries indicates that the cost per locality increases markedly (and the number of beneficiaries decreases) when more remote areas are included. Further, additional investments must be considered for the communications platforms and terminal equipment in the cases where Internet service will be set up. In some cases, the private operator may contribute significant complementary financing, but in others, projects must be financed entirely with subsidies. The biggest unknown is the investment required to finance the complementary programs being considered (health, education, etc.), which could produce the majority of the benefits, but could be astronomically expensive (production of relevant Internet content, adequate training for health service personnel, teachers, etc.). At the international level, there is little concrete information on this aspect. Without an adequate cost-benefit evaluation, it is risky to declare that it would be convenient to extend the service to all these localities, and one could only go forward on the basis of a political strategic decision at the national level.
[181] We strongly recommend such telecommunication demand assessments prior to the development of rural telecentre programs. The upfront costs of this work will insure that donors, telecom operators and communities realize an optimum return on their investments in time and money. Such assessments will also help proponents construct viable, needs-based and market-oriented business plans for rural telecentres. The Demand Analysis shows the critical importance of voice telephone demand and related potential revenue flows to telecenter sustainability.

current telecommunication use patterns, expenditures and future potential expenditures in Santivanez and two neighbouring communities. The results of the demand analysis also provide an indicative picture of the rural telecommunication use patterns and expenditure patterns that might be expected in other rural communities in Latin America, in that the data highlights the financial importance of voice telephone use for the sustainability of rural telecommunication initiatives. Indeed, our experiences with similar research in other rural areas of Latin America and the developing world point to the importance of basic telephone service as the single most important service delivered by rural telecentres. The survey was conducted by the TeleCommons Development Group in partnership with Winrock International, and with assistance from World Vision staff in Santivanez and Cochabamba. World Vision staff in Canada were instrumental in facilitating the survey work. The survey interviews were conducted between November 15 and 19, 2001. Interview data was compiled in Bolivia and analyzed in Canada.

Based on the results from the survey, it is clear that the main source of revenues for a rural telecentre is going to come from the use of telephones – voice telephony. This has fundamental implications for any program or project promoting the use of information and communication technologies for rural development. For example, the Bolivian government's PRONTER program for the establishment of rural telecentres provides only for Internet access, and does not explicitly encourage the deployment of voice telephony. The results from Santivanez indicate that the PRONTER program will not likely be financially sustainable unless the demand for voice telephony is addressed. Internet and E-mail revenues can only be expected to begin at a level of about USD $6,245 per year which, in our view, would not be sufficient to sustain a telecentre that provides only Internet access. In comparison, revenues from accessible and well-maintained telephone services would be able to capture a significant proportion of the estimated USD $129,792 currently spent on telephone services among people in Santivanez. Given that the single public payphone in Santivanez is not operational, these telephone users must travel to Cochabamba to use the telephone, use the telephones of family members, friends or local businesses, or use cellular phones where that service is reliable. In this context, a well-managed telecentre that also provides payphones in strategic locations would likely be able to capture the majority of the local telephone expenditures, and would also be able to significantly enhance telephone traffic and local revenues.

While the number of Internet users, could grow, at this stage it is not clear how many people will be using it in the near and medium term. A telecentre equipped with two to three Internet connected computers would be more than adequate to serve current users, and build awareness and demand among future users. Expansion of Internet services could be based on revenue growth. It is quite likely that telecentre computers would generate more revenue when used as a basic computer training lab, than as Internet connection devices alone. In parallel with findings from rural telecommunication studies Telecommons has undertaken in other countries,[182] it is interesting to note that there is a gender dimension associated with telecommunication use. In Santivanez, females prefer more to use residential, institutional, and communication centres. This may be related to cultural factors and/or safety issues. Regardless of the factors involved, we interpret this to mean that a telecentre facility, or even a simple shop where an operator assists telephone users, would be more comfortable for female users than a public payphone.

[182] See for example our study of Grameen Telecom's Village Phone initiative in Bangladesh – www.telecommons.com/villagephone/index.html

This has implications for telecentre and telephone business planning because in order to capture all of the available revenue to financially sustain a service, it is important to make the service attractive, comfortable and accessible to all segments of the population.

There is an excellent business case for establishing a telephone-focused telecentre in Santivanez—a telecentre that would provide centrally located telephones with staff to provide user assistance and revenue collection, plus strategically located card operated payphones, including payphones in more remote communities. This approach would also likely prove successful elsewhere in rural areas Bolivia and Latin America/Caribbean. Even if the telecentre were able to capture 50% of currently available revenue, $65,000 could easily support the installation of 10 to 12 phone lines and/or payphones. Conservatively, one could expect a 1-year return on investment on the capital costs required. If a telecentre is going to be established in the community of Santivanez and similar communities**,** they will have to compete for customers with other service providers in the area. This fact should be taken into consideration by the telecentre management, while preparing their business and marketing plans. Opportunities for a local organization to collaborate with the local telephone operator in each region would likely be productive if the operator were able to review this demand analysis, and the local organization had access to capital to facilitate installation of a telecentre and payphones.

5.1.3. Current and Proposed Rural ICT Initiatives

Bolivia is a very fertile environment for rural telecenter/ICT initiatives, with a number of different rural telecenter activities being implemented and planned by the Bolivian Government, including by the Vice Ministry of Energy and Hydrocarbons (VMEH), with proposed World Bank financing, and by the Vice Ministry of Transportation, Communications and Civil Aviation based on national funding under the FNDR and PRONTER described above. A number of private sector entities, including for-profit and non-profit entities, are also pursuing rural ICT activities.

As one of the PRONTER initiatives, the Ministry of Economic Development (Vice Ministry of Transport, Communication, and Civil Aviation) is currently in the process of selecting a winning bidder for an Investment Subsidy Contract for the provision, installation, operation, and maintenance of rural telecenters in selected communities. Through this solicitation, the Government is attempting to use a portion of the approximately $4 million (US) of the remaining FNDR telecommunications funds to support rural telecenter projects offering telephone services, access to computers and the Internet, and other complementary services. This procurement is expected to lead to the the installation of 60-100 telecenters in localities of up to 10,000 inhabitants, with the FNDR funds used to subsidize companies interested in installing and operating these telecenters. The winning bidder will be selected in part on basis of the lowest subsidy bid, using a model similar to that used for rural telephony in Chile, Peru, and Colombia. The procurement is in process as of late March 2002, with a winning bidder expected to be selected shortly. This initial RFP and resulting project activity should provide useful experience and information that can guide subsequent telecenter development programs. Experience may show that this model, with various adjustments suggested by near-term experience, can be broadly replicated in Bolivia.

The Ministry of Energy is considering a similar rural connectivity and energy project, Decentralized Energy and ICT for Rural Transformation, with proposed World Bank financing. This project, to be implemented via the national rural electrification program (PRONER), would support rural electrification, rural telephony, and rural Internet connectivity. As part of the preparation process for the Decentralized Energy and ICT for Rural Transformation Project, the World Bank is supporting (via the Japan-supported Policy and Human Resources Development Fund of PHRD) a detailed market study analyzing the market for rural electricity, telephony, and internet services, and characterizing the development services (e.g. education, health) and potential economic impact. This study is expected to serve as the foundation for the preparation of a project document for the proposed World Bank loan. The indicative figure for the proposed World Bank loan for this effort is $20 million. As of late March 2002, the Market Study was still in process, and the World Bank was in the process of preparing the Project Concept Document (PCD) for the Decentralized Energy and ICT for Rural Transformation Project. The PCD is a fairly brief summary document produced early in the project preparation cycle, and would be followed by preparation of more detailed project documents. While the Ministries of Transportation and Communications and of Energy were pursuing separate rural ICT initiatives under the PRONTER and PRONER programs, efforts will be made to consolidate these in the World Bank-supported project. Although this project will not focus exclusively on renewable energy systems, it is likely that renewable energy systems will be the most appropriate options for many of the smaller and more remote communities.

In addition, a number of private sector entities are active in ICT development and are working to develop innovative rural ICT initiatives. This includes an NGO, the Quipus Cultural Foundation, which has developed a number of rural ICT initiatives and also worked to develop a CISCO Acadamy in La Paz, and NUR University. Quipus Foundation, Nur University, and other partners have jointly developed a for-profit joint venture, Desarrollo, Energias Alternativas, y Telecomunicaciones (DESATEL), to pursue rural ICT and energy service development activities. This includes developing a team to pursue opportunities related to the ongoing PRONTER solicitation and other Government of Bolivia-supported projects, as well as other innovative private sector development activities. For example, the OAS team working on this initiative identified a potential project involving a Bolivian micro-enterprise bank, PRODEM, Fondo Financiero Privado, S.A., that wishes to employ ICTs to strengthen its rural lending operations. The proposed project would deploy, in approximately 70 villages, advanced telecommunications systems (i.e., VSATs and spread-spectrum radios), computers and related hardware, and renewable energy generation technologies where necessary due to absence of reliable grid-supplied electricity. The goal is that these integrated systems, together with the delivery of human capacity and institutional strengthening packages would significantly strengthen rural banking/micro-enterprise finance services, while offering these same communities access to internet-based distance education, municipal management systems, telemedicine, agricultural support information, and other community services. The interest of PRODEM in this project was catalyzed by the private sector development efforts of DESATEL.

One of the important lessons from Bolivia is the critical importance of a transparent process for enabling entities—including private rural service providers—to interconnect with the national telecom network and long-distance service providers. It is important to both have in place policies mandating the ability to interconnect, and to have effective and transparent mechanisms for arbitrating or resolving disputes between telecom companies. It appears that Bolivia has done a very good job of putting in place such a system. This makes it much easier to develop small, innovative ventures for serving rural areas, including service providers willing to invest in telecenters and rural ICT.

ICTs for Rural Education

With the exception of very general statements (e.g. regarding the PRONTER RFP for telecenters), no ongoing or proposed initiatives were identified involving use of ICT in rural education. In recent years Bolivia has been implementing a thorough reform of its basic educational system (i.e. primary and secondary education) that has significant implications for rural education coverage. The reform is focused on improving education quality and responding to severe shortfalls in availability of education including in rural areas and among indigenous groups. Of necessity, the reform has focused on the fundamental areas of curriculum and materials development, provision of basic educational materials (e.g. schoolbooks, basic school libraries), teacher training, and institutional reforms in the ways schools are funded and managed. Under the Popular Participation Law (1994), municipal governments have responsibility for education infrastructure (i.e., school) construction, maintennce, equipping, and expansion. Some central funding is available, for example for teachers salaries, but municipalities need to complement this with their own resources under Social Investment Fund (FIS). Another important element of the reforms is to increase participation of parents in the management of the schools, and to support decentralized management where teachers, students, parents, and local directors play a strong role in identifying needs and problems, responses, and determining needed resources. The lack of emphasis in the reforms to date to use of ICT or distance education does not appear to stem from lack of interest, but rather on the need to attend to most urgent and fundamental problems. Bolivian educational authorities have shown interest in use of ICTs such as educational television, and it remains to be seen whether the decentralized management structure and/or existence of ICT initiatives such as the PRONTER-supported telecenters will lead to small initiatives involving ICT in rural education.

Bolivian Examples of Telecenters, Telemedicine/Telehealth, and ICT Support for Rural Economic Development

<u>Information Centres for Agro-Ecological Producers, Association of Agro-Ecological Producers of Bolivia (AOPEB)</u>
This is a network of six information centres in Bolivia for producers of ecological products supported through AOPEB (www.aopeb.org). The centres will provide access to Internet, information on production and commercial methodologies and a virtual market place assisting in the direct commercialisation of ecological products.

Beneficiaries include 100 producer organisations, at least 300 institutions and researchers and large number of national and international traders of ecological products.
Sponsored by the International Institute for Communication in Development (IICD)

ICT use in rural development under CONCADE

The Counter-Narcotics Consolidation of Alternative Development Effort (CONCADE) provides technical assistance to USAID, Bolivian government agencies and the private sector to support the creation of viable legal alternatives to growing illegal coca in the Chapare region of Bolivia's Cochabambe Department. Coordinated by Development Alternatives International (DAI) with technical support from Winrock International, CONCADE promotes the production of alternate crops, such as bananas, pineapple, heart of palm, passion fruit and black pepper, through agricultural technology transfer, agribusiness marketing, private sector investment promotion, strengthening of alternative development organizations and alternative development policy. Project technicians are trained in the use of ICTs to help them provide critical outreach services, such as facilitating the delivery of market information to local farmers, families and producer groups. ICTs are also used to provide training information to project technicians, and to help track project costs.

CONCADE is a prime example of the significant impact the enhanced use of ICTs can have on alternative agricultural development programs. Local farmers' interest in producing legal alternatives to illegal crops is dependent on their ability to produce the alternate crops in a safe and commercially viable manner. Alternative development projects must get information out about the relative attractiveness of producing alternative crops to the majority of farmers in the target area. In the case of CONCADE project, there are 17,000 families in the Chapare region. By using ICTs, each project extensionist now serves 200 rural families, with a total of approximately 7,000 families currently being served. The CONCADE project plans to enhance its use of ICTs, including integrated Geographic Inforamtion System applications and handheld devices, to facilitate technicians' wider coverage in order to ultimately reach all 17,000 families. The project also plans to incorporate GIS-based applications into its project performance monitoring information system to facilitate more timely and accurate information gathering and dissemination and more accurate evaluation and documentation.

Libre Ondas - Network of Local Radio Producers

This project focuses on the integration of radio and Internet to enhance the impact and coverage of local radio programs produced by NGOs in Bolivia. Radio programs on themes including sustainable development, environment, agriculture and gender are exchanged through the network. Coordinated by Casa de la Mujer in Santa Cruz. Radio programs are sent by email to be stored in the network's website "Libre Ondas". Initially included one radio station in Eastern Bolivia and four NGOs, but is expected to grow to include more radio stations. Participants are being trained in database and web development, and Internet access of participants will be upgraded. The program, funded by IICD, is at early stages, with the web site still not functional. Potential audience expected to be 130,000 people. Funding requirement estimated at US$39,000 annually for the next four years.

Sustainable Development and Environmental Network – REDESMA

The Centro Boliviano de Estudios Multidisciplinarios (CEBEM) will enhance the Sustainable Development and Environmental Network (REDESMA). REDESMA (www.cebem.com/redesma) is set up to support the exchange of information and knowledge on sustainable development and environmental issues between local, national and international organisations. The project will focus on upgrading REDESMA into a fully dynamic Internet portal with advanced search facilities, directories of environmental organisations and experts and an electronic discussion platform.

Apoyo Para el Campesino-Indígena del Oriente Boliviano (APCOB)
APCOB will develop a multi-media system that allows to preserve and distribute Etnografic materials which contain important Indigenous knowledge on culture and economic practises in the Eastern lowlands of Bolivia. The multi-media productions will be used as educational materials serving national and international schools, academic institutions and NGOs. To address this issue, the project will assist in the enhancing the local capacity to produce multi-media based educational materials on indigenous cultural and productive practises. In detail, the project will focus on: 1) storage of existing text, audio and video materials on indigenous knowledge in digital format; 2) training of Indigenous groups in the joint development of new basic materials; 3) development of multi-media productions on selected issues, e.g. Cultural history of the Ayoréode; Forestry practices of the Chiquitanos, etc.; 4) distribution of the productions to national and international educational institutions and NGOs; and 5) development of similar multi-media productions on request of other NGOs.

The primary beneficiaries of the project are the indigenous groups participating in the project. In addition, the projects' target groups of the multi-media productions are educational institutions including national and international schools, academic institutions and NGOs. The initial activities for the project have started with financial support of HIVOS (the Humanistic Institute for Development Cooperation) of the Netherlands

Bolivian Agricultural Technology System (SIBTA)
The Bolivian Government is developing an Information, Planning, Monitoring, and Evaluation System (SIPSyE) in order to support the Bolivian Agricultural Technology System (SIBTA). The SIBTA support agriculture technological development and change in different agro-ecological zones of the country, responding to needs identified by local producer groups. This information system, which is being developed under an IDB loan, will support agricultural development, but is not aimed at rural users per se. For example, it is not intended to provide market pricing information or technical information to rural producers.

5.1.4. Recommendations Regarding Potential OAS Rural ICT Activities

It is clear that in the near future rural ICT development in Bolivia will be dominated by the PRONTER-related telecenter development project or program, which should shortly result in a chain of privately-operated, publicly subsidized rural telecenters, and by the proposed Decentralized Energy and ICT for Rural Transformation project currently under preparation with the World Bank. One of the challenges for the OAS/IACD will be to identify specific niches and complimentary roles it can play in these efforts, and where it can provide the greatest value.

At present, it appears that thinking and development efforts in Bolivia are relatively more advanced in the general area of rural telecenters, and generally less well advanced in the area of rural education. At the same time, the changes in the basic education program in favor of greater local autonomy, combined with near-term experimentation (whether labeled as such or not) in rural telecenter development appear to create an interesting opportunity for the OAS/IACD to work on development of ICT for rural education activities in Bolivia.

In a similar manner, the near-term development of a significant number of rural telecenters will also provide opportunities for development and deployment of content and systems for economic development applications such as the possible PRODEM project discussed previously, where ICT would be used to support the rural operations of a small enterprise financial institution, or for example to support provision of technical and market information to agricultural producers. While private telecenter operators would benefit from existence of such capabilities, it is by no means clear that they will have sufficient financial incentive or resources to develop the necessary systems and content.

5.2. COLOMBIA

General Country Data (1999, except where indicated):
- Surface area: 1.1 million km^2
- Population: 41.5 million
- Population Growth (annual %): 1.8%
- Rural population: 26.5%
- Illiteracy: 8.5%
- Poverty (1997 survey data):
- Poor households: urban, 40%; rural, 54%
- Destitute households: urban, 15%; rural, 29%
- GDP: US$ 86,600 million (market prices in current Dollars)
- GDP Annual Growth Rate: -4.3%
- GDP average annual growth rate between 1989-1999: 3.4%
- Per capita income: US $2,170 (current Dollar); US $5,749 (PPA Dollars)
- Per capita income annual growth rate: -10.33%
- Human Development Index (UNDP): 0.765
- Per capita income average annual growth rate between1989-1999: 1.6 %

Sources: World Bank (2001c); CEPAL (2000); UNDP (2001).

Of the countries covered by this study, Colombia has the most fully developed program for promoting use of ICTs including the Internet for economic and social development, including education, agricultural, health, public sector governance, and other applications. The national government has developed an initiative known as the Connectivity Agenda that is intended as a comprehensive set of policies and activities to support broad use of ICTs and make Colombia a leader in the use of ICT for development and in IT industry development. Colombia also has the most advanced rural telephony program, and is in the early stage of supporting rural telecenter development. A number of the Connectivity Agenda policies and initiatives are potential models for replication in other OAS member countries, and some of the relevant agencies and personnel in Colombia may be able to support the OAS/IACD activities in other countries, through assisting in transfer and replication of best practices.

5.2.1. Rural Electrification

The Columbian Energy Solutions Planning and Promotion Institute, or IPSE (Instituto Planificación y Promoción de Soluciones Energéticas, formerly known as ICEL or Instituto Colombiano de Energía Eléctrica) was created by the Ministry of Mines and Energy ro support rural electrification. The IPSE is the government agency responsible for planning, implementation and operation of rural electrification and rural power supply programs. Since its inception in 1999, it has assumed responsibility for operating and managing electric generation assets, specifically, small diesel generating plants and small hydroelectric plants, in the non-interconnected zones—ZNI (Zonas No Interconectadas). The ZNI incorporates all the regions not served by the National Interconnected System (SIN), with some southern departments fully within the ZNI and other departments split between the SIN and the ZNI. The unelectrified population and the communities served by distributed generation—the ZNI—is spread over 66 percent of the national territory and is concentrated in three major regions: Amazonia, Orinoquia and the Pacific Andes. Accessibility to some of these territories is extremely difficult; some of them can only be reached by boat or by plane.

Twenty two departments and 115 municipalities have populated centers in the ZNI, including five departmental capitals: Leticia, San José del Guaviare, Mitú, Puerto Inirida, Puerto Carreño, 46 municipal capitals and more than 913 isolated rural population centers (centros poblados) of different categories (villages, hamlets, police inspection spots, Indigenous settlements, etc.). Total net population in rural populated centers (capitals and municipal capitals) is about 527,720 inhabitants, and in isolated rural areas the total amounts to 996,584 inhabitants. Approximately 90% of Colombia's 41.5 million inhabitants live in communities receiving 24-hour electric service through the national grid. The total unelectrified population in Colombia is approximately 1 million, and approximately 1 million people receive part-time electricity service—three to eight hours per day—from diesel power plants.

There are 912 isolated rural communities with access to diesel generating sets from 100 kilowatts to over one megawatt. Fuel for these communities is provided by IPSE, and is often transported by barge or aircraft at excessive cost. Service is generally only available at night for four to six hours. Diesel generation systems often lack proper operation and maintenance (O&M) and suffer frequent breakdowns, necessitating maintenance and repair visits by IPSE staff. The factor that most affects generation cost in the ZNI is the fuel costs. In some populated centers a gallon of diesel costs $10,238 Columbian Pesos, while in Bogotá it costs $2,030 Colombian Pesos (as of July 2000). High diesel and gasoline costs are due mainly to transportation costs, and partially to security-related restrictions on fuel marketing.

One of the distinguishing characteristics of the rural electrification situation in Colombia is this widespread use of decentralized generation—particularly diesel generation—in community mini-grids. One result of this is that much of the focus on rural electrification involves efforts to improve service for these communities receiving part-time elctric service. From the perspective of this OAS/IACD Rural Connectivity and Energy Initiative, communities with part-time electric service—primarily evening service—share many characteristics with unelectrified communities. ICT projects in these communities will have to take into account many of the energy efficiency, power consumption, and power supply "balance of system" issues as ICT projects in unelectrified communities. IPSE officials recognized the challenges to use of ICTs in communities with part-time power systems, and expressed interest in receiving information and assistance from the OAS/IACD in addressing these challenges.

Electricity in the ZNI is mainly used for domestic consumption (84%), with institutional use at 5%, commercial use at 6%, and only 3% is used in productive applications. Domestic use is mainly for lighting and communications (radio and TV). The IPSE estimates that the current effective installed generation capacity meets only half of the ZNI's energy requirements. The demand is currently estimated at 198.6 MW, while the supply is only 99.8 MW

Realizing the difficulties inherent in supporting hundreds of distributed generation plants through one government entity, the Colombian Government has announced its intention to institute reforms in order to provide reliable and dependable electric power service in the ZNI, increase the availability of sustainable energy sources, and facilitate the participation of private firms as energy service providers. The participation of private firms would be under the municipal service companies (Empresas de Servicios Públicos—ESP) arrangement or modality, which is covered by Law 143 of 1994, and complementary decrees regulating the electric power generation, transmission, distribution and trade in Colombia. The existing generation and distribution facilities in the ZNI would be grouped into eleven regional packages, with each bid out separately for management, operation, maintainance, and expansion by private companies. Each regional package or franchise would be awarded on a least-subsidy basis. This is an interesting proposal, although implementation may be difficult, in part due to the security situation, and resulting perceptions of risk on the part of potential investors.

The Government of Colombia does plan on devoting significant resources to electrification and improvement of existing rural electric service. Resources to be available include Rural Electrification Support Fund established under Law 633, which establishes a peso per kilowatt-hour fee to support the fund, levied on all power dispatched on the SIN, as well as bilateral assistance funding including as part of Plan Colombia. It is expected that $140 million will be available over the next several years to fund electrification projects and rural power system strengthening interventions.

Ministry of Energy and Mines and IPSE officials think that small-scale renewable energy systems will often be least-cost options for many hundreds of the smaller (<200, 200-500) off-grid communities, and IPSe is institutionalizing the use of renewable energy systems in its routine operations. For example, consideration of PV, hydro, and other small-scale renewable energy systems is explicitly incorporated into IPSEs planning methodology and manual (Manual Methodologico Para La Formulacion, Evaluacion, y Priorizacion de Proyectos de Soluciones Energeticas Para La Zona No Interconectada-ZNI). IPSE has been working with NREL on a number of technical assistance and training activities designed to strengthen the technical capabilities of IPSE staff. Over 5,000 PV systems (mainly solar home systems) were installed in 2001 under the electrification programs.

5.2.2. Rural Telephony

Colombia has made significant strides in recent years in expanding rural access to telephone service through the use of innovative service delivery models which are now being applied to rural telecenter development.

Legal and Regulatory Aspects

Colombia does not have a formal Basic Telecommunications Law. However, the legal framework of the sector is fairly complicated, with numerous laws, decrees and other sectoral norms that govern the sector, many of which have been modified through the years, leaving others obsolete without beling explicitly or completely repealed.[183] Nevertheless, the dynamic nature of the sector has left behind several of these legal elements. Some specific legal texts have been issued for certain services or situations, such as mobile telephony and others. In recent

[183] A list of the main legal bodies of the sector, with successive modifications to each one, can be found at www.mincomunicaciones.gov.co/templates/normas/index.htm.

years, the government presented Congress with a general telecommunications law project, but its approval is uncertain.

Although the original basic legal cornerstones are Law 72/89, especially Decree 1900/90, which contains orientations, general definitions, service classifications, and network authorization regulations, to a large extent these texts today appear to have been superseded in many practical aspects. In 1990, Decree 1901 was also issued, redefining the competence of different institutions in the sector and creating a new regulatory entity, the Telecommunications Regulation Commission. In 1991, a new Constitution was approved in Colombia, which defined several principles that influenced the development and regulation of telecommunications, and which greatly strengthened the powers of the regional authorities (mayors, governors, etc.) related to the services offered in their respective territories. In 1993, a new special law was issued (Law 37/93) to regulate cellular mobile telephony service.

In 1994 the most important law regarding telecommunications and other services, Law 142/94, the Public Domestic Services Law, was passed in 1994, establishing a common general legal framework for many public and private services, including basic switched public telephony and local mobile telephony in the rural sector.[184] The Law sets the procedures for operating companies; defines regulatory, control and monitoring systems for the State regarding these services; establishes the relevant institutions and their functions; determines principles, applicable charges and practices; specifies applicable administrative procedures; and regulates relationships between operators and customers. The Law is extensive but contains some ambiguities that some parties have tried to eliminate in subsequent modifications.

Other laws have specifically addressed television service, PCS and electronic commerce.[185] Decree 1130/99 restructured the Communications Ministry and transferred some functions to other public institutions.

In general terms, throughout the 1990s, laws and regulations have tried to promote a more competitive environment and greater private investment. However, this has proven complicated, given a strong tradition of publicly owned companies at the national and regional (district and municipality) levels, with powerful unions that have not easily accepted privatization, and frequent differences being aired between national and regional authorities.

After a conflictive period in the early 1990s, when the Government failed to open the sector to competition, enactment of Law 142 gave certain stability to the telecommunications sector. This 1994 Law opened the possibility for competition in local telephone service, eliminating concession requirements, but keeping some technical and financial requirements for providers and services. However, this law did not solve the property problem of existing state companies or private participation, nor the competition in the long distance telephone service. In some services, such as cellular telephone, ad-hoc legislation was issued, which allowed for some competition among cellular service providers (regional duopolies).

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[184] It is interesting to highlight that this is one of the few national cases to have a common legal framework for the different services.

[185] Colombia Law 182/95 and Law 335/96 (television), Law 527/99 (Electronic Commerce), and Law 555/99 (PCS).

The problem with introducing competition for basic services began to be solved in 1997, when regulatory grounds for telephone service were defined[186] and the possibility for competition in long distance service was established. This started to be implemented soon after, but only among pre-existing companies. The property problem of the original state companies is still pending (at least for the biggest companies), since attempts to allow private capital to be invested in them has not been successful to date.

Law 142 also established a Communications Fund in the Communications Ministry, intended for "investing through social telephony program implementation, directed at rural and urban areas characterized by the existence of users with high indexes of unsatisfied basic needs".[187] This Fund, managed by the Ministry, was enacted in 1994, and was then restructured in 1999 as a special administrative unit of the Ministry, with legal status.[188]

The Law also defined a quite sophisticated institutional system, separating sectoral policy functions, regulation and control into three different institutions (Communications Ministry, Telecommunications Regulation Commission, and Public Home Services Superintendence, respectively), although with certain dependency problems. Historically, the Commission has had a markedly technical character, while the Ministry and the Superintendence have been more political.

The Communications Ministry's objective is the "formulation and adoption of policies, general plans, sector projects and programs." The Telecommunications Regulation Commission (CRT) is a special unit, with administrative, technical and financial independence, according to the Law. However, it does not have its own legal status, members are appointed by the President of the Republic, and the President is the Communications Minister.[189] Its objective is to "promote and regulate free competition for rendering of telecommunications services, to regulate monopolies when competition is not possible, and prevent disloyal conduct and restrictive commercial practices." The Public Home Services Superintendence is a technical entity with legal status, administrative and financial autonomy, managed by a Superintendent, who is nominated and freely removed by the President of the Republic. Its objective is to practice "control, inspection and surveillance of the entities that render public home services". The institution has a division and an Appointed Superintendent for home telecommunications services.

Progress in many aspects related to telecommunications is in large part due to CRT, which, despite some political issues, appears to be an institution of great technical strength. Possibly the most complicated issue, which remains to be resolved is that of private participation in a sector in which the biggest companies are still State-owned (national and municipal Governments).

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[186] Colombia Resolution 87/97, Telecommunications Regulation Commission.
[187] Colombia Law 142/94, Art. 74.3e.
[188] Colombia Decree 899/99, 27 May 1999.
[189] It is worth noting that the Communications Ministry also carries out, ex-officio, the position of President for Telecom's Board of Directors, the largest state telecommunications company, which suggests that the separation between political, regulation and operational functions of the sector is not complete.

Industry Organization

In Colombia, for many years the business structure of the telecommunications sector was based almost exclusively on state entities, which provided traditional telephone services. There were two types of state entities: national (central Government company), and regional (municipal, or in some cases departmental, company).

At the national level the National Telecommunications Company (Telecom), created in 1947, renders national and international long distance service (until recently, it had a monopoly over these services), and local service to smaller municipalities that do not have the means of offering them directly. Of the total amount of operating telephone lines in the country in mid-2000, the company and its affiliates had 33%. Telecom is the only local service provider in 15 out of 31 Departments in the country. Recently, the company also started offering services in other areas, such as Bogotá.

Many of the telecommunications providers at the regional level are municipal companies, some of them providing telephone service exclusively, but others providing integrated public services, including telecommunications, electricity, and others. Until recently, all of them operated local telephone service as a monopoly. Generally, other companies provide long distance service. In some cases extended local service (or, local long distance) is provided. The companies that serve the three main cities of the country—Bogotá, Cali and Medellín—dominate the local market (approximately 60% of the total installed lines).

This oligopolistic structure, with quasi-exclusive dominance by State entities, has been slowly eroding. Some municipal companies have experienced complications given their political connections and union conflicts, and have not been able to respond to additional investment needs to satisfy demand. Many others are too small to be able to keep afloat in the rapid evolution of the sector.

In the beginning of the 1990s, the Government made an attempt to privatize some companies, or at least, tried to inject private capital into them. This attempt failed, however, due to opposition faced from union groups, especially from within Telecom, whose employees blocked international communications in the country for several days.

As a result, the Government decided to pursue a different route, encouraging private participation and the creation of new aggregate value service companies. These were defined rather broadly, in a way which they could even be considered substitute, at least partially, for long distance service providers.

Subsequently, private participation also increased in the cellular telephony sector, for which a special statute was announced. Mixed companies as well as other completely private companies appeared as cellular service providers. Some state companies started incorporating private capital via joint ventures for specific projects, in which the participating private company frequently was an equipment manufacturer that brought its products into the deal.

The following table presents an up to date panorama of the sector:

Table 5-8: Telecommunications Market Information in Colombia

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Land lines in service (thousand)	2415	2633	2822	3139	3513	3873	4645	5395	6367	6665
Density (lines/100 inhabits)	6.91	7.38	7.75	8.46	9.28	10.05	11.82	13.47	15.59	16.03
Waiting list (thousand)	458	628	650	...	756	...	728	800	979	1155
Public phones (thousand)	32	34	35	36	39	41	43	46	60	106
Mobile cellular customers (thousand)	-	-	-	-	87	275	523	1265	1800	3134
Mobile density (cust./100 inhabits)	-	-	-	-	0.23	0.71	1.33	3.16	4.41	7.53
Installation fee, residential	...	...	258	317	327	357	321	340	214	181
Installation fee, commercial	...	...	324	...	490	552	484	507	305	226
Monthly rate, residential	...	...	5.9	...	...	3.3	2.9	3.4	3.3	3.8
Monthly rate, commercial	...	...	7.9	...	...	...	6.5	8.0	5.0	5.0
Rate for fixed local 3-minute call	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.04
Connection fee, cellular phone	-	-	-	-	396	493	579	701	491	368
Monthly rate, cellular phone	-	-	-	-	42	41	34	24	19	11
Rate for 3-minute cellular call	-	-	-	-	0.57	0.62	0.63	0.65	0.59	0.59
Total sector revenue (US$ million)	914	774	1024	1039	985	1213	2042	3736	3042	2742
Sector investment (US$ million)	211	333	134	363	503	617	577	1635	1125	1247
TV Receivers (thousand)	3800	3800	4200	6968	7139	7314	7614	7766	8102	8273
Personal computers (thousand)	...	...	320	390	500	630	920	1214	1300	1400
Internet Hosts (thousand)	-	-	-	-	1.1	2.3	9.1	10.2	16.2	40.6
Estimated Internet users (thousand)	...	...	...	...	38	69	123	208	433	664

Notes: Rates quoted are in current US$, with taxes. Telecommunications income and investments are quoted in millions of current US$, without taxes.
Source: ITU (2001b).

Traditionally, telecommunications companies were not categorized into different affiliate groups, except for those linked to Telecom (who were called "Tele-affiliates"). The remainder were mainly municipally owned and operated individually. The majority of the Tele-affiliates were previously municipally owned small local companies. These could not survive on their own, so they were partially or completely transferred to Telecom. But with the onset of cellular service and the opening of the long distance telephony market to competition, several local companies have gotten together to form associations between themselves and with private investors in order to comply with regulatory demands and to come up with the necessary investment resources (long distance permits cost US $150 million each). For example, the Capitel company, created by Telecom for providing local service in Bogotá, and the EPM Bogotá company are joint ventures with different international telecommunications equipment makers.

Colombian regulations include a peculiar characteristic regarding rates: a legal pricing differentiation according to income levels of land line residential telephony users (applied also to other residential services governed by Law 142/94).[190] These are classified into six different "strata" (using as reference the cadastral appraisal of the customer's home), plus commercial and industrial users. Stratum distribution of current customers and telephone density is as follows (stratum 1 has the lowest socio-economic level, and stratum six has the highest):

[190] Colombia Law 142/94, Art. 89, based on Art. 367, of the 1991 Political Constitution.

Table 5-9: "Strata" Distribution of Telephone Customers (March 2000)

Stratum	1	2	3	4	5	6	Industrial and Commercial	Total
Telephone Lines %	5.15	23.43	35.96	7.95	3.94	2.23	21.34	100
Density (tel/100 inhabits.)	3	9	17	18	20	30		16

Sources: CRT (2001a); and Colombia DNP (2001).

According to the law, an additional contribution in the rate of up to 20% of the service cost is applied to strata 5 and 6 and industrial and commercial customers. These proceeds are used to subsidize strata 1, 2 and 3, though with certain limitations. The subsidy cannot exceed the basic consumption of these lower income strata, and it cannot exceed 50%, 40% and 15% respectively of their average supply cost, respectively. Stratum 4 does not receive subsidies nor pay overcharges.[191] New competitive service providers must apply the same contribution and subsidy factors as the dominant operator in the respective market.[192] Charges are not exactly the same in all the localities, and there are differences among competitors in areas with more than one service provider.

Local rates are still very unbalanced, with very low monthly base charges. The average monthly telephone bill for land line telephony, in Colombia is only US $11, compared with countries such as Mexico at US $39.6, Argentina at US $26.9, and Brazil at US $16.9.[193] On top of this distortion there is also a re-distribution framework oriented toward the most profitable segments that complicates matters greatly, especially when introducing competition.

The market structure for mobile telephony is somewhat different. From its beginnings in 1993, the country was divided into three geographic areas (North-Caribbean, Central-East and South-West), so that each area included one of the three major cities (Medellín, Bogotá and Cali), and competition was opened for two licenses in each one of the areas (bringing license income above US $1 billion). One license had to be for a private company and the other for a mixed (public/private) company.

Cellular telephony does not have an official "rates strata" system, given that it is not considered residential service. However, it is estimated that stratum six represented more than 40% of users until 1999.[194] As frequently happens, average traffic per user has been decreasing in recent years, still, total revenue for cellular telephony almost equaled that of the regular local telephony (Col $1.44 billion, compared to Col $1.56 billion for fixed local service; long distance produced Col $1.52 billion) as early as 1998.

Despite many difficulties, in the last decade sectoral development has shown very positive results. Density of the land lines has increased substantially: 9.8% annually on average between between 1990 and 1999. Despite some fluctuations (due in part to foreign exchange fluctuations), a strong increase in income and investment has been observed, though in the last

[191] Until December 31, 2001, there were contributions that exceeded 20% and subsidies above 50% because CRT allowed this during the established transition period.
[192] CRT (2000).
[193] Colombia DNP (2001).
[194] CRT (2000), Chapter 4.

few years there seems to be less growth, which could partially be due to a declining national economy.

Support for Rural Services

Rural services development has been a topic of concern in Colombia for a long time. More than 20 years ago, the Government established a special Vice-presidency in Telecom to improve the rural service situation; however, the great majority of installations carried out occurred in small urban areas rather than in rural areas. Rural needs are still great, especially in smaller localities. The following table shows the land line telephony density according to population of municipalities established in Colombia:

Table 5-10: Telephone Density According to Municipality Population

Municipality population (Thousands of inhabitants)	Tele-density (Land lines in service / 100 inhabitants)
Less than 7	3
7 to 15	3
15 to 30	4
30 to 50	5
50 to 100	9
100 to 300	13
300 to 500	17
500 to 1,000	19
More than 1,000	31
National average	16

Source: Colombia DNP (2001).

Out of 706 populated centers with more than 1,000 inhabitants, 617 of them have a telephone density of less than three lines per 100 inhabitants; 219 of the 1,097 municipal capitals fall within this category. Out of a total of 18,800 dispersed rural areas and centers with less than 1,000 inhabitants, only 3,314 (18%) have home or community (public phone) telephone service. Another 6,535 areas are being considered for service in the social telephony program which is currently active, but there remain another 8,951 areas (47%) without service of any kind.[195]

The Government was not satisfied with what has been accomplished, and indicated that there have been "weaknesses and defficiencies" in the implementation of the social telephony program since 1995. Until 1998 a scheme was used for financing equipment acquisition for the program, working through existing local service providers, but it was concluded that it would be more effective to support for-profit rural service delivery ventures through a system of subsidies to cover the deficits in providers' business plans.

For the near to medium term, the Compartel Social Telephony Program (from Compartir Telecomunicaciones, or Share Telecommunications) was developed in 1999 to implement

[195] Olea (2001).

community telecommunications solutions directed at rural populations. For the long term, a Universal Access and Service Program has been proposed to provide universal telephony service to rural areas, distinguishing between universal access (the possibility that everyone is able to use the service) and universal service (service availability for everyone in their homes and/or work place).

The COMPARTEL program was designed by the Ministry of Communications to facilitate universal access to telecommunication services in rural areas by subsidizing new private sector operators through a telecommunications fund. In the first phase, through a bidding process a consortium (Global Village telecom) led by Gilat was selected to provide services, and today it is already operating community telecommunication centers in 30% of the target areas with cellular technology and in 70% of the cases with satellite (VSAT) technology. In a second phase COMPARTEL is supporting installation of an additional 3,000 rural telephone systems, with the expectation that this will primarily based on VSAT technology (The technology is not determined by COMPARTEL, but rather by the winning bidder).

Compartel is also supporting development of telecenters with access to the Internet in all the municipal capitals of the country (1,100), of which at least 600 are already in service, with the remaining 500 to be installed in 2002. These telecenters include at least two computers, Internet access, printers, fax, scanner, digital camera, and payphones. The communications infrastructure—typically VSAT—also supports installation of a payphone in the municipal office and the health clinic, with these phones connected to the VSAT terminal via landlines or wireless links. The private service providers—Telefonica and Global Village Telecom/Gilat—are responsible for hiring or otherwise arranging for local operators of the telecenters. University students or recent university graduates performing their social service under "Opcion Colombia" are sent to rural communities for six month periods to provide training and technical support to telecenter managers and local organizations and individuals, and a modest budget is made available to local NGOs and other institutions for development of content and speciailized systems. This "Social Internet" program is not explicitly a rural telecenter program, but many of the Municipal Seats are in fact rural towns so there is a strong rural telecenter element to the program. Once all the municipal seats are served by Telecenters, it is expected the program will begin to support installation of telecenters in smaller rural communities. In many cases, the VSAT-based rural telephony systems installed under COMPARTEL will be able to be upgraded to support Internet connectivity.

These programs are financed with contributions from the Communications Fund, whose resources come from a fraction of the payments made by cellular telephony licenses, and from the dues and rights that all operators must pay the Ministry for concessions, licenses, permits, fines, etc. Fund administration and collection was not very transparent until 1998. Although it has been reported that from 1995 to 1998 the Fund contributed to the financing of 121,458 new telephone lines (using unknown criteria).[196] In 1999 the Fund reported income of US $64.8 million from dues alone.

The Compartel phase that started in 1999 supports telephony service installation, operation and maintenance in community centers of some 6,535 areas in six geographic zones throughout the

[196] Ministry of Communications, as cited in Ovum (no date), Section H.5.

country. It was bidded and awarded to the Global Village Telecom NV – Gilat Satellite Networks Ltd. consortium, for a total of US $33.7 million. In 2000 an attempt was made to expand the Program to other areas, but respective bids were declared defective. For this reason, the Program was redesigned in 2001, and has become part of a larger framework known as the Connectivity Agenda.

The Compartel Program is considering allocating subsidies for projects in 3 different sub-programs, which are expected to bid between the last quarter of 2001 and the first quarter in 2002.[197] The first is the Social Internet program described above. The second is providing rural community telephony for dispersed rural areas, which includes service installation and operation in approximately 3,000 localities over six years. In this sub-program the focus will be on installing the service in areas of more than 150 inhabitants that are currently without service and located a certain distance from other areas with service. Of these 3,000 localities, approximately 2,500 have been identified from existing information, and another 500 will be designated in different municipalities according to their profiles and based on field visits. Companies taking part in this sub-program must have been owners and operators (within or outside of Colombia) by June 30, 2001, of at least 10,000 fixed or cellular telephone lines, or owners and operators of at least 2,000 rural public telephones.

The third is providing rural home telephony for municipal district capitals and populated centers with more than 2,000 inhabitants but less than 100 telephone lines in service. This sub-program aims to promote the installation of about 25,000 rural lines in about 150 municipal capitals and populated centers that currently lack sufficient service. In each case, the technical and economic feasibility of the service must be guaranteed, given that the Fund would only contribute to the initial investment stage of the projects. These would be developed by and at the own risk of the interested operator, which would guarantee service continuity.

In addition to these sub-programs, additional programs to support the replacement and maintenance of existing networks and rural services are under considerations for support from the Fund.

All resources would be assigned in public bids and selected on the basis of the lowest subsidy requested. They would be subject to certain technical and service quality standards, and in most cases, to certain tariff provisions. They will be allowed special conditions to access radio-electric spectrum bands, and regarding the corresponding dues for spectrum usage.

It is estimated that funding available for the Communications Fund will increase over the next several years due to projected increased fees from telecom companies. Though it is not necessarily the only institution to receive such resources, Compartel is presently the Fund's main beneficiary. Estimated annual income for the Fund this decade is as follows:

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[197] Ibid.

Table 5-11: Estimated Income for the Communications Fund (from fees payable to the Ministry)

Year	Amount (US$ million)
2000	57.8
2001	58.9
2002	62.7
2003	73.7
2004	79.2
2005	86.3
2006	92.3
2007	100.0
2008	107.4
2009	116.7

Source: Olea (2001).

In summary, rural telecommunications project development in Colombia has relatively large institutional and economic support, though these support mechanisms have undergone changes in recent years. Clearly, of the five countries analyzed, Colombia is the biggest and has the most developed infrastructure in this regard. Resources are much more available here than in other countries, though the needs are also greater. Lastly, while it is true that Columbia's deteriorating political situation can be a deterrent to starting projects here, these same problems cause even greater demand for these services in rural areas and make it even more necessary to supply adequate means of communications for rural populations here.

5.2.3. Current and Proposed Rural ICT Initiatives

<u>Connectivity Agenda and COMPARTEL</u>

The Government programs to provide universal access to telephone service and broaden internet access (including establishment of community access centers), described in detail in the rural telephony section above, are all explicitly part of an ICT initiative known as the Connectivity Agenda. In February 2000, the government of Colombia created a new framework for developing the telecommunication sector called the "Agenda de Conectividad" in which the government promised to provide telecenters to all counties and Internet access via telephone lines (e.g. dial-up access) to major towns that were then without access. The Compartel program (www.compartel.co) is funded by the Vice Ministry of Communications through the Communications Fund, a special entity within the National Development Fund (FONADE) that provides financing for installation, operation and/or maintenance of telecommunication projects. The Compartel Telecenter program, know as "Programa Internet Social," is intended to expand Internet access to all communities that are currently without access, especially poor rural and urban communities. It is the hope of the government that the new telecenters supported under COMPARTEL will be used as virtual libraries, as tools for business development and that they will promote telemedicine and education programs using the support of the telecenter network. In addition to supporting installation of 1,100 telecenters, the program is also supporting provision of dial-up Internet access in forty larger towns.

The Colombian Centro de Investigación en Telecomunicaciones or Telecommunications Research Center (CINTEL) is a center of excellence for investigation in the area of information technology and telecommunications that brings together telecommunications operators, solution providers, academia, and regulatory entities. CINTEL provided valuable information and guidance to the OAS/IACD team working on the Rural Connectivity and Energy Initiative, and it is expected that CINTEL would be a strong counterpart for rural ICT activities in Colombia.

ICTs for Rural Education

Colombia has long had a major focus on rural education including specialized models for rural education. At present, the Government of Colombia is supporting the use of multiple rural education models or options, essentially presenting municipal leaders with a menu of options, including the Escuela Nueva (New School), Tutorial Learning System, the video-based Telesecundaria, the Post-Primaria Rural, Learning Acceleration Program, and the Rural Education Service. The Telesecundaria model is the largest of the activities to explicitly include ICTs; the model in Colombia is based in part on the Mexican Telesecundaria model, but with significant adaptation and production of Colombian instructional materials. In unelectrified regions—and in communities with diesel powerplants operated at night--the Telesecundarias will generally require renewable energy-based power systems or energy storage systems that can be charged when diesel generators are being operated. In addition, the Escuela Nueva model, a primary school (grades 1-5) model which uses one or two teachers each working with multiple grades and extensive self-study, is also being implemented in some cases based on extensive use of ICTs, namely computers and educational software and materials (via CD) to facilitate self-study. This variation on the Escuela Nueva, known as Escuela Virtual (Virtual School) is being widely supported in the Department of Caldas, and is described in more detail below.

The Ministry of Education is implementing a World Bank-financed Rural Education Program, as the first three year phase of a 9 to 12 year Adaptable Program Loan. In the initial three-year period the program will focus on selected municipalities in 10 departments in Colombia, and the budget for this first phase is $40 million (U.S.), with the World Bank financing half of this total. The Rural Education Project will work in a demand-based manner, where the Departments and specific Municipalities will have a large voice in decisions on which educational models to employ, including modifications to these models. Given the pervasive focus on ICT in Colombia including major focus on incorporation of computers and internet into schools it is likely that many Departments and Municipalities will want to adopt rural educational models incorporating at least some use of ICT.

<u>Escuela Virtual con metodología Escuela Nueva en la zona rural de Caldas</u>
Forty-five rural public schools in the coffee region of Colombia are carrying out this ICT-related rural education project, with the assistance of the National Federation of Coffee Growers, a private, non-profit organization, representing the rights of farmers. With the help of three levels of government, the Federation has introduced several education projects to improve the coverage and quality of education offered by schools in the coffee-growing region. One of these is the "Virtual School" initiative, which is introducing computers, educational software and Internet into the schools. Learning from previous failed ICT projects for schools, the Federation designed a project that places the emphasis less on computers than on pedagogical processes and training. Also, schools are obliged to seek funding for the hardware and the connection on their own, which requires the support of both the community and the teachers. This commitment is

considered essential for the success of the project. Each school works independently, using what is known as the "New School" methodology. Expert training provided primarily at the outset, with Web resources and email being the main tools for ongoing training. This is intended to promote sustainability of the project. Virtual Schools have had an impact on more than 7,000 students, 450 teachers and 45 communities. Students, who are stimulated by connection with other students throughout the world, are staying in school longer, and do not feel compelled to move to urban areas. Teachers are learning, too, and their job is made easier with the access to new information resources. Challenges include the need to raise funds, as well as the lower standard of connectivity in the rural regions. This program appears to be very successful, and it is expected that it will be replicated in many other departments in Colombia.

Under the broader Connectivity Agenda, there is also a large emphasis placed on use of ICTs in education including provision of computers to schools, including rural schools. In some cases this is being effectively integrated into the basic curriculum, for example in the Escuela Virtual program discussed above.

Another program to emerge from the Connectivity Agenda, "Computers for Education," collects computers donated by entities of the public and private sectors and reconditions them for use in schools. It has several centers for the overhaul or refurbishment of computers, including installation of software (operating systems, applications, educational software) donated by Microsoft and other companies, and is placing several tens of thousands of computers in schools each year. The program works with other public and private entities to provide follow-up training and services to the schools for the operation and maintenance of the computers. University students or recent university graduates performing six months of social service via the "Opcion Colombia" program are dispatched to schools to assist in training teachers and students.

Colombian Examples of Telecenters, Telemedicine/Telehealth, and ICT Support for Rural Economic Development

<u>Strategic Information System for the Agricultural Sector (Sistema de Informacion Estrategica del Sector Agroalimentario-SIESA)</u>

As part of the SIESA program (www.cci.org.co/information/home.html), the Ministry of Agriculture has supported the development of agricultural information systems incorporating agricultural product pricing information (Sistema de Informacion de Precios del Sector Agropecuario—SIPSA), a market information system (Sistema de Inteligencia de Mercados—SIM), quality standards and phytosanitary requirements (Sistema de Normas Tecnicas, Fitosanitarias, y Ambientales), and technical information for producers on production technologies, post-harvest handling, soil and water management, and disease and pest control (Sistema de Informacion Tecnologica de Productos Hortofruticolas).

<u>Inforcauca</u>

Inforcauca supports sustainable development initiatives through three community telecentres in the south-west of Colombia. Two of these are rural (Centro del Cauca, Tunia, Piendamo; and Santander de Quilichao, ACIN), and one urban (Centro de services comunitarios Aguablanca, El Poblado II, Cali). Inforcauca aims to improve access to ICTs by people marginalized communities, with the understanding that these technologies can be used to support development initiatives through access to information and networking with other supportive groups.

Inforcauca has developed a number of collaborative agreements. Because nine different local organizations manage the operation of the telecentres, working relationships have between organizations with varying levels of experience in commercialization of agricultural products. Also, relationships have been formed between the telecentres and the Ministry of Communication, various NGOs, and donor agencies.

The ACIN telecentre serves a largely indigenous population, and supports development programs including health, education, environment, and heritage preservation. ACIN has linked with a local radio station, Radio Nasa, providing ICT training and access to global information resources for programming. Inforcauca is supported by the Centro Internacional de Agricultura Tropical (CIAT), and the Corporacion Universitaria Autonoma de Occidente de Cali (CUAO), with support from the International Development Research Centre (IDRC) of Canada.

The Tunia telecentre is managed by a group of seven organizations whose mandate is to support farming and rural microcredit activities. The third telecentre, Aguablanca, is located in one of the poorest and most densely populated neighbourhoods in Cali, whose 450,000 inhabitants are mainly migrants from the Pacific coast of Colombia, and people from nearby rural communities.

Niños de la Calle

Funded by Canada's IDRC and DFAIT, the primary goal of the Niños de la Calle projects (http://www.chasquinet.org/ninosdelacalle/e-pag1.html) is to provide computer skills and Internet tools to street children, to allow them to exchange knowledge and experiences in order to help tem solve their problems and create opportunities for a better life. The project has established a street children portal among other initiatives. The telecentres offer kids access to well-structured learning and guidance, to provide a minimum of training. Apart from their access to information, skills and jobs, these children are more likely to gain self-confidence and an opportunity to survive on the street. The programs are delivered in collaboration with local organizations working with street children in each of the countries. Activities include: improving existing infrastructure for Internet access and use; providing training programs for selected youth, who can then act as trainers for their peers; documenting the experience and sharing lessons learned with other partners in the country or region.

Out of these combined project experiences the sponsors will produce documentation of the experiences in print and video, and a concept paper for a larger second phase project based on the results of the pilots. The aim is to expand this network through Latin America and the Caribbean.

Asociacion de Veredas de La Calera

This activity will strengthen communication in the Asociacion de Veredas de La Calera by making better use of Internet resources. It will: 1) train 15 women members of the Association; 2) design and implement a strategic communication program that uses Internet resources and that is based on the daily lives of women in the Association; 3) strengthen the exchange of information and experiences with other peasant and women's associations in the country and region; 4) improve the communication infrastructure of the Association by updating their computer system and installing a new phone line in the office; and 5) generate a process with the use of Internet tools to help the production and commercialization of handicraft and agricultural products of the Association. This activity is funded by IDRC.

Cardiobip

The Cardiobip telemedicine initiative (http://www.serviciosmedicosavia.com/) is based in Bogota, Colombia, and provides services to both Bolivia and Colombia. It stared providing services in 1995, and last year there were 3,000 patients who used the services of Cardiobip. The main type of application is in cardiology, and it employs a Store-and-Forward (SandF) system.

5.2.4. Rural ICT Opportunities Identified

Norte De Santander Regional Connectivity System (SCR) Project

The OAS/IACD has identified the Department of Santander's proposed Regional Connectivty System (SCR) Project as a promising potential activity to be supported under the Rural Connectivity and Energy Initiative. The proposed Norte de Santander Regional Connectivity System" (Sistema de Conectividad Regional – SCR) project is designed to provide connectivity and place information and communication technologies (ICTs) in 40 municipal capitals and 60 smaller towns of the Department of North Santander in Colombia. The project would include establishment of an Internet Portal, and provide content/services in the areas of education, health, agriculture, and public administration. It is expected that in many cases, where the communities lack access to reliable power grids, the ICTs will be powered by sustainable renewable energy technologies—such as solar photovoltaics (PV). A number of factors create a favorable environment for the development of a telecenter project in the Department of North Santander. The Governor of North Santander has placed his full political support behind the project and is capable and willing to finance at least part of the implementation. The Department of North Santander is also in dire need of the social services that the Rural Connectivity and Energy Initiative of the IACD might facilitate. The Department's guerrilla activity and extensive coca production require that steps be taken to improve the economic and social conditions of the population. The Department also suffers from inadequate health and education coverage. It has, for example, the second lowest school enrollment rate of the country, and all schools lack information technologies. As a result, the Department has been selected by the Ministry of Education for participation in the World Bank-financed Rural Education Project that could provide a valuable synergy for the proposed SCR project. North Santander has a population of 1,375,000 (73.8% urban and 26.4% rural) with a teledensity of only 6.7% and difficult terrain, which makes it hard to extend the telecommunications grid.

As discussed above, as part of its connectivity agenda the State supports specific programs, including the social telecommunications program COMPARTEL. This program was designed by the Ministry of Communications to facilitate universal access to telecommunication services in rural areas by subsidizing private sector operators through a telecommunications fund. As described above, in the first phase of the COMPARTEL program, through a bidding process Gilat was selected to provide rural telephony services. In a second phase, COMPARTEL is developing projects to establish telecenters with access to the Internet in all the municipal capitals of the country (1,100), of which 600 are already in service. The SCR Project of North

Santander will seek to reinforce this program by connecting still unserved geographical areas to the Gilat network or by linking government buildings, schools and health clinics in areas where Gilat is operating to the Gilat-operated VSATs.

5.3. GUATEMALA

Guatemala General Country Data (1999, except where indicated):

- Surface area: 108.9 thousand km^2
- Population: 11.1 million
- Population Growth (annual %): 2.6%
- Rural population: 60.5%
- Illiteracy rate: 32%
- Poverty (1989 survey data):
- Poor households: urban, 48%; rural, 72%
- Destitute households: urban, 23%; rural, 45%
- GDP: US$ 18.2 billion (at market prices, in current US Dollars)
- GDP Annual Growth Rate: 3.6%
- GDP average annual growth rate between 1989-1999:
- Per capita income: US $1.680 (current Dollars); US $3.674 (PPA Dollars)
- Per capita income annual growth rate: 1.8%
- Human Development Index (UNDP): 0.626
- Per capita income average annual growth rate between 1989-1999:

It must be stressed that Guatemala has the highest proportion of rural population among the 5 cases analyzed. Much of the rural population is Indigenous. Among them there are important groups that speak very little Spanish.

Sources: World Bank (2000); CEPAL (2000); UNDP (2001).

5.3.1. Rural Electrification

Electrification Coverage in Guatemala

As of the year 2000 approximately 76% of the Guatemalan population of 11 million people received electric service from the grid, or a total of approximately 8.4 million people. The electrification coverage rate is approximately 92% in urban areas and 50% in rural areas. The country has made significant strides in rural electrification over the past decade, as national electrification coverage grew from 46% in 1992 to 76.4% in 2000, and the Government has recently put in place policies and mechanisms to continue expanded rural electrification through extension of the electric grid. The approximately 2.6 million people who lack access to electricity primarily live in rural areas, totaling approximately 500,000 households.

There are significant geographic differences in electrification coverage, ranging from 94.8% in the Department of Guatemala to 29.3% in the Department of Alta Verapaz. Six departments have service coverage exceeding 90%; six departments have coverage levels exceeding of 70%-90%; Eight departments have coverage rates of 50% to 70%, and two departments (Peten and Alta Verapaz) have coverage rates below 50%. Table 5-22 presents information on the number of users and percentage of coverage by department[198] and Figure 5-21 below shows electricity access rates by department for the country. Table 5-22 also shows the percentage increase in coverage between 1991 and 2000, and demonstrates that increases in electrification coverage

[198] Guatemala MEM (2001).

have been very broad-based with many departments increasing coverage by more than 30% to 40%.

Figure 5-12: Access to the Electric Grid by Department in 2000

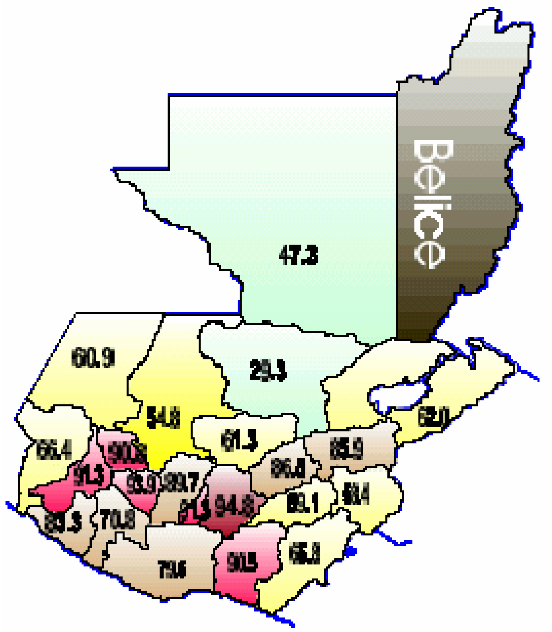


Table 5-13: Access to Grid Electricity Service in Guatemala

2000			1991-2000
Department	**Users**	**Coverage**	**Increase in Coverage**
Guatemala	514,463	94.8	6.3
Sololá	48,914	93.9	51.1
Sacatepéquez	42,640	91.3	18.0
Quetzaltenango	101,762	91.2	42.2
Totonicapán	57,882	90.8	44.5
Santa Rosa	54,986	90.5	45.9
Chimaltenango	66,987	89.7	44.6
El Progreso	24,507	86.5	34.3
Zacapa	33,853	85.9	32.7
Retalhuleu	36,411	83.3	56.8
Escuintla	73,853	79.5	33.8
Suchitepéquez	50,035	70.8	33.4
San Marcos	94,488	66.4	46.5
Jutiapa	48,838	65.8	27.1
Izabal	36,776	62.0	34.9
Baja Verapaz	23,655	61.3	38.6
Huehuetenango	88,501	60.9	45.6
Jalapa	25,534	59.1	28.6
Chiquimula	31,937	58.4	20.4
Quiché	60,656	54.8	40.9
Petén	25,108	47.3	30.6
Alta Verapaz	33,337	29.3	18.5
Total	1,575,123	76.4	32.0

Source: Guatemala MEM (2001).

Power Sector Organization and National Rural Electrification Programs

Guatemala has privatized its power sector, through the sale of the generation and distribution assets of the Empresa Electrica de Guatemala (EEGSA) and creation of the private firm DECASA, and through the sale of the distribution assets of the Instituto Nacional de Electrificacion (INDE) which resulted in creation of two additional private distribution companies, Distribudora Electrica de Occidente (DEOCSA) and Distribudora Electrica de Oriente (DEORSA). In addition to the above three distribution companies, 14 municipalities control their own power distribution systems. INDE retains control of the transmission system.

Through the above-mentioned privatization and the establishment of several complimentary policies and mechanisms, the Ministry of Energy and Mines (MEM) has put in place the institutional structure to ensure continued expansion of rural coverage, and provided for at least a significant portion of the required investment funding. These policies include the imposition on the privatized distribution companies of a service obligation that requires them to extend service (upon request) to potential users within 200 meters of their existing grid, and the development of a rural electrification fund to support investment in transmission and distribution. The MEM has established a rural electrification goal of increasing electric service coverage from the current 76.4% to approximately 90% in 2004 and 96% in 2006, although projected results are slightly lower (e.g. 87% coverage in 2004).

The Rural Electrification Program (Programa de Electrificacion Rural or PER) is overseen by the Rural Electrification Coordination Office (CODERURAL), which is a unit under the MEM General Directorate for Electricity. CODERURAL is responsible for establishing and maintaining databases on un-served communities, defining priorities for electrification, and procedures for execution of rural electrification investments. CODERURAL coordinates rural electrification efforts of different institutions including public sector (e.g. INDE, Peace Funds, etc), international and bilateral donors and non-governmental organizations (NGOs) as well as coordinating actions related to the execution of the rural electrification trust fund that was established under the General Law of Electricity.

A portion of the INDE distribution privatization proceeds have been used to capitalize the Electrification Trust Fund (Fideicomiso de Administracion INDE Obras Rurales de Occidente y Oriente), which will be used to subsidize investments in rural electrification. The planned size of the Trust Fund is $333.6 million, of which $151.9 would be intended to fund transmission investments and $182.7 million would be used to subsidize investment in distribution networks, with the bulk of investment channeled through DEORSA and DEOCSA. The initial capitalization for the fund consists of $101 million in proceeds from the sale of the INDE distribution assets; the Government of Guatemala has committed to provide $97.6 million in additional funding, and is in the process of securing a BCIE (Central American Bank for Economic Integration) loan for $40 million and an IADB loan for $95 Million (IADB loan GU-0126).[199] The Trust Fund investment in distribution is effectively a grant passed through to end-

[199] It has been suggested that the Government may have difficulty in meeting the commitment for the additional $97.6 million in funding, due to the significant costs incurred in subsidizing electricity tariffs. The Social Tariff provides for a 50% subsidy for the first 300 kWh/month of consumption. The Private Sector Department of the

users, as the distribution companies are prohibited from including this investment in their rate base. The Electrification Trust Fund is expected to support extension of service to approximately 281 thousand (280,798) users or connections, located in 2,634 communities. The implicit average subsidy per connection is substantial, $1188 including both investment in transmission and distribution, and $650 for the distribution investment subsidies alone.[200] The electrification projects to be supported under the Trust Fund include the following eight subregions:

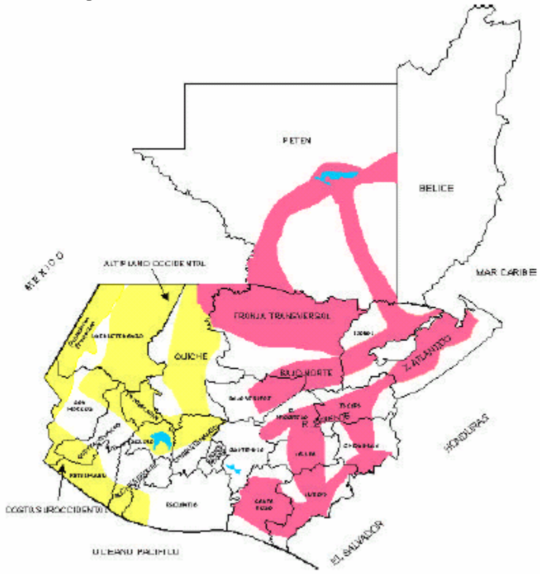
1. Northern Transversal Strip (Franja Transversal del Norte) in the north of Alta Verapaz, serving 22,500 users in 168 communities in 7 municipalities.
2. Quiché, serving 76,000 users in 708 communities in 21 municipalities.
3. Petén, extending service to 18,500 users in 150 communities in 11 municipalities.
4. East (Oriente), extending service to 46,000 users in 514 villages.
5. Atlantic, serving 13,000 users in 109 villages in the Department of Izabal.
6. Western Plateau (Altiplano), benefiting 50,000 users in 522 communities in Chimaltenango, Solola, Totonicapan, Huehuetenango, Quetzaltenango, and San Marcos.
7. West Coast, extending service to 31,000 new connections in 242 villages in the departments of Suchitepequez, Retalhuteu, San Marcos, and Quetzaltenango.
8. Lower North, serving 22,000 connections in 221 communities in the departments of Baja Verapaz and Alta Verapaz.

Figure 5-14 shows the regions where the electrification activities supported under the Rural Electrification Trust Fund will be executed.

IADB is also providing $85 milion in financing to Union Fenosa, which owns 80% of DEOCSA and DEORSA. While this will primarily be used for upgrading and rehabilitation of its distribution facilities, it appears a portion of the financing will also be used to finance rural electrification undertaken as part of its service obligation for connections within 200 meters of its existing network.

[200] It should be noted that this is the average across all connections, and not the average per residential connection, including public infrastructure (e.g. schools, clinics, public buildings), commercial, and industrial users, although the latter will be in the minority. This new transmission and distribution infrastructure may also facilitate additional connections in the future.

Figure 5-14: Planned Project Areas under Rural Electrification Trust Fund



Source: Guatemala MEM (2001).

Table 5-15: Projected Electrification Coverage in 2004

Department	Users (connections)	Projected Coverage	Projected	
			Unserved	of which are rural
Alta Verapaz	60,875	51.5	57,329	
Huehuetenango	99,781	68.9	45,039	
San Marcos	111,763	75.4	36,464	
Chiquimula	40,384	70.9	16,575	
Jutiapa	59,697	78.3	16,544	
Izabal	46,453	77.7	13,332	
Baja Verapaz	30,924	75.5	10,035	
Suchitepequez	63,064	85.7	10,523	
Esquintla	84,300	87.2	12,374	
Guatemala	655,863	97.6	16,128	
El Progreso	28,504	96.7	973	
Zacapa	39,358	96	1,640	
Santa Rosa	60,513	95.7	2,719	
Jalapa	42,157	95.1	2,172	
Chimaltenango	78,806	96.6	2,774	
Sacatepequez	53,852	96	2,244	
Quetzaltenango	111,094	96.1	4,508	
Retalhuleu	43,994	95.9	1,881	
Solola	54,352	95.6	2,502	
Totonicapan	65,392	95.7	2,938	
Quiche	116,728	95.7	5,245	
Peten	52,073	94.3	3,148	
TOTAL	1,999,927	87.19	267,086	202,852.5

Source: Guatemala MEM (2001).

In addition to the program described above, INDE and the Mexican Federal Electricity Commission (CFE) are supporting the Guatemala-Mexico Frontier Communities (Poblaciones) Electrification Program, which is supporting extension of service to approximately 4000 customers in 45 communities in the departments of Huehuetenango and San Marcos.

The National Rural Electric Cooperative Association (NRECA) has supported rural electrification in Guatemala, primarily under USAID-funded activities. In addition to supporting some implementation of electrification projects, NRECA has assisted in the development of electrification planning methodologies.

The Rural Electrification Trust Fund is focused exclusively on grid-extension, and does not support off-grid electrification based on renewable energy or other distributed technologies. In large part, this is because the Trust Fund was developed as an integral part of the privatization of INDE distribution facilities, where it was clear before the bidding process that the privatization proceeds and other funds would be used to support rural electrification, and that these resources would be used to support grid extension of the DEORSA and DEOCSA distribution networks. MEM officials have also have an understandable preference for grid extension when this is a possible, due to the greater possible impact on rural economic development. [201] Although on first glance the exclusive focus of the Trust Fund on grid-extension-based electrification through DEORSA and DEOCSA may appear to limit the scope of action for the OAS initiative, there are several synergies. The main synergy is that the current program strives to clearly identify the regions that will receive grid extension and the regions and communities that will not benefit from grid extension. This will facilitate identification of areas that will remain unserved by the electric grid, where the OAS initiative can best contribute. In addition, the Trust Fund provides a model that can be emulated subsequently to support off-grid projects.

Renewable Energy Programs and Projects

Even if the rural electrification programs meet the MEM targets, there will still be a significant fraction of the population that cannot be served through extension of the electric grid. Table 2 above shows, at a departmental and national level, the projected rural electrification coverage in 2004. Over 260,000 potential users or connections will still not be served, approximately 200,000 of which will be in rural areas, representing a rural population of roughly one million. The unserved rural population is not expected to decline beyond this point, as rural population increases are expected to outweigh progress in grid extension between 2005 and 2010. It is projected that even by 2010 over 230,000 rural households in 2,700 communities cannot be served via grid extension, and can only be served by renewable energy and other decentralized energy technologies.[202]

The MEM is interested in supporting renewable energy options such as PV, microhydro, and others, to support electrification where grid extension is not practical. It has supported PV

[201] Compared to small-scale renewable technologies such as PV, provision of electric service via the grid does provide greater flexibility to consumers in selecting and adding loads, and can more economically support productive loads requiring tens or hundreds of kilowatts (e.g. irrigation water pumping, milling, refrigeration, etc.). Solar PV will be most appropriate for relatively high-value low-power-consumption applications such as lighting, communications, and potable water supply.

[202] World Development Consultants et al. (2001).

illumination systems for 1,200 homes, and is planning a Photovoltaic project that is expected to install 5,500 PV systems by 2004, primarily in the departments of Alta Verapaz, Huehuetenango, Peten, Jutiapa, Chiquimula, and San Marcos. MEM officials are conscious of the need for off-grid rural electrification to support broader economic and social development, and the need to support applications other than household lighting, for example electrification of schools, health clinics, rural telecom and other ICT systems, and potable water supply systems.

In the area of school electrification, the MEM has developed a proposed project with the Ministry of Education to electrify 15 existing Telesecundaria schools with PV systems, including three schools in each of five departments (Alta Verapaz, Jutiapa, Peten, Huehuetenango, and San Marcos). These schools already have audiovisual equipment to support video-based distance education, but rely upon gasoline or diesel powered generator sets and have experienced significant operational problems. This is discussed in more detail in the section on rural education, below.[203] The estimated cost for the 15 PV power systems for these existing schools and existing audiovisual equipment would be $40,000-$60,000.

Box 5-16: Proposed PV-Powered Telesecundarias

Department	Municipality	Community
Peten	Poptun	Esquipulas
Peten	Poptun	La Provedencia
Peten	Dolores	Parcelamiento El
Quetzalito		
Jutiapa	Moyuta	San Antonio Miramar
Jutiapa	Moyuta	El Zapote
Jutiapa	Conguaco	El Nance
Alta Verapaz	Coban	Copala La Esperanza
Alta Verapaz	Coban	Sesajb II
Alta Verapaz	San Pedro Carcha	Vista Hermosa Xaliha
Huehuetenango	Chiantla	Caserio Los Pozos
Huehuetenango	Cuilco	Hoja Blanca
Huehuetenango	Barillas	Aldea Jolomquej
San Marcos	Tajumulco	Aldea Nueva Florida
San Marcos	Tajumulco	Aldea Suchiate
San Marcos	Tajumulco	San Jose La Paz

The MEM has commissioned the development of a National Strategy for the Expansion of Rural Electrification, covering activities outside the reach of the Trust Fund contract and the obligatory service zones for the two privatized distribution companies, and defining a strategy for increasing service coverage to 95%. This strategy is expected to include decentralized energy services as an option, and is expected to be completed in early 2002.[204]

[203] As part of a team including Sandia National Laboraotories, Fundacion Solar, and New Mexico State University, Winrock has supported TA and a pilot project focused on use of renewable energy to support rural distance education. This team is providing TA to the MEM and MINEDUC in planning the 15 school PV project. The funding for the 15 school PV systems has not yet been identified.

[204] Winrock will contact MEM officials for an update on the status of this report.

In addition to the above-mentioned off-grid renewable energy projects, the MEM is planning several specific initiatives to support broader renewable energy development in Guatemala. This includes establishment of the proposed Renewable Energy Information and Promotion Center, a Renewable Energy Financing Fund, and a proposed Renewable Energy Project Development Incentive Law. The Renewable Energy Information and Promotion Center is intended to serve as a gatherer, repository, and source of renewable energy resource data, establish a portfolio of potential renewable energy generation projects, promote renewable energy projects, and facilitate preparation of feasibility studies by project developers. The Renewable Energy Financing Fund is intended to support private grid-connected projects, primarily through addressing the lack of commercial bank financing for terms of longer than 7 years. The Fund would finance up to 20% of project costs at 12 year terms with 7 years grace; the typical project would involve 30% investor equity, 50% commercial debt at 7 year term, with the Fund providing the balance of debt financing for years 7-12. The proposed Renewable Energy Incentive Law is also primarily intended to support grid-connected renewable energy projects, and is less relevant to the type of off-grid ICT projects the OAS is interested in supporting.

Two NGOs, the Fundaciaon Solar and NRECA, have developed a number of renewable energy projects or project portfolios that could serve as focal points for activities the MEM and/or the OAS may wish to support, allowing for incorporation of ICT-related project components. These are described below.

a. Department of Alta Verapaz, Municipio de Cahabón: PV Systems for Electrification of Households and Community Infrastructure Services. This proposed project developed by the Fundacion Solar is intended to provide service to 39 communities with 34,000 inhabitants, including 4,900 PV home systems, community infrastructure systems including electrification of schools, clinics, a radio telecommunications network, and community centers, as well as improved stoves. The 39 communities include 19 communities where Fundacion Solar worked over the past two years to electrify over 800 homes with PV systems.

b. Department of Quiché: Micro-Hydro for Micro-Enterprise Productive Projects. This project, also developed by the Fundacion Solar, is designed to support electrification of for productive uses, social infrastructure, and 6000 households (~40,000 people), based on 10 isolated microhydro systems.

c. Department of El Petén: PV Energy Services for the Productive Reactivation of Mayan Biosphere Buffer Zone Communities. This program, developed by NRECA, is aimed at electrifying 5,600 households and 75 productive centers in order to bring energy services to an unserved population of approximately 40,000 inhabitants.

Rural Ability and Willingness to Pay for Improved Energy Services

In general, the unelectrified rural population in Guatemala is very low income. Several small studies of household energy expenditures and willingness to pay for improved energy services show the bulk of rural households spend \$3-\$4 per month on lighting (e.g. candles) and other energy services (radio batteries) that could be supported by off-grid electrification systems (i.e.

not including cooking or heating fuel).[205] Data on willingness to pay show over 80% of the respondents indicated willingness to pay more than $3/month, dropping to 35% willing to pay more than $4/month, 20% willing to pay than $5/month, and less than 3% willing to pay more than $10/month. More than half of the unelectrified households indicated monthly incomes below $90/month. The Fundacion Solar's surveys in Quiche identified average lighting expenditures of $3/month, primarily for candles. In very poor communities in Alta Verapaz, where it has been supporting PV-based electrification, the Fundacion Solar determined average ability to pay for electricity of approximately $2.50/month. It is important to note that the above information refers to ability and willingness to pay for household energy services rather than ability and willingness to pay for ICT-related services. General guidelines or "rules of thumb" concerning rural household's willingness to spend for telephony services can be used in this case. For the poorest rural communities, it is safe to assume that ability to pay for ICT investments for distance education and analogous services will be fairly to extremely limited, and this can only be undertaken as a combination of donor and government resources.

As indicated above, the MEM estimates that by 2004 over 200,000 rural households will still be unserved, and that by 2010 the number of unserved rural households will total over 230,000 in approximately 2,700 communities with an average of 85 households and 470 people per community. [206] If one takes these numbers as the one indicator of the communities where the OAS Rural Energy and Connectivity Initiative is relevant, this implies a potential target of over 2,700 primary and secondary schools, 2,700 community centers with ICT capabilities, as well as other potential ICT system sites such as rural telecenters. In addition, there will be a significant number of communities that are electrified via grid extension where the wireless rural ICT technologies will still be least-cost, most feasible options.

5.3.2. Rural Telephony

Legal and Regulatory Aspects

The sector's basic Law is Decree 94-96, dated 17 October 1996, and modified by Decree 115-97. The Law establishes a market system notably open to telecommunications services, probably the most open at the Latin American level. The Law specifies that,

> *"Contractual conditions, as well as prices, for rendering all types of commercial telecommunications services, will be stipulated freely among the parties and will not be subject to regulation or approval by state authorities, except due to its relationship with regards to access to essential resources (...)."*[207]

There are no service obligations of any type, nor restrictions in a determined territory, or regulations on tariffs or rates of any type. There are no restrictions on foreign investment. The legislation only recognizes the existence of certain singularities in the market, corresponding to

[205] This includes surveys conducted by the Fundacion Solar in Quiche and Alta Verapaz, and nationwide surveys (402 interviews) conducted by Consultaria Interdisciplinaria de Desarrollo (CID) on behalf of the UNDP. Source: Fundacion Solar, Guatemala.
[206] World Development Consultants et al. (2001).
[207] Guatemala General Telecommunications Law, ("Ley General de Telecomunicaciones"), Art. 22.

spectrum use rights, phone numbers and the designated "essential resources" (interconnections). Regarding the first ones (spectrum and numbering), according to the Law, these are granted through public bids.

There are no licenses or concessions for rendering of telecommunications services in Guatemala, but rather the obligation alone of commercial operators to register with the Telecommunications Register. If the operators require the use of spectrum, they must obtain spectrum use titles from the bids put out by the Government, or from other title holders, who may freely sell these titles.[208] Regarding interconnections, in principle these are obligatory, but under the conditions agreed to freely by the parties, or if there is no agreement, they are implemented according to the conditions determined by an expert specifically summoned for this effect.

The Law created the Superintendence for Telecommunications (SIT), a technical body of the Ministry of Communications, Transportation and Public Works, as the regulating body of the sector, but it has very limited powers. Though it has some functional independence and resources, the Superintendent is nominated and removed by the Minister. SIT manages spectrum exploitation, elaborates the numbering plan, and settles any interconnection controversies in accordance with the corresponding expert reports. In addition, it manages the Telecommunications Register, the list where all sector operators of commercial networks must enroll.

SIT does not have the power to request information from the operators regarding the networks, services or activities in general, except in very specific cases which are determined by the law. For this reason, the general situation of the sector and that of the businesses is not transparent.

Guatemala adheres entirely to the General Agreement of Trade in Services (GATS) of the WTO, without true limitations in access to the markets, nor any limitations of national treatment of investments.

Industry Organization

In the market defined by the Telecommunications Law, all telecommunications services provided in Guatemala are done in a competitive manner. Since 1997 several new companies have been created, and the State sold a great deal of the old Guatemalan Telecommunications Company (GUATEL).

Land lines and mobile telephony services have developed strongly, especially after 1997, as the following table shows:

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[208] Spectrum use rights titles are granted for 15 years and are able to be sub-divided, fragmented and commercialized among private companies.

Table 5-17: Information on the Telecommunications Market in Guatemala

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Land lines in service (thousand)	190	202	214	231	245	286	338	430	517	611
Density (lines/100 inhabits.)	2.1	2.2	2.3	2.4	2.5	2.9	3.3	4.1	4.8	5.5
Waiting list (thousand)	201	100	100	100	100	...	...	...	...	...
Public phones (thousand)	2.5	2.4	2.7	3.2	3.6	3.1	...	...	...	...
Mobile cellular customers (thousand)	0.3	1.2	2.1	3.0	10.5	30.0	43.4	64.2	111.4	337.8
Mobile Density (cust. /100 inhabits.)	-	0.01	0.02	0.03	0.11	0.30	0.42	0.61	1.03	3.05
Installation charges, residential	334	298	290	266	261	258	...	...	258	223
Installation charges, commercial	334	298	290	266	261	258	...	...	258	223
Monthly rate, residential	0.9	0.8	0.8	0.7	0.7	0.7	...	...	-	-
Monthly rate, commercial	2.7	2.4	2.3	2.1	2.1	2.1	...	...	6.9	6.0
Rate for 3 minute local call	0.04	0.04	0.03	0.03	0.03	0.03	...	...	0.10	0.09
Connection fee, cellular phone	...	...	...	443	313	103	...	...	...	14
Monthly rate, cellular phone	...	...	...	28	28	27	...	...	...	20
Rate for 3 min. cellular call	...	...	...	1.0	1.0	1.0	...	...	...	0.6
Total sector revenue (US$ mill.)	151	145	166	173	172	217	243	251	263	246
Sector investment (US$ mill.)	11	32	42	...	...	...	...	...	...	...
Equipment import (US$ mill.)	...	...	...	60.4	33.9	45.8	53.4	71.8	98.9	203.6
TV Receivers (thousand)	475	490	510	530	545	600	620	640	660	...
Personal computers (thousand)	...	...	...	10	20	30	...	...	90	110
Internet Hosts	-	-	-	-	-	27	274	665	913	1772
Estimated Internet Users (thousand)	...	...	...	...	...	0.3	2	10	50	65

Notes: Rates are quoted in current US$, with taxes. Telecommunications revenue, investments and imports are quoted in millions, in current US$, without taxes.
Source: ITU (2001b).

In September 2000, there were 667,000 land lines (more than 65% higher than in 1997) and 660,000 mobile phone lines in service, reaching densities of some 5.35 lines per 100 inhabitants in each one of these services. However, only four operators provided rural telephony services in 2000. In all, the number of people and organizations that are registered as network operators is greater; this administrative procedure is simple and inexpensive, and it is a requirement for eventually being able to offer the service.[209]

The primary provider of basic services is still TELGUA, which also offers corporate services, PCS mobile service, public phones, Internet service and others. The second largest operator is Telefónica, which operates mobile service, long distance and Internet service. Other important providers are Comcel (property of Millicom), which is the largest and oldest cellular provider, and Bellsouth, which recently started cellular service. In long distance service, TELGUA and Telefónica are also the primary provders, though there are about a dozen other smaller operators (among them, AT&T, Americatel, Comcel WorldXchange and others).

The main difficulties in the organization of the industry have been obstacles encountered for the effective implementation of interconnections, and in particular those that must be made through TELGUA, the leading company. Even though several interconnection contracts have been

[209] For example, according to the information found on SIT's web page (www.sit.gob.gt/red-comercial-contenido.htm), the total number of registered operators for local telephony is 43, for inter-city telephony 29, international telephony 42 and 14 for public phones.

signed, almost all the companies report delays and blockages made by TELGUA when implementing the respective connections, or when taking them to the capacity required. By law, in cases of disagreement they must appeal for an external expert study, but realistically this has not been feasible. One of the reasons is because the legislation obliges the parties to share inspection costs (half and half), which becomes rather difficult for small companies that are trying to penetrate that market. Also, SIT alone does not have the power to intervene in these cases. Besides, Guatemala has not developed a legal or institutional system that defends competition, which allows the leading service provider to always hold a strong position.

Competition among the larger operators (TELGUA and Telefónica, and Comcel for mobile service) has driven prices down, quite significantly for some services, particularly in international communications (calling rates for US have gone down from US $1.30 per minute in 1997, to about US $0.25 today). Strong competition is also quite evident in mobile telephone service.

In local service, competition is due more to the quality of service than to prices. In some cases, new local service providers have been created in order to satisfy small, localized demands (for example, one of them is a housing construction company's affiliate).

Support for Rural Services

The 1996 Telecommunications Law created the Telephony Development Fund (FONDETEL), "to promote service development in rural and/ or low income urban areas."[210] This fund is managed by a special Administrative Unit created in the Ministry of Communications, Transportation and Public Works (that is to say, it is not managed by SIT). It has access to 70% of the revenue from the spectrum use rights auctioned during the first eight years in which the law is valid (with a maximum imposed of Guat. Q30 million per year (US $3.88 million at the current exchange rate),[211] as well as from financial returns from the Fund and subsequent transfers and allocations that may be made by the Government or other entities.[212]

The Law states that any individual or organization can present specific telephony projects for subsidy by the Fund; however, the subsidies can only be used for telephony projects. For evaluating the possibility of a subsidy, the Ministry carries out social and economic evaluations of the projects, which according to the law must be ranked taking into account the difference in the social and private return rates for each one.

Subsidies are awarded by means of auctions, which must be called 40 days after receipt of the applications. The announcement must include technical characteristics of the respective project, minimum service area, capacity and quality of service, and timeframe to start civil works and for service start-up. The maximum subsidy amount, calculated by the Ministry, is only published after all the offers are received, and before opening the respective sealed bids.

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[210] Guatemala General Telecommunications Law, Art. 71 and subsequent articles.

[211] In the present, the exchange rate is approximately US $1 = Q. 7,95.

[212] From 1997 to 2000, spectrum bids have produced some Q. 890 million, but due to limitations indicated, FONDETEL only gets Q. 117 million (around US$ 14.7 million). From 2000, spectrum bid collections have declined significantly.

The Law does not take into account any other special conditions (rates, for interconnections or other types) for rural telecommunications services. In a fashion similar to that of the new operators, one of the main difficulties encountered by service providers in rural areas has been making sure that there is an interconnection with TELGUA.

In theory, projects that undergo subsidy bids can be presented by private institutions interested in their development, or can result from internal studies carried out by the Ministry. In practice, only the latter has taken place, that is to say, all projects offered as eligible for subsidy have been cases detected and prepared by the Ministry itself.

Between 1999 and 2000 three bids for FONDETEL subsidies have been carried out, which have benefited 14 projects in different areas of the country. A total of 3,063 telephones are already operating (subsidies are granted only when the project has been constructed and is fully functional). These phones are installed under the banner of "community telephones," where the service provider comes to an agreement with a responsible local party at each site to equip the site, allocate profits from calling charges, and carry out other additional services (messages, etc.).

In each one of the cases VSAT technology has been used, given the difficult geographic conditions and access to the sites. However, operation of this technology has proven difficult (aside from the charges incurred for use of a space segment), thus in the future digital multi-access will be considered as an attractive option.

Other projects, corresponding to some 4000 additional lines are being implemented. However, given regulations, corresponding subsidies have not yet been awarded and will not be until the telephones are operating. In these latter projects new regulations have been added for the award of the subsidies; among them restrictions on the rates charged, which must be comparable to those of other sites with similar conditions.

Subsidies already granted correspond to the following cases:

Table 5-18: Rural Projects with FONDETEL Subsidies

Case	Date	Operator	Number of Projects	Total telephone lines	Subsidy assigned
1	December 1999	Prearc	9	1.974	Q. 24 million
2	December 1999	Sersat	3	884	Q. 10 million
3	December 2000	Hidroc	2	205	Q. 2.5 million

Source: Personal communication with technical management at FONDETEL.

Originally, GUATEL and TELGUA competed in some of the projects of the first bid, but in the end other companies were the ones that received the award. Apparently, GUATEL is keeping a very low level of activity, and TELGUA is directing its efforts to market segments that are more profitable.

However, FONDETEL'S regulations do not demand that installations be used solely for the demands of the respective project. For that reason, service providers are able to "piggy-back" on its networks or those of other companies to render the required services (and in that manner they would require fewer subsidies and would increase their possibilities of winning the respective bid), but they can also rely on the installations of FONDETEL'S rural project, to carry out marginal investments and serve other private or public service demands. In this manner, rural service providers are able to look for ways in which to improve profitability of the integral package of projects, looking for adequate compatibility among social and private projects. FONDETEL has no information on these aspects, but estimates that subsidies, on average, cover around 30% of the total investment made by the service providers.

5.3.3. Current and Proposed Rural ICT Initiatives

At present, Guatemala does not have a single focused rural ICT or telecenter initiative such as the COHCIT Aldeas Solares project in Honduras. Nevertheless, there are a number of factors that appear to create a favorable environment for rural telecenter and other rural ICT deployment. These include: a telecom sector that has already been restructured and partially privatized, and which fosters a high degree of competition between different service providers; a well defined and ambitious rural electrification program; strong interest in the use of distance education technologies in rural areas, including a 400 school Telesecundaria pilot program; and a number of different pilot programs supporting telecenters aimed at rural enterprise development and support or educational strengthening through teacher training.

ICTs for Rural Education

Guatemala is one of the Central American countries that has been supporting increased use of rural distance education technologies, including video-based education. The Telesecundaria program is an example of the Government's supports the application of ICTs for the expansion and improvement of secondary education in rural areas. At the same time, there are other programs, such as the FUNRURAL's Escuela Rural Activa project under the PRONADE program, the though not explicitly distance education oriented, that are interested in exploring ways to incorporate ICTs to improve their rural education programs.

The Telesecundaria Program

Over the past several years, the Government has supported a video-based Telesecundaria pilot program, based on the well-established Mexican Telesecundaria program, in approximately 400 schools. The Telesecundaria program is a formal service of the national education system to promote the continuation of education for students who have finished their primary education. It is the only means of addressing the demand for secondary education that exists in many rural areas where formal secondary schools do not exist. The primary objectives of the Guatemalan Telesecundaria program are to:

- Meet the demand for secondary education in rural areas, where, for geographical and economic reasons, establishing a school for secondary education is prohibitively difficult; and to help meet the demand in urban areas;
- Meet the demand for secondary education in rural areas through the use of electronic tools and methods of communication;

- Link rural secondary schools to the community through community development activities; and
- Offer teachers support in implementing innovative teaching methodologies.

In the Telesecundaria program, one teacher is responsible for teaching every subject area within a particular grade level, similar to the primary school teaching model. The curriculum is based on “interactive” television programs and supporting printed materials. Printed materials consist mainly of “Basic Concepts” books that present the essential program content for each subject area and complementary “Learning Guides” for the students. There are seven daily sessions by grade; each one lasts a total of 50 minutes (15 minutes for the television program, and 35 minutes for written materials). The books present the content in a synthesized manner and suggest activities and provide the necessary tools for self-evaluation. Teacher resources also include a Schedule Guide aimed at efficiently managing his/her double duty as educator and community promoter.

A prospective Telesecundaria school is subject to the following eligibility criteria:

- It must be located no less than 5 km from an official education institute, and must be privately established, by a cooperative or some other manner.
- It must have an electrical energy source.
- It must have a minimum of 30 students between the ages of 12 and 17.
- The area must have a complete primary school.
- It must demonstrate a true interest in providing educational services.
- It must be able to operate afternoon/evening classes from 1:00 to 7:00 PM.

The authorization of a telesecundaria center must follow the following procedures:

- The prospective community must be assessed, highlighting the educational aspect.
- A student census must be conducted to establish the target population.
- Students must pre-register.
- A community support committee for the Telesecundaria center must be established.
- The prospective school must obtain authorization to use the local primary school facilities.
- The classroom(s) to be used must be secure (e.g., must have metal doors and iron bars on the windows).
- The prospective classroom must have electricity.
- The prospective center must have the approval of the local primary school principal and the relevant education department director.
- The prospective school must be able to show the Curriculum Vitae of its proposed teacher, who must be qualified, at a minimum, as a Professor of Intermediate Education.
- The prospective center must present the above materials to the Central SIMAC Unit.

To date, 382 Telesecundaria centers have been established and fitted with a TV and VCR. The Education Ministry is also exploring possible applications of ICT including computers in schools including telesecundaria schools, and for teacher training and professional development of existing teachers. Ministry staff have expressed interest in integrating use of computers into some existing Telesecundaria schools as an initial step in this process. They also noted that 16 of the Telesecundarias are in unelectrified communities and are using diesel or gasoline-fired generators, which is impacting the reliability of school operation. The staff are interested in retrofitting these schools with solar Photovoltaic (PV) systems, and are discussing this with the Ministry of Energy. This is discussed in more detail above in the section on Rural Electrification. This is a possible opportunity for an OAS-supported pilot activity, which could either focus solely on solar electrification of the Telesecundarias, or also support integration of computers into these Telesecundarias. The Ministry staff noted that the IDB is supporting an Education project (Educational Reform II), which could possibly support additional Telsecundaria development and integration of computers into rural schools. IDB representatives later clarified that the loan had a component for Educational Innovations, which could include the type of activities mentioned by the Education Ministry staff.

As discussed below, Guatemala is one of many countries in the hemisphere moving torwards more decentralized management of basic education, including greater reliance on communities and NGOs in education decision-making. One of the NGOs that has been active in basic education in Guatemala is Fundación Rural (FUNRURAL), which is affiliated with the National Coffee Association (ANACAFE). In 2001, FUNRURAL implemented a solar-powered Telesecundaria school, with support from Sandia National Laboratories, Winrock International, and the Fundacion Solar. FUNRURAL and the Fundacion Solar are currently developing a proposal to establish 10 additional Telesecundarias, the majority of which would be in unelectrified areas and use renewable energy power systems.

The PRONADE Program

The Programa Nacional de Autogestión para el Desarrollo Educativo (PRONADE – the National Self-Management Program for Educational Development) is a Ministry of Education program created to bring education to the most remote communities in Guatemala. The program promotes "Community Self-Management" and the decentralization of education by making the community itself responsible for the management of education funds in its community.

PRONADE coordinates with, monitors and evaluates the actions of Education Committees, or COEDUCAs, Education Services Institutions (ISE), and the teachers of the Community Self-Management Schools. COEDUCAs, composed of parents, are organized and legalized to support the education of their communities. They work by signing a financial management agreement with PRONADE. This authorizes them to hire teachers and to watch over the proper operation of the schools. The Ministry of Education hires foundations, non-government organizations and private companies (for profit and non-profit), which accompany the COEDUCAs, providing them with technical support so that they can accomplish the operations for which they are responsible. Community Self-Management School teachers are hired by the COEDUCAs, and receive training and technical support from the ISEs, based on the technical and administrative characteristics of the Ministry of Education. The teachers must live in the communities, or near them, have knowledge of the language, culture and customs of the area.

This initiative officially started in May 1993 with the inauguration of 19 schools in Chimaltenango, a program called Sak'bé (National Fund for Co-participatory Rural Education). PRONADE, as it is currently structured, began in 1996 with the Government Agreement 457-96, which highlighted parents' participation as the cornerstone of the program. In January 1999, 20,454 parents participated in COEDUCAs. To date, 3,769 teachers have been hired and trained, and 178,879 students in 2,922 communities have received quality education.

The Escuelas Rurales Activas (ERA) Program

The National Coffee Association's (ANACAFE's) Rural Development Foundation (FUNRURAL) have received funding under PRONADE to operate the Escuelas Rurales Activas (ERAs – Active Rural Schools) program, a pilot program to support secondary education in coffee producing areas for the children of coffee plantation workers. ERA employs an innovative flexible, self-paced study program for students, supported by some teacher guidance, and operates out of existing multi-level rural primary schools, cooperatives, municipals and farm schools. This pilot program will last six years, from 1998-2003. To date, some 16,911 children from 206 schools in 30 municipalities from eight different departments have benefited from the ERA program.

Table 5-19: Active Rural School Program Coverage

Department	Municipality	Schools	Teachers	Students
Chimaltenango	1	1	5	88
Chiquimula	1	15	26	1,669
Huehuetenango	3	16	40	1,210
Quetzaltenango	2	3	10	236
Retalhuleu	7	36	88	2,830
San Marcos	10	99	223	8,586
Suchitepéquez	5	21	45	1,758
Zacapa	1	15	26	534
Total	30	206	463	16,911

Winrock International is part of a team led by Sandia National Laboratories (also including the Fundación Solar of Guatemala and New Mexico State University) that recently installed one PV-powered ERA, under a USAID-supported activity, in conjunction with FUNRUAL. FUNRURAL staff working on the ERA program have expressed a strong interest in incorporating use of computers with CD-ROMs, and Internet where possible, to support secondary-level students in self-study programs. Winrock, Sandia, and the Fundación Solar will follow up with FUNRURAL to refine the possible pilot project, for consideration by the OAS.

Telecenters, Telemedicine/Telehealth, and ICT Support for Rural Economic Development

<u>Centro de Mujeres Comunicadoras Mayas "Nutzij"</u>

The Centro de Mujeres Comunicadoras Mayas "Nutzij" (www.rds.org.ge/cmcm) provides training in literacy, audiovisual equipment, computers and Internet. It specializes in training in multi-media communication for development.

Learn Link
Funded by USAID. Implemented by Academy for Educational Development (AED). Implementing an ITC project in Quiché to better prepare teachers to teach in local languages. They are setting up 6 telecentros within the department of Quiché.

Peoplink
Peoplink (www.peoplink.org) is a non-profit organization helping producers in remote communities all over the world market their products on the Internet. Peoplink has built a global network of Trading Partners (TPs) that, in turn, provide services to several community-based artisan producer groups. Each TP is a development organization that supports producers in its local region or country. They are usually nonprofit organizations that provide marketing and design services to numerous producer groups. PEOPLink equips the TPs with digital cameras and trains them to capture images and edit them in a compressed format suitable for transmission via the Internet. They then place images of the crafts on the PEOPLink Web page and promote them to retail and wholesale buyers in the industrialized countries. This same Web page contains educational materials, sent in electronically by the TPs, about the work and lives of the artisans. The TPs also help the artisans build and maintain their own Web catalogs and provide on-line training and product development support.

5.3.4. Rural ICT Opportunities Identified

Both USAID and the World Bank are supporting pilot telecenter initiatives aimed at supporting rural enterprise development and assisting producers to market products to foreign and domestic buyers. USAID has supported the development of four telecenters in the Department of Quiche, in conjunction with an association of exporters (Asociación de Gremial de Exportadores de Guatemala or AGEXPRONT). This is being supported under a component of the USAID Peace Program known as Inversiones Para la Paz (IPP) / Centros de Negocios Electrónicos. As the next phase of this activity, USAID is implementing two additional telecenters in the Alta Verapaz Department through an NGO (Talita Kumi). These telecenters—each of which has five PCs and satellite-based internet access--are installed in electrified communities, although in some cases the electric service is very unreliable. (Supporting ICTs in rural areas with intermittent power is an area the the OAS may wish to consider supporting, since it involves some of the same competencies as supporting ICTs in unelectrified areas.) Also, while the market towns where these telecenters are located are electrified, many of the surrounding communities are not. One possible project opportunity for the OAS involves possible establishment of off-grid mini-telecenters and micro-telecenters in the surrounding communities, using low-cost wireless technologies to connect to the larger telecenters in order to utilize their satellite connection to the internet (i.e. the larger telecenters would basically serve as internet service providers or ISPs). Winrock will task the Fundacion Solar to investigate possible community needs for ICT services in the smaller communities near the two towns in the Alta Verapaz Department where the USAID-supported telecenters are being installed. Fundacion Solar is already very active in solar-based rural electrification projects in Alta Verapaz; this experience in the Department and established presence there will facilitate the conduct of this needs assessment.

The World Bank will also be developing telecenters focused on rural enterprise development, through a small pilot project called Micronets. This project, which is also being done in conjunction with AGEXPRONT, will focus heavily on supporting innovative business development services and simple computer-based tools and content for rural enterprises.

Providing rural producers with current information on prices and buyers/sellers for agricultural products and inputs is one of the high-value rural ICT services that can contribute to rural economic development. In Guatemala, the Ministry of Agriculture (MAGA) has developed a comprehensive Market Information System containing Guatemala City prices on approximately 100 agricultural products and 100 agricultural inputs (e.g. seeds, fertilizers, pesticides), with the prices updated several times a week. Pricing information on a smaller number of agricultural products and inputs is also available for a number of smaller towns in Guatemala. MAGA staff recognized that rural telecenters of some type would be required for rural producers to be able to better access this pricing information. If the OAS Initiative supports rural telecenter projects in Guatemala, it should work to ensure reliable access to the Market Information System by rural agricultural producers.

5.4. HONDURAS

Honduras General Country Data (1999, except where indicated):

- Surface area: 112.1 thousand km^2
- Population: 6.3 million
- Population Growth (annual %): 2.7%
- Rural population: 48.3%
- Illiteracy rate: 26%
- Poverty (1997 survey data):
- Poor households: urban, 67%; rural, 80%
- Destitute households: urban, 35%; rural, 59%
- GDP: US $5.400 million (market prices, in current US Dollars)
- GDP Annual Growth Rate: -1.9%
- GDP Average Annual Growth Rate between 1989-1999: 3.2%
- Per capita income: US $770 (current Dollars); US $2,340 (PPA Dollars)
- Per capita income annual growth rate: 4.1%
- Human Development Index (UNDP): 0.634
- Per capita income average annual growth rate between 1989-1999: 0.8%

Sources: World Bank (2001e); CEPAL (2000); UNDP (2001).

5.4.1. Rural Electrification

Legal and regulatory structure

The National Electric Energy Company, ENEE, was created by decree in 1957 as an autonomous public service organization with the responsibility for the generation, transmission and distribution of electricity in Honduras. Today, ENEE is the principal electricity generator and the sole responsible party transmission and distribution of electricity through the National Interconnected System (SIN).

The energy sector in Honduras is governed by the "Framework Law for the Electric Sub-Sector" and a group of Decrees derived from this Bill No 158-94 issued on November 1994. In November 1998 Bill No 267-98 "Law of Incentives for the Power Generation with National Renewable Energy Resources" was issued. These bills regulate the generation, transmission and distribution activities in the country, and include incentives to private investment on RE projects. A new law to reform the current one, presented to congress at the end of 1999, proposed the establishment of a competitive spot market and the promotion of private investment in generation and distribution; however due to severe opposition from the organized popular sectors is on hold with no perspectives to be voted before the new government takes place. To complement the 1994 Law, the following institutions were created:

- The *Energy Cabinet*, responsible for energy policy, is presided over by the President of the Republic and includes the Secretary of Natural Resources and Environment, Secretary of Industry and Commerce, the Secretary of Finance and the Secretary of Public Works, Transport and Housing.

- The *Ministry of Natural Resources and Environment (SERNA)* is responsible for the implementation of energy policies and regulations through the General Directorate of Energy (DGE).
- The *National Energy Commission (CNE),* a technical decentralized entity within SERNA, has regulatory responsibility for the electricity sector, including tariff setting.

According to the Framework Law for the Electric Sub-Sector, any company engaging in generation or distribution activities in the country must sign a Contract of Operation with SERNA, except for self-producers, and a PPA with the National Power Company (ENEE), if supplying the power to it. In addition, general requirements include an environmental license approved by SERNA, and construction permission from the municipality in which the project will be constructed. For hydropower projects a water contract approved by SERNA is required. This water contract serves as an authorization to exploit water resources for electricity generation since a concession process does not exist. For biomass projects utilizing wood/forest products or biofuels derivitives, the general forestry management law applies (LF – Decree No. 85, 18 November 1971), although there are no specific regulations guiding the use of biomass for energy generation.

Electric System

The total installed capacity of the SIN is 913.4MW (2001), of which 47.5% is hydropower generation and 52.5% is thermal. ENEE's generation (hydro and thermal) is 55% and private thermal generation is 45%. Activities in the sub-sector during the last 20 years have been limited to expanding and upgrading the distribution systems, extending the grid to rural areas, and upgrading substations; thus an expansion of the installed capacity of the country has been carried out and will be carried out by private investment.

ENEE plans to invest around $118.3 million dollars in a transmission expansion plan over the next five years, including new transmission lines and transmission substations. Within this plan are two specific projects: "Line Pavana" for the transmission of 230 kV between Honduras and El Salvador and the Electric Interconnection System of Central American Countries (SIEPAC) project. These will facilitate the creation of the Electric Regional Market, for which the countries have already signed agreements to build this market in a short-term basis.

In terms of generation, AES Honduras plans to invest $650 million over the next 4 years in a 780 MW natural gas generation project, which will be the largest private investment in a single project in Honduras and Central America history as well as the first regional project. The project includes the construction of a combined cycle 780 MW generation plant, a terminal to import the LNG and a 373 km transmission line to interconnect Honduras, El Salvador and Guatemala. The IFC and IDB will finance $450 million on the total project investment, and the remaining $200 million will be AES's equity contribution. In the first years of operation, 30-35% of the energy produced by this project will be sold to Honduras, and the rest to the other countries in Central America. However, as the domestic demand increases, a higher percentage of the energy produced will be sold in Honduras. Some of the benefits expected from this project to the local economy are a reduction on the energy price to around $0.05/Kwh, an annual increase of $224 million in exports and $20 million in taxes. This project is expected to start operations by the year 2004. Currently the study to obtain the environmental license from SERNA is being undertaken.

Renewable Energy

Honduras' energy generation is 47.5% hydropower (434MW), and the estimated untapped hydro potential is between 3,600 and 5,000MW. Undeveloped geothermal resources are estimated at 120MW, wind and solar at over 60MW. In addition, generating potential estimated at 140MW exists from the palm oil and the sugar and wood processing industries.

Today there are twenty-one companies developing renewable energy projects in Honduras, principally hydropower. There are four companies that focus on the distribution and installation of solar electric (photovoltaic) energy and one company developing a 60MW wind energy project. With the exception of CENIT, however, which operates the small hydro project in Zacapa, all of the other projects are in study or construction phase.

Table 5-20: Renewable Energy Companies in Honduras

Renewable Energy Company	Technology
CENIT S. de R.L.	Hydropower
Compañía de Generación Eléctrica COMGELSA	Hydropower
Consorcio de Inversiones CISA	Hydropower
Electrotecnia S.A.	Hydropower
ENERGISA	Hydropower
Energía y Transmisión, ENETRAN	Hydropower
Hidroeléctrica Río Blanco	Hydropower
Hidroeléctrica Yojoa HIDROYOJOA	Hydropower
Hidro Ingeniería	Hydropower
Honduras Electric Corporation HECO	Hydropower
Industrias Eco-Sostenibles INDECO	Hydropower
Sistemas Solares de Honduras SOLARIS	Solar PV
Sociedad Hidroeléctrica La Nieve	Hydropower
Soluz Honduras	Solar PV
Soluciones Energéticas	Solar PV
CADELGA	Solar PV
Hidroeléctrica El Cisne	Hydropower
Hidrocentrales Eléctricas de Honduras HIDROCEL	Hydropower
Compañía Azucarera Tres Valles	Cogeneration
Empacadora el Atlántico	Biomass
ZOND de Honduras	Wind

Source: AHPPER (2002).

A total of twenty renewable energy projects are negotiating the signature of PPAs with the National Power Company (ENEE). The 20 projects represent the total of 152.3 MW of installed capacity, and include hydro, biomass-cogeneration and wind projects. Some of these projects already signed as well the Contract of Operation with SERNA. These will be the first renewable energy projects from private investment to sign PPAs with ENEE.

Table 5-21: Renewable Energy Projects Currently under Negotiation in Honduras

Project name	Installed Capacity (MW)
Hydropower	
La Boquita	0.17
La Nieve	0.48
El Cisne	0.71
San Carlos	2.26
Cortecito	3.20
Cececapa I	2.67
Río Blanco	3.70
Coronado	4.00
La Gloria	4.70
Cuyamel	7.80
Cuyamapa	10.50
La Esperanza I	1.40
La Esperanza II	12.00
Suyapa	8.00
Tres Valles	15.00
Total hydropower	76.60
Wind	
Eoeléctrico Honduras 2000	60.00
Total wind	60.00
Biomass cogeneration	
Planta Aguan	0.50
Planta Lean	0.50
Azucarero Tres Valles	6.70
Azucarero La Grecia	8.00
Total biomass cogen	15.70
TOTAL	152.30

Source: AHPPER (2002).

Renewable Energy NGOs

Honduran Association of Small-scale Renewable Energy Producers (AHPPER) – a non-profit organization established to represent and advocate the interests of the renewable energy industry in Honduras. The membership of the association is open to manufacturers, developers, consultants, operators, and the financial community involved in renewables projects. The goals of AHPPER are to:

- Promote the development of renewable energy projects in the country;
- Encourage/construct a policy and regulatory environment conducive to private sector investment in renewable energy projects in Honduras;
- Conduct communication and outreach activities including promotional campaigns to broaden and to open awareness of the dynamics and benefits of privately managed renewable energy projects;
- Represent the interests of the renewable energy industry and the association members in the local, regional and overseas arena;

- Identify partners for members interested in investment or technical assistance from foreign sources; and
- Identify and approach multilateral funds, developments banks and other financial institutions with funds available for the development of renewable energy projects.

Adesol Honduras – a non-profit organization created in 1997 to contribute to improving the quality of life of rural Hondurans by implementing renewable energy projects for development. ADESOL is an affiliate of an international non-profit organization, ENERSOL Assoc, and collaborates with national and international NGO entities to provide support and renewable energy technical assistance and training. ADESOL works with families who live in the most isolated areas of the country and who are in need of lighting, potable water and communication. To date, ADESOL has installed over 3,000 solar PV system in Honduras and several micro-hydro, biomass generation and hybrid solar-wind projects are under study. The principal objectives of ADESOL are to:

- Create programs that support education and health as the primary focus of poverty reduction;
- Provide training processes and technical assistance to technicians and microenterprises;
- Promote and develop programs in non-electrified zones to facilitate the purchase of renewable energy systems, including developing credit lines for rural people to purchase solar home systems; and
- Promote the use of renewable energy for pumping potable water supply, for irrigation and for other community projects.

Rural Electrification

Since 1989, rural electrification has barely kept ahead of population growth. Population has increased on average 3.2% a year, and electric coverage has increased on annual average 4.64% from 33.37% electric coverage in 1989 to 54.89% in 2000. ENEE's electrification expansion plans project universal electrification by 2015 (utilizing an annual population growth rate of under 1%, which doesn't reflect the trend of the last decade), which will require an estimated US $704.5 million of investment.

Over 7,000 communities are still not served by the grid, and there is an increasing realization that traditional grid technologies are too expensive to serve these remote areas. An ENEE estimate of rural demand for electricity is 190MW, which if installed would electrify over 630,000 rural homes, the equivalent of 3.24 million people.

Table 5-22: Electrification Rate by Department (2000)

Department	Population	Electrification Index
Francisco Morazán	1,109,160	79.36%
Cortes	905,705	89.04%
Atlantida	338,072	67.12%
Yoro	471,338	45.50%
Comayagua	356,488	51.73%
Colon	223,012	49.85%
Islas de la Bahia	31,311	65.85%
Ocotepeque	103,836	37.96%
Valle	163,783	40.13%
Copan	304,570	37.63%
Santa Barbara	381,808	35.76%
El Paraiso	354,789	34.21%
Choluteca	403,791	31.29%
La Paz	152,020	28.10%
Olancho	421,341	31.49%
Intibuca	175,317	19.93%
Lempira	249,595	10.29%
Gracias a Dios	52,807	54.89%
TOTAL	6,198,833	54.89%

Source: ENEE (2002).

Twelve of the eighteen departments have electrification rates under 50%: Lempira, Intibuca, La Paz, Choluteca, Olancho, El Paraiso, Santa Barbara, Copan, Ocotepeque, Valle, Yoro and Colon. These departments represent over half the total population of the country. Twenty-one municipalities are completely unelectrified, nine of which are in Lempira.

Current sources of energy in rural areas include kerosene, dry cell batteries, candles and fuelwood for cooking. Average monthly expenditures per rural household are estimated to be L161 or US$10 (ENEE reports from a survey in four communities in Lempira). Priority energy needs in rural areas include cooking, lighting, entertainment, communications, agricultural energy inputs, health care (for vaccine refrigeration etc) and lighting for schools and health clinics.

National Rural Electrification Programs

ENEE's Social Electrification Program

In November 1994 ENEE began a new stage in its process to increase electric coverage in rural communities and those zones more isolated from the principal cities. The creation of the Social Fund for Electric Development (FOSODE), created a large demand in unelectrified communities in all eighteen departments, motivating ENEE to undertake the technical studies necessary to understand the requirements for electrification, the resources available and needed to implement the projects.

This was the beginning of the first phase of ENEE's National Social Electrification Program, a program which represents a total investment to date of US$65.92 million and will electrify 1,442 communities by 2002. The first phase (two projects) has been concluded and others and in various stages of planning and execution, depending on the availability of financing and funding sources such as loans from CABEI and the governments of Japan, Norway, Korea and Mexico. In addition, ENEE has reached an agreement with the National Coffee Fund (FCN) for the electrification of the coffee-producing zones.

In response to community solicitations, ENEE has executed projects through mixed external and internal financing to supply the necessary hardware. The communities supply labor and locally available materials, thus stretching scarce funds farther and allowing for a direct and active participation by the project beneficiaries.

UNDP/GEF/CABEI

The Central American Bank for Economic Integration (BCIE) announced to the RE community in its latest event on September 14th, 2001 a new program called "Accelerating the Investment on RE in Central America", with the GEF and UNPD as partners. The objective of this program is to expedite the financing of renewable energy projects, reducing the emissions of CO_2 and contribute to the rural economic development of Central America. Honduras, Guatemala, El Salvador, Nicaragua, Costa Rica, Belize and Panamá will be the beneficiaries of this project, which will focus in removing the financial barriers that hinder the development of RE projects in the region. Among the results of this program are an adequate environment within the BCEI to finance RE projects, with a well-identified portfolio of projects, risk mitigation activities designed and policies, procedures and parameters specifically for RE projects developed.

This program finished the first phase, the Introductory Assistance Phase (PDF-B), in December 2001. Some of the activities during this phase were reviewing and analyzing the actual policies of the bank toward RE projects, designing the adequate structure within the bank for the development of this program, and regional workshops on RE. The implementation phase of the program is scheduled to begin in early 2002. The $489k project is being funded by UNDP/GEF $310k, UNDP $25k, other sources $65k and $89k of in-kind share from the Government of Honduras.

COHCIT / IADB

The Honduras Science and Technology Council (COHCIT) has developed a $9.5 million project that will be financed ($8.5 million) by the IADB. The goal of the project, Expansion of Technological Capabilities in Poor Communities, is to help reduce the causes of poverty related to the disadvantages of isolation and unequal opportunity. COHCIT will test a model for providing education and information services to rural communities using modern technologies. The three components of the project are:

1. Financing of technologies that facilitate educational and market-knowledge service (this component includes financing for renewable energy systems to power the technology packages);
2. Institutional strengthening of COHIT; and
3. Monitoring, evaluation and external auditing.

5.4.2. Rural Telephony[213]

The state of the telecommunications sector in Honduras is likely to be a constraint to the development of the COHCIT-IDB project and other rural ICT projects. The Government-owned HONDUTEL enjoys a monopoly in long distance and local telephone service, apart from cellular telephone service that is provided by CELTEL. A recent effort to privatize HONDUTEL failed when two of the three bidders withdrew from the bidding process. The lack of competition, and the desire for income or profits from HONDUTEL, result in fairly expensive services and relatively low investment in new infrastructure and services. This is a common situation with monopoly telecommunications entities that are expected to be privatized in the near to mid future. Two recent telecenter projects implemented by the International Telecommunications Union (ITU) and HONDUTEL in Valle de Angeles and Santa Lucia demonstrate that it is possible to develop innovative projects within the context of HONDUTEL services, but in some cases it is necessary to adapt and accept certain limitations (e.g. restrictions on voice over IP telephony, possibly forgoing use of VSAT systems). Experience in most rural telecenters worldwide is that voice-traffic (i.e. telephone calls) represents about 80% of revenues; therefore, if they are to be sustainable, it will be essential that telecenters in Honduras somehow provide basic telephony service and overcome voice over IP constraints.

Legal and Regulatory Aspects

In Honduras, the sector's basic law is the Framework Law of the Telecommunications Sector.[214] All in all, subsequent modifications have been made to the Law, especially with respect to privatization conditions for the Honduran Telecommunications Company.[215]

The Framework Law establishes three important aspects of sectoral reform:

- A regulatory framework for telecommunications services operation, including service classification, radio-electric spectrum administration principles, and principles for concessions, rates and interconnection systems;
- A new regulating body, the National Telecommunications Commission (CONATEL), to which authority and obligations are assigned;
- A privatization or capitalization procedure for the existing monopolistic state-company (HONDUTEL). By modifying its Organic Law, it gives authority to this company to form partnerships or to agree on the creation of subsidiaries with private investors, with the objective of operating telecommunications services.

Of these three aspects, the first two have been met rather well. However, the third one ended in a failure (temporarily at least) in October of 2000. The only offer received for HONDUTEL'S privatization bid was only about a third of the minimum value that was determined by the Government. As a consequence, the company is still sole property of the Government.

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[213] This section contains material from a report that was recently prepared for the IDB on a similar topic, and which will be used here with approval from the institution specified.
[214] Honduras Decree No. 185-95, 5 December 1995.
[215] Honduras Decrees No. 118-97, 244-98 and 89-99.

The Law promotes open development with private investment participation, in a framework of efficiency and competition, and with a tendency to globalize services (even though HONDUTEL is still the exclusive provider of telephone service, carriers and public phones until 2005). The Law also establishes institutional principles of the sector, separating regulation from operation. Sectoral policy is still entrusted to the President of the Republic, with the collaboration of The National Telecommunications Commission (CONATEL).

The Framework Law established conditions for concessions, which must be issued by the sector regulator (however, another legal rule apparently requires all concessions that last more than one presidential term or period to be approved by Congress).

Regarding the regulatory institution, CONATEL, created by the Law, is an entity decentralized from the Finance Secretariat. Its Commissioners are appointed for 4 years by the President of the Republic, and their positions are essentially incompatible with any other position. However, they can be removed from their positions by the President. In other words, even though it has some autonomy in terms of resources and internal administration, the entity is not completely independent from the Government.

CONATEL was formally established on 16 January 1996. From the time of its creation until now, the institution has worked to put together a set of technical regulations (fundamental technical plans and service rules), and definitions for interconnection conditions between the existing land line service providers and the existing cellular telephony operator. Along the way, there have been some difficult relationships with certain institutions: for example, it did not have a very active role in defining the strategy and privatization mechanism for HONDUTEL (even though it legally was a "collaborator" in sectoral politics, and though it was in charge of issuing the company's concessions).

With regards to HONDUTEL'S privatization, the Law allowed private invertors to participate in the company given the following terms:

> *"HONDUTEL will operate directly or through the company or companies with which it collaborates, has management contracts, or agrees with on the establishment of one or more subsidiaries to render national and international telecommunications services that it operates when the Framework Telecommunications Sector Law comes into effect.*
>
> *The company or companies referred to in the previous paragraph must be internationally known in the telecommunications arena and must make capital investments to modernize and increase telecommunications services; also, they will have administrative and operational control of the entity or entities that are created.*
>
> *For all intents and purposes, HONDUTEL will follow the public bidding procedures set forth and in agreement with the State Contracting Law."*[216]

[216] Honduras Framework Law, Article 53.

However, as it is detailed below, these legal rules have not been successful, despite detailed long preparation procedures. By October 2000 the privatization process was deemed unsuccessful.

The Law indicates that CONATEL will regulate charges when it has determined that services are not rendered in adequate competitive conditions, for which CONATEL itself will establish the framework in which these charges will be determined. Charges must be uniform and homogeneous.[217] In 1999 CONATEL issued a Regulation of Charges,[218] which establishes that charges must be based on marginal long-term service costs, and that the regulation will be applied through the price-cap mechanism.

For land line telephony service, rate classes are regulated, including monthly base rates, local traffic, national long distance and international long distance. For cellular phone service, line activation, base monthly rate and traffic are regulated. Rules are also issued for access charges to the local land line network, which have determined that the charge cannot be higher than half the value of local traffic.

Currently, both land line and cellular telephony rates are regulated (there is a legal monopoly on land line service and a de-facto monopoly for cellular service). HONDUTEL's present regulation of charges has been established for a time horizon equivalent to the company's period of exclusiveness (until December 2005). By this date the rebalancing of charges should be completed.

Public phones and community center phones are charged the same long distance rates as those of urban customers. Community centers can be assessed small additional charges for taking messages and other services, since users can be far from the phone when calls come in.

Local rates are very low compared to those of countries with competitive services and rates adjusted to costs. In contrast, international rates are very high: calls to the US are more than seven times more expensive than from countries with competitive service providers.[219] This stimulates other practices, such as call back and collect calls (legally or illegally), and seems unsustainable even in the short term.

In the case of cellular service, CELTEL offers alternative rate structures. First, there is the possibility of using the service as a credit customer or pre-paid. For the latter option, rates can reach US $0.70 per minute more.

Industry Organization

Service development is scarce, and supply shortage for fixed telephone service is extremely intense. Even though cellular phone service has contributed some to lowering the pressure of

[217] Honduras Framework Law, Arts. 31 and 32.
[218] Honduras CONATEL Res. 028/99, 22 December 1999.
[219] For example, in Chile, the daytime rate some service providers offer for calls to the US is less than US$0.15 per minute, for low users that don't make many calls. On the other hand, the base monthly charge for a land line (which does not include any free minutes) is US$ 16.9 in Santiago and it reaches more than US$ 25 in smaller locations; the price for daytime local use is US$ 0.027 per minute (Telefónica CTC's rate). Prices for residential and commercial customers are the same. The amounts indicated do not include taxes.

demand, Honduras has one of the longest waiting periods for telephone lines.[220] Rates show a severe imbalance, with land line service levels being very low, and rates for international calls extremely high. General market development numbers for the last few years are shown here:

Table 5-23: Honduras Telecommunications Market Inforamation

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Land lines in service (thousand)	88	94	105	117	131	161	190	234	250	279
Density (Lines/100 inhabits.)	1.7	1.8	1.9	2.1	2.3	2.7	3.1	3.8	4.0	4.4
Waiting list (thousand)	122	142	209	229	249	269	262	260	*689	170
Public phones (thousand)	0.6	0.6	0.7	0.9	0.9	1.3	1.2	1.9	2.6	3.1
Cellular phone customers (thousand)	-	-	-	-	-	-	2.3	14.4	34.9	78.6
Mobile density (cust./100 inhabits.)	-	-	-	-	-	-	0.04	0.2	0.6	1.2
Installation charges, residential	76	59	57	49	37	33	17	15	15	25
Installation charges, commercial	153	118	114	97	75	66	34	31	30	60
Monthly rate, residential	4.9	3.8	3.6	3.1	2.4	2.1	1.7	1.5	1.5	2.1
Monthly rate, commercial	9.7	7.5	7.3	6.2	4.8	4.2	3.4	3.1	3.0	5.6
Rate for local 3-minute call	0.02	0.02	0.01	0.01	0.01	0.06	0.05	0.06	0.06	0.06
Connection fee, cellular phone	-	-	-	-	-	-	...	...	10.0	5.0
Monthly rate, cellular phone	-	-	-	-	-	-	...	...	20.0	15.0
Rate for cellular 3-minute call	-	-	-	-	-	-	...	...	0.84	0.79
Total sector revenue (US$ million)	92	92	103	100	104	132	169	170	184	195
Sector investment (US$ million) (**)	70	81	42	139	99	215	115	179	64	106
TV Receivers (thousand)	370	385	405	420	435	450	550	570	590	600
Personal computers (thousand)	...	...	...	...	...	...	...	20	50	60
Internet Hosts	-	-	-	-	-	-	408	74	99	119
Estimated Internet Users (thousand)	...	...	...	...	...	2,1	2,5	10	18	20

** An error from the source must be assumed.*
*** Investment and income amounts of the sector must be carefully considered, given that they are not from audited sources.*
Notes: Rates quoted are in current US$, with taxes. Telecommunications income and investments are quoted in millions of current US$, without taxes.
Source: ITU (2001b).

Rural services are extremely limited. Of the 300 municipalities in the country, more than 100 do not have phone service of any kind (not even a public phone). The main avenue for providing phone service in rural areas currently is HONDUTEL'S Teleservice Community Centers, which occasionally also have fax service, and other additional basic telecommunication services. There currently are 597 of these community centers (some with two or more lines), of which a little more than half are in rural areas, and the rest in peri-urban zones or in smaller urban areas. These centers are geographically distributed in the following manner:

- 274 in the South-central area (Francisco Morazán, Valle, Choluteca, Olancho, Comayagua, La Paz, El Paraíso and Intibuca Departments).
- 230 in the North-western area (Cortés, Yoro, Santa Bárbara, Ocotepeque, Copán and Lempira Departments).
- 93 in the Atlantic coast (Atlántida, Colón, Gracias a Dios and Islas de la Bahía Departments).

[220] According to ITU (2000c), in 1998 the waiting period for a telephone line was more than 10 years.

Of the total number of community centers, 349 telephone lines are land lines (furnished with multi-access systems, such as VSAT, and some physical links), and another 329 operate through cellular lines (see below). However, the majority of towns are medium in size, and there is almost no service in the smaller localities.[221] In terms of coverage, the reach of the program has been rather limited, considering that there are more than 5000 rural localities with more than 500 inhabitants, and many more, smaller in size.

With regard to sector companies, even though the objective of the Law is to foster a competitive market, the present situation is far from that. Essentially, two companies dominate the sector: HONDUTEL, which provides basic and carrier services, and CELTEL, which provides cellular phone service.

The 1995 Framework Law established a 25-year concession for HONDUTEL, including exclusive rights for 10 years (until 2005) for the company and its associates for national and international phone service. However, detailed conditions were left to a concession that CONATEL should issue as a result of the call for bids for the privatization of the company. Subsequently, the reach HONDUTEL's exclusiveness was expanded beyond telephone services, to carrier services, telex and telegraphy services, and public phone service as well.[222]

The failure of the October 2000 privatization bid and the Government's decision to postpone the privatization process indefinitely left sector reform in a very tenuous situation, since there were several aspects that depended on it. The company was expected to commit the necessary capital according to negotiations criteria defined by the investor itself, but HONDUTEL's investments had been reduced to a minimal amount during the period of bid preparation. This, combined with the Government's financial difficulties at the time, has led to a significant lull in service expansion during the past few years.

Support for Rural Services

Currently there is only one formal support mechanism for rural services, established in CELTEL's concession. The company has to assign, free of charge, a certain number of cellular lines, equivalent to a maximum of 5% of its installed capacity,[223] for terminals installed in rural areas, distributed throughout the entire network. Conditions, characteristics and sites for these installations are periodically defined by CONATEL, which transfers the said installations to HONDUTEL for operation.[224] This obligation is valid until June 2006, at which time the service provider must comply with universal service regulations established by CONATEL, according to the same conditions all other providers are subject to. CELTEL does not receive any income for the operation of these lines, but it is able to discount the corresponding interconnection charges from licensse charges it must pay to the regulatory body. The company cannot install cellular phones for fixed service, not even as public telephones, given HONDUTEL's exclusivity.

[221] In selecting a town, it is usually assumed that it has electricity, for which a great number of the smaller towns/localities are not eligible.
[222] Honduras Decree No. 244/98, Art. 1, modified by Decree No. 89/99.
[223] The original concession language stipulated that the obligation was for 5% of the *total lines*, but this has later been reinterpreted in the way indicated.
[224] As it has been indicated, approximately half of HONDUTEL's Community Centers operate with cellular lines transferred by CELTEL.

Currently, however, this program has only installed approximately 400 lines, only 25% of CELTEL's installed capacity.[225] This gap is partly due to the complexity of the site selection process, difficulties in the agreement between the companies and CONATEL, and to the much larger demand among urban and peri-urban cellular phone users than among rural populations. According to CELTEL, the average traffic for the telephones installed in community centers is 10 times higher than the average, 80% of which is outgoing traffic, with a significant part being international traffic. In practice, the majority of these rural cellular lines are in areas with more than 1000 inhabitants, but not in large cities.

The basis for HONDUTEL's privatization bid included certain obligations for the privatized company with regards to rural telecommunications, which would be included in the respective concession. According to the obligations, HONDUTEL (or its successor or subsidiaries) would be obligated to install at least two public or community system phones in each site with more than 500 inhabitants included in a list prepared by CONATEL, before the end of its period of exclusiveness.[226] At the same time, at the end of the period of exclusiveness, CONATEL would "determine and request" from the Finances Secretariat resources from the national budget, at least 10 million lempiras (at the current exchange rate, some US $650,000) for the development of biddable projects for the sites listed.

Although these measures already had ambiguities,[227] the failure of the bid and the concession introduced even more uncertainty. Legally, HONDUTEL is not currently obligated to expand service to areas of the list indicated, given that the respective legal instrument was never formalized. No resources have been assigned to finance that obligation. HONDUTEL'S situation and that of rural telecommunications in particular, is currently very uncertain.

There are two additional private initiatives related to rural services:

- The ITU / HONDUTEL Multipurpose Telecenters Project, has installed centers that offer public telephone service, Internet access and other added services, such as ISP and computer classes, in two small urban locations close to the capital, connected to the capital via physical link. It is not clear whether the project, managed by HONDUTEL, has yet become self-sufficient (notwithstanding the initial investment in the amount of US $32,000). The project is in the pilot stage, and there are currently no plans for replication.
- The Honduran Science and Technology Council's (COHCIT) Solar Villages Project, is currently under consideration by the IDB for a US $5 million loan. Two years ago, COHCIT started a solar energy installation pilot project (photovoltaic and solar thermal) in some remote locations of the country, especially for supporting education and health centers. Restrictions established by HONDUTEL'S right to exclusiveness in

[225] There are discrepancies in terms of the exact value of this variable, according to different sources. As indicated later on, a great part of the origin of these discrepancies lies in the constant incorporation of new installations.
[226] The list that was originally prepared by CONATEL had around 5000 sites. However, later versions of the list reduced the number of sites to some 3000.
[227] For example, about what would happen if the Finances Secretariat did not approve CONATEL'S request, or if Congress did not approve that item in the budget; how services for areas with less than 500 inhabitants would be financed; and whether the amount indicated for the period post-2005 was enough to tackle the rural telecommunications problem.

telecommunications have yet to be defined. Currently, two locations are operational (San Ramón Centro and San Francisco); and one is under construction (La Hicaca), installed with initial support from UNESCO and OAS. Recently, COHCIT also obtained support from a US company to install Internet access service for computers at the local school through a satellite installation operated with solar energy in San Ramón Centro, which has been operational for a few months now.[228]

5.4.3. Current and Proposed Rural ICT Initiatives

ICTs for Rural Education

Supporting rural education with ICTs is one of the major areas of focus for COHCIT, the Ministry of Education, and the IDB project preparation team. There are several education projects or programs that appear to be relevant to rural telecenters and ICT deployment, including the Honduran Community Education Project (PROHECO); a 36 school pilot program known as Telebasica, which is a secondary-level video-based program modeled after the Mexican Telesecundaria (the Telebasica schools are all Centros Basicos); and the Educatodos project. Each of these programs offer certain advantages and disadvantages, from the point of view of rural ICT programs.

PROHECO

PROHECO supports primary schools managed by community/parent groups; the program of establishing a network of "Centros Basicos" schools throughout the country, combined primary and secondary schools receiving improved infrastructure and teacher support. The community/parent committees which operate the PROHECO schools appear to provide an existing institutional structure for managing telecenter facilities. At the same time, these schools are currently focused on primary education, and among many educational experts worldwide there is a degree of skepticism regarding the relative contribution computers make to primary-level education, particularly in the earlier grades (e.g. grades 1-3). On the other hand, the PROHECO schools will likely have to expand to cover secondary grades in the near future, making ICTs more relevant.

The Telebasica Program[229]

Honduras' Telebasica pilot program, which, like Guatemala, is based on Mexico's Telesecundaria program, was established in February 1996 to facilitate expansion of basic education in rural areas. Telebasica's current model, which integrates grades seven, eight and nine, was implemented in 1999.

The Telebasica pilot program is supported primarily by Mexico's Secretary of Public Education Telesecundaria (SEP), which has provided programming, teacher training, educational materials, equipment for satellite signal reception (antenna and decoder) and other technical assistance for

[228] However, the site does not have a phone.
[229] Sources: Personal communication with Ing. Gustavo Izaguirre, Telebasica Coordinator; and USAID (2001a).

Honduras' 36 Telebasica pilot schools. Mexican aid was scheduled to end in December 2001. The Telebasica program has also received financial support from USAID and the Japanese Government. This support has been used for training of teachers and model technicians, equipment, printed teaching materials, videos, and teachers' salaries, transportation and meals.

As in the Mexican Telesecundaria model, the Honduran Telebasica pilot program centers on three basic elements: interactive television programs, printed educational guides, and the teacher. The main objectives of Honduras' Telebasica program are to:

- Meet the demand for primary education in rural areas which, for geographic and economic reasons, is otherwise untenable;
- Offer modern educational support to teachers, to allow them to have a greater impact on the students' education;
- Link primary education centers and the community through productive socio-cultural activities, sports and community development activities; and
- Favor the spreading of culture.

The Honduras government receives its educational programming from the Mexican government via the Edusat satellite. It then records the programs onto VHS cassettes and distributes them to the Telebasica schools. (Because Mexico's school year varies from that of Honduras, it is not possible to use the signal from the satellite directly in the classroom.) The program has, however, formed a collaborative relationship with INICE for alternative satellite signal reception and video reproduction, as well as the training of teachers, principals, district supervisors and department supervisors.

Each Telebasica classroom has a television and a VCR; this equipment that allows teachers to use the materials to support the educational activities with the students. The teacher uses the Learning Guide and Concepts Book to supplement the content from the TV program. Subjects taught include: mathematics, Spanish, natural sciences, general geography, global history and English. As of yet, however, no history or geography content specific to the Honduras context has been developed—a priority need currently facing Honduras' Telebasica program.

Despite rampant problems in the Honduran educational system, Honduras developed the Telebasica Pilot Project in record time and has so far shown promising results. Telebasica centers have been operational since 1997. Between 1999 and 2001, 35,580 books and 12,880 videos were distributed. Telebasica schools have attained a learning rate greater than that of other primary and secondary schools.

Expansion plans for the Telebasica Program in Honduras include:

- Expand into 20 additional centers in 2002.
- Support development of Telebasica schools in off-grid areas to be powered by solar energy.
- Transmit educational programs and teacher trainings through a local or national television channel, with the intent to improve efficiency of the education model.
- Develop the educational programming and materials on Honduran geography and history.

- Purchase or secure the donation of appropriate and sufficient printed materials, and support reproduction at the local or regional level.

Video-based education programs such as Telebasica or Telesecundaria have a demonstrated track record, and appear to be a good match for computer and internet-based approaches. The video-based instruction, combined with a teacher-facilitator, can address core curriculum subjects (e.g. science, math, Spanish) in a cost-effective manner. At the same time, in unelectrified areas Telebasica schools or other video-based instructional facilities would require the same types of remote power systems as telecenters, and be a natural fit with the OAS Rural Connectivity Initiative.

The Educatodos Project

Between 1992 and 1994 the Educatodos (Education for All) pilot project was developed to test the feasibility of using interactive radio instruction (IRI), or radio lessons coupled with complementary teacher-led discussion, as an alternative system for the delivery of primary education services to children and adults outside the traditional primary education system.

The Educatodos project was implemented in 1995 under the Primary Education Efficiency Project (Proyecto Eficiencia de la Educación Primaria), a government project designed to support economic development by investing in education and other sectors to boost human capital.

The Educatodos project targets teens and adults between the ages of 14 and 29 that have not received or completed their studies through the traditional primary educational system. The goal of the project was to produce 250,000 graduates (of which 50% should be women) by 2000. Other goals include civil society strengthening, democracy building, and local social and economic development.

Educatodos schools follow the same curriculum for all nine grades as that prescribed by the country's regular primary education system. They use a methodology for education delivery based on two programs that used radio lessons in the past: 1) the Secretary of Education's "The Numbers Family" program, which taught mathematics, and 2) the Catholic Church's radio schools program, which demonstrated that the radio can be an appropriate means for reducing teaching costs and reach hard-to-reach areas. Each grade level has one hundred IRI lessons and complementary printed material. As the student progresses through the levels, the importance of the radio lessons diminishes, and students take on more responsibility for their own education.

The Educatodos program has encountered a number of problems, including:

- Lack of support.
- Technical problems with radio stations.
- Difficulties receiving the signal from the stations (in the most remote regions).
- Lags in the delivery of printed materials to learning centers.
- Student motivation and attendance problems. A student survey found that 33% of students dropped out because of job responsibilities; 29% because of family responsibilities; 8%

because they did not like to study; 5% because they were not learning; and 16% for other reasons (illness, distance from the center, etc.).
- By 1998, educational materials still had not been developed for all nine levels, and as a consequence, the graduation rate dropped far below the project's targets.
- No funds were allocated for equipment, vehicles or materials, and no systematic plan was put in place to ensure project sustainability.
- The lack of technical and administrative readiness within the Department and District Management structures in the management of alternative education delivery systems as a result of the on-going decentralization process.
- Administrative and financial problems, including tardiness in signing agreements, making payments, paying salaries and making supervision rounds.
- Lack of experience in developing appropriate IRI content.

It should be noted that Telebasica and Educatodos are aimed at different target populations, with Telebasica intended for secondary school students attending formal schools, while secondary-level Educatodos is aimed at adults and working school age young people who cannot attend school during the day. Therefore, it is entirely possible that educational facilities or multi-purpose telecenters including a classroom could be used both for Telebasica and for Educatodos classes, as well as supporting other rural education activities.

Telecenters, Telemedicine/Telehealth, and ICT Support for Rural Economic Development

Hurricane Mitch Relief Coordination

This is one of many examples of emergency networking provided by RDS Honduras in the aftermath of hurricane Mitch, the worst natural disaster to hit Honduras in this century. RDS describes its role as "putting people who have information in touch with people who need it, and putting people who need something in touch with people who have the resources."

In its two-room office with four employees, four computers and 30 telephone lines, RDS was in the right place at the right time when Mitch struck, and soon became the hub of grass-roots disaster-relief networking in the country. During the six months following the hurricane, membership in the RDS network grew from 360 organisations to 449, scattered throughout almost all of Honduras's 18 provinces.

But the actual introduction of Information Technology (IT) was only a means to an end. RDS has never lost sight of its primary goal of using IT to promote grassroots participation in sustainable development. It has done this by creating a community of civil society organisations and providing the means for its members to interact, exchange information and support one another. In addition to providing email and Internet access at reduced rates, RDS established a system of networks -- email mailing lists that grouped NGOs according to their development activities -- fostering not only communication but partnerships and, as a result, empowerment.

Valle de Angeles and Santa Lucía Telecenters

These multi-purpose telecenters provide several telecommunication services to the community and others of communal interest. Telecenters are present physically as well as in the virtual world of Internet. Valle de Angeles and Santa Lucia Telecenters (http://www.itu.hn/cpt) were established by the ITU and HONDUTEL with the cooperation of the following institutions: Valle de Angels and Santa Lucia Township, Central American Technological University (UNITEC), UNESCO, Tegucigalpa Rotary Club, Valle de Angeles and Santa Lucia Management Boards, United Nations Voluntaries, GRAPA Amateur Radio Club, and Telecom Companies. The telecenters are intended to serve the communities, national and foreign tourists, the Central Government, offering them services of added value, through information technology (IT) and communication by means of Internet. The Telecentre includes a library—both virtual and physical, which is accessible to the local school and college.

The management of the Telecenters is in charge of a Community Administrative Board established for the Telecenters headed by the community commercial sector. The Board is composed of representatives from different sectors of the community such as the township, community board, teachers, HONDUTEL and ITU. The operation of the Telecenters is self sustained and their income comes from the services provided to the community. The Telecenters are non-profit organizations and the income provides both operational costs and capital for equipment renewal and developing of new services and applications.

The Valle de Angeles Telecenter is located in the arts and crafts sector of the commercial community and occupies an area of 50 square meters. This area provides services to the public, a work area that consists of computers, a small area for a reference library, an administrative office and an area for a small office materials store.

The Telecenter has ten PCs en a configuration of a Local Network, a network server, an Internet router, a connection hub, a 64 Kbps synchronous modem, a laser printer, a dot matrix printer, a CD server (electronic library), 4 asynchronous modems, 4 lines for telephone access and a 3-kW backup system with 6 hours of autonomy in case of electrical blackouts. The office materials store has a photocopier, a paper cutter and binder system for documents.

5.4.4. Rural ICT Opportunities Identified

The broader Rural Connectivity Initiative activities in Honduras are framed against the background of the significant OAS support for the Honduran Science and Technology Council (COHCIT) “Aldeas Solares” rural telecenter projects in San Ramon Centro, San Francisco, and Hicaca, as well as more modest support for near-term projects in Las Montanas and Trojas. As a result of this support and involvement, the OAS is already a partner in the project activities, and has established a high degree of recognition and legitimacy for the Connectivity Initiative. It has also laid a foundation for possible participation in the telecenter project replication phase to be financed by the IDB under the project Ampliación de Capacidades Tecnológicas en Comunidades de Bajos Ingresos, which would be based on a $5 million Learning and Innovation Loan from the IDB. A number of areas have been identified where guidance from the OAS and the Winrock team can strengthen the project.

One issue that has arisen in Honduras appears to be a generic problem across many countries. In order to maximize the benefits from investments in rural telecenters or other rural ICT facilities, it is important these facilities be used to address needs in a variety of sectors including telecommunications (e.g. basic rural telephone service), education, agriculture, rural enterprise development, health, and others. At the same time, it is the usual practice of government agencies in many countries to focus exclusively on their own sector, and it can be difficult to foster inter-agency collaboration or coordination. In the case of Honduras, the COHCIT project would involve a number of different sectors, which will present an interesting challenge for the project implementers.

5.5. BELIZE

Belize General Country Data (1999, except where indicated):

- Surface area: 22.960 km^2
- Population: 246.9 thousand
- Population Growth (annual %): 3.4%
- Rural population: 46.6%
- Illiteracy rate: 7.0%
- GDP: US$ 732.5 million (at market prices, in current US Dollars)
- GDP Annual Growth Rate: 4.7%
- GDP average annual growth rate between 1989-1999: 4. %
- Per capita income: US$ 2,730 (current Dollars); US$ 4,959 (PPA Dollars)
- Per capita income annual growth rate: 2.2%
- Per capita average annual growth rate between 1989-1999: 1.0%
- Human Development Index (UNDP): 0.776
- Density of permanent telephone lines: 15.6 per 100 inhabitants

Sources: World Bank (2001a); CEPAL (2000); UNDP (2001).

The total enumerated population of Belize as of May 12, 2000 was 240,204. This is the official population of Belize as at Census Day. Belize has a low population density, twenty-three acre per person. The population is racially mixed. The urban/rural distribution of the population is of some significance, since there is a larger rural population than urban. The further south of (Toledo and Stann Creek) country you venture, the larger the population of people living in rural areas as compared to central Belize. Similarly, the poverty rate in the south is higher than other parts of the country. In terms of social and economic infrastructure development, Stann Creek and Toledo districts lag behind the rest of the country. Only recently, the provision of potable water, electricity, and to a lesser extent telecommunication services have become available in the southern region largely, in response to 1993 and 1996 poverty assessments. These assessments established that Toledo is the most indigent district in Belize. The level of poverty is linked to, among other factors, the availability and quality of basic social services such as health care, education, safe water, electricity, telecommunication and transportation.

As in many developing countries, Belize's main focused of development is the cities and towns. Rural development has always been placed as a low priority with minimum financial resources budgeted to carry out the activities of the ministry mandate. This has resulted in the rural areas lagging behind in the overall development of the country that is especially apparent in the southernmost remote rural communities in the country. For example, Southern Belize remains the most inferior in terms of transportation links. Until recently, the southern highway was unpaved, the current "*Southern Highway Rehabilitation Project*" funded by the British, IAB, the Kuwaiti and Taiwanese Governments will upgrade the entire 78.5 miles of road.

5.5.1. Rural Electrification

Overview of the Energy Sector

Belize Electricity Limited (BEL) operates a 115 kV grid, connected to the Mexican grid, that interconnects Belize's eight major load centers. Eighty-five percent of BEL's capacity (25 MW) comes from the Mexican Comision Federal de Electricidad (CFE) and from the Mollejon Hydro Plant, a foreign-owned independent power producer. A recent and significant addition to Belize's power system is the 34.5 kV submarine cable from Belize City to Ambergris Caye, which has the capacity to supply 10 MW of power.[230] Today BEL serves approximately 55,000 customers and meets a peak demand of 47 MW. Estimated load growth is approximately 10% country-wide.[231]

Of the 51 communities in the Toledo district, 23 receive electricity from BEL.[232] Currently about 34% of the communities in Belize's largely rural southern region have access to the electric grid;[233] of this, the majority is in the Stann Creek District, where 16 of its 25 communities have access to the grid. As shown in Table 5-24, the southern region lags behind the northern and central parts of the country in access to electricity.

Table 5-24: Rural Communities Access to Electricity

Districts	BEL Grid	Under Construction	Generator	Without Access
Toledo (southern)	23		2	26
Stann Creek (southern)	16			9
Cayo (central)	26	2	1	10
Belize (central)	22	8	1	1
Orange Walk (northern)	30			4
Corozal (northern)	27			1

Those unserved by BEL depend on either generator sets or solar panels, if they can afford them. Several feasibility studies have been conducted on solar power in Crique Sarco and Corazon, wind-power in Punta Negra, and hydroelectric power.[234] Yet, to date, renewable technologies have not significantly penetrated the market.

Until 1992 the government of Belize was the sole owner of the Belize Electricity Board, but by March 2000, Maritime Electric Cayman Inc. held 21.48%, Newfoundland Energy Cayman Ltd. held 23%, Fortis Cayman Inc. held 20.60%, and the Social Security Board of Belize held 25%, with the remainder held by small shareholders.[235] In 1999 the Belize's electricity sector underwent privatization and Fortis became BEL's majority shareholder. Today, Fortis is the only electric provider in Belize.

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[230] BEL (2001c).
[231] Chalillo Project Belize (2001).
[232] Personal communication with Andy Palacio, Rural Communication Development Officer, Ministry of Rural Development, Belize, March 2002.
[233] ESTAP (2000).
[234] For example, Miller and Miller Ltd. (1998) and Lee et al. (1995).
[235] BEL (2001a).

Status of Rural Electrification

Fifty-two percent of Belize's population lives in rural areas (Table X). Belize's Ministry of Rural Development has a manadate to ensure that all rural communities have access to safe potable water, electricity, adequate health care and other critical development services. However, rural development in Belize has so far been inadequately addressed due to a lack of funds to carry out the Ministry's mandate. This is especially true in the southern region, where the majority of the population lives in rural areas, poverty rates are higher, and social and economic infrastructure development lags behind the rest of the country. The central and northern parts of the country have had access to electricity and other necessary services, potable water, electricity, and to a lesser extent telecommunication services for some time, which have only recently become available in the southern region. Compounding matters in the south, in October 2001 Hurricane Iris hit southern Belize, destroying much of the existing infrastructure and leaving more than 13,000 people homeless.

Table 5-25: Urban and Rural Population in Belize

Districts	Toledo	Stann Creek	Cayo	Belize	Orange Walk	Corozal	Total Population
Urban	4,329	8,814	26,478	53,549	13,483	7,888	114,541
Rural	18,968	15,734	26,086	14,648	25,407	24,820	125,663
Total	23,297	24,548	52,564	68,197	38,890	32,708	240,204

In 1999, the Government of Belize and BEL developed a Rural Electrification Program, which was expected to expand electricity supply from 91% to 98% of Belizean homes by 2003.[236] Of the Government's capital projects for fiscal year 2001-2002, $15 million is allocated for its rural electrification program,[237] which is being jointly implemented by the government and BEL. However, the Government's goal of 98% coverage by 2003 is not likely to be achieved due to other government priorities, including natural disaster relief and repair efforts.[238]

Upcoming Renewable Electricity Projects

<u>Chalillo Hydro Project</u>
Fortis, Inc, the parent company of BEL and owner of the Mollejon Hydroelectric Plant, has recently proposed to build the Chalillo Project to create a water storage facility to better manage hydroelectric supply. The Environmental Impact Assessment for the project is currently under review by the Department of Environment, and though it received criticism from several international environmental groups, the project was approved in December 2001.

<u>Belize Sugar Industry Bagasse Plant</u>
In August 2000, the Belize Sugar Industry (BSI) and BEL signed a Memorandum of Intent for BEL to purchase 15 MW of power from BSI. BSI is developing a proposal to construct a

[236] Chalillo Project (2001).
[237] BEL (2000b); U.S. Dept of State (2000).
[238] Personal communication with Roy Caytano, Chief Executive Officer, Ministry of Rural Development, Belize, October 2001.

bagasse-fuel electric generation facility.[239] This is the first example of a company in Belize considering co-generation as an alternative to meet the growing demand for electricity in Belize.

5.5.2. Rural Telephony

Legal and Regulatory Aspects[240]

Belize enacted its Telecommunications Law in 1987, which allowed for the privatization of the national telecommunications company in 1988. The new company, known as Belize Telecommunication Ltd. (BTL) is the sole telecommunications service provider in the country, with the exception of media services. The Government holds a minimum property percentage (4.5%) of this company.

Regarding institutional aspects, the Law distinguishes between the entity in charge of sectoral policy (Ministry of Public Works, Energy and Communications) and that in charge of regulation (Telecommunications Office, OFTEL). However, OFTEL is equally dependent on the Ministry, and does not have the characteristics of an autonomous institution. Licenses and rates are proposed by OFTEL with prior consultation with the ministerial cabinet but are ultimately determined by the Ministry.

Though sectoral development in these times has been significant, the Government is not completely satisfied with the results, and plans to modify the legislation currently in force at the end of the period of exclusiveness (2002) and does not plan to renew this exclusiveness. Among other aspects, the legislation currently in force makes no mention of special characteristics of telecommunications in rural areas, nor does it mention any mechanism that supports service in these areas.

The development panorama of the sector is observed in the following table:

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[239] BEL (2000a).
[240] ITU (1996).

Table 5-26: Information on the Telecommunications Market in Belize

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Land lines in service (thousand)	17.3	21.3	24.8	28.6	28.2	28.9	29.6	30.7	31.6	36.6
Density (lines/100 inhabits)	9.2	11.2	12.5	14.0	13.4	13.4	13.3	13.7	13.8	15.6
Waiting list (thousand lines)	2.7	0.9	0.8	0.6	0.6	0.7	0.4	0.3	...	...
Public telephones	...	...	182	...	...	588	596	622	...	...
Mobile cellular customers (thousand)	-	-	-	0.4	0.8	1.5	2.2	3.0	3.4	6.2
Mobile density (customers/100 inhabits)	-	-	-	0.2	0.4	0.7	1.0	1.4	1.5	2.6
Installation charges, residential phone	...	...	45	45	45	45	45	45	45	45
Installation charges, commercial phone	...	...	45	45	45	45	45	45	45	45
Monthly rate, residential phone	...	...	4	4	4	4	4	4	4	4
Monthly rate, commercial phone	...	...	5	5	5	5	10	10	10	10
Rate for regular local 3-minute call	...	...	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Connection fee, cellular phone	-	-	-	55	55	55	55	55	55	25
Monthly rate, cellular phone	-	-	-	23	23	23	23	23	23	-
Rate for cellular local 3-min. call	-	-	-	1.7	1.7	1.7	1.7	1.7	1.7	1.3
Total sector revenue (US$ million)	25.4	28.7	32.3	35.0	35.1	36.2	36.6	37.5	40.0	42.5
Sector investment (US$ million)	6.4	6.3	5.1	7.8	6.4	8.1	5.8	10.2	12.0	...
Equipment import (US$ million)	...	...	3	5	...	4	2	3	8	10
TV Receivers (thousand)	27	29	30	31	36	39	40	41	42	...
Personal computers (thousand)	...	...	...	...	...	6	10	15	20	25
Internet Hosts	-	-	-	-	-	1	12	257	252	276
Estimated Internet users (thousand)	...	...	...	...	...	0.01	1.6	5	10	12

Notes: Rates are quoted in current US$, with taxes. Telecommunications revenue, investments and imports are quoted in millions of current US$, without taxes.
Source: ITU (2001b).

Regarding the difference between urban and rural areas, Belize currently has a telephone density of 27.4 lines / 100 inhabitants in urban areas and only 2.9 lines / 100 inhabitants in rural areas.[241]

Approximately half the population is distributed among 537 rural communities. Out of these, only 84 have a connection to the switched network; only another 63 have community phones (located at a distance of 1 to 30 miles from the communities), while 390 communities have no service whatsoever.

Industry Organization

In accordance with the legal regime and sale conditions of the BTL, the company enjoys exclusiveness for 15 years for all services (including cellular telephony), that is, until December 2002. Media services are the only ones exempted (including cable TV).

In the original privatization of BTL, British Telecom (BT) acquired 25% of the company. However, BT later sold its share to MCI, and this one has recently been transferred to a local group (Carlyle).

[241] Belize OFTEL (2001).

Despite the fact that quality of service is relatively good, prices are very high and, according to the Government rates are much less attractive for the general public and for user companies than in other neighboring countries that compete with Belize, such as Costa Rica and Barbados.

Support for Rural Services

There are no special support systems for the development of rural telecommunications. The Government believes that BTL has not been very interested in service development in rural areas and has favored the service in more profitable areas.

The Government has a land registry of the rural areas, its population and location, and services needed in each site. Currently the bulk of the work is focused on identifying expansion costs for service to areas lacking it. It is estimated that satellite solutions would be very costly, for which it is possible that wireless alternatives be analyzed with priority.

On the other hand, the introduction of a legal modification to create a fund for the development of rural telecommunications is being considered, with the contribution defined as a fraction of the revenue of the operating companies. A percentage has not been established as of yet, due to the great care being taken to determine the correct amount needed for the expansion of rural service, while at the same time trying to avoid adverse effects of the contribution on company results and a subsequent decrease in interest in investing in Belize.

5.5.3. Current and Proposed Rural ICT Initiatives

ICTs for Rural Education

No current programs were identified involving us e of ICT for rural education

Telecenters, Telemedicine/Telehealth, and ICT Support for Rural Economic Development

No examples were identified.

5.6. KEY EXPERIENCES IN OTHER LATIN COUNTRIES

Chile

Red de Informacion Comunitaria

La Red de Informacion Comunitario (RIC – www.redcomunitaria.cl) provides Internet access through community telecentres, but also provides locally relevant information, including government, social and commercial services, through well-developed and presented Web portals. The telecentres, located in public centres such as libraries, are linked to local municipalities, which provide resources, personnel and operational support. Each of the communities—all in the Region of La Araucania—can create an individual web portal, providing information on their local services, news, events, forums and resources, but with links to others in the network. People in the communities can also tailor a personal portal through the web site, selecting the information they want displayed on their portal. The initiative is supported by the Government of Chile, Telefonica del Sur and the Instituto de Informatica Educative de la Universidad de la Frontera.

Asociacion de Telecentros Activos de Chile ATACH

ATACH (www.atach.cl) is an organization formed to coordinate the activities of existing telecentres in Chile. Their aim is to extend government services and support the use of telecentres for developing civil society.

Costa Rica

INFOAGRO – Information System for Agriculture (Sistema de Informacion del sector Agropecuario Costarricense)

Aimed at small and médium producers, INFOAGRO (www.infoagro.go.cr) is an agricultural information system, supported by the Consejo Nacional de Produccion (CNP). It provides information services through Internet, email, and GIS; training and awareness-raising in order to create an "information culture;" technology to facilitate Internet access; and extension of information delivery through other media such as radio, television, print and extension services. INFOAGRO services are aimed to benefit farmers, agricultural institutions and organizations, local governments, civil society, research and teaching centres, agribusiness, national and private banks, exporters and importers, and organizations and businesses that support the ag sector.

LINCOS – Little Inteligent Communities

Little Intelligent Communities (LINCOS) (www.lincos.net) is an initiative of the Fundación Costa Rica para el Desarrollo Sostenible, developed along with the Massachusetts Institute of Technology (MIT) and the Instituto Tecnológico de Costa Rica. LINCOS are modern community centers designed to help disadvantaged communities access electronic services. The centers are pre-constructed, structurally self-contained, locally tailored and permanently installed units, and are coupled with training workshops to build local capacity in the use of ICTs. Each unit includes a computer science laboratory, a telemedicine unit, a videoconference center, an information center with electronic trade possibilities, and communitarian electronic mail and newspaper. Some systems include a satellite, which connects the center to a master station. These digital centers can be designed to fit with both off-grid and grid-connected power systems.

Dominican Republic

Centro Rural Alternativo – Limon de Ocoa

With the assistance of Eco Partners, an environmental group based at Cornell University, the community of Limon de Ocoa was able to establish an Internet connection via digital radio, and establish a community telecentres. Very quickly, email became the primary means of communication, owing to a general lack of phone service in the village. It became apparent that the Internet allowed a direct connection between the community and international organizations that could support much needed housing and agricultural projects. Two such projects have been successfully negotiated with UNDP and the InterAmerican Foundation.

The Web has also become an important tool in informal education. Local youth are acting as information and communication intermediaries, providing information access and communication services for villagers, including teachers. Some of these young people have become very skilled at ICT use, and have moved to the city because of lack of opportunities for them in the village.

Now a new facility for the telecentres is being built. The focus is on education, owing to the general lack of adequate schooling (e.g. no public schooling past grade six). Activities will include the production of educational materials by community members (in CD, Web, and video). Also, a wireless distance education network is being developed to serve communities across the island. Charging for telephone service is being explored as a method of financing educational activities.

Ecuador

Servicio De Información Agropecuaria Del Ministerio De Agricultura Y Ganadería Del Ecuador

Servicio De Información Agropecuaria Del Ministerio De Agricultura Y Ganadería Del Ecuador (www.sica.gov.ec) is a World Bank funded agricultural portal geared to information needs of commercial producers. It provides domestic and global commodity prices and ready-made radio broadcasts on cassette for a network of over 70 radio stations throughout Ecuador, through a program called Microinformativo Agropecuario. These include commodity prices, farming tips, weather, for both coastal and Andean conditions, and information is aimed at the small farmer. Broadcasts, available in both Spanish and Quechua, are produced by Radio de la Casa de la Cultura Ecuatoriana

Peru

Casa Cultura Asháninka - Connectivity for a Remote Indigenous community

The Asháninka (http://www.rcp.net.pe/ashaninka/) do not see the Internet as the beachhead of a cultural invasion from the North. Rather, they have seized it as a tool to reinforce and perpetuate their own culture, to build a larger sense of community purpose among the 400-odd Asháninka villages scattered across South America, and to tell their own story to the world. In the process, they bypass outside news media and governments, which they think tend to marginalize them. The community plans to use the Internet to build and structure their own study program and create an Asháninka school, compatible with the Peruvian education system, for sharing experiences with other communities.

In many respects, the Asháninka continue to do the same things they've always done. Their new communication tools just make them more efficient. For instance, they find the Internet useful for choosing the best time to take their produce to market in Lima. They now know if market prices are good before they even set foot out of their villages, and their economic standing has already improved as a result. In the course of embracing the Internet, the Asháninka are moving from an oral to a written culture. Parents hope their children will be able to learn new things that the Asháninka have not known before.

On 28 August 28 2001, the telecentre burned to the ground, a victim of arson.

Cabina de Internet Cotahuisi

La Asociacion para el Desarrollo Sostenible (AEDES) has been working in Cotahuasi, La Union (Arequipa), one of the most remote regions in Peru, supporting local efforts to export high-value organically produced local products. In 1997, when the first satellite phone was installed, AEDES personnel began to use email and the Internet to communicate and gather information. Soon, rural leaders and public officials, especially those working in health and education, began to request use of the new ICTS. AEDES complied, but soon found that the demands for use of the computers grew, the financial burden became excessive. In response, AEDES opened up the Cabina de Internet Cotahuisi, which offered use of its computer for the general public.

Local growers of kiwicha (amaranth) use the Cabina to communicate with exporters and are looking for new ways to diversify their production. Leaders of the Women's Federation in the Province of La Union, are trying to link up with other women leaders to enhance their bargaining power and social-standing. Local schools have used the Cabina to do research on biodiversity in the region, and have begun to use the material in specific projects, linking with students in other parts of the world.

Rates vary from US $0.43 per hour for students, to $0.86 for professionals, and $0.58 for farmers. Leaders pay nothing when engaged in community work, thanks to a subsidy from a Canadian project. Special rates are charged when the equipment is used for courses run by the school.

6. CONCLUSIONS/RECOMMENDATIONS

1. Demand for Rural Connectivity and Energy

This investigation has clearly shown that there are many thousands of communities where the OAS Rural Connectivity and Energy Initiative could be relevant. This includes thousands of communities where there is no possibility of electrification via grid extension in the foreseeable future, and where even basic telephony services are currently unavailable, as well as communities served by part-time diesel generation where ICT project implementation will present a challenge. In addition, there are many thousands of communities where grid-based electricity is or will be available, but where wireless connectivity approaches will be least cost and most appropriate. In many cases, assistance such as the OAS/IACD can provide can be essential in addressing challenges to successful rural ICT programs and ventures. In many cases, grid-connected communities will be the best location for larger telecenter facilities and for some of the main connections to the Internet. In lieu of focusing exclusively on off-grid connectivity and energy activities, the OAS/IACD should expand its activities to include grid-connected rural areas and communities served by part-time generation.

2. Indirect Relationship Between Country Market Conditions and Early OAS/IACD Opportunities

Given the very early stage of rural ICT activities in developing countries, and a number of unique factors, there is not necessarily a strong relationship between the overall market conditions in a given country and the prospects for near-term OAS/IACD work under the Rural Connectivity and Energy Initiative. For example, in the case of Colombia the advances in development of the Connectivity Agenda and great strides in private sector delivery of rural telephony and telecenter services create a positive environment for initiatives such as the Norte de Santander Departmental Connectivity project. In the case of Honduras, however, the lack of progress in telecommunications privatization and restructuring creates what is in many ways an unfavorable environment from the point of view of connectivity options and costs. Nonetheless, the existence of the IDB-financed “Aldeas Solares” project (Ampliacion de Capacidades Technologicas en Comunidades de Bajo Ingreso), which builds on earlier OAS/IACD work, creates a strong possibility for significant OAS/IACD work there on rural connectivity activities.

3. Key Role of Education Programs

The education sectors in several of the countries are leaders in efforts to apply ICT to rural programs, including both traditional communications technologies such as television and radio and early efforts to integrate information technologies into rural education. Integrating computers and connectivity into more mainstream distance education programs can provide a lower-risk means of accelerating rural ICT activities, and tap into strong donor/MDB interest in supporting strengthened rural education. The OAS/IACD should seek to include in its Rural Connectivity Initiative at least one project focused on education which integrates IT into an already proven rural education model such as Telesecundaria/Telebasica (Colombia, Guatemala, Honduras), Escuela Post-Primaria Rural (Colombia), Escuela Virtual (Colombia), or Escuelas Rurales Activas (Guatemala).

4. Critical Importance of Voice Telephony

If rural ICT investments, particularly multipurpose telecenters, are to be sustainable and recover all or a significant portion of their investment and operating costs, it will be essential to ensure they can provide basic telephony access to rural communities, on a fee for service basis. General experience with rural telecenters shows that voice telephony generally accounts for a large majority of operating revenues, often in excess of 80%. For this investigation, a Demand Assessment was conducted in several Bolivian communities, which showed that projected revenues from voice telephony would constitute 90% of projected revenues in the initial years of telecenter operation. In some cases, legal or bureaucratic obstacles exist to incorporating voice telephony into rural telecenter. If these obstacles are not overcome, it will be extremely difficult to develop sustainable rural telecenter programs.

5. Content Issues

Significant educational content exists that is appropriate for secondary and upper level students, both for computers and for more basic ICT approaches such as video, and secondary and higher-level students benefit most from the ability to search out information from a variety of sources. Greater uncertainty exists as to quality and value of content available for primary school students. Good examples exist of specialized information systems appropriate for rural productivity, such as specialized agricultural information systems. To be genuinely useful in any given location, such an information system needs to be linked to local market information and local produce buyers and input sellers, and technical information provided needs to be adapted to local problems.

6. Challenge of Multi-Sectoral Interventions

Impact of investment in rural ICT facilities and services will be maximized if this infrastructure can support multiple sectors and respond in a flexible manner to needs in sectors such as education, health, agriculture, rural enterprise, improved governance, and other areas, as well as supporting basic voice telephony. This presents a challenge for government agencies, which in most countries are accustomed to working within their specific sector. Development of effective rural ICT activities, and development of effective ICT programs in general, will require countries to develop integrated strategies combining different public sector efforts and private sector development efforts. The OAS/IACD can play a key role in helping countries analyze their ICT needs and develop integrated national strategies for promoting effective use of ICT for development.

7. Identification of OAS/IACD Roles/Strengths

One other implication of the strong interest many multilateral and international agencies are showing in ICT and rural ICT activities is that the OAS/IACD should identify a number of specific niches or areas of particular competence in the area of rural ICT development. This does not mean that the OAS should limit itself to these niches or areas. Rather, by clearly establishing a number of areas where it is an undisputed leader and valued partner, it can strengthen its ability to pursue broader rural ICT activities. We recommend that the OAS/IACD consider three complimentary approaches to identify the specific roles or areas to focus on: a) identify activities that build on the OAS's well-established "convening" authority or power (informal and formal) and coordination roles related to hemispheric events and initiatives; b) identify areas or niches that build on and are thematically related to existing OAS initiatives (e.g. rural education activities, building on OAS's existing initiatives related to university-level distance education); and c) identify specific problems or gaps common to a number of countries that are not yet being effectively addressed by other organizations.

8. Early Point on the Learning Curve

Compared to developed country and developing country urban ICT development, developing country rural ICT activities are at a very early stage of development. Many experts and organizations are aware that they are at an early point on the learning curve, in terms of identifying best practices regarding rural applications, equipment recommendations, institutional approaches, and other essential elements. In some cases, there is a need for best practices to be conceptualized, tested, and documented, before they can become solid recommendations or standardized equipment packages. It appears that the OAS Rural Connectivity Initiative can play an important role in this process of testing and documenting such "best practices," so that they can become effective tools for streamlined program implementation.

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ANNEXES

Annex 1: Demand Analysis for Telecommunication Services in Santivanez, Bolivia – Summary of Findings

Annex 2: Equipment Package Specifications and Assumptions

ANNEX 1

Demand Analysis for Telecommunication Services
Santivanez, Bolivia

Summary of Findings

Rural Connectivity and Energy Initiative

Demand Analysis for Telecommunication Services

Community of Santivanez

Summary of Findings

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1. Introduction

The Executive Secretariat for Integral Development of the Inter-American Agency for Cooperation and Development (SEDI/IACD) in collaboration with the Renewable Energy in the Americas (REIA) Initiative of the Organization of American States (OAS) is establishing a Rural Connectivity and Energy Initiative with the aim of delivering information and communications technologies (ICT), to community buildings in isolated rural areas of the OAS Member States, thereby facilitating the provision of high value community services.

2. Rural Telecommunication Demand analysis

A rural telecommunication demand analysis was undertaken to gain an understanding of the potential for establishing a financially sustainable rural telecentre in a representative region of Bolivia. The results provide a perspective on the *current* telecommunication use patterns, expenditures and future potential expenditures in Santivanez and two neighbouring communities. The results of the demand analysis also provide an indicative picture of the *rural* telecommunication use patterns and expenditure patterns that might be expected in other rural communities in Latin America, in that the data highlights the financial importance of *voice telephone use* for the sustainability of rural telecommunication initiatives. Indeed, our experiences with similar research in other rural areas of Latin America and the developing world point to the importance of basic telephone service as the single most important service delivered by rural telecentres.

The survey was conducted by the TeleCommons Development Group in partnership with Winrock International, and with assistance from World Vision staff in Santivanez and Cochabamba. World Vision staff in Canada were instrumental in facilitating the survey work. The survey interviews were conducted between November 15, 2001 and November 19, 2001. Interview data was compiled in Bolivia and analyzed in Canada.

3. Conclusions

Based on the results from the survey, it is clear that the main source of revenues for a rural telecentre is going to come from the use of telephones – *voice telephony*. This has fundamental implications for any program or project promoting the use of information and communication technologies for rural development. For example, the Bolivian government's PRONTER program for the establishment of rural telecentres provides only for Internet access, and does not explicitly encourage the deployment of voice telephony. The results from Santivanez indicate that the PRONTER program will not likely be financially sustainable unless the demand for voice telephony is addressed.

Internet and E-mail revenues can only be expected to begin at a level of about USD $6,245 per year which, in our view, would not be sufficient to sustain a telecentre that provides only Internet access. In comparison, revenues from accessible and well-maintained telephone services would be able to capture a significant proportion of the estimated USD $129,792 *currently* spent on telephone services among people in Santivanez. Given that the single public payphone in Santivanez is not operational, these telephone users must travel to Cochabamba to use the telephone, use the telephones of family members, friends or local businesses, or use cellular phones where that service is reliable. In this context, a well-managed telecentre that also provides payphones in strategic locations would likely be able to capture the majority of the local telephone expenditures, and would also be able to significantly enhance telephone traffic and local revenues.

While the number of Internet users, could grow, at this stage it is not clear how many people will be using it in the near and medium term. A telecentre equipped with 2 – 3 Internet connected computers would be more than adequate to serve current users, and build awareness and demand among future users. Expansion of Internet services could be based on revenue growth. It is quite likely that telecentre computers would generate more revenue when used as a basic computer training lab, than as Internet connection devices alone.

In parallel with findings from rural telecommunication studies we have undertaken in other countries[1], we note that there is a gender dimension associated with telecommunication use. In Santivanez, females prefer more to use residential, institutional, and communication centres. This may be related to cultural factors and/or safety issues. Regardless of the factors involved, we interpret this to mean that a telecentre facility, or even a simple shop where an operator assists telephone users, would be more comfortable for female users than a public payphone. This has implications for telecentre and telephone business planning because in order to capture all of the available revenue to financially sustain a service, it is important to make the service attractive, comfortable and accessible to all segments of the population.

There is an excellent business case for establishing a telephone-focused telecentre in Santivanez – a telecentre that would provide centrally located telephones with staff to provide user assistance and revenue collection, plus strategically located card operated payphones, including payphones in more remote communities. We believe that this approach would also prove successful elsewhere in rural areas Bolivia and Latin America/Caribbean. Even if the telecentre were able to capture 50% of currently available revenue, $65,000 could easily support the installation of 10 to 12 phone lines and/or payphones. Conservatively, we could expect a 1-year return on investment on the capital costs required.

If a telecentre is going to be established in the community of Santivanez**,** it will have to compete for customers with other service providers in the area. This fact should be taken into consideration by the telecentre management, while preparing their business and marketing plans. Opportunities for a local organization to collaborate with the local telephone operator in Cochabamba, Comteco/Bolivia Tel, would likely be productive if the operator were able to review this demand analysis, and the local organization had access to capital to facilitate installation of a telecentre and payphones.

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[1] See for example our study of Grameen Telecom's Village Phone initiative in Bangladesh – www.telecommons.com/villagephone/index.html

Finally, we strongly recommend the use of telecommunication demand assessments prior to the development of rural telecentre programs. The upfront costs of this work will insure that donors, telecom operators and communities realize an optimum return on their investments in time and money. Such assessments will also help proponents construct viable, needs-based and market-oriented business plans for rural telecentres.

3. Organization of the survey

3.1 Content of the survey

The main sections of the survey were a) demographic information on the respondents (three questions), b) information on non-phone users (two questions), information on non – Internet users (two questions), d) current phone users (nine questions), e) current Internet users (nine questions), f) current e-mail users (four questions), and g) telecentre and services (two questions).

3.2 Sample frame

The three communities where the survey was conducted have a total population of 5503 residents. Each of the communities has the following number of residents: a) Santivanez – 4159, b) Caporaya – 642, and c) Huanacota – 702.

3.3 Sample size

During the survey a total of 139 questionnaires were completed (55 in Huanacota, 43 in Santivanez, 27 in Caporaya, and 14 in Villa Horizonte).

3.4 Confidence level and margin of error

Based on the total population, and the number of surveys completed, the confidence level is 90% and the margin of error is 7%.

3.5 Estimation

Whenever the estimated number is provided in ranges, the lower range is based on the lower range of the range provided with the survey question, and the higher range on the higher range provided (i.e. when asked about the average length of the phone calls the respondents are asked to provide the response in the range of 1-3 minutes, 4 – 6 minutes and so on.)

3.6 Exchange rate

The exchange rate used for the conversion of Bolivianos in USD is 1 Bolivianos = USD $0.15.

3.7 Assumptions

3.7.1. Selection of respondents

We assume that the selection of the respondents was done randomly, and that both the gender and the age of the respondents represent the gender and age distribution of the residents in the three communities.

3.7.2. Usage pattern
As we lack the information on the gender and age breakdown of the population in the three communities, the following analysis is based on the assumption that gender and age do not play a significant role in the phone usage pattern. At the same time, we are assuming that the place of residence does not have a significant influence on the phone usage pattern.

3.7.3 Number of users
For the purposes of the survey, everyone 15 years old and over is considered a potential user for the ICT tools, and based on the demographic data for Bolivia 61.84% of the population falls under this category. We therefore assume a similar population structure in Santivanez.

3.7.4 Number of ICT users
As the distance of the communities of Caporaya and Huanacota from Santivanez is respectively 8 and 12 Km, the assumption was made that in the case of establishing a telecentre, it would be in Santivanez. At the same time, based on this assumption, all the estimations were done based *only on the number of residents living in Santivanez*.

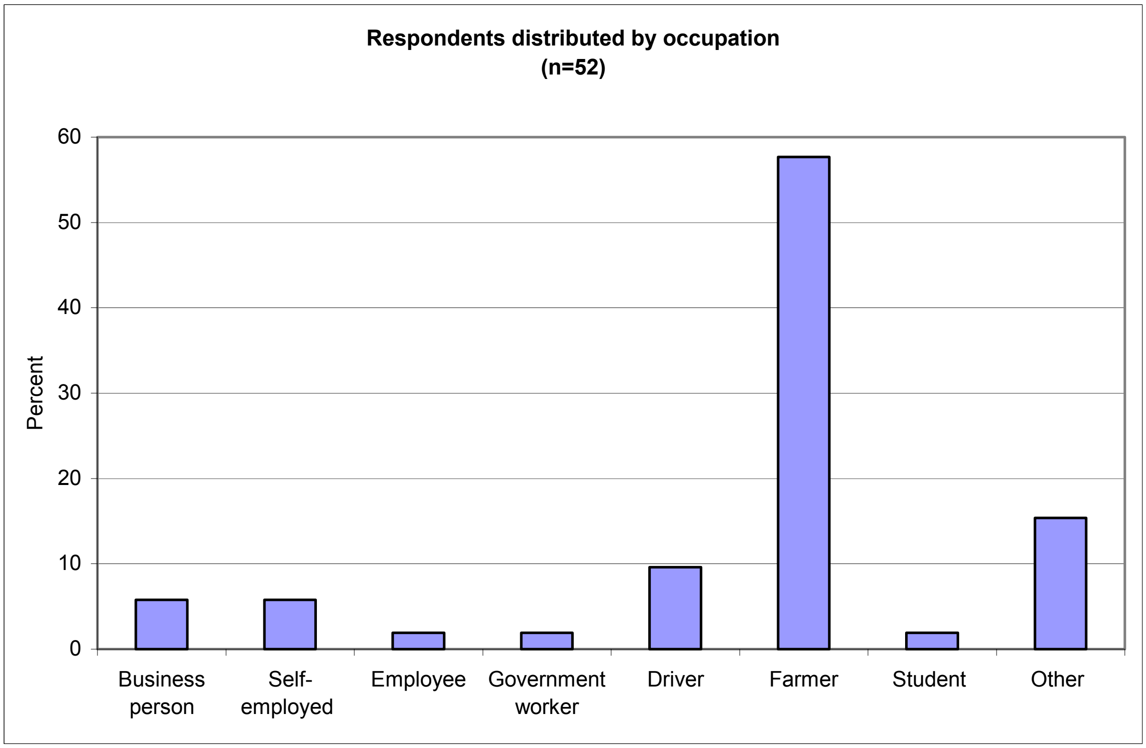
4. Findings

The survey was conducted between November 15 and 19, 2001, and was administered by a team of ten people. During the course of the survey, 139 people in residing in 4 different communities were surveyed. The following section describes the findings of the survey. It follows the same order as the sections in the survey form.

4.1. Demographic data

While the number of males (51.8%) in the survey was slightly higher than the number of females (48.2%), there was a more equal breakdown of the respondents when the age was taken into account. Three age groups (21 to 30 years old, 31 to 40, and 41 to 50) had an equal representation with 23.7%, and the respondents who were between 51 and 60 years old represented 28.8% of the sample population. As far as occupation of respondents, most of them were farmers (57.7%), followed by drivers (with 9.6%), business people and self-employed (with 5.8% each), and employees, Government workers, and students (with 1.9% each).

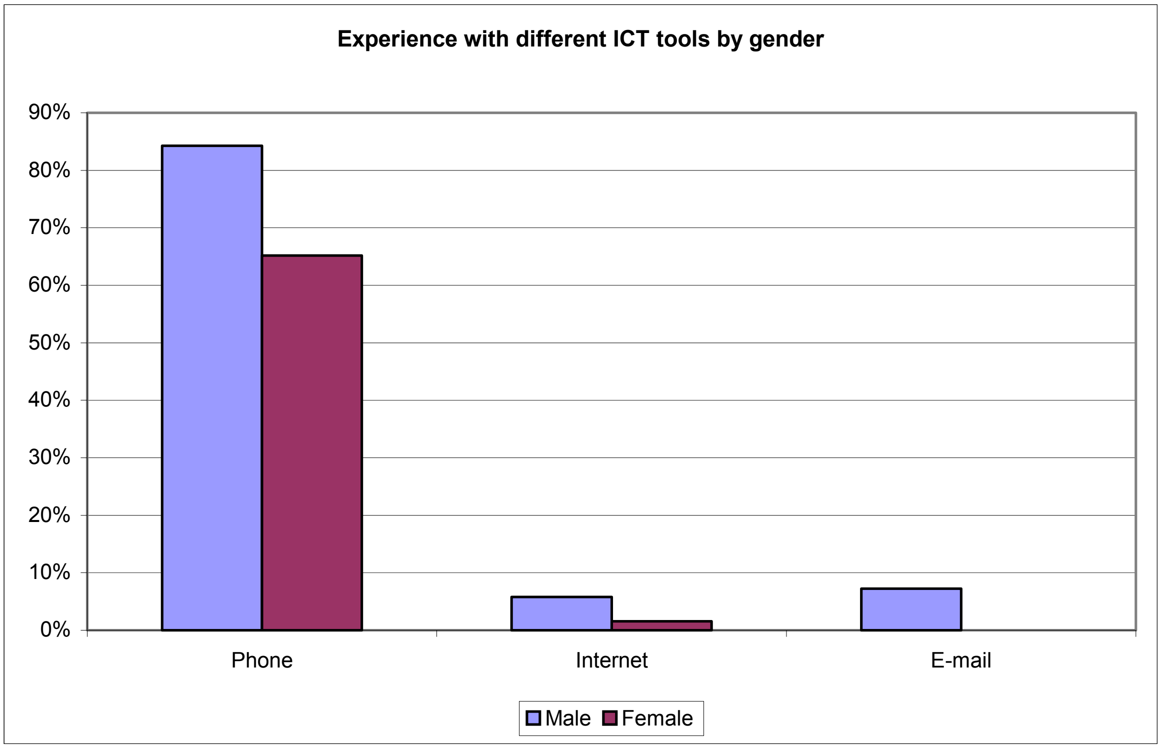
Graph 1. Occupation of respondents



4.2. Previous experience with ICT tools

The majority of the respondents had pervious experiences in using phones (91.1%), while only 4.5% reported having experience in using Internet and e-mail. While age plays a limited role in the use of different ICT tools, gender seem to have a greater influence. No females reported to have experience in using e-mail (all the e-mail users were male). At the same time males reported to have more experience in the use of Internet (use of the World Wide Web) (6% compared to 2% of females), and phone (84% of males compared to 65% of females).

Graph 2. Previous experience in using different ICT tools by gender



4.3. Non-phone users

Two of the main reasons for not using the phone, were reported to be the distance to the nearest phone (30.7%), and the absence of the phone in the community (30.1%). When asked about the willingness to pay for phone calls if a phone was placed nearby, the majority of the non-phone user respondents (84.1%) said that they are willing to spend between 1 and 50 Bolivianos per month on phone calls.

4.4. Non-Internet users

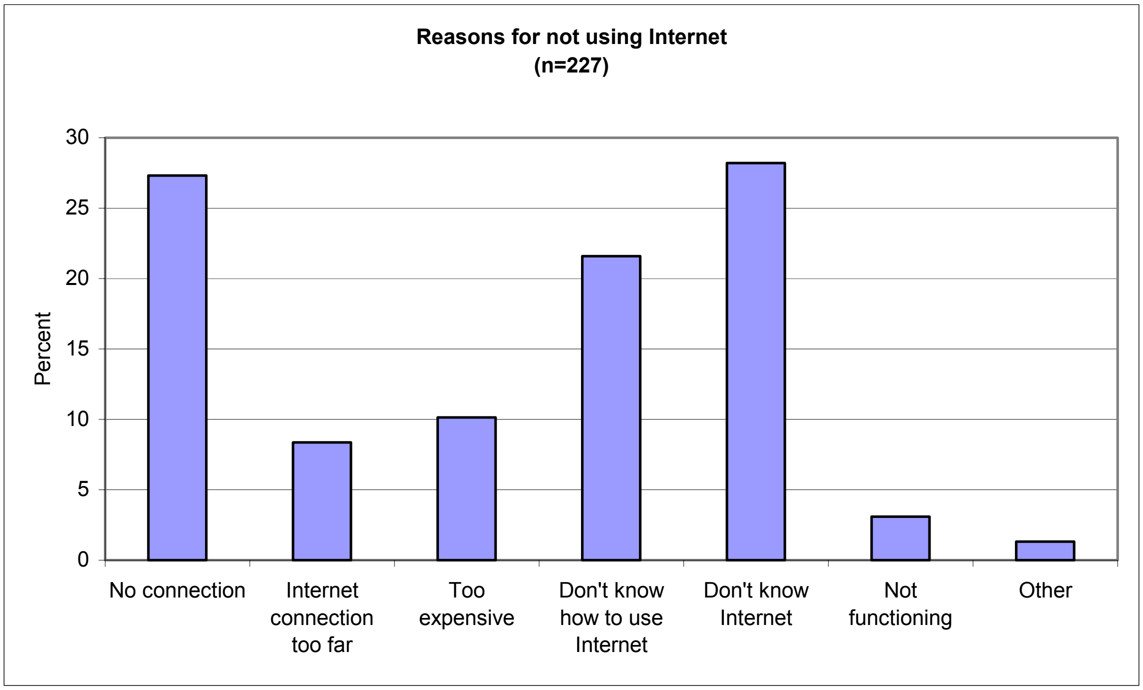
The main barrier in using the Internet was reported to be the lack of knowledge of Internet or the lack of knowledge on how to use it (with 49.8% of responses). The cost of an Internet connection was stated as a barrier only in 10% of the responses.

4.5. Phone users

More than three-quarter of the respondents (83.3%) reported to have used the phone in the last three months, and for close to two-thirds of them (62.1%) the most used type of phone is a public payphone. Payphones and cellular phones are preferred more by males, while females prefer more to use residential, institutional, and communication centres.

Calling family or friends is the main purpose of phone calls (89.9% of originated calls – where females make more calls than males), followed by discussing financial matters with family (5.6% - with males making more calls than females). Other purposes include business or trade (1.7%), and health issues (2.8%).

Graph 3. Reasons for not using Internet



More than half of the originated calls (51.5%) are local calls (with males making more local calls), followed by national calls (29.7%), and international calls (18.8% - with females making more). The survey showed that close to one – quarter of the originated last three phone calls (26.1%) are between two and five minutes in length, and that more than half of the originated last three phone calls are less than ten minutes in length. The average length for the last three originated phone calls is between 8.5 and 11.3 minutes.

Table 1. Length of last three originated phone calls (Cumulative percentage)

Duration of phone calls	Percent	Cumulative percent
Less than 2 minutes	10.3	10.3
2 - 5 minutes	26.1	36.4
6 - 10 minutes	22.4	58.8
11 - 15 minutes	14.5	73.3
16 - 20 minutes	10.3	83.6
More than 20 minutes	16.4	100.0
Total	100.0	

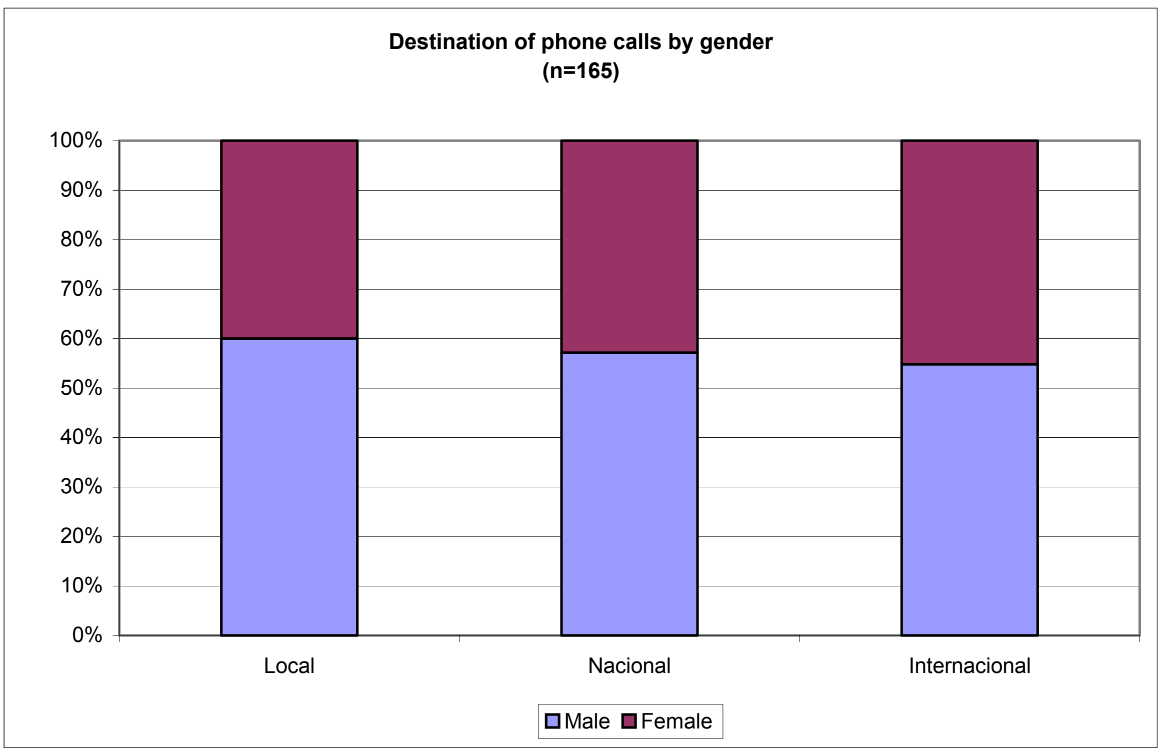
In general, the average length for a phone call is between 6.8 and 10.6 minutes, where close to one-third of calls (32.7%) are between three to six minutes, followed by phone calls between 11 and 15 minutes (30.9%).

Table 2. Length of originated phone calls (in general)

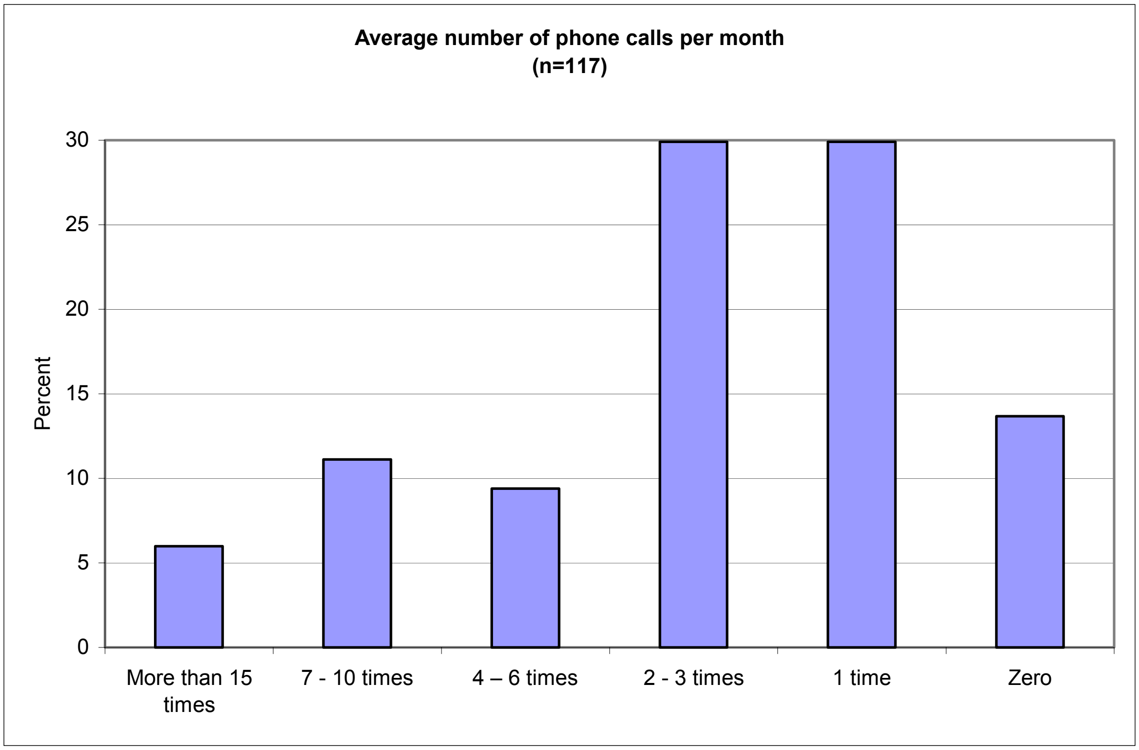
Duration of phone calls	Percent	Cumulative percent
1 – 3 minutes	10.9	10.9
4 – 6 minutes	32.7	43.6
7 – 10 minutes	20.0	63.6
11 – 15 minutes	30.9	94.5
16 – 30 minutes	5.5	100.0
Total	100.0	

When asked about the average use of phones (in number of times) per month, the respondents indicate that close to two-thirds (59.8%) use the phone between one and three times per month. On average, the phone is used between 3.4 and 4.4 times per month. Males use the phone on average between 4 and 5.2 times a month, while females use it between 2.6 and 3.3 times.

Graph 4. Destination of outgoing phone calls by gender



Graph 5. Average number of phone calls per month



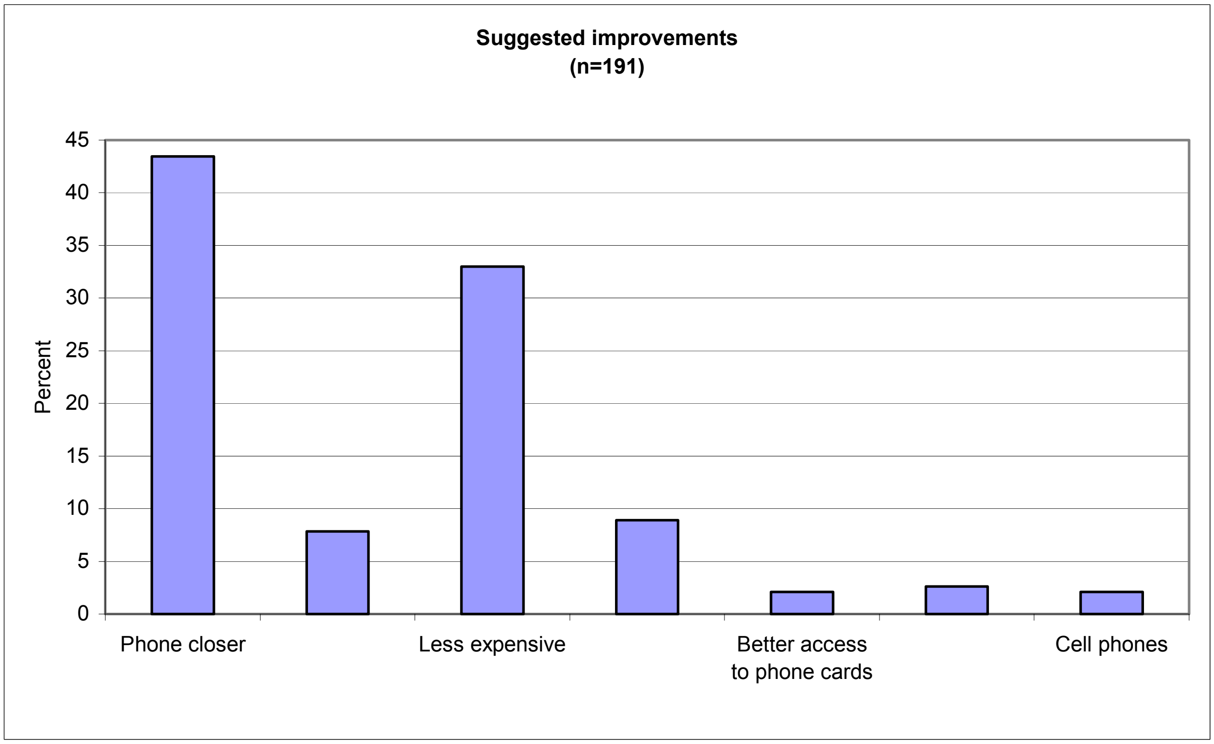
Most of the respondents (81.7%) stated that on average they spend between one and 50 Bolivianos per month on phone calls. The remainder of respondents spend between 51 and 200 Bolivianos per month. The average user spends between 8.5 and 59.5 Bolivianos per month on phone calls.

4.6. Improvements to be made

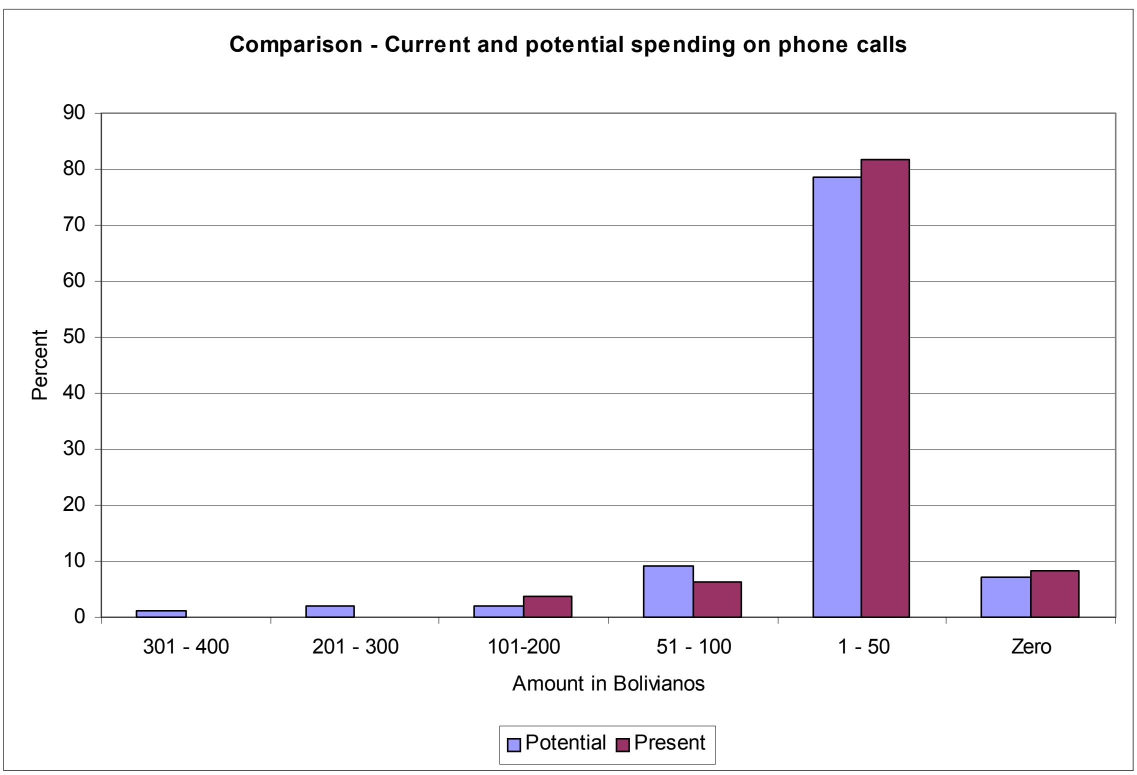
The main improvement suggested by the respondents is related to the vicinity to a phone (with 43.5% of responses), followed by the reduction in the price of phone calls (33%), and better functioning of phones (8.9%).

If the suggested improvements are going to be implemented, more than two-thirds of the respondents (70.8%) stated that they would spend more money of phone calls, and only 29.2% stated that they are not willing to spend more. If the improvements are made, however, the responses do not indicate that overall telecommunication expenditures would increase dramatically.

Graph 6. Suggested improvement for the phone system



Graph 7. Comparison between current and potential expenditures on phone calls per month



4.7. Internet users

Only six (7.5%) of the people who responded to the question regarding the use of Internet (80 altogether), reported to have been using Internet previously. The main suggestion made by the respondents in relation to the use of Internet was the provision of training (26.8%). Other suggestions were to have a closer Internet connection (25.9%), availability of Internet connection (25%), and lower cost of service (11.6%).

If the suggested improvements were to be implemented, more than half of the respondents (57.4%) stated that they would be willing to spend more money on Internet use. The majority of the respondents (91.7%) stated that they would spend between 11 and 15 Bolivianos per month.

6.8. E-mail users

Only eight (11.9%) of the respondents who replied to this question (67) said that they have used e-mail previously. The majority of the users (93.8%) spend between 11 and 15 Bolivianos on monthly basis for the e-mail service.

6.9. Telecentre

The most preferred location for the telecentre is Santivanez (with 31.9% of responses), followed by Caporaya (with 29.7%). As far as the services that the respondent would like to be provided by the telecentre, phone is the first choice (22.3%), followed by Internet (19.2%), photocopy (16.2%), and fax services and training (14.9%)

5. Analysis

5.1 Number of phone calls

The survey showed that 91.1% of the respondents were phone users. Based on this figure and the average number of telephone calls made on monthly basis, the total number of phone calls per month is estimated to be between 6,912 and 8,833.

5.2 Types of phones used the most

The type of phone used most often is the public payphone, from where 62.1% of all calls are made. Based on this, the estimated of number of monthly calls from payphones is between 4,292 and 5,485.

5.3 Destination of phone calls

The average number of phone calls directed locally is estimated to be between 3,560 and 4,549 (51.5% of total calls), the calls directed nationally are estimated to be between 2,053 and 2,623 (29.7% of total calls), and the calls directed internationally are estimated to be between 1,299 and 1,661 (18.8% percentage of total calls).

5.4 Traffic

Based on the average number of phone calls per month and the average duration per call (for the last three phone calls), the monthly traffic (in minutes) for this population is estimated to be between 59,408 and 77,870.

5.5 Average length of phone calls

Based on the average number of phone calls per months and the average number of minutes per month, the average length per phone call is estimated to be between 6.8 and 10.5 minutes.

5.6 Amount of money spent on phone calls

It is estimated that the amount spent on a monthly basis on phone calls is between USD $4,056 and USD $19,207 (and an average of USD $10,816 per month or USD $129,792 per year). This equates to an average monthly expenditure, per potential telephone user in Santivanez of about USD $4.20, and an annual expenditure per potential telephone user in Santivanez of about USD $50.00.

5.7 Potential amount of money to be spent on phone calls

If the improvements suggested in the survey are implemented, the potential amount of money to be spent on phone calls per month will range between USD $4,507 and USD $20,560 (and an average of USD $13,375), an increase of approximately 24% in telephone expenditures.

5.8 Revenues from the use of Internet and E-mail

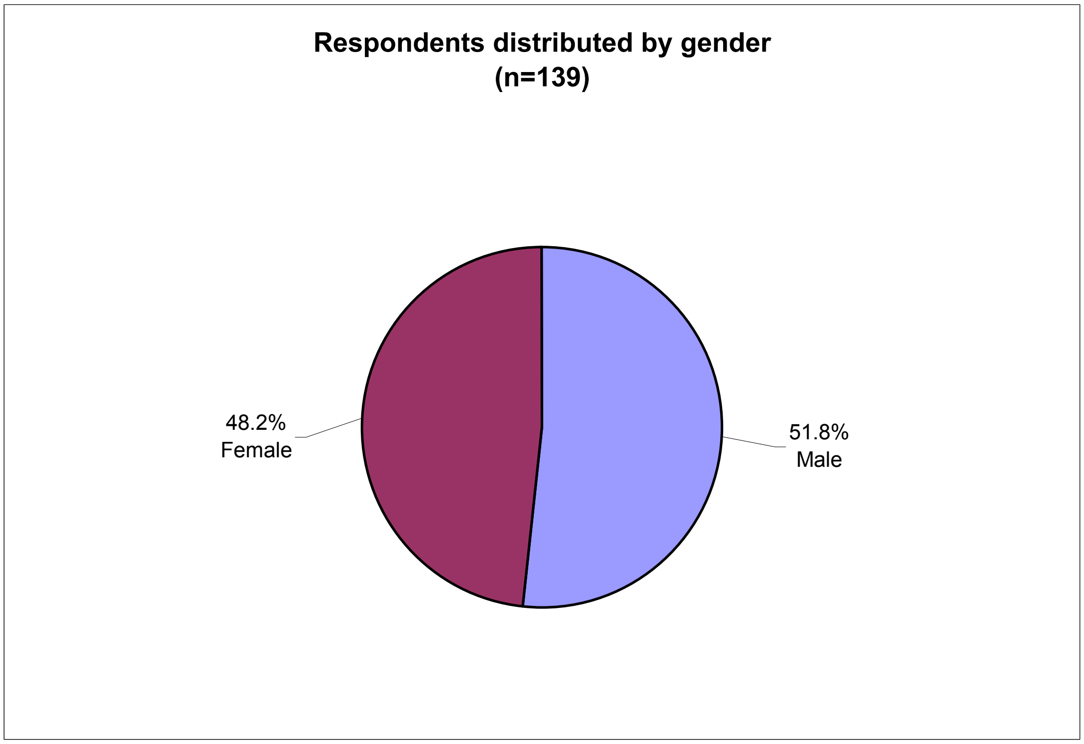
The use of Internet and e-mail from the residents in Santivanez for the time being is limited (only 4.5% of the respondents reported to have used these tools). Based on this information, it is estimated that the total amount of money that *all local* users currently spend on Internet (web use) on monthly basis is between USD $232 and USD $301 (with an average USD $289 or USD $3,476 per year).

The revenues from e-mail use are estimated to be between USD $197 and USD $266 (with an average of USD $231 or USD $2,777 per year).

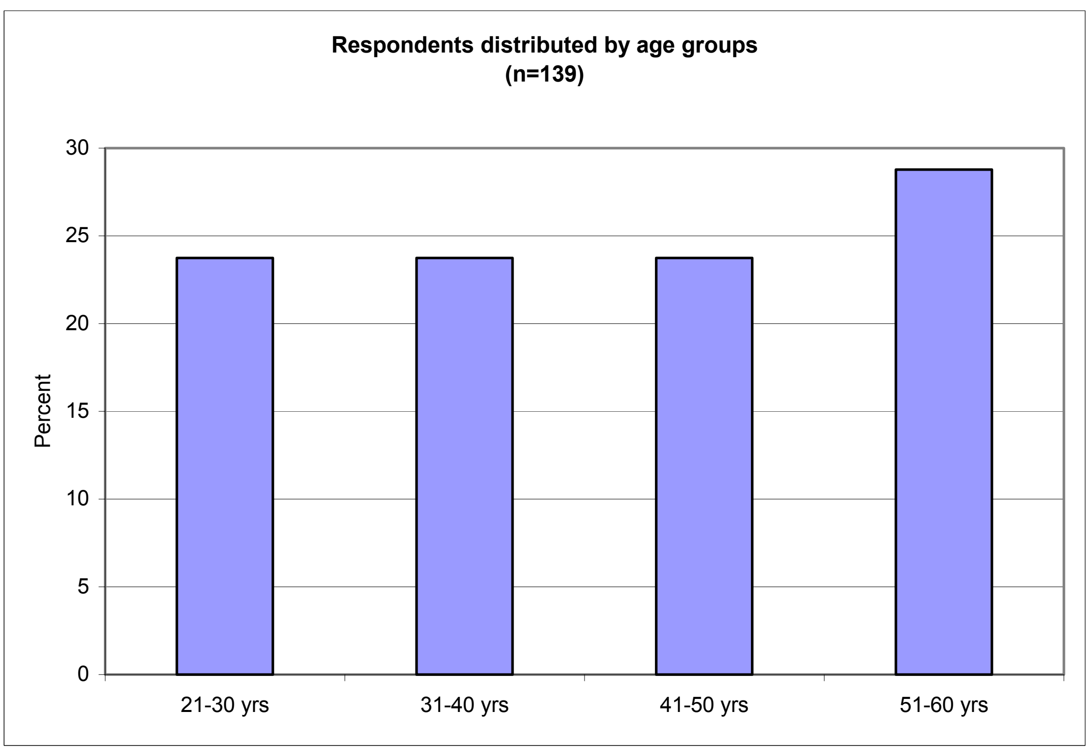
Thus total revenues from all Internet and email use can be expected to be in the range of USD $6,245 per year.

ANNEX - GRAPHS

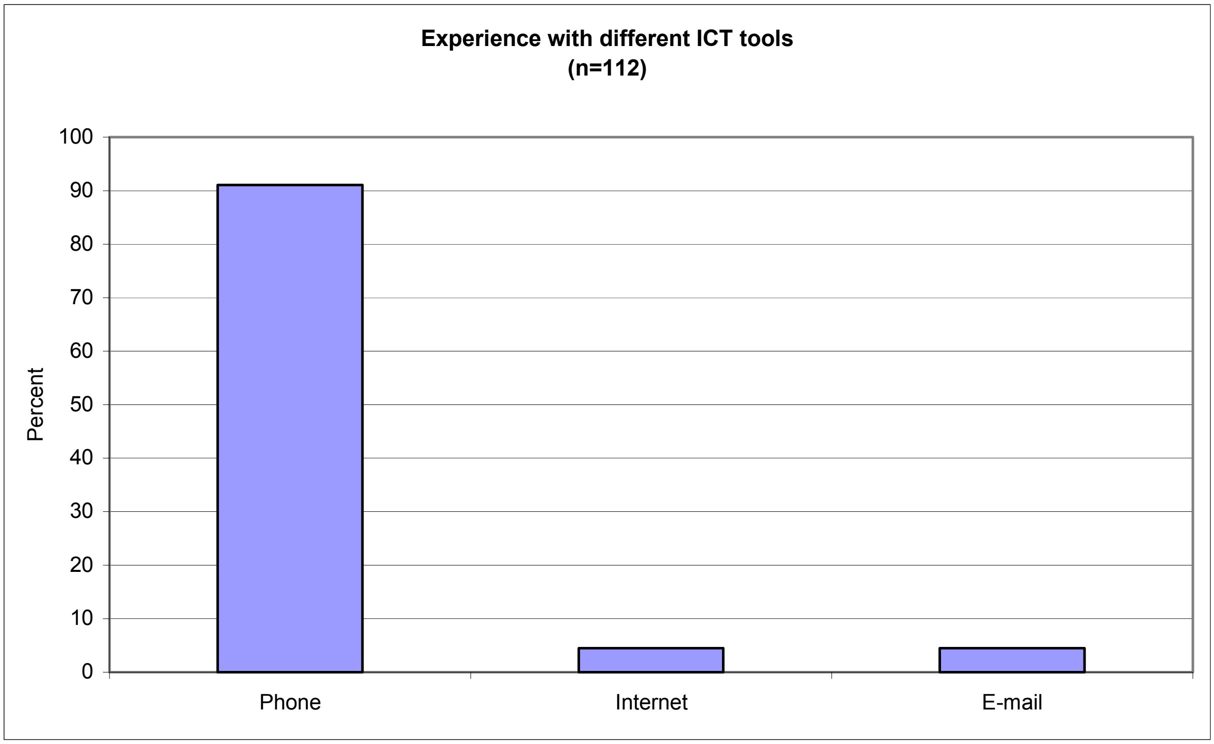
Graph 1 – Respondents distributed by gender



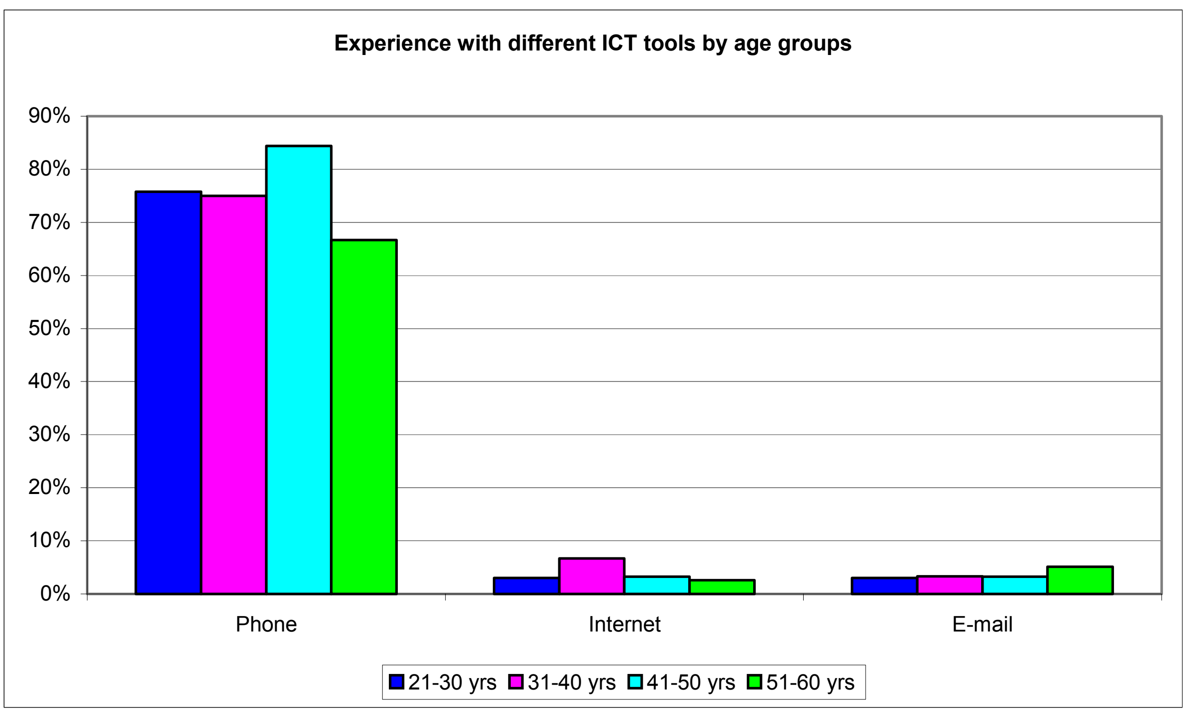
Graph 2 – Age of respondents



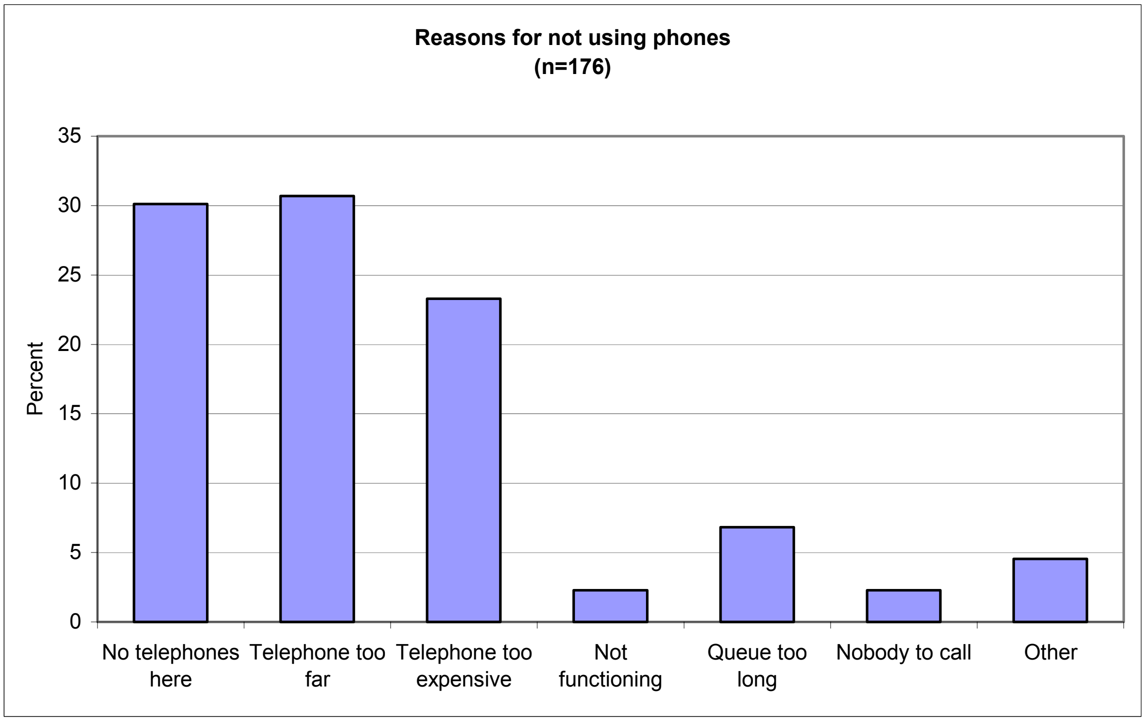
Graph 3 – Experience with different ICT tools



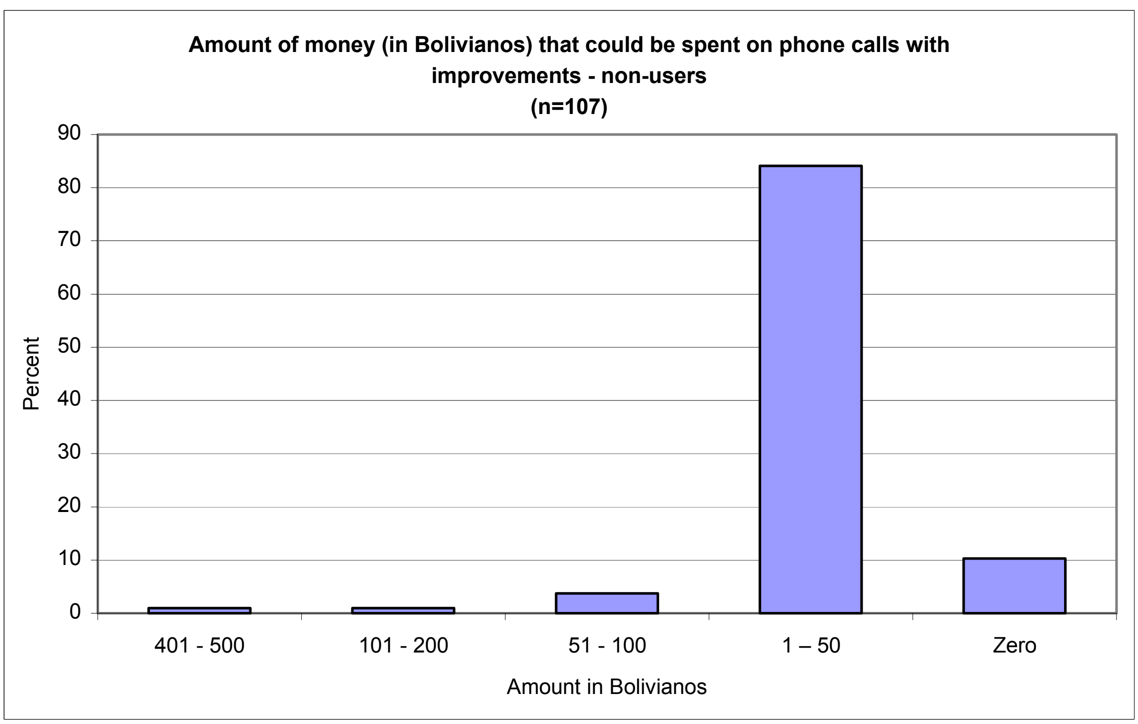
Graph 4 – Experience with different ICT tools by age



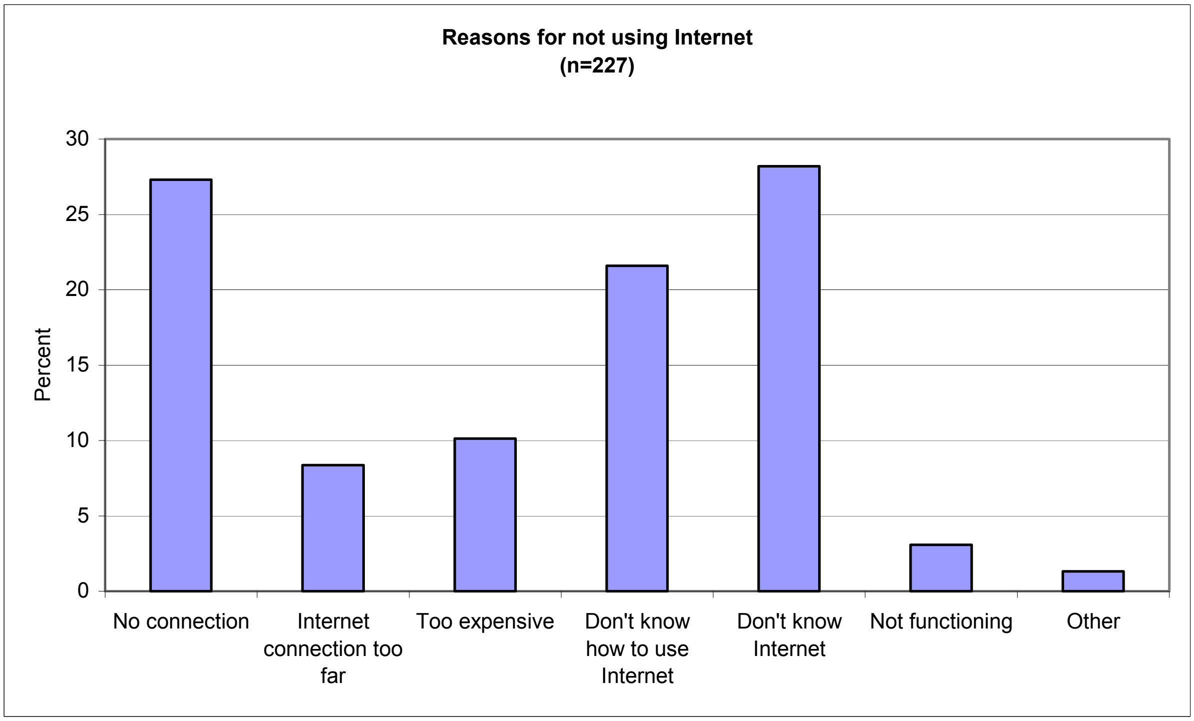
Graph 5 – Reasons for not using the phone



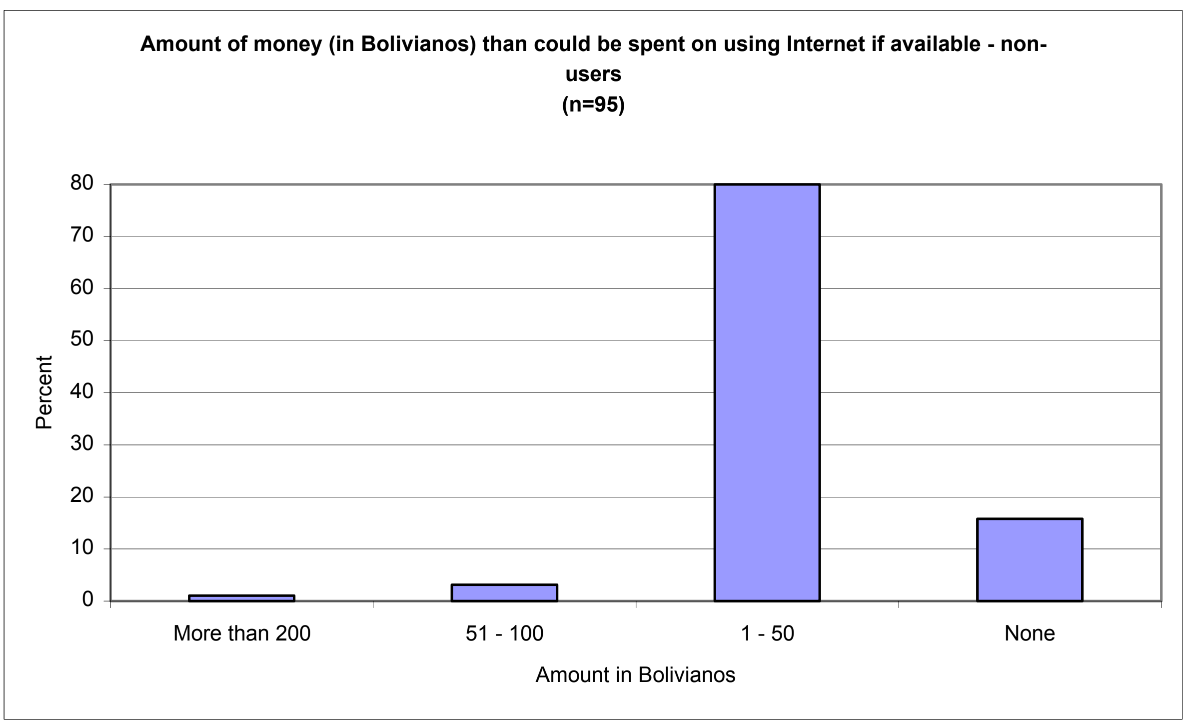
Graph 6 - Amount to be spent in phone calls with improvements – non-users



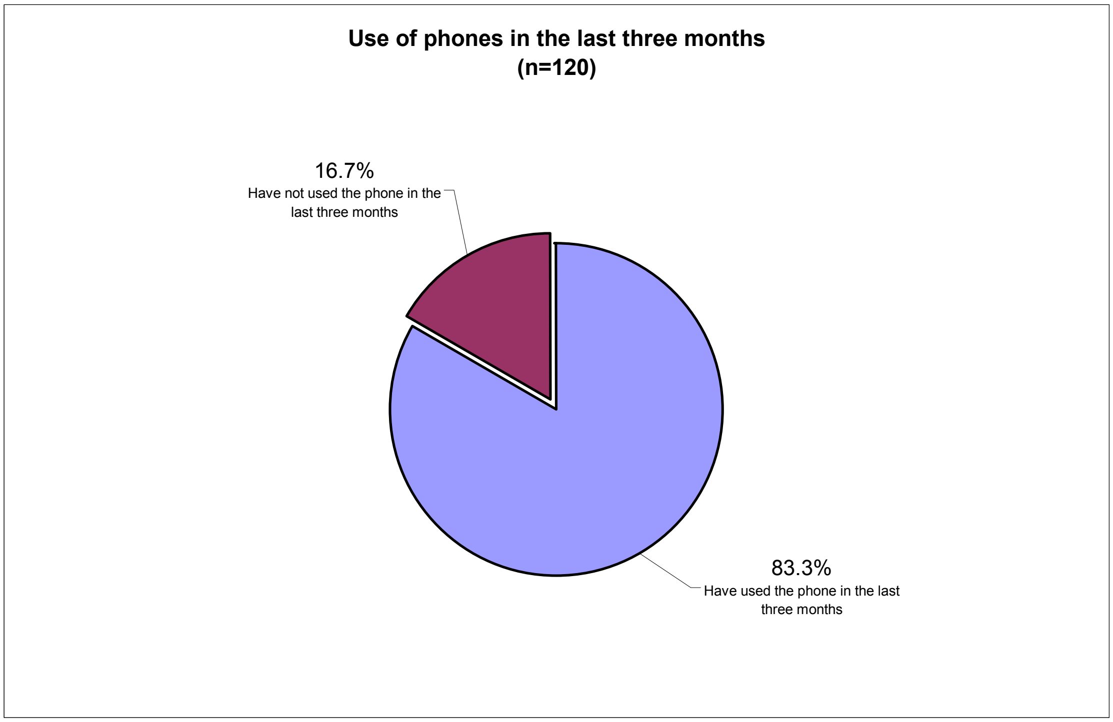
Graph 7 – Reasons for not using the Internet



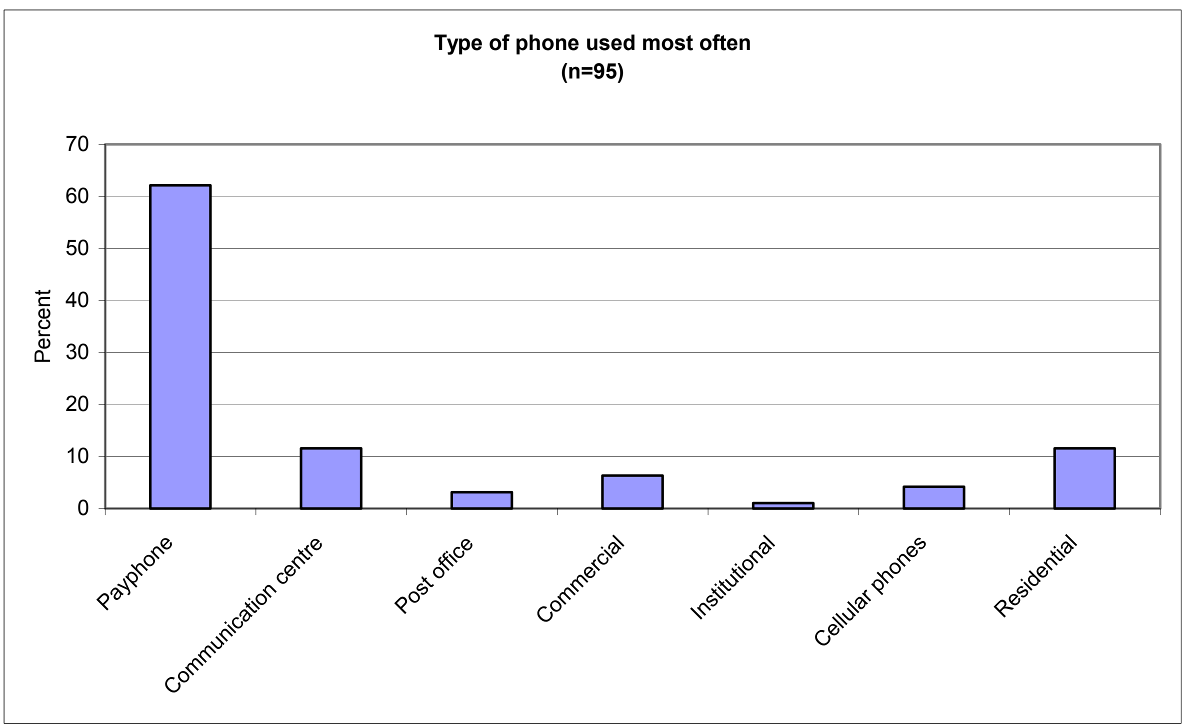
Graph 8 - Amount that could be spent on Internet if available – non-users



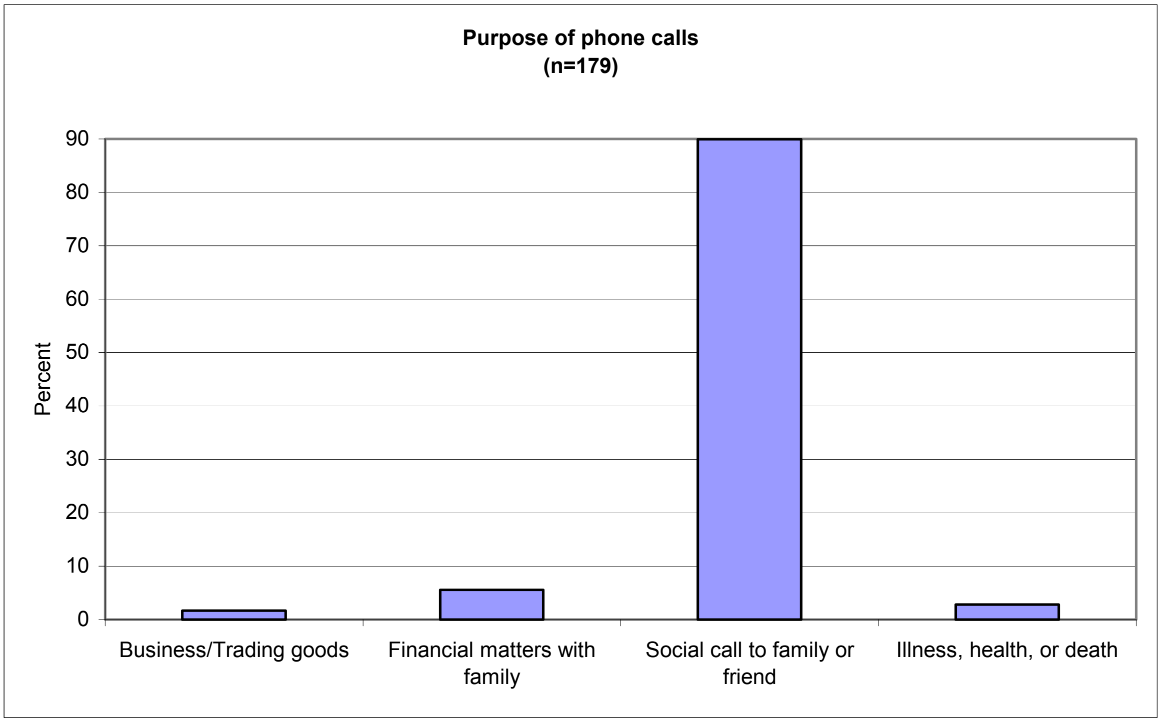
Graph 9 – Use of phones in the last three months



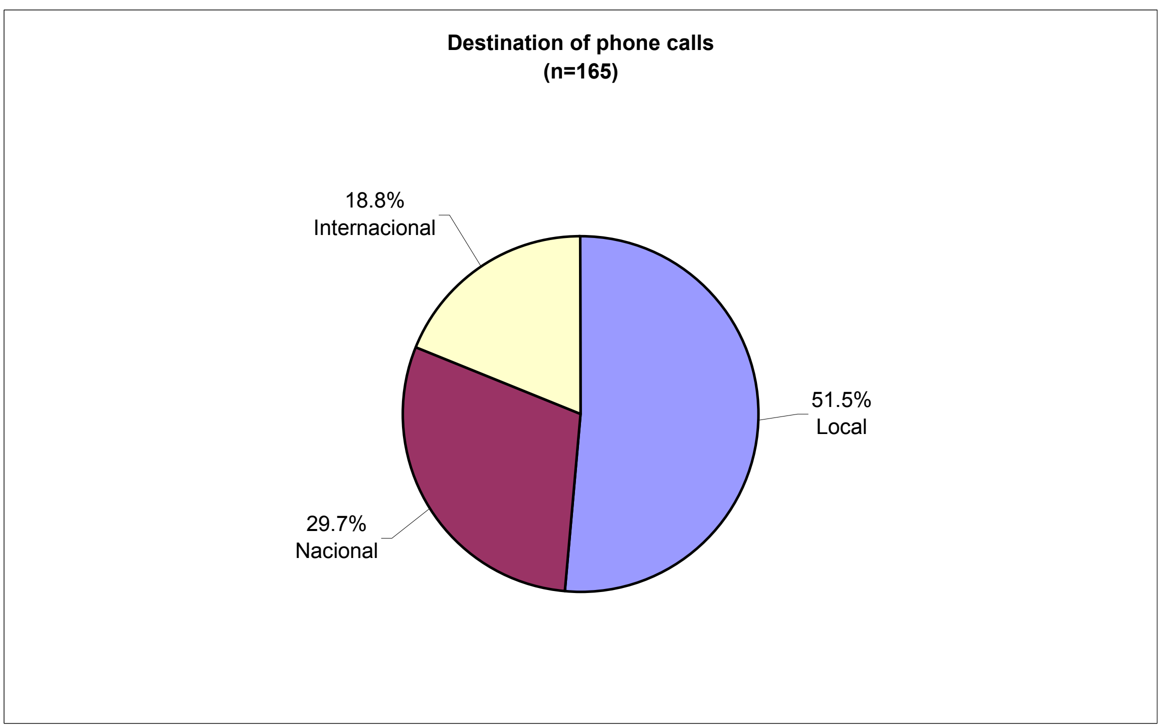
Graph 10 – Type of phone used the most



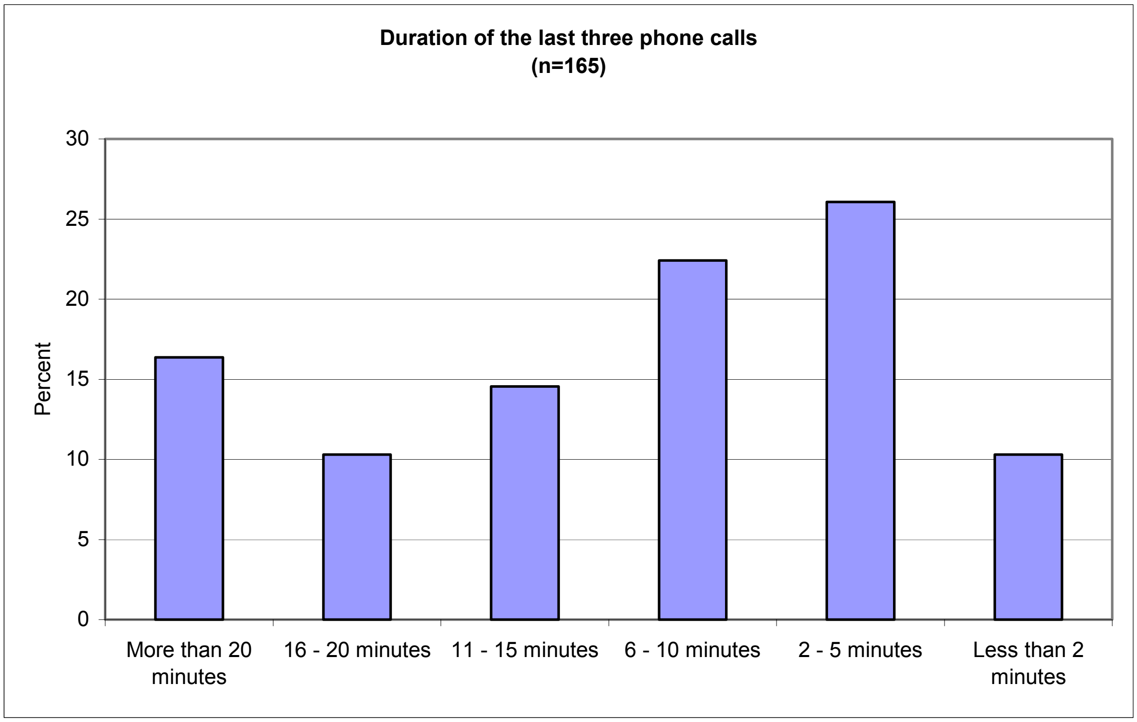
Graph 11 – Purpose of phone calls



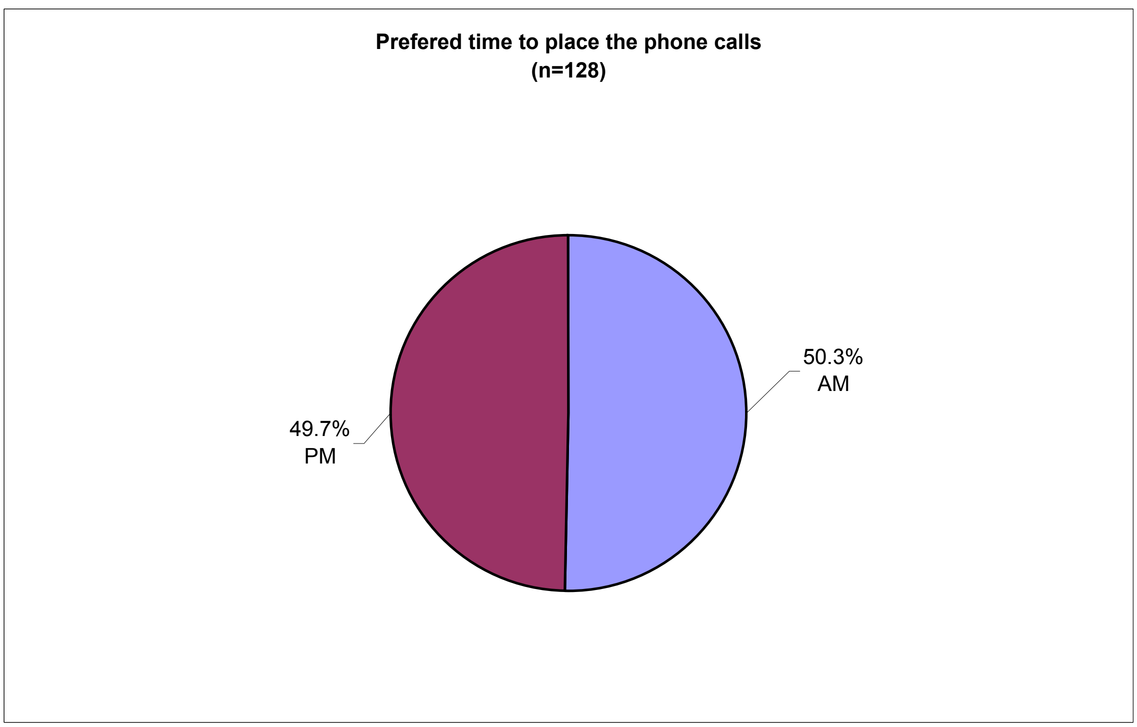
Graph 12 - Destination of phone calls



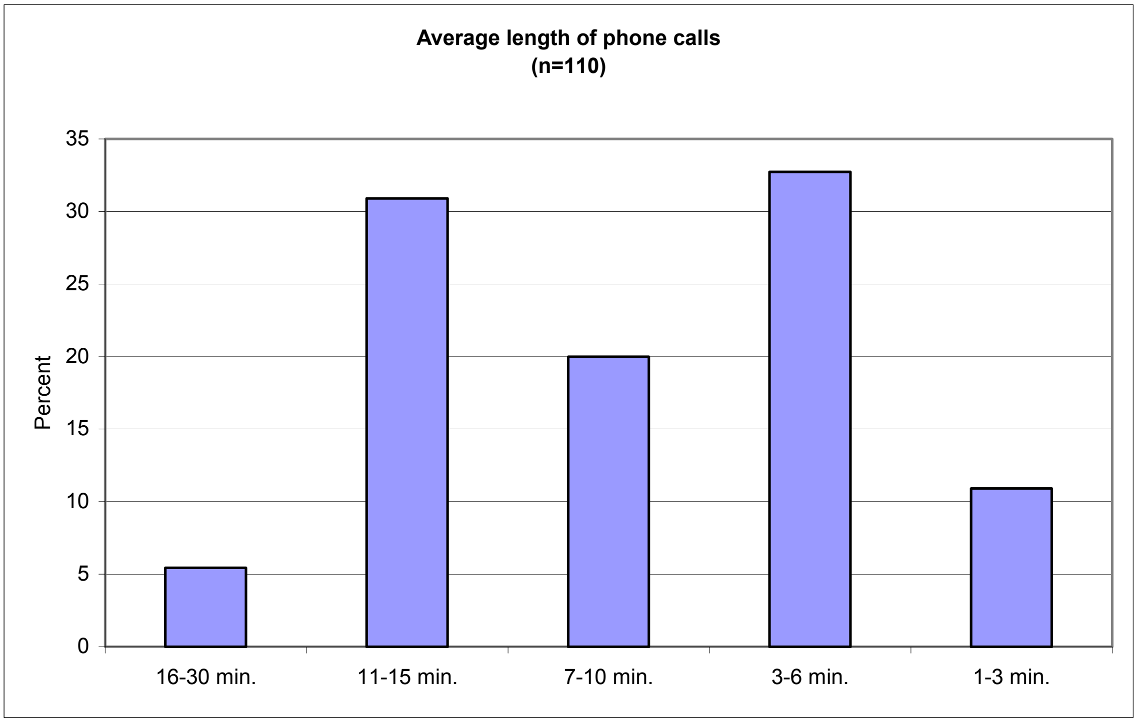
Graph 13 – Duration of the last three phone calls



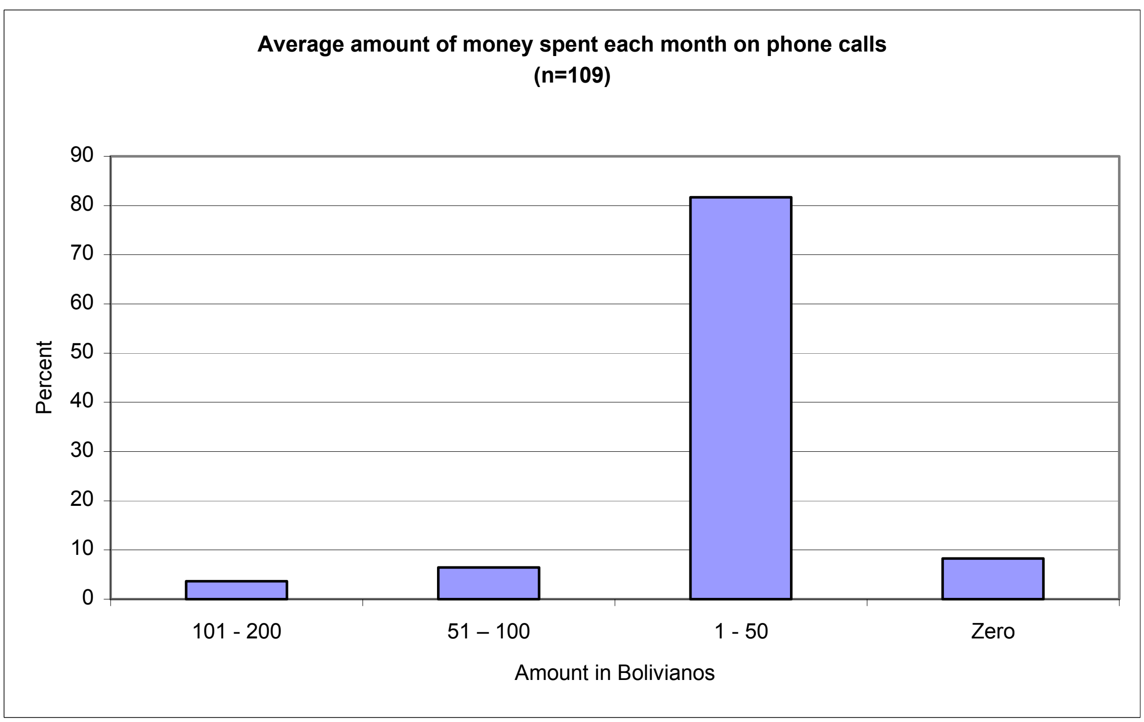
Graph 14 – Preferred time to place phone calls



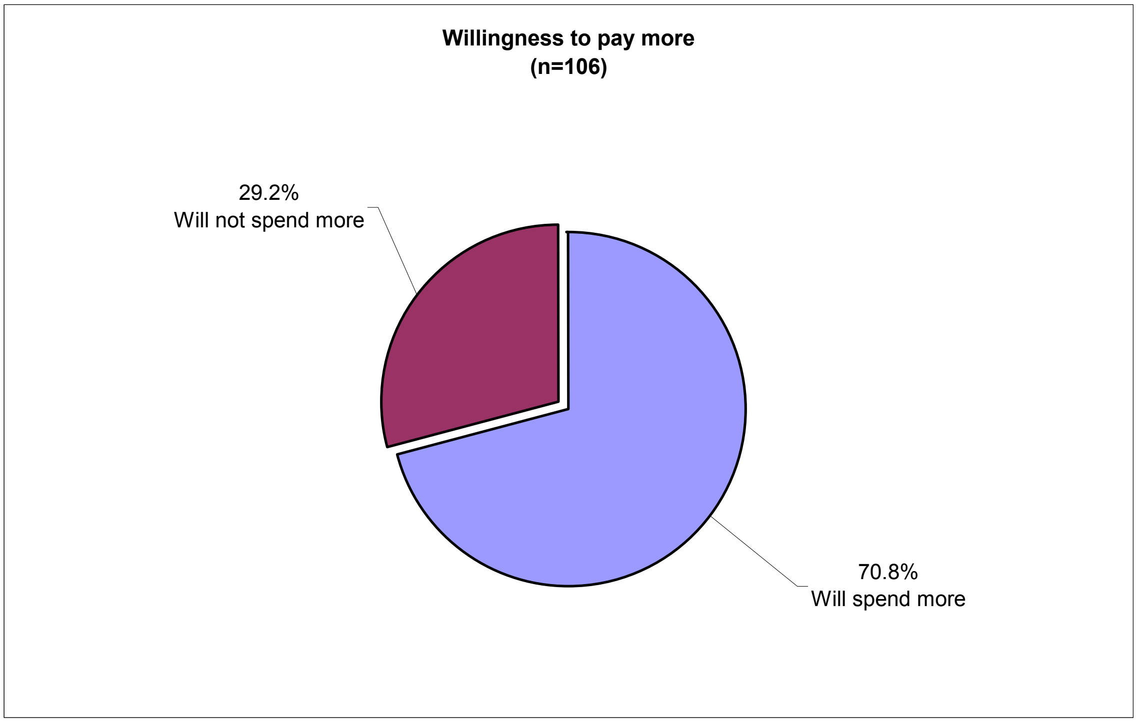
Graph 15 – Average length of phone calls



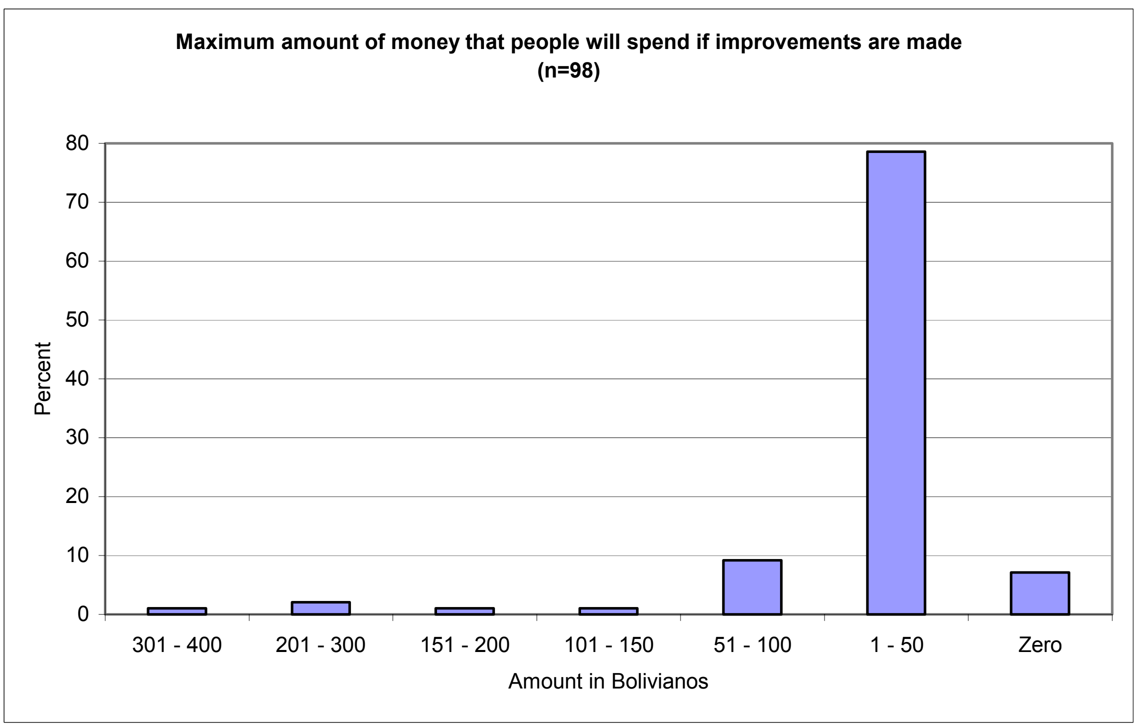
Graph 16 – Average amount of money spent each month on phone calls



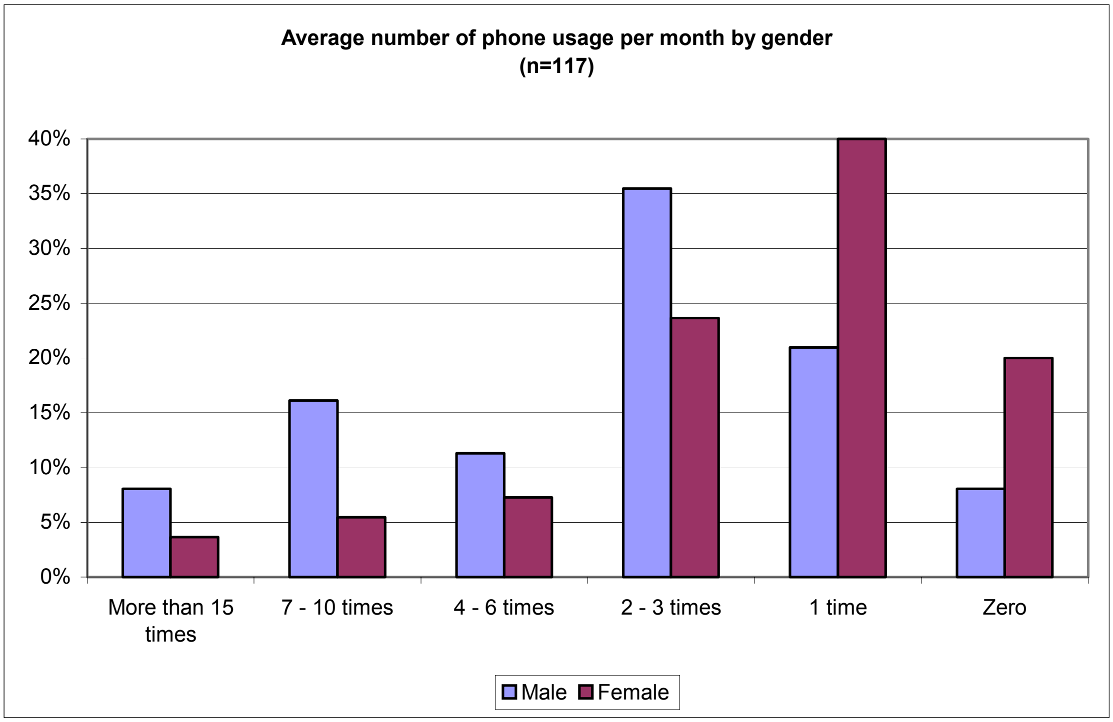
Graph 17 – Willingness to pay more



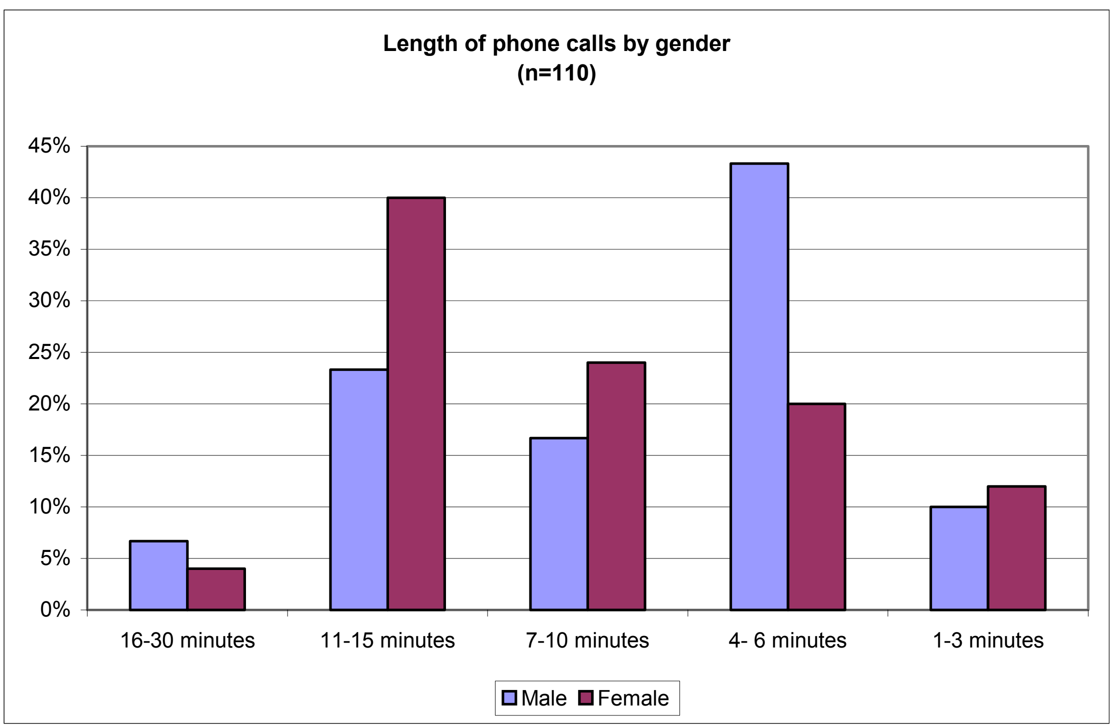
Graph 18 – Amount of money that could be spent on phone calls



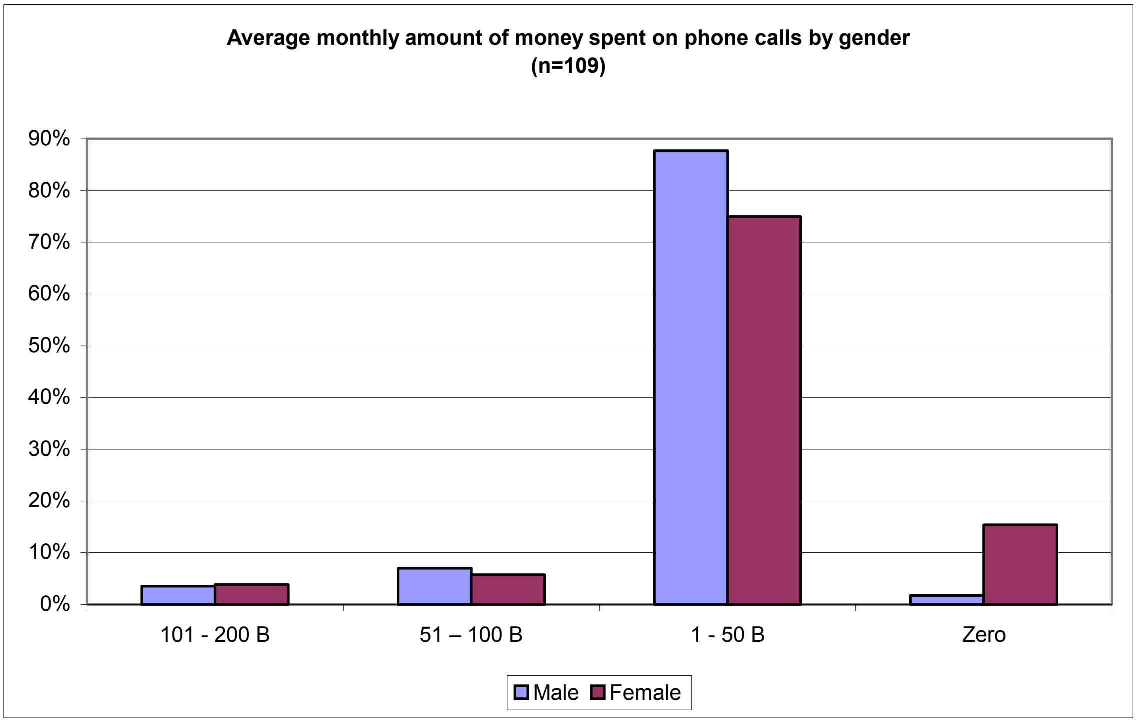
Graph 19 – Average phone usage by gender



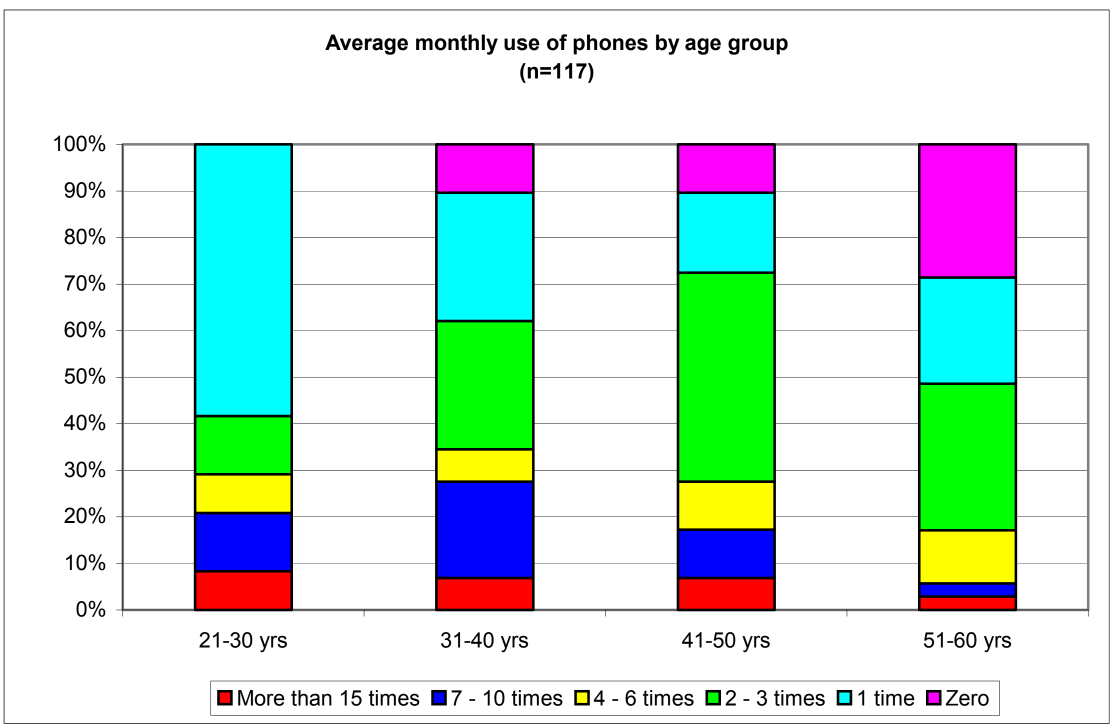
Graph 20 – Length of phone calls by gender



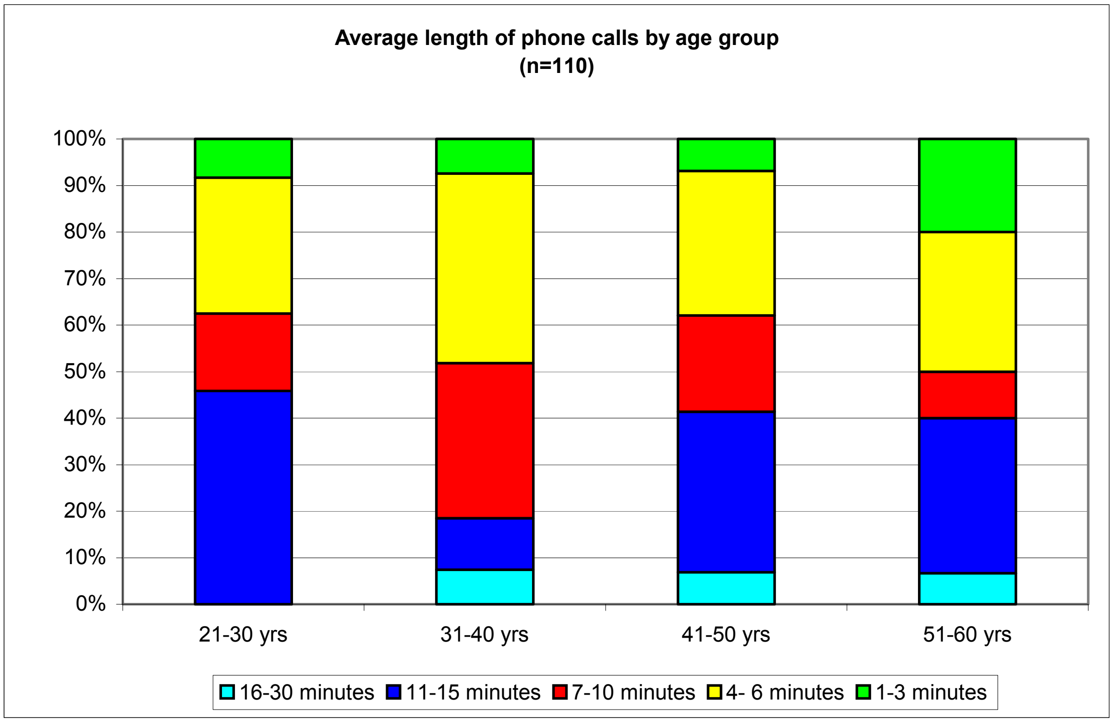
Graph 21 – Average amount of money to be spent on phone calls by gender



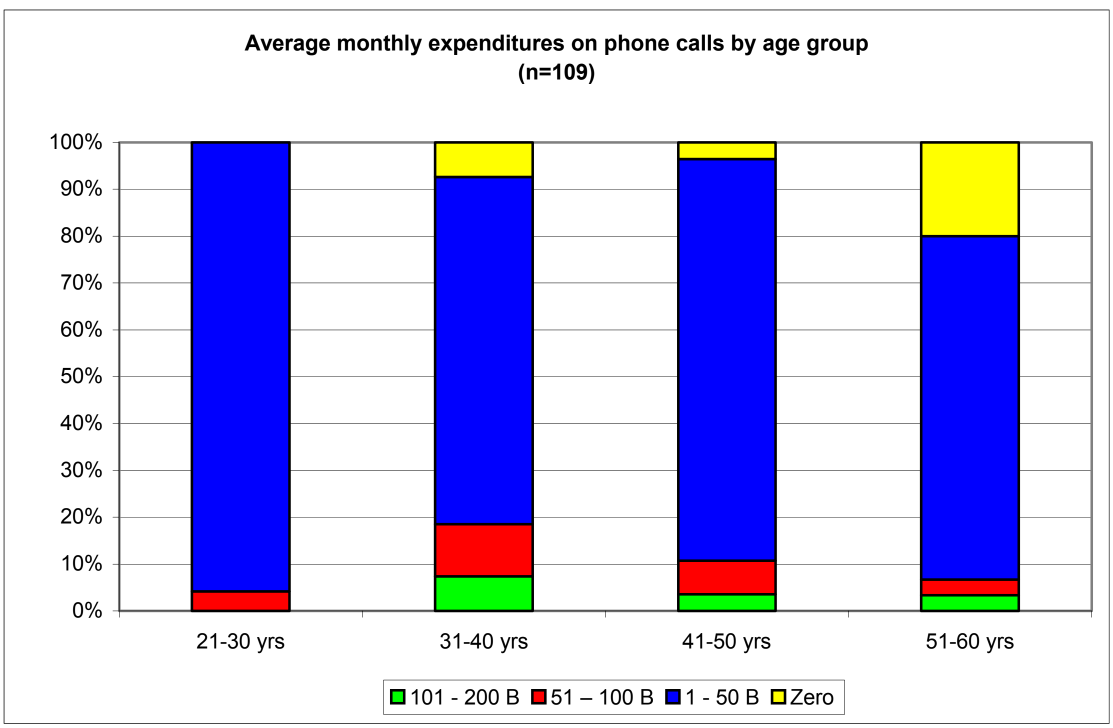
Graph 22 – Average monthly use of phones by age group



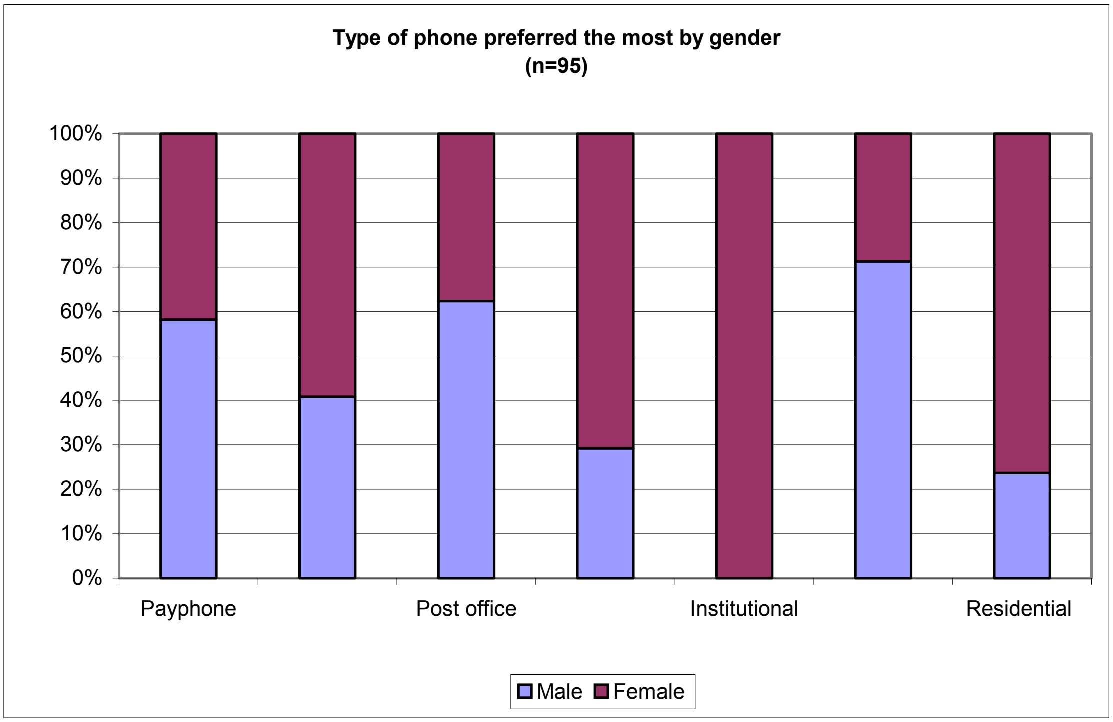
Graph 23 – Average length of phone calls by age group



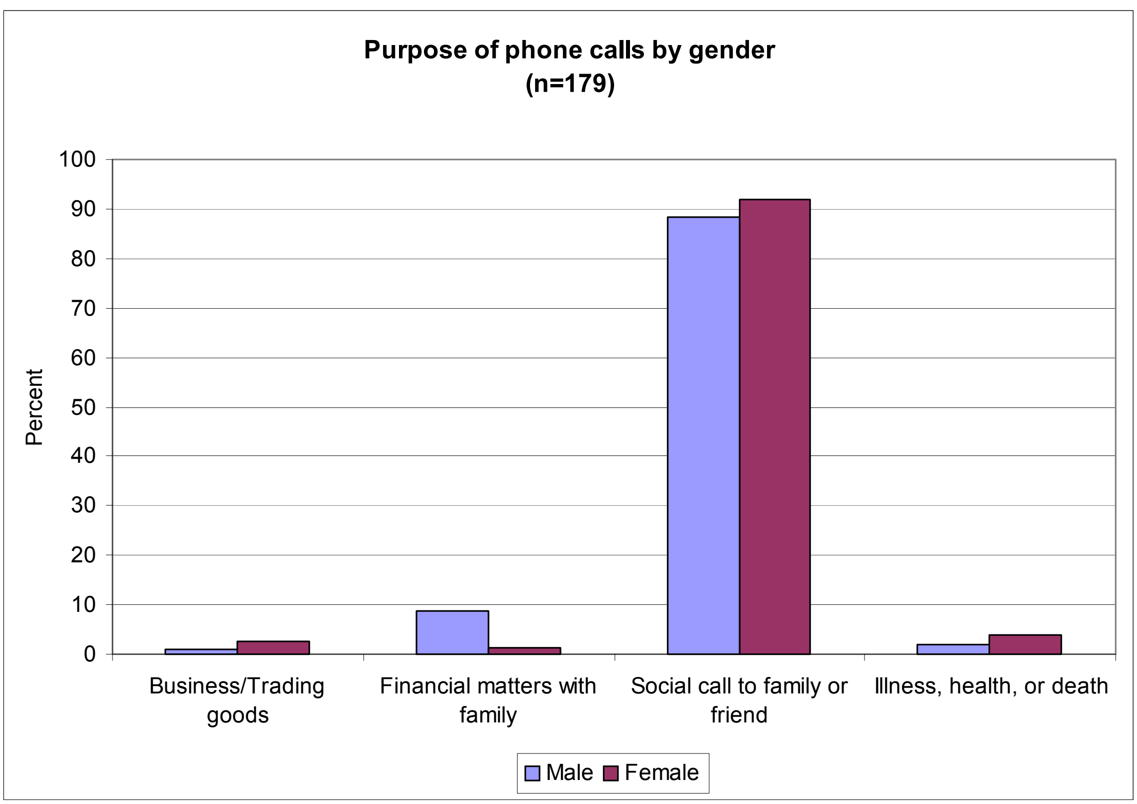
Graph 24 – Average monthly expenditures on phone calls by age group



Graph 25 – Type of phone preferred the most by gender



Graph 26 – Purpose of phone calls by gender



ANNEX 2

Equipment Package Specifications and Assumptions

ICT Packages

Telecenter Packages

	Equipment Cost	Power System Cost	Vendor Markup & Installation Fees
Telecenter A			
Internet Requirements: 9.6 - 64 Kbps			
No. of Telephone Lines: 1			
A1. IBM Thinkpad i Series 1200 Notebook	$1,432	**$2,558**	**$1,567**
A2. Acer TravelMate 200 Notebook	$1,204		
A3. HP ePC Desktop	$1,250	**$5,390**	**$2,417**
A4. IBM Netvista A20 Desktop	$983		
Telecenter B			
Internet Requirements: 48 - 256 Kbps			
No. of Telephone Lines: 3			
B1. IBM Thinkpad i Series 1200 Notebook	$6,832	**$7,868**	**$3,160**
B2. Acer TravelMate 200 Notebook	$5,692		
B3. HP ePC Desktop	$5,922	**$22,180**	**$7,454**
B4. IBM Netvista A20 Desktop	$4,587		
Telecenter C			
Internet Requirements: 128 - 512 Kbps			
No. of Telephone Lines: 6			
C1. IBM Thinkpad i Series 1200 Notebook	$13,977	**$13,525**	**$4,858**
C2. Acer TravelMate 200 Notebook	$11,697		
C3. HP ePC Desktop	$12,157	**$42,538**	**$13,561**
C4. IBM Netvista A20 Desktop	$9,487		

Telecenter A configuration
- PCs
- Inkjet printer
- Telephones
- Lights

Telecenter B configuration
- PCs
- 8-port ethernet hub
- Inkjet printer
- Telephones
- Fax machine
- Lights

Telecenter C configuration
- PCs
- 16-port ethernet hub
- Inkjet printer
- Telephones
- TV
- VCR
- Multifunction fax/printer/copier
- Lights

Telecenter Equipment Inputs

	Price (US$)	Energy consumed (W)	Estimated Daily Usage (hours)	Avg. Daily Watt-Hours	Source
PC Option #1					
Model: IBM Thinkpad i Series 1200 (1161-43S)	$1,268				
active usage		18	8	120	
sleep		6.5	4	23	
off & disconnected from power source		0	12	0	
subtotal				***144***	
PC Option #2					
Model: Acer TravelMate 200	$1,040				
average		15.4	12	158	
subtotal				***158***	
PC Option #3					
HP ePC desktop computer	$850				
active usage		36	8	237	
sleep		5	4	18	
15" CRT monitor (IBM 6331)	$236				
active usage		65	8	435	
standby		3	4	11	
subtotal	$1,086			***701***	
PC Option #4					
IBM Netvista A20 (6270) desktop computer	$819				
active usage		73	8	488	
sleep		73	4	263	
15.9" CRT monitor (IBM 6332 E74)	included				
active usage		65	8	435	
standby		3	4	11	
subtotal	$819			***1196***	
8-Port Ethernet Hub					
NetGear NETGEAR EN108 10Mbps Hub (8 ports)	$50	15.9	12	***164***	cnet.com
16-Port Ethernet Hub					
D-Link DE 816TP 10 Mbps Hub (16 ports)	$100	25	12	***257***	cnet.com
Printer					
HP Deskjet 840c Inkjet Printer	$99				mysimon.com
active		15.4	0.8	11	RM estimate
idle		2.2	11.2	21	
subtotal				***32***	
Telephone					
Standard corded telephone	$20				
off-hook		2.5	1.5	3	
on-hook		1	22.5	19	
subtotal				***23***	
Television + VCR					
Sanyo 25" TV (DS25390)	$200				
active		88	1.5	113	www.sanyo.com
Sanyo 4-Head VCR (VWM-400)	$65				walmart.com
active		13	1.5	17	
subtotal				***130***	
Fax Machine					
Canon Faxphone B640	$129				
active		30	0.25	6	
standby		8	23.75	163	
subtotal				***169***	
Multifunction Device (printer/scanner/copier/fax)					
HP PSC 950	$400				
active		22	1.6	30	
standby		8	22.4	154	
subtotal				***184***	
Lights					
Compact fluorescents (15W)	$15				

ICT Packages

Connectivity Components

		Estimated Daily Usage (hours)	Avg. Daily Watt-Hours	Equipment Cost
VSAT Connectivity @ Telecenter A Usage Level				
active		1.8	59.4	
idle		10.2	130.8	
standby		12.0	51.4	
	subtotal	24.0	***241.7***	***$3,000***
VSAT Connectivity @ Telecenter B Usage Level				
active		4.9	158.8	
idle		7.1	91.6	
standby		12.0	51.4	
	subtotal	24.0	***301.8***	***$3,000***
VSAT Connectivity @ Telecenter C Usage Level				
active		11	358.3	
idle		1.0	12.9	
standby		12.0	51.4	
	subtotal	24.0	***422.6***	***$6,000***
PTP Packet Radio Connectivity For WISP to Type A Telecenter				
transmitting		2.0	106.0	
receiving		2.0	7.2	
standby		20.1	37.1	
	subtotal	24.0	***150.3***	***$1,541***
PTP Packet Radio Connectivity @ Telecenter A Usage Level				
transmitting		0.8	42.4	
receiving		3.1	11.5	
standby		20.1	37.1	
	subtotal	24.0	***91.0***	***$1,541***
PTP Spread Spectrum FWA Connectivity For WISP to Type A Telecenter				
transmitting		2.0	16.7	
receiving		0.8	1.2	
standby		21.3	18.2	
	subtotal	24.0	***36.1***	***$1,894***
PTP Spread Spectrum FWA Connectivity @ Telecenter A Usage Level				
transmitting		0.8	6.7	
receiving		2.0	3.0	
standby		21.3	18.2	
	subtotal	24.0	***27.9***	***$1,894***
PMP Spread Spectrum FWA Connectivity For WISP to 5 Type A Telecenters				
transmitting		9.8	83.6	
receiving		3.9	6.0	
standby		10.4	8.9	
	subtotal	24.0	***98.5***	***$2,339***

Telecenter A configuration	**Quantity**
PCs	1
Inkjet printer	1
Telephones	1
Lights	3
Telecenter B configuration	
PCs	5
8-port ethernet hub	1
Inkjet printer	2
Telephones	2
Fax machine	1
Lights	4
Telecenter C configuration	
PCs	10
16-port ethernet hub	1
Inkjet printer	3
Telephones	5
TV	1
VCR	1
Multifunction fax/printer/copier	1
Lights	9

ICT Packages

Spread Spectrum Router Inputs

			Cost (US$)	Energy consumed (W)
Option #1				
WISP installation:				
Orinoco COR + 1 Orinoco PC card+12 dBi wide angle antenna+lightning arrestor+		$	2,339	
transmit				10
receive				1.8
standby				1.0
	subtotal		*2339*	
Remote telecenter installation:				
Orinoco ROR + 1 Orinoco PC card+24 dBi directional antenna+lightning arrestor+l		$	1,894	
transmit				10
receive				1.8
standby				1.0
	subtotal	*$*	*1,894*	

Pricing Assumptions

24 dBi antenna	$	150
12 dBi antenna (list price)	$	295
COR	$	1,695
ROR	$	1,395
PC card	$	99
6m Low loss cable	$	85
Lightning arrestor	$	165
Pigtail	$	95

ICT Packages

Packet Radio Inputs

Bandwidth supported: 9600 baud (12.5 KHz) to 153K baud (~200 KHz)
Range: 30-50km with line of sight (LOS)
Frequency band: 144-145 MHz

	Cost (US$)	**Energy consumed (W)**
Symek TNC31S terminal node controller + FSK9601 modem with zero power GAL	$256	
active		1
standby		0.5
Symek TRX2S transceiver	$985	
transmit power level: 20W		63
receiving		3
standby		1.7
Antenna + cabling	$300	
subtotal	$1,541	

ICT Packages

VSAT Inputs

	Energy consumed (W)
Option #1	
Model: Gilat DialAway VSAT remote station	
Bandwidth supported: 1-3 telephone lines plus always-on Internet access	
VSAT - active transmit/receive	38
VSAT - idle	15
VSAT - standby	5
Estimated price ranges:	
Equipment cost: $2500-$5000	
Installation and configuration charges:	
Import duties, taxes, shipping charges:	
Model: Gilat FarAway VSAT	
Bandwidth supported: 2-8 telephone lines	
VSAT - active transmit/receive	38
VSAT - idle	15
VSAT - standby	5
Estimated price range:	
Equipment cost: $5000-$7000	
Installation and configuration charges:	
Import duties, taxes, shipping charges:	

ICT Packages

Usage Assumptions

Hours of Telecenter Operation per day, 6 days/week	12
Days of Telecenter Operation per week	6
PC Usage Rate	65%
Online activity as % of PC Usage Rate	50%
PTP WISP transmit/online activity ratio	50%
PTP WISP receive/online activity ratio	20%
PTP remote telecenter transmit/online activity ratio	20%
PTP remote telecenter receive/online activity ratio	50%
Printer - Active Usage (hours/day)	0.8
Telephone - Active Usage (hours/day)	1.5
TV active usage	1.5
VCR active usage	1.5
Fax - active usage	0.3
Copier - active usage	0.5
Multifunction fax/printer/copier usage	1.6

Telecenter A - No. Of PCs	1
Telecenter B - No. Of PCs	5
Telecenter C - No. Of PCs	10