Thematic Report

Rural Access: Options and Challenges for Connectivity and Energy in Zambia

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Rural Access: Options and Challenges for Connectivity and Energy in Zambia

Findings of a study carried out for the International Institute for Communication and Development (IICD) by Dean L. Mulozi, Zambia Association for Advancement of Information and Communication Technology (ZAA-ICT), Zambia.

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List of acronyms and abbreviations

ADSL	Asymmetric Digital Subscriber Line
ATM	Automated Teller Machine
CAZ	Communication Authority of Zambia
CDMA	Code Division Multiple Access
DSL	Digital Subscriber Line
EDGE	Enhanced Data rates for GSM Evolution
EASSy	East African Submarine Cable System
EUR	Euros
GSM	Global System for Mobile communications
GPRS	General Packet Radio System
Ghz	Gigahertz
IICD	International Institute for Communication and Development
ICT	Information and Communication Technology
ISP	Internet Service Provider
Kbps	kilobit per second
LAN	Local Area network
Mbits/s	Megabytes per second
NRSE	New and Renewable Sources of Energy
PC	Personal Computer
PSTN	Public Telephone Network
PTC	Posts and Telecommunications Corporation
QOS	Quality of Service
REF	Rural Electrification Fund
REA	Rural Electrification Authority
SLA	Service Level Agreement
SADC	Southern Africa Development Community
TRASA	Telecommunications Regulators Association for Southern Africa
UNIDO	United Nations Industrial development Organisation
UNZA	University of Zambia
USD	US dollar
VAT	Value Added Tax
VOIP	Voice over Internet Protocol
VSAT	Very Small Aperture Terminal
WAN	Wide Area Network
WAP	Wireless Application Protocol
WiFi	Wireless Fidelity
WiMaX	Worldwide Interoperability for Microwave Access
ZAMTEL	Zambia Telecommunication Company
ZESCO	Zambia Electricity Supply Corporation
ZAMPOST	Zambia Postal Services Corporation
ZCCM	Zambia Consolidated Copper Mine
ZMK	Zambian Kwacha (national unit of currency)

Purpose of this report

This report was commissioned by the International Institute for Communication and Development (IICD); an international, not-for-profit, non-governmental organisation (NGO) that promotes Information and Communication Technology (ICT) in developing countries to alleviate poverty and achieve sustainable development. It is part of a wider initiative by IICD to prepare a series of reports on connectivity and Internet access in rural areas with its partners in Zambia, Tanzania, Ghana, Uganda, Burkina Faso, Mali, Ecuador, Bolivia and Jamaica.

The purpose of this report is to enable organisations engaged in rural development in Zambia to make informed decisions on issues relating to rural connectivity and obtaining access to the Internet. It also aims to demystify the technical issues associated with connectivity and Internet access which often confuse lay-persons. The report also provides a general inventory of connectivity options and costs. As energy is a major concern for rural connectivity, the second part examines this issue and outlines the potential use and cost of alternative energy sources such as solar power, wind, hydropower and bio-mass.

This comprehensive overview is not just a one-off exercise. Rather, it is a work in progress as connectivity options and costs change rapidly. The report follows the set-up of an earlier study into connectivity options and costs in Tanzania, the results of which were first published in May 2006. Future follow-up studies are planned. Their findings will be published biannually.

If, after reading this report, individuals or organisations can critically and analytically study the options available to them and achieve Internet connectivity that is efficient and cost-effective in remote and rural areas, then the report will have fulfilled its goal.

Executive Summary

This document provides an overview of Internet connectivity in Zambia and covers technical considerations, existing services and related costs. The report further highlights rural energy for rural connectivity services in areas that are not served by the electricity grids. It also addresses factors that determine the speed of development of rural connectivity in Zambia.

The report has been prepared under the auspices of the eBrain Forum of Zambia, a multi-stakeholder network on information and communication technology for development (ICT4D) in Zambia, in collaboration with the International Institute for Communication and Development (IICD). IICD is a Netherlands-based international organisation that fosters the use of ICT to improve livelihoods and the quality of life for citizens in nine developing countries: Zambia, Uganda, Tanzania, Jamaica, Ecuador, Bolivia, Mali, Ghana and Burkina Faso.

The objective of this report is to provide information about the options and cost of connectivity for individuals and organisations to enhance Internet access in rural Zambia. Having a reliable energy supply in the rural areas has also been identified as a key factor for rural access. In view of the rapid emergence of new technologies and changing costs, this study will be updated on a regular basis.

The report contains the following elements:

- Part A covers the general background of connectivity in Zambia and the situation with regard to information and communication technology (ICT).
- Part B deals with the types of connectivity available within the country. It also highlights future deployments and technological developments.
- Part C deals with existing Internet Service Providers (ISPs), services and geographical coverage as well as technologies used. The connectivity services available from six selected ISPs show the average cost of accessing the Internet in Zambia.
- Part D provides an overview of energy sources and options.
- Part E provides conclusions and recommendations on options to support rural connectivity in Zambia.

The main issues that are raised are:

- Zambia's connectivity is characterised by a few major Internet providers, high dependency on VSAT access to the Internet, and a poor landline telecom system. Mobile phone use is expanding to the rural areas.
- Connectivity is expensive in Zambia for a number of different reasons. Much of rural Zambia is not serviced by ground telephone and fibre optic cables – the mainstay of communication - are still being constructed. Zambia's ISP services are concentrated along the railway line from Livingstone to Chingola. The country depends on VSAT access as it is not yet connected to the international submarine cable which interconnects with the global Internet backbone. This is a major disadvantage for Zambia's connectivity infrastructure. However, ZAMTEL, ZESCO and Copperbelt Energy Corporation (CEC) are pursuing fibre optic cable projects and these will eventually improve the use of available Internet access services. The East African Submarine cable System (EASSy) which plans to connect six countries in Sub-Saharan Africa, including Zambia, may improve access and reduce costs for connectivity, but it is unlikely to be effective within the next five years.
- Out of the eleven registered Internet Service Providers (ISPs) in Zambia, six provide services to rural areas with an estimated 17,800+ clients. More than 50% of the clients use dial-up services.
- Within the last 10 years three mobile phone companies have been established, namely Cell Z, CELTEL and MTN. The companies continue to extend their services and coverage to rural districts with technologies such as GPRS and EDGE. However, the cost of using the Internet through the mobile phone services is still relatively high.
- Internet is mainly accessed by dial-up telephone lines and VSAT, sometimes combined with wireless broadband systems. Dial-up services via telephone lines are the main source of connectivity in rural areas. However, they do not reach many rural people, are unreliable, and the speed of connectivity is low (less than 28 kbps (kilobits per second)). Private and community information centres, telecentres and Internet cafés can enhance access for populations in rural areas.
- Connectivity rates in Zambia are relatively high compared to other countries in the region. In 2007, a typical monthly cost of Internet access varied from ZMK 200,000 to ZMK 20,000,000 (40-400 US dollars), depending on the quality and volume of bandwidth ordered.
- The lack of an adequate energy infrastructure in rural areas affects overall rural connectivity services. Use of electricity - mainly from hydro power - is concentrated in urban and peri-urban areas. Most rural areas are not connected and expansion of the power grid is a costly undertaking. There is a need to address and identify alternative rural energy options, such as renewable energy, if connectivity services are to improve.
- The Renewable Energy Act (REA) has planned to increase the use of hydropower in rural districts and connect these to the main national grid. Implementing the Renewable Energy Act may in the long term increase access and use of alternative energy sources. The report suggests intensified interventions by the government, civil society, the private sector, and the donor community.

Part A: Connectivity

Major Developments

Connectivity developments in Zambia are partly attributed to the development of the Zambian telecommunication system. Just after 1991, the Posts and Telecommunications Company (PTC) was dissolved, leading to the establishment of the Zambian Telecommunications Corporation (ZAMTEL) and Zambia Postal Corporation (ZAMPOST). The enactment of the telecommunications in 1994 resulted in ZAMTEL becoming as a separate telecommunications company. ZAMTEL took over all telecommunications links and services including the microwave backbone at Mwambeshi. The development also paved the way for the establishment of the Communications Authority of Zambia (CAZ) whose functions include regulating, licensing and promoting competition within the ICT sector. Although communication was liberalized to allow for competitors, ZAMTEL remains the only provider that operates a PSTN in Zambia whilst the International Gateway component is accessible but cost prohibitive. This means that as a public telephone network supplier, ZAMTEL has an advantage over other communication companies that cannot compete favourably.

Figure 1: Schoolchildren at the Munali computer lab taking lessons in ICT

In the early 1990s Zambia was, after South Africa, the first country in Sub-Saharan Africa to pioneer the use of Internet services. The driving force behind this was the University of Zambia which, in 1994, promoted the establishment of ZAMNET which is now a separate ISP Company. Connectivity at that time was based on dial-up services and was coupled with the use of analogue systems and this affected the quality of services. Moreover, Zambia had fewer ISPs as most of them were established at a later stage. ZAMTEL did not take up major communications development immediately after privatisation due to uncertainties that existed at the time.

However, liberalisation polices facilitated the prolific development of mobile phone providers and Internet Service Providers in the country bringing the registered number to eleven (11).

By 2004, three mobile phone providers were registered by the Communication Authority:

- CELL Z under ZAMTEL
- TELECEL (currently acquired by MTN group) and,
- CELTEL (formerly ZAMCELL).

The number of mobile phone providers and Internet Service Providers are however expected to increase if the government creates more incentives in the ICT sub-sector.

Connectivity in Zambia relies on international foreign satellites such as the Intel Sat. All Internet Service Providers have to set up their own connectivity communication systems to access international bandwidth. This means that the cost of connectivity and quality of services is affected by this dependence. The ISPs have a right to use any international satellites of their choice. However, although ZAMTEL has offered the use of the Mwambeshi satellite station to ISPs at a cost, most of the ISPs have chosen to use foreign satellites.

Internet in most of the rural areas of Zambia uses dial-up services via telephone lines as source of connectivity. Dial-up services, however, do not reach many rural people as the ground lines have limited coverage. In addition, they are not be very reliable and the speed of connectivity can be lower than 28 kbps (kilobits per second) in some cases. Another option available is the VSAT access through local ISPs. Wireless broadband systems are mostly accessed by people along the railway lines which includes the belt from Livingstone to the Copperbelt towns. Private and community information centres, telecentres, and Internet cafes can enhance access to populations in rural areas.

The major connectivity developments cited in this report so far include:

- The deployment of CDMA 2000 1x technology by ZAMTEL enabling connectivity services in major urban towns and some rural areas. The introduction of CDMA EVDO may be deployed some time in 2008.
- The rolling out of WIMAX by major ISPs such as MICROLINK and CELTEL in 2007 ensures connectivity services and improvement of wireless technology to rural areas. Through the simple use of a small radio you will now be able to access connectivity in some of rural areas in Zambia. WIMAX is set to be part of a solution to rural connectivity options, particularly in remote places where connectivity services are scarcely available.

- The digitalisation of the ZAMTEL exchange from the old analogue systems to a digital communication infrastructure. This means that communication systems, including ground telephone and Internet communication, will improve.
- The development of mobile connectivity services by CETEL and MTN to introduce advanced mobile connectivity services of GPRS and EDGE. The mobile connectivity means one can access Internet on the mobile phone anywhere in each of the networks covered by the mobile company. You have to use a special type of a phone that is equipped to access this type of service.
- The introduction of the Universal ICT Fund by government through the Communication Authority to facilitate universal access. The ICT Fund was established to support rural ICT activities and enterprises and promote and facilitate rural connectivity services. It is managed by the Communication Authority.
- Within the connectivity infrastructure, ZAMTEL, ZESCO and the Copperbelt Energy Corporation have started to develop fibre optic projects that will facilitate and increase broadband and the quality of services within the country. In both cases, the national fibre projects are intended to improve communication services within their own networks and improve overall communication systems including rural connectivity in Zambia. ZESCO has competed the first phase of the project and the second phase is well underway. The national project implemented by ZAMTEL will eventually connect to a regional EASSy fibre optic project through border points.
- With regard to energy, REA has completed its energy master plan and plans to develop the use of isolated hydropower in the rural districts and connect these to the main national grid. Implementing the Renewable Energy Act (REA) may, in the long term, increase access to and the use of alternative energy sources. The report advocates intensified government, civil society and private sector as well as donor community interventions.

Status of Voice over Internet Protocol (VoIP) and its use in Zambia

Voice over Internet Protocol (VoIP) can currently be used within organisations that have a licence to facilitate internal communications. Voice over Internet Protocol allows users to make telephones calls, send faxes, etc. for a minimal fee as most data transfer is routed over the Internet. It is a network device that converts voice and fax calls, between the Public Switched Telephone Networks (PSTN) and an IP network. In many countries, VoIP is used by individuals as well as commercial telecom providers to communicate at highly reduced rates.

International Gateway for Satellite Access

The International Gateway is terrestrial and based at Mwambeshi Satellite Station. It was built by the Government and is under the control of the Zambia Telecommunications Company (ZAMTEL). Both the voice and data international gateways are liberalised. The International data gateway is liberalised and all ISPs are free to connect to the outside world. The public policy that was issued in 2002 as a statutory instrument authorised a $12 million license fee which was reduced from the previous fee of $18 million. This situation has led to complaints by GSM mobile companies and ISPs about unfair competition.

Part B: Types of Connectivity

Uses of Connectivity

Connectivity can be used for various purposes. Access to the Internet is one important application but it is often misunderstood as the ONLY use of connectivity. Several different types and uses of connectivity are outlined below.

Surfing a Local Website
It is possible to have access to, and surf for, local websites with local content. This requires a link to the server where the information is stored but does not need a link to the global Internet.

Surfing the World Wide Web
Useful resources and information are available on the World Wide Web and when you are connected to the Internet, you are able to access these vast resources. Surfing the web is the most common and conventional type of access and when you are connected, you can surf for websites using the global Internet.

Voice over Internet Protocol (VoIP)
This is a fast-growing application for making telephone calls at much cheaper rates than through conventional mediums. To access it you will need to set up an exchange for voice communication. This will be cheaper and will allow voice communication at a much cheaper rate or at the rate of a bandwidth. Voice over Internet Protocol (VoIP) relies on the quality of the existing link available. It can be very useful in certain sectors such as health and education.

Data exchange for software applications
When you are connected to the Internet your system can exchange data and interact through the software applications that have been installed. Data exchange without pictures or photos may require very little bandwidth.

Video-conferencing
Connectivity can also support other uses such as video-conferencing. This means that when you are connected, the link can be used in cases such as eLearning, telemedicine, or conducting a conference with people located in one or more different geographical locations. Any organisation or company that has the necessary equipment can organise or take part in a video-conference as long as it is connected to the global Internet link. This means that one will need an Internet connection with a greater capacity and a high-speed connection.

E-Mail Communication
Emailing is the oldest and most common method of electronic communication. Internet Service Providers can also provide emailing services at cheaper rates. Monthly rates are pegged monthly at a rate almost similar to telephone calls.

Types of connectivity services in Zambia

There are various connectivity services currently available in Zambia that can be used to connect homes, businesses, and organisations to the Internet. Some of the services have been customised to suit certain categories of customers. It is important to first understand the type, medium, cost, coverage, speed and reliability of each service available from the different Internet Service Providers and mobile phone companies before purchasing a connectivity service. Some of the advantages and disadvantages of the different services available are described below, as well as the basic equipment you need to use them.

Wired connectivity

Dial-up
Dial-up is a service that is widely used in most rural areas in Zambia today. The dial-up connection is a medium that requires either a stand-alone PC or a network server calling an Internet Service Provider using regular telephone lines. The purpose of the computer is to enable users to read their emails and browse the Internet. A modem will also be required: this will act as an interface between the computer and the telephone line. Basically, the modem is responsible for converting the computer signal into a telephone signal and vice versa. Modems are critical components of a dial-up system. The telephone line is required to enable your modem to connect to the Internet server. It is important for dial-up clients to have all three components in working order otherwise it will be difficult to connect to the Internet. In Zambia, the dial-up Internet speed can go up to 56kbps for some Internet Service Providers, but the speed may be even lower. The average speed with most Internet Service Providers is between 28Kkbps. The dial-up service is currently the main mode of connectivity being used by most organisations and individual homes in the rural areas of Zambia. This is because a wireless broadband connection is not available for various reasons, including the

lack of a communication infrastructure. Dial-up access may also be an alternative for people who have limited budgets as it is available at standard telephone rates.

Dial-up is currently being offered by some Internet Service Providers including ZAMTEL and ZAMNET with services available in rural towns with a fixed telephone line. However, the Dial-up service can be unreliable at times. The service is usually very slow and time-consuming and can be adversely affected by interferences and power cuts. Yet despite its unreliability it is a common connectivity service for many Zambians living along the railway lines and in the rural areas. This is because it is cheaper than most of the other services currently on the market.

The average cost for Dial-up ranges from $20 to $50 per month, depending on service rates offered by various Internet Service Providers. Some Internet Service Providers can charge as much as $853 per month for their corporate services. Dial-up is comparatively cheaper than wireless broadband. The service is dependent on ZAMTEL ground copper cables deployed in Zambia's major districts. It also depends on the cost of the telephone call and the time spent on the line. If you are dialling out of town or to a rural setting, the cost will be regarded as a trunk call. This means that the longer you stay online, the higher the bills. One needs to consider various factors when considering whether or not to purchase a Dial-up service: firstly, the cost of a telephone call related - or translated into - a truck call depending on the location; secondly, how often you will use the service or stay online; thirdly, the connection speed is another factor as elaborated above. You will spend more time online as the speed may be too low. A moderate Internet home user or small organisation with one or two Personal Computers for sending and receiving emails in a rural district may opt for a Dial-up service. However, Dial-up services are slowly being phased out by some private Internet Service Providers and are being replaced by other connectivity technologies.

Digital Subscriber Line (DSL) Connection

An acronym for Digital Subscriber Line (DSL) and ISDN and is capable of carrying both data and voice at the same time. Therefore you can have a landline acting as a router for Internet connectivity as well. It connects to the broadband service with speeds from 64 to 1024 kbps. It uses a Digital Subscriber Line (DSL) modem and runs a dedicated line to the premises. You will need to install a DLS modem and Cisco router at a location to safeguard the connection. The service is mainly used by banks for Automated Teller Machines (ATMs), Internet cafes and for data transmission purposes. Zambian Internet Service Providers (ISPs), including ZAMTEL and Coppernet, provide this service.

Asymmetric Digital Subscriber Line (ADSL)

The Asymmetric Digital Subscriber Line (ADSL) is a much more efficient version of the Digital Subscriber Line (DSL) and depends on the copper wire of the normal telephone line allowing both Internet and the telephone to be used simultaneously. The client receives voice and data from the provider at different frequencies using the telephone line. The service requires a Personal Computer, router and telephone connection. Using Internet access via ADSL goes with a monthly subscription fee and does not require a telephone call with associated time-bound telephone expenses. ADSL was first introduced by ZAMTEL in August 2006. Today, it is also offered by other Internet Service Providers such as UUNET in major cities such as Lusaka, Ndola and Kitwe.

ADSL can be used by both home users and corporate clients. The limiting factor for this option is the reach of the ZAMTEL copper wire network. The typical broadband ranges from 64 to 512 kbps for home users, whereas commercial users can go up to 1024 kbps. The cost of ADSL can also be high, making the service more suitable for corporate clients.

Wireless

Wireless Broadband involves using the Internet wirelessly without depending on a telephone line or cable. Wireless connectivity has developed in Zambia and Internet Service Providers have categorized the services to suit clients from different classes. There is a notable development in wireless connectivity services each year in Zambia. There are currently several wireless services on offer and the following types can be distinguished: there are two types of wireless - licensed frequency bands and unlicensed. The licensed frequency bands are more reliable due to the fact that they are regulated and are not prone to interferences. Equipment and access to these frequencies tend to be more expensive.

There are two types of wireless connectivity; one is non line-of-sight and the other is line-of-sight. Non line-of-sight does not require wires or antenna but it is a set of equipment procured from an Internet Service Provider and can be self-installed in the office or home. The line of sight is the wireless broadband that will require a wireless link with an Internet Service Provider. The features of non line-of-sight have proved to be popular among users in most urban areas in Zambia and are suitable for both home and business.

The wireless shared services are designed to provide high speed broadband Internet services via VSAT to a site in the country. The wireless connectivity is used mainly by organisations that need fast Internet speeds. A number of Internet Service Providers provide wireless services mainly to clients who are located in urban areas or along major Points of Presence (PoPs). Many of the Zambian Internet Service Providers have established PoPs and provide wireless connectivity along the line of rail. In the case of non line-of-sight, a customer can buy the equipment and do the installations with minimal support from the ISP. Wireless combines the portability of mobile data services with similar speeds to fixed line broadband, all the way up to 1Mbps. For portability, you will need a Wireless Card, or Wireless Modem w/ Battery. Wireless Broadband will be operating in most ISPs in dedicated 2.6 GHz band and is Zero-install with true plug-n-play capabilities. It is easy to install.

The cost of wireless varies according to the choice one makes. It can range from $75 to $5,000 monthly subscriptions, excluding the cost of equipment and installation costs. Variations in the cost depend on the type of service one opts for, mainly speeds and data uploads.

Wireless broadband is mainly offered along the line of rail where many ISPs have Points of Presence, i.e from Livingstone up to Chingola and Solwezi in North-Western Province. Clients in some of the provincial towns can access wireless connectivity as long as ISPs are maintaining a connectivity point within the geographical area. Some of the rural provincial towns having that access to wireless broadband off the line of rail are Solwezi, Chipata and Kasama. It must be stated that fewer ISPs have Points of Presence in rural areas.

Minimum and maximum speeds as well as bandwidth allocation will depend on the choice of services. Most of the ISPs have categorized wireless services according to the needs of their clients. Services range from home users and small enterprises such as Internet cafes to corporate clients such as banks and mining companies. Therefore, bandwidth allocations and speeds differ from one category to another. ISPs offer dedicated and shared services. The higher the cost, the better the service and the more bandwidth one gets.

Urban areas enjoy a better quality of connectivity services than rural areas. The quality of services will also depend on the financial commitments with the ISP. For example, a corporate client will access a download of 1125 kbps with a connection of 32 computers at typical usage of 36GB at a cost of $4,301 per month. A home user will pay $128 with a minimum download speed of 64 kbps and I GB usage. On the other hand, a corporate client pays $2,373 for VSAT equipment at a monthly rate of $1,113 from an ISP. This gives a client 9GB of usage. Refer to tables in Annex 1 at the end of this report. Therefore, wireless connectivity is the main service to go for if you are located in one of Zambia's major towns.

WiFi

WiFi is an unlicensed frequency and a shorter range system, typically hundreds of a metre that uses the unlicensed spectrum to provide access to a network covering only the network operator's own property. WiFi is a wireless service with an internationally agreed protocol used by many different vendors .WiFi is an indoor technology that allows users to roam within a building and remain connected. However WiFi can also be used outdoors and across cities. ISPs can deploy it as the cost of deployment is less than that of proprietary technologies.

WiMax

This is another protocol that is being introduced and developed operating on a frequency range. WiMaX is an acronym that stands for Worldwide Interoperability for Microwave Access and refers to wireless networks that can cover a wider area. WiMaX is a long range system covering many kilometres and uses licensed or unlicensed spectrum to deliver a point-to-point connection to the Internet from an ISP to an end user. Zambian companies are closely examining WiMaX for "last mile" connectivity. This could result in lower pricing for both rural and urban areas as well as home users and business clients as competition will lower prices. Some WiMaX equipment can support frequencies ranging from 2 to11GHz in both licensed and unlicensed bands and can be configured to be used in both base station and subscriber station applications.

The main benefit of WiMaX is that it opens up a completely new access alternative to bring broadband access to the business community in urban areas. ZAMTEL copper networks are limited and often in poor shape. WiMaX is therefore a cost effective way of serving the business community with high-speed access. This is a cost effective technology both for ZAMTEL and existing Internet access providers. WiMaX has the potential to become a countrywide broadband access technology that also serves the rural areas. For the development to effectively take off national backbone transmission networks with cheap bandwidth costs are needed. WiMaX will be rolled out by leading ISPs and GSM providers in some parts of rural Zambia. Some of the ISPs that were planning to introduce the service by 2007 are MICROLINK and CELTEL. This protocol has been presented as a major advancement in rural connectivity.

Although the equipment is still much more expensive than that of WiFi, it is feasible as it becomes an accepted standard. WiMaX will ensure the extension of wireless technology and can be an alternative solution to rural connectivity options, particularly in remote places where connectivity services are scarce. When seeking alternative connectivity solutions, WiMax should definitely be considered, however, its technical applications have yet to be understood.

Portable Satellite Terminal

Clients can use Internet in the rural outskirts of Zambia where there is no power or access to any other connectivity infrastructure. It is five times faster than Dial-Up and is mainly used by professional reporters and travelling business executives. The service and equipment is currently offered by AFRICONNECT. The cost of access is $750 and 7$ per Mb download. The more you use the more you pay. This facility is much more reliable and offers high quality services.

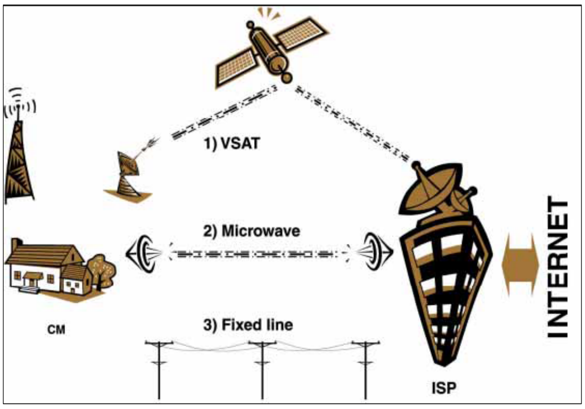


Figure 2: VSAT applications in remote sites

Wireless (Licensed Frequency Bands)

The licensed frequency bands are more reliable due to the fact that they are regulated and are not prone to interference. The cost of equipment tends to be higher and access via these frequencies is also more expensive.

Satellite (VSAT)

VSAT is an acronym for Very Small Aperture Terminal. The word 'terminal' refers to the small satellite dish that can be installed at a specific location, office or home. They consist of an antenna with an outdoor unit and an indoor unit connected to the users' equipment. The dish is a small, two-way satellite ground station with an antenna with an average diameter 75 cm to 1.2 m, though you can get more than 1.2 m. The data rates of a VSAT typically range from narrowband up to 4 Mbit/s.

Uses of VSAT

VSAT is used for a wide range of applications including digital video-broadcasting, local networking and Internet services as well as telephone calls via Internet protocol (VOIP). VSAT services are used across the world as a means of delivering broadband Internet access to locations that cannot get less expensive broadband connections such as ADSL or cable Internet access; usually remote or rural locations.

VSAT can also be used for communication services such as VOIP, pay phone, data transmissions, financial services and topical applications such as telemedicine and Elearning. VSAT can contribute to increasing last mile connectivity between end-users and the VSAT backbone by introducing a Local Area Network (LAN) where multiple users can use a VSAT backbone. VSAT can provide Internet access in remote areas where landlines would be costly to install. KU band can be used to obtain broadband connection in most rural areas of Zambia.

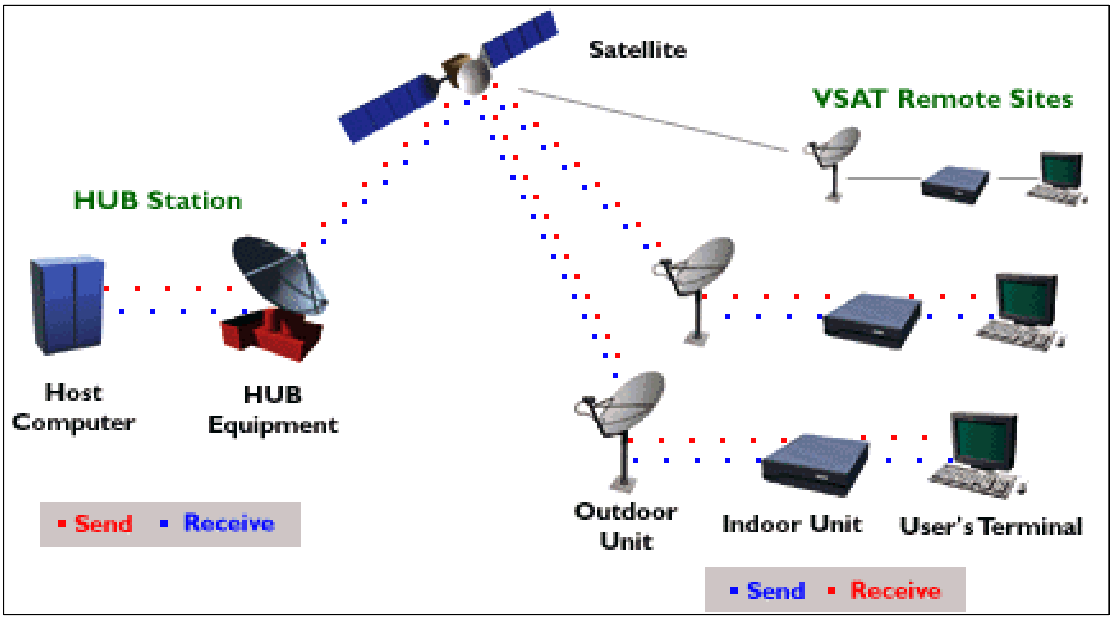


Figure 3: A Local ISP providing a VSAT connectivity demonstration

Applications and Installations of VSAT

Setting up a VSAT is cheaper and easier than installing other communication technologies such as copper wire thus bringing phone and Internet access to remote sites. The most commonly used satellite frequency bands in Zambia are C-Band (4-8 GHz) and Ku-band (10-18 GHz). C-Band Satellite systems give a very high quality signal and are used by corporations. Ku band and Ka Band wave lengths are shorter. The quality of signal is lower and acceptable for domestic and small business communication requirements. Ku band is increasing becoming reliable to many customers in peri urban and rural areas in Zambia. Satellite communication does not depend on terrestrial infrastructure and is reliable and easy to deploy. However, it is important to use local ISPs when securing VSATs as securing the equipment from outside the country may cause problems as local providers may provide back-up technical services. Most ISPs in Zambia provide VSATs such as Africonnect, UUnet, ZAMNET (see annex 1). Foreign satellite companies such as the Iway Africa and IntelSat which are located outside Zambia and Europe are the main source for VSATs. Using foreign satellites can affect the quality of the signal, increase the cost of access and latency (the time it takes for data to travel a complete round trip between the 2 points). Using an external satellite will not necessarily improve performance and reduce costs: a lot depends on its applications.

For example, interaction between a rural health centre and the University Teaching Hospital in Lusaka for a live video-conference about offering telemedicine, requires a short link so that latency is minimal. As mentioned above, 'latency' is the time it takes for data to travel a complete round trip between the two points. Latency between two computers in a perfect network within an office should be less than one millisecond. The longer the distance, the more it will affect latency, the distance between Lusaka and Europe may be in the range 20-80 milliseconds. The latency between the same two points but through a single satellite hop would be between 600-800 milliseconds.

VSAT is a solution and virtually a necessity for companies or organisations based in rural areas. The options for a stand-alone VSAT vary widely and depend on the needs of the user and the size of the company. For example, a rural community telecentre, a health centre or a farmer with a primary need for sending and receiving e-mail would probably be best suited to considering a Ku-band VSAT (where the initial equipment costs are relatively low) and a lower tier monthly bandwidth package. By contrast, a mining company with overseas headquarters and a sizable staff may elect for a C-band VSAT and dedicated bandwidth.

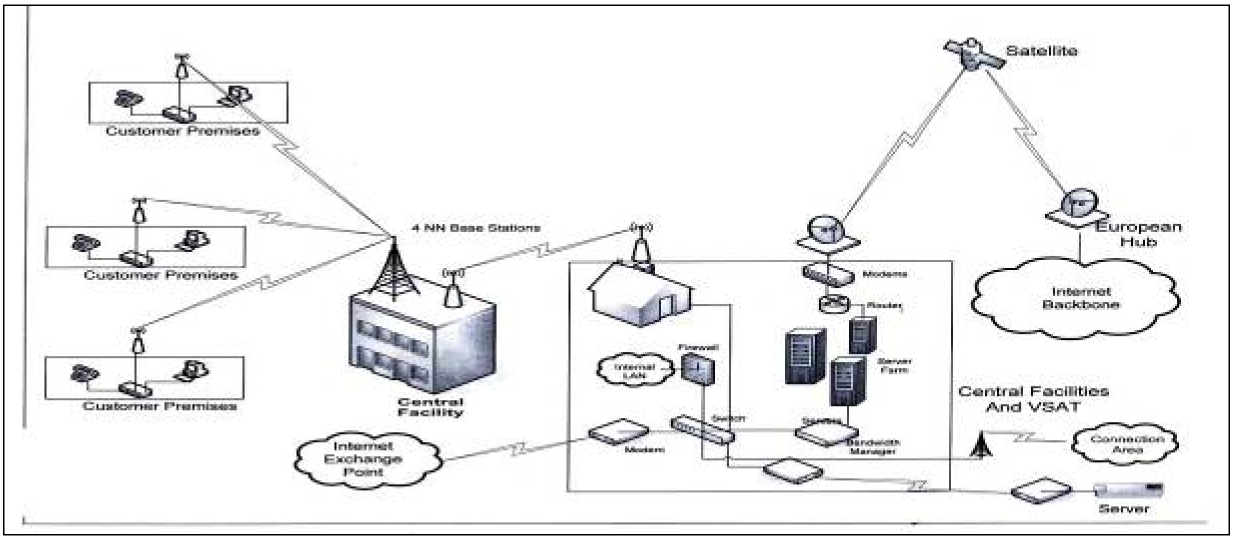


Figure 4: Example of a Zambian Internet Service Provider using a foreign Satellite Hub providing wireless and VSAT Internet connectivity services within the area.

Cost of VSAT

Ku-Band VSAT devices are becoming increasingly more reliable thanks to technological developments, although their quality cannot be comparable to that of C-Band. Depending on the supplier and source C-Band Antenna (dish) and modem could cost between $10,000 – $16,000, while that of Ku-Band ranges from $2000-$6,000). The major difference is the antenna. The antenna ranges from 1.2 metres to 2.4 metres. The larger the antenna, the greater the cost. C-Band can be four times more expensive than Ku-Band. In Zambia, most ISPs provide supplier orders for VSATs though their companies which can provide both technical services and equipment. The cost of VSAT can be minimized by sharing the cost where local users can use shared services. Refer to Annexes 1.

Advantages of using VSAT

- VSAT services can be deployed anywhere. It provides Internet access independent of the local terrestrial/wireline infrastructure, which is particularly important for backup or disaster recovery services.
- The services can be deployed quickly - within a few hours or even minutes.
- VSAT enables customers to get the same speeds and SLAs at all locations across their entire network regardless of location.
- Most modern VSAT systems use onboard acceleration protocols and deliver high-quality Internet performance regardless of latency.
- Current VSAT systems use a broadcast download scheme which enables them to deliver the same content to tens or thousands of locations simultaneously at no additional cost.

Disadvantages of using VSAT

- Latency (delayed repsnses) can be experienced by VSAT links. As signals relay from a satellite 22,300 miles above the Earth, a minimum latency of approximately 500 milliseconds for a round-trip appears.
- The acceleration schemes used by most VSAT systems rely upon the ability to see a packet's source/destination and contents; packets encrypted via VPN defeat this acceleration and perform more slowly than other network traffic.
- They are subject to signal disturbances due to the weather; the effect is typically far less than that experienced by one-way TV systems that use smaller dishes,
- VSAT services require an outdoor antenna installation with a clear view. This may make installation in skyscraper urban environments or locations where a customer does not have roof rights problematic.

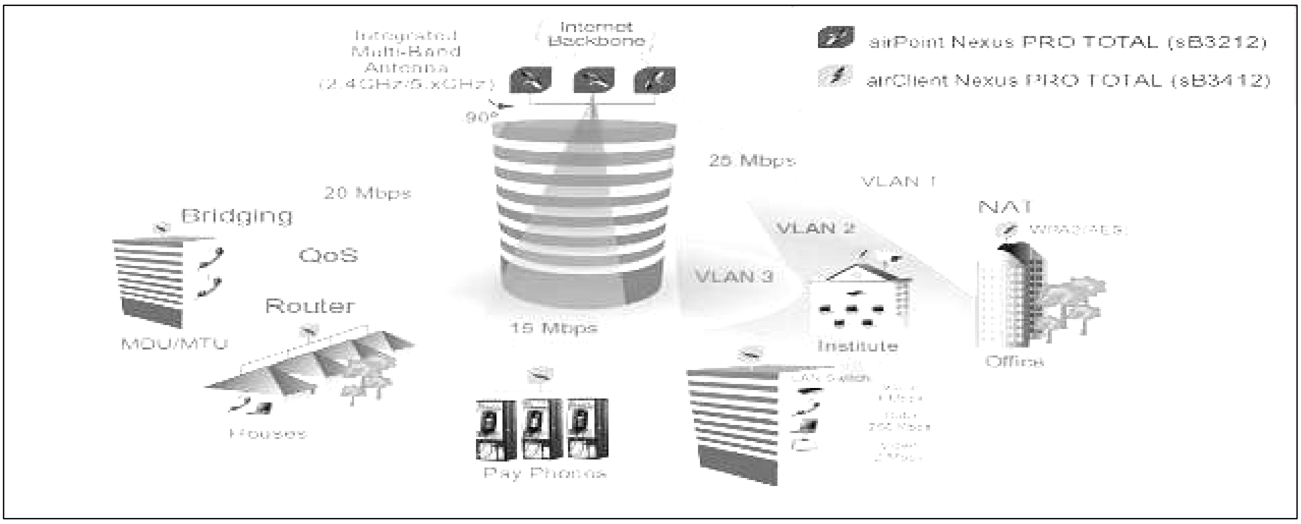


Figure 5: VSAT extending services to a wider area using VSAT

The Macha mission is using Ku-Band and C-band for its connectivity services in its multipurpose cooperative centre. (www.linknet.zm)

Another VSAT practice on community connectivity access is at Namwala in Southern Province where AfriConnect is supporting a rural connectivity business outlet in partnership with a local entrepreneur. The minimum total investments for Ku-Band V-SAT range from $25,000 to $30,000. The minimum monthly rates are from $770 for 256 kbps and 1mb download shared. The monthly rates depend on the number of Personal Computers in the area. The coverage area will range from 10 to 16 km. The Namwala project uses the CELTEL mast on a rental basis. Therefore, when considering this type of connectivity you have to take into account different factors such as the number of Personal Computers, estimated usage, budgeted amount, and how large the area is that you wish to cover. (www.namwala.com)

Mobile Technologies (GPRS, EDGE and CDMA)

There are different types of connectivity access that use the infrastructure of mobile telephone networks. These allow for voice and data communication via small hand-held devices or larger mounted devices, both of which can be connected to a computer or a computer network. There were several developments with these technologies during 2006 and 2007. Celtel and MTN are already providing mobile Internet technologies in Zambia. General Packet Radio System (GPRS) provided and further introduced a more advanced technology called EDGE which is faster than GPRS. This requires gadgets to be used to connect the Personal Computer to the mobile services via USB and PC cards.

The GPRS/Mobile Internet

GPRS stands for General Packet Radio System. This mobile Internet service allows users to access Internet through the GSM provider. To get connected to mobile Internet, you will need to have a mobile Internet-enabled handset or a personal computer card to access the Internet using their computer or laptop. The mobile handset or phone set needs to be enabled to ensure that it has a web browser or GPRS/EDGE profile connectivity. Phones with colour screens and camera mobile phones are more likely to be compatible with mobile Internet. You can easily configure the mobile phone through the mobile company instructions or automatically. Configuration is usually free of charge. PC cards, USBs and billing systems can be obtained from the mobile phone company. To use GPRS one needs to install special software on the PC. This means that you pay for accessories and time spent for the use of connectivity services. To use GPRS you will need to purchase a monthly 'bundle' which is a quantity of data. A client with a bundle reserves a certain amount of units dedicated to accessing the mobile Internet. These units are not touched for the entire month should the Credit for voice calls run out. Currently, Celtel provides this service to all the areas it covers: all 9 provinces and 72 districts in Zambia. Furthermore, Microlink and CELTEL are about to roll out WiMaX. CELTEL is also offering a WAP service to mobile devices that includes GPRS. These technologies will charge the customer based on the USB and transfer rate.

CDMA (Code Division Multiple Access)

ZAMTEL introduced the CDMA 2000 1x system in August 2006. CDMA uses both radio and Internet with land line. It has a high speed dial-up service and does not have to use a modem on the computer but uses software to access the Internet. It is three times faster than dial-up; up to 153 kbps. You will need to purchase a CDMA, WILL equipment, a handset, a USB cable and software. The charges are the same as a fixed telephone line. The service is available in Lusaka, Southern Province, Mkushi, Ndola, Kitwe, Kasama and Ndola and Lumwana in Solwezi. There is a high potential for development and deployment of CDMA 2000 to other outlying areas in Zambia.

Deployments and technological developments in Zambia

Digitalisation of the telephone system

ZAMTEL has started digitalising the telephone switches in its stations. Originally these are analogue or manual systems; an old type of technology that affects telephone and Internet communication. Digitalisation will improve the speed of Internet and telephone services, for example by reducing telephone cuts, interferences and the number of crossed lines.

National and Regional Optical Fibre Cable Network Projects

Linking Zambia to the global Internet backbone

Zambia depends on foreign satellites for its Internet and fixed telephone line communications. The country is not yet linked to the submarine network which interconnects various countries in Africa to the global backbone and facilitates communication services around the world. The development of the East African Submarine Cable System (EASSy) fibre optic project promises to improve ICT infrastructure and connectivity services in Zambia but will take several years, at least, to complete. Fibre optic has a much greater capacity for data transfer than copper cables.

The fibre optic uses glass to transmit data. A fibre optic cable consists of a bundle of glass threads, each of which is capable of transmitting messages in the form of light. Fibre optic has a much greater capacity than metal cables, which means they can carry even more data. The quality of connectivity is currently affected by the state of the copper cables dotted across the country. Services are at times poor, particularly in rural areas, due to poor infrastructure facilities. The services are also affected by distance: the further away you are, the less speed and bandwidth you will get and the more time you will actually spend. The cost is also compounded by this state of affairs.

Fibre optic projects for national use

The fibre optic cable networks within Zambia are currently carried out by the Copperbelt Energy Corporation and the Zambian institutions, ZAMTEL and ZESCO.

ZAMTEL

ZAMTEL is developing its Fibre Optic Cable Project to improve its internal communications. The project began in June 2007 and is expected to be completed by the end of 2007. It focuses on Lusaka, Kitwe and Ndola. The project aims to improve the quality of communication services such as the Internet and fixed telephone services in urban and rural areas and is intended to link to the external communication network in other countries, for example through the East African Submarine Cable System (EASSY). The National Fibre Optic Cable Project that ZAMTEL is developing on behalf of the government will link Zambia to the external communication network. This project has not been completed yet and is expected to finish at the end of 2008 or in 2009.

ZESCO

ZESCO has also engaged in an optical fibre cable network to improve its internal communications. The first phase started in May 2006 and was completed in June 2007. It connects a number of locations (Katima Mulilo and Kazungula, Namibia, Vic falls, Kariba to Lumwana in the North) and should link to external Internet, for example Congo DR. The second phase of the optic network focuses on connecting provincial centres. It is anticipated that levels of efficiency will rise by 20%. The company has also indicated that it would be willing to enter into partnerships with other communication companies, such as Internet Service Providers, that wish to increase their connectivity. This can be explored further.

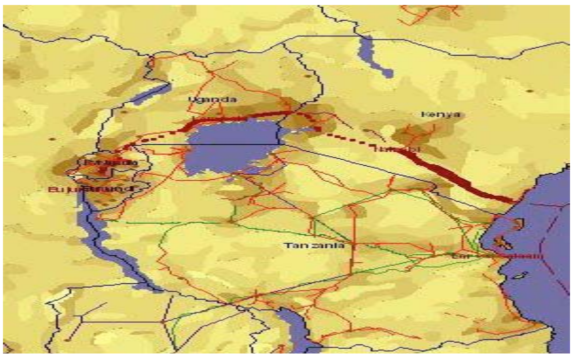


Figure 6: Existing EASSy Fibre Cable East Africa

The East African Submarine Cable System (EASSy)

The EASSy infrastructure project, which was initially supported by the World Bank, is a fibre optic cable intended to connect the six (6) sub-Saharan African countries, including Zambia. This fibre optic cable system is destined to run from a port in South Africa to a port in the Sudan in North Africa and will connect Rwanda, Burundi, Kenya, Tanzania, Mozambique, Uganda and Zambia to the international communication system. The cable system will have landing ports in each of the six countries. This means that Zambia will benefit from the high bandwidth fibre maritime cable and will no longer be dependent on foreign satellites. In addition, connectivity services will be improved and access costs fall.

This will eventually have a positive impact on rural connectivity services throughout Zambia. Although fibre would boost ICT development, it will be very slow in materializing unless the private sector/mobile operators get involved. The private sector generates the bulk of demand. For example, in East Africa the East African Submarine Cable Sytem (EASSy) submarine cable has suffered many delays and will not be operational until late 2008. The map shows the regional fibre link under construction, namely the backbone connecting Kenya, Uganda and Rwanda.

Part C: Connectivity in Zambia

Existing ISPs, mobile telephone companies, and their services in Zambia

Internet Service Providers (ISPs)

There are eleven registered Internet Service Providers (ISPs) in Zambia, out of which six are active. These are:

- ZAMTEL Online
- Zamnet Communication Systems
- Coppernet Solutions
- Microlink Technologies
- UUNet Zambia
- Africonnect
- Real Time
- Pronet
- Bring.Com (Z) Limited
- Oisat Cable Limited
- Afriswitch Epochal

This report deals with the six major Internet Service Providers and three mobile telephone companies in Zambia and their services. The three mobile telephone companies are CELTEL, MTN and CELL Z. The report has concentrated on the six ISPs because their services have demonstrated focus and coverage to a wider geographical area and they have taken connectivity services as their core business in Zambia. Our focus on six ISPs does not mean, however, that the other Internet Service Providers are not providing connectivity services.

The main services offered are:

- **Dial-up services**: these are available in all districts with a telephone line.
- **Wireless Broadband**: this service is only available in the Lusaka area within a 10 km radius, from Lamya House near the Lusaka Post Office area. It provides speeds from 64 to 1024 kbps (kilobits per second). It uses Cisco Airnet Bridge connects to Point of Presence and transmits an internet signal through the antenna.
- **Digital Subscriber Line (DSL) Connection**: this provides a broadband service with speeds from 64 to 1024 kbps. It uses a DSL modem and runs on a dedicated line to the premises. The service is mainly used by banks for Automated Teller Machines (ATMs), Internet cafes, and for data transmission purposes.
- **ADSL**: this is a new service introduced by ZAMTEL and covers the main cities of Lusaka, Ndola and Kitwe. It requires a regular telephone line and a special modem and uses both Internet and telephone simultaneously. The service is used primarily by home users and corporate clients. The broadband ranges from 64 to 512 kbps for home users. Businesses can go up to 1024 kbps.
- **Portable satellite terminal**
- **SMS Services:** provided by iconnect.zm
- **CDMA 2000:** which uses both radio and Internet services through a land line. It has high speed dial-up services. The maximum speed for CDMA is 153 kbps and it can be accessed in some major towns and mining areas of Lusaka, Southern, Copperbelt and Chipata in the Eastern Province.
- **Wireless line-of-sight, Unwired Broadband** or Non line-of-sight, **VSAT Satellite Ku-Band technology**.

A summary of services in each company is provided below:

- VSAT are mainly used for data transmission, voice and video. Coppernet provides line-of-sight and non line-of-sight wireless technologies
- WiMaX (Worldwide Interoperability for Microwave Access) is increasingly being introduced and provided by ISPs and mobile companies and offers connectivity solutions in rural Zambia.

A brief outline of each of the six ISPs is given below:

ZAMTEL Online introduced Internet connectivity services in 1998 and serves a combination of businesses and private customers, estimated at around 6,000. About 70% of its revenue comes from dial-up connections. In addition to providing traditional Internet connectivity services, the company is trying to acquire new business by offering value-added services such as web hosting, intranet and consulting services. ZAMTEL Online has points of presence (PoPs) in Lusaka, Kabwe, Ndola, Kitwe, Chingola and Solwezi.

ZAMNET was established in 1994 under the University of Zambia ICT project and its coverage are mainly along the line of rail, i.e Lusaka, Kitwe and Livingstone. ZAMNET currently has four manned points of presence (PoPs) in Lusaka, Kitwe, Livingstone and Solwezi and maintains virtual PoPs in Ndola, Luanshya and Mazabuka. The drop-off point is in Kabwe. ZAMNET provides various types of broadband connections, its link: www.zamnet.zm. Zamnet provide the following services: Dial-Up. Other services include Email applications (including web mail), Internet browsing services, private and virtual networks, fax over IP, instant messaging, File Transfer Protocol (FTP), Voice over Internet Protocol (VoIP), audio and video, streaming, domain name registration, website design and web hosting, a training and testing centre, and training in Microsoft-certified courses.

Africonnect is a fast-growing ISP in Zambia. It was initially providing dial-up Internet services which however gave problems due to the quality of copper wire cables. Africonnect now provides services in Lusaka, Livingstone, Kabwe, Kitwe and Ndola through Iconnect wireless broadband services (www.iconnect.zm) which provides equipment and connectivity services in urban and selected rural districts, although mainly along the line of rail.

UUNET Zambia (www.Unnet.zm) was officially launched in November 2001 to provide its clients with a mix of products and services. More recently, UUnet has developed its connectivity infrastructure in Lusaka and the copperbelt, having deployed nodes since 2001. UUnet provides services to a number of towns, including Lusaka, Kabwe, Kitwe, Ndola, Chingola and Chililabombwe. Its 2MB link-in exists in the Copperbelt through ZESCO. The services are customized to meet the needs of small and major clients as well as home users and include shared, dedicated and leased line services.

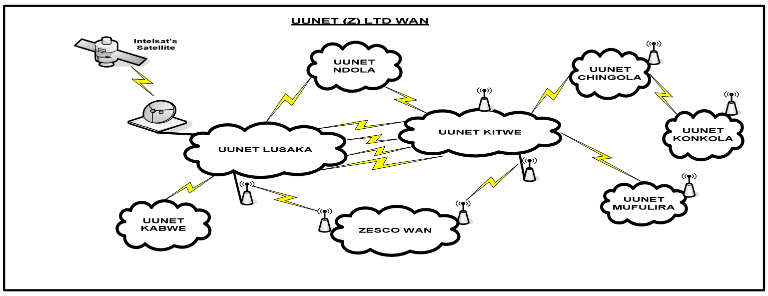


Figure 7: UUNET Wide Area Network (WAN) in Zambia

CopperNET Solutions (www.coppernet.zm) is an ISP that provides ICT (Information and Communication Technology) services in Zambia. The company was set up in 1999 following a management buy-out by Zambia Consolidated Copper Mines (ZCCM). The buy-out was the result of the privatisation exercise embarked upon by the Zambian Government. CopperNET Solutions has branches in Choma, Solwezi and Kitwe. Most of its clients are based along the line of rail.

Microlink Technologies was established in November, 2001 to provide dial-up services in Lusaka. Today, Microlink also provides wireless broadband services via satellite. Microlink has international gateways in Lusaka, Kitwe and Livingstone with Points of Presence in Ndola, Chingola and Kafue. Further expansion into other towns is an ongoing process.

Mobile telephone providers

MTN, Cell Z and CELTEL are the main mobile telephone service providers in Zambia. Celtel and MTN have continued to introduce Internet connectivity through the mobile telephone. The technologies that are being introduced include GPRS and EDGE, while WiMaX is being considered.

The GPRS mobile Internet service was launched by CELTEL in late 2006 and covers all areas in Zambia where CELTEL operates. The access speed ranges from 30 to 160 kbps. To use GPRS one needs to have a PC-card (ZMK 950,000) or USB-card (ZMK 1,170,000). Cost of usage are ZMK 1,600/ MB and one can also purchase bundles of 100 MB for ZMK 85,000, which is about half-price.

Billing options	**Rate (ZmK)**	**Monthly costs**
Pay per Use	1,600/MB	No Monthly fees, you pay as you use
100 MB bundle	850/MB	ZMK 85,000, Pay once a month and use Internet up to 100 Mb of information, top up as you require, get another bundle
Post paid	1,600/MB	Pay at the end of the month based on usage in MB

***Table 1** Billing options*

EDGE is an improved and advanced version of GPRS with higher speeds of up to 384 kbps. A similar access process is also applied for Edge and is available in the Copperbelt, Lusaka and Livingstone.

USB cards costs ZMK 1,170,000 and are referred to as 'SAMBA'. The PC cards or modems show how much you are using once connected.

Reflections on rural connectivity in Zambia

The above information has been condensed in Table 1 to provide an overview of the situation in Zambia.

Table 2: *Internet coverage by selected Internet Service Providers (ISPs): status in July 2007*

Internet Service Provider	Service	Number of clients	Geographical presence
1. ZAMNET	Dial-Up	5,368	Along the line of rail
	Wireless - Line-of-sight - non line-of-sight	 270 506	More than 50% in urban areas
	VSAT	a) 85	80% rural areas
2. ZAMTEL online	ADSL	a) 73	
	Wireless	b) 10	Lusaka area
	Leaseline	c) 77	Over 50% along the line of rail
	Dial-Up	5,700	Mainly urban areas
	CDMA 2000		Mainly rural areas
3. Microlink	Wireless	Approximately *8,000* in all services	Along the line of rail
4. CopperNET	Dial-Up	1,200	Mainly in Lusaka and fewer in provincial towns
	Wireless: - Dedicated - Shared	 300 500	Along the line of rail, Solwezi and Kasama Along the line of rail
	VSAT	120	Rural areas
5. UUNET	Dial-Up	600	Mainly Lusaka and Copperbelt
	Wireless - DSL -	71 11	
	VSAT	4	
6. Africonnect	Dial-Up	Currently not offered	
	Wireless (Iconnect)	-	Main services are provided along the line of rail
	VSAT	-	VSATs are provided to clients located in rural areas

The Table above indicates that:

- An estimate of over 17,000 users are served by six ISPs in the country. Over 50% of the clients use dial-up services. Internet Service Providers are not rushing into the rural areas because of the lack of infrastructure and the fact that they expect a low volume of demand for their services. Rural areas are seen by some as uneconomical because people living in the rural communities cannot afford connectivity services. The absence of an adequate telecommunications infrastructure in the rural areas is also a key factor: there are often few or no fixed telephone lines and if they are present they are often in a poor state of repair.

- The importance of Internet services has not been fully appreciated by people living in rural and remote areas. There is also little appreciation of the use of computers and their availability. As a result, the demand for Internet services among entrepreneurs and home users living in rural Zambia is low.

- The cost of access and infrastructure in rural areas is higher than in urban areas. There are more private telecentres such as Internet cafes in the urban areas than in rural areas. The cost accessing the Internet cafes in the rural areas is five times higher than in the urban areas. In some cases, it costs between ZMK 500 – ZMK 1,000 to access the Internet (about 0.10-0.25 USD) in the rural areas compared to an average of ZMK 100.00 (0.025 USD) per minute in Lusaka and the Copperbelt.

- It is also important to note from the Table above that over 50% of services provided by the ISPs are concentrated in the major towns along the line of rail. Users in the rural areas mainly use dial-up services to connect to the Internet. Services available for the rural areas include CDMA, offered by ZAMTEL, and GPRS, offered by CELTEl and MTN, as well as VSAT satellite systems offered by some ISP companies. VSAT systems are more frequently used in the rural areas than in the towns. Wireless broadband tends to be predominantly used by urban users.

Geographical overview of connectivity in Zambia

As the obvious case arises, that ISPs and mobile communications have concentrated their investments in urban areas, the issue of high and low connectivity emerges. This means that urban areas with high connectivity receive better and cheaper services than rural areas with low connectivity. Furthermore, new investments in the mines and some parts of the rural areas have also attracted an extension of connectivity services, for example Lumwana mine in Solwezi, North-Western Province and Mazabuka in Southern Province. Areas with high and low connectivity emerge partly as a result of the absence of ISPs and the ZAMTEL telephone communication infrastructure in these areas. The table below segments areas with low and high connectivity services in Zambia:

Table 3: Connectivity overview

Description	Region / province	Power sources	Towns	Common peering services
High				
The belt covering the line of rail from Livingstone to up the North, to the Copperbelt Province	Southern	Connected to the main power grid	Livingstone, Choma, Mazabuka	Various types of Wireless broadband services; Line-of-sight and non line-of-sight, DSL and ADSL, WiMaX, CDMA 2000 1x and dial-up services.
	Lusaka	Connected to the main power grid	Lusaka and Kafue	
	Central	Some parts connected	Kabwe, Kapiri Mposhi and Mkushi farm block	
	Copperbelt	Almost all of the area is connected	Kitwe, Ndola, Chingola, Ndola, Munfulira, Luanshya	
Medium	Northern, Eastern, North-Western	Many of the areas are not connected	Kasama, Chipata, Lumwana in Solwezi	Dial-up, VSAT and a few cases of wireless services
Low	The rest of rural Zambia	Many of the areas are not connected	The rest of the rural districts	Dial-up and VSAT satellite services

Note:

High: Areas with easy access and many options to connectivity services
Medium: Areas with provincial towns with some towns having access to wireless services
Low: Not easy to locate connectivity options that are fitting

The table above indicates that most of the ISPs and their services are located within an area of high connectivity; the belt from Livingstone to the Copperbelt. This means that services in this area are not only cheaper, but are also readily available to the urban residents. Therefore, the table is designed to provide a guide to where and what type of connectivity services to select if you are located in any of these regions. The medium connectivity area is slowly emerging with wireless connectivity and others such as WiMaX, WiFi and GPRS.

Issues to consider when selecting connectivity services

Selecting the service level and the ISP

Various Internet connectivity options need to be considered so that a client gets the best service for their home, office and/or business. The right type of service needs to be identified from the many different options currently available on the market. The first step is to decide whether you need to have a continuous service or one that you can access from time to time. You also need to consider whether you need heavy data uploads or data transfers. The client also has to know how many computers are needed as well as the number of users who will require Internet services. If an international non-governmental organisation (NGO), Bank or utility company subscribes to a service intended for use in the home, the service will definitely not fulfil its needs.

As elaborated earlier in Table 2, it is important to note that in Zambia some connectivity services can only be obtained by clients who reside in the urban areas. For example, wireless broadband which is a common connectivity service for businesses can only purchased from ISPs by clients who are located in the main towns.

When selecting a relevant service package and appropriate ISP it is beneficial to use a checklist that will help in selecting the service and ensuring that it is adequate, as illustrated in the example given in the table below:

Table 4: Technical issues for connectivity

Considerations	Home	Small Office	School lab	Community centre	Internet café	Commercial Company
Type of service						
Purpose of usage, for example: data, email downloads etc						
Intended number of users/computers						
Time of Internet use						
Your budget limits equipment/monthly bills						
Transaction sizes uplink/downlink						
Bandwidth requirement						
Rebate plan						
Bandwidth monitoring						

Type of service

It is very important to identify the right type of service you require and to match it up with your home, organisation or Internet café, based on your daily usage. Your service may also be determined by where you live. If you are located off the line of rail, the service you select will definitely not be a wireless broadband. On the other hand, if you are a home-user and need to send and receive emails and small data uploads then your service requirements may not be a VSAT. It may not be fair for your home or organisation to select a service that is not suitable or adequate for your requirements. So, in simple terms, the type of service you select will be determined by two things: the type of work you wish to perform using an Internet connection and where you live in Zambia.

Purpose of usage

The other important consideration is why you need an Internet service in the first place. For example, if you are a school in Lusaka that has a school lab equipped with 15 to 20 Personal Computers you will need a good, high speed wireless broadband connection with a sizable bandwidth to enable students to download information resources. A medium-sized company might need a similar connection. The best example of this is Munali High School in Lusaka. You may also opt for a VSAT if you are a College or University as in the case of the University of Zambia computer training centre.

Intended Number of users/computers

It is necessary to specify the number of computers when seeking a connectivity service. This will be important when bandwidth levels are secured. The number of computers and the bandwidth will correspond with the monthly cost for the service applied for from the ISP. Indicating the correct number of computers or users will enable the ISPs to furnish you with the right bandwidth and will, in turn, allow you to efficiently access the service you deserve.

Extent of Internet use

The other big question is how long you intend to spend on the Internet. You may end up paying for a service that you are unable to use if you make the wrong choice.

Your budget limits - equipment/monthly bills

The budget for connectivity is crucial. There are cases where individuals have secured a service they cannot afford. Therefore advice should be sought to ensure that you get a right service for your budget. Some services can be very expensive and making a mistake in the beginning can result in the service being withdrawn. If you are located in a rural setting without a wireless broadband, for example in the Western Province, and are looking for a cheaper connectivity service - emails and simple access for a home or small office – then the alternative service you should go for is a Dial-Up service.

Transaction sizes - uplink/downlink

What is the size of the downloads you require? This will depend on the nature of work and the amount of data you download. This is important information for the ISP as it will help to select the service and determine the monthly payments.

Bandwidth requirement

Knowing and getting the right type of bandwidth is critical for the right type of service. Two options are normally given: 'shared' and 'dedicated'. 'Shared' means that several users are sharing a 128kbps link. For example, it would be unrealistic for a small business to get a dedicated bandwidth when its requirements can be simply shared. Similarly, there are cases in which a large company will opt for a shared bandwidth when its business requirements are not so large.

Rebate plan

The ISPs sometimes provide rebates to clients: this should be made known to clients right from the start. Details on rebate plans are normally provided in the SLA (service level agreement). Care should be taken to fully understand which rebates should be given in each of the service options selected.

Bandwidth monitoring

Bandwidth monitoring is important to enable your business to get and pay for the right type of bandwidth. There are tools that can help you to monitor bandwidth through report monitoring. Link: http://manageengine.adventnet.com/products/netflow/bandwidth-reports.html#report. A NetFlow Analyzer provides extensive reports on bandwidth usage. The bandwidth reports include details about bandwidth and an overall bandwidth usage report for an interface link can be seen using the consolidated report.

In general, if you are located in a rural setting without a wireless broadband, for example in Western Province, and are seeking a cheaper connectivity service - emails and simple access for a home or small office - the only alternative service you can go for is Dial-Up, assuming you reside within a ZAMTEL telephone line infrastructure. It is advisable for rural community-based institutions such as community health centres, rural schools and colleges with a limited number of computers in use, which are located in a low or medium-level connectivity location, to acquire a VSAT Ku or C-band satellite service. This is the best option as it will give a good shared access to Internet from any rural setting in Zambia. With the right equipment, a good C-band or Ku-band satellite connection will even enable the rural institutions to get involved in E-learning, Telemedicine or Video-Conferencing activities. Using last generation compression codec allows one to have a very competitive bandwidth rate (for example, an audio stream uses only 2KB/s and an average of 10 KB/s for an audio and video stream). Questions about the right type of bandwidth and equipment can be found at: http://www.tixeo.com/Faq.htm

One interesting example is the Mongu Trades Training School in Mongu which acquired a VSAT Ku-band link, despite the fact that Mongu can also access Dial-Up services and is a rural provincial town. Similarly, a rural health centre in Southern Province has opted for VSAT services.

A large company located in Lusaka will definitely opt for either a high speed wireless broadband from a reputable ISP or VSAT Ku-Band or C-band with a dedicated bandwidth. A tourist visiting Zambia may have to use a mobile phone handset, can access wireless connectivity through his or her laptop if located in Livingstone, or can access Internet services at any district location in Zambia using the facilities of a mobile telephone company. Other practical experiences relating to rural connectivity in Zambia can be found at www.namwala.com, www.macha.org.zm and www.wiki.link.net.zm

After selecting the service level, it is very important to monitor the bandwidth provided. If the bandwidth received is less than agreed in the rebate plan indicated in the Service Level Agreement, the service can be requested from the ISP. However, it is important to note that a slow Internet speed can be due to a number of different reasons, for example: poor PC maintenance, a virus on the PC, low disk space and poor software configuration.

In order to address these problems, it might be necessary to consult a local expert. Alternatively, you can visit sites such as online Tools and Tips which is available at:
www.infobridge.org/jml/index.php?option=com_content&task=view&id=26&Itemid=120

Service Monitoring tools

In cases where clients do not receive proper services from ISPs, disagreements may occur. In such cases it is advisable to ask the ISP to provide a graph and overview of usage and services provided. In addition, software tools can also be used to monitor the type of use (traffic, downloads) and help determine the quality of service, especially bandwidth and up-time (see Annex 1). They can also help to identify leakages of bandwidth, caused by viruses and worms for example, or identify excessive downloads such as movies and songs that distort the use of the network. Other software tools can help a company to control usage of the network, for example by allowing certain users to access e-mail only, while allowing others to access the web, as well as by blocking services such as downloads of songs and movies or chatting. Monitoring and controlling use is necessary to optimise available bandwidth and ensure proper maintenance.

Service Level Agreement (SLA)

Service Level Agreements (SLAs) specify the level and quality of service to be delivered by the ISP including the reliability of services. It protects the client and includes clauses on refunds in case the ISP fails to meet the minimum acceptable terms of the SLA. It is strongly advised to ask for the SLA when making a service contract with an ISP. As this is a liability, some ISPs only offer SLAs to customers who pay for higher levels of service.

Some of the issues to look out for are:

- *Up-time guarantee* – this is the guaranteed time that an ISP might give for the service. The ISP may guarantee an up-time of 95%. This will guarantee to prove to a client that at least 28.5 days a month of 30 days of service will be provided.
- *Compensation for downtime* – this is used to meet a minimum quality of service (QoS). It can also be used to claim compensation for undelivered services. By taking the monthly rate and deducting the number of hours of downtime, the quality of service is found.
- *Latency* – this is the length of time taken for an amount of data to make a complete round trip. A normal satellite connection would give about 600 milliseconds latency at best.

Bandwidth Allocation – shared vs. dedicated

Bandwidth determines the speed of the data transfer. The smaller the bandwidth for a given volume of data, the longer the latency period. Satellite communication networks in general offer access for more than 99.5% of the time. Internet Service Providers offer two options for bandwidth usage: the first is 'shared', implying that a number of customers share that bandwidth. Therefore, a 128kbps shared link theoretically means that there are several users sharing the same link. However there needs to be a minimum bandwidth.

Dedicated bandwidth is a fixed segment used solely by a specific customer and nobody else. As bandwidth is expensive, this option is more costly than shared bandwidth. The majority of people use shared services. However, at peak times this can lead to drastically reduced speeds.

Common reasons for downtime

Downtimes are breaks in Internet connectivity. These are problems related to the use of Internet as well as the use of sharing bandwidth with others. Interferences are at times caused by the Internet Service Providers when they share a 2.4Ghz band which causes overcrowding. Internet Service Providers have submitted that they usually compensate downtime of Internet access. However, this is seldom offered in practice. Private users and cafes interviewed in Lusaka complain of the poor services provided by the ISPs. They also suffer from ZESCO's power black-outs. The list below highlights the most common reasons for downtime:

Low power voltage and power cuts

The power system is not very reliable, either in the towns or rural areas. At times, voltage is low which affects the equipment and causes breakdowns in the communication systems in most areas in Zambia. There are also regular power cuts due to load shedding by ZESCO. Whilst ISPs offer in principle compensation to their clients for reduced services, ZESCO does not give compensation to ISPs for the break in power distribution which affects the ISP services. ZESCO introduced load shedding in most rural areas of the country to preserve or redistribute available power. Load shedding causes cuts in the communication systems and services in rural areas.

Adverse weather conditions

Cloudy weather conditions as well as thunder are some of the factors commonly affecting Internet access. Thunder and lightening also affect the power supply as they cause breaks in the power transmissions by damaging ZESCO's transformers. This in turn affects the ISPs' sites, especially in rural areas, for extended periods as breakdowns in power are usually not quickly repaired. The power supply for the VSAT at the user-location can also be affected.

Low or shared bandwidth

Bandwidth-sharing with others may cause breakdowns in Internet access, especially if number of people is more than the allowance. Sharing bandwidth becomes one of the most common contributory factors for slow access and breaks in communication transmissions. Some people may be downloading large amounts of data, such as photographs or music, which will cause congestion and delays or interruptions in access. The other is using minimal bandwidth that does not respond to the requirements of your usage.

Poor quality of copper cables/telephone connections

Telephone lines can function poorly due to the quality of the copper cables, which also affects services such as Dial-Up. This has been a concern to many clients. In addition, the quality of service provided by some ISPs is also poor.

Emerging Challenges to rural connectivity in Zambia

As discussed in the previous sections, Zambia was one of the first countries in sub-Saharan Africa - after South Africa - to adopt Internet. Despite being an Internet pioneer, the country still lags behind in connectivity coverage with high connectivity costs. The following includes some of the main challenges faced by the rural areas in Zambia:

Lack of 'last mile' infrastructure

The lack of an adequate infrastructure refers to the issue of communication as well as other infrastructures such as power and access to main roads. One major constraint for rural connectivity is the lack of a 'last mile' infrastructure; the link between a major Point of Presence (POP) of a provider and a user. It should be observed that more ISPs are along the line of rail because of infrastructure problems. Areas serviced by ZAMTEL are confronted with poor quality copper cables that affect the speed of the communication services. The introduction of new technologies by ZAMTEL such as the digitalisation process and the National Fibre Optic Project may eventually improve its telephone and communication services. Most operators are reluctant to invest in the rural areas because of the infrastructural problems they have and therefore tend to focus their attention on the urban areas.

Although not a direct constraint, poor access to roads does affect movement and investments in the ICT sector by hindering communication companies from setting up or maintaining an ICT infrastructure. Whilst there have been some significant improvements in the inter-town roads in the past few years, access roads in rural areas are still problematic.

Lack of energy supply

Zambia's hydro power grid is mainly concentrated in the districts. Most of the remote rural areas have no access to ZESCO power grids. Although most of the districts are connected to the main grid, these are coupled with intermittent cuts. Power grids are normally far away and therefore areas are not serviced by hydro power. This makes it difficult for people to access connectivity as a reliable energy source is needed for the necessary connections and to use the equipment.

High costs of the Internet

The cost of Internet connectivity in Zambia is high which excludes many users who cannot afford the high cost of equipment and the monthly fees. A private user wishing to connect his or her home to a fast speed wireless Internet, pays an average monthly amount of ZMK 700,000 (or some 100 EUR) excluding installation costs. An average Zambian household simply cannot afford these prices. One cost-effective type of connectivity service that is currently affordable for rural areas is Dial-up. However, a Dial-up connection might not be the best option for people living in rural areas as telephone lines are unreliable, and the service is often poor and slow which results in people wasting time and money. In some rural areas people pay as much as ZMK 1,000 (0.25 USD) per minute for a Dial-Up Internet café whilst in Lusaka people pay only ZMK 100 (0.025 USD) per minute for a wireless connected service. The cost of Internet is increased by the lack of a terrestrial infrastructure.

The cost of bandwidth

Zambia currently does not have a Fibre Optic cable and the cost of bandwidth is generally expected to be more due to its reliance on foreign satellites. The main reasons for the high costs of bandwidth in Zambia are generally believed to be the following:

- **Dependence on satellite connections.** Zambia, like most African countries (with the exception of Nigeria), does not have its own satellite system and therefore relies on foreign commercial satellites. This brings along rather high satellite fees.

- **High Import Taxes and license fees**. Most Internet Service Providers are affected by the high import taxes on communication equipment. They are required to pay 15% duty and 17.5% VAT (Value Added Tax). In the communication sector, much of the equipment is imported from abroad and VAT is not reclaimable in Zambia. The high costs of services and connectivity equipment are transferred to the clients. The five percent (5%) levy charge on turn-over that has to be paid by the communication companies to the Communication Authority is also considered a burden by ISPs and would-be investors in the sector.

- **US Dollar/Zambian Kwacha rate factor**. The rate of fluctuation of the Kwacha against the dollar and euro at times poses a major challenge to ISPs as planning becomes difficult. This is due to the fact that ISPs depend on equipment that is imported from outside the country. Inconsistencies in the exchange rate makes budgeting difficult.

- **The lack of adequately qualified or skilled technical staff**. There is a shortage of skilled human resources in the ICT sector so many companies import skilled staff from abroad. The University of Zambia (UNZA) offers IT courses but ISP companies complain that courses given at UNZA are not practical and that students often graduate without having any practical experience.

Part D: Energy for Rural Access

Energy sources in Zambia

Zambia uses many types of energy sources including wood fuel, hydropower, coal and renewable energy sources. The original focus of Zambia's hydro-powered electricity grid was meant to feed the copper mining industry. This means that Zambia did not have adequate programmes to extend the power grid to remote rural areas. As a result, the government established Rural Electrification Authority (REA) in 2003 to support the development of energy resources and services for rural Zambia. The Rural Electrification Authority went on to identify 1,216 rural growth centres all over the country as 'ports of radiation' to support the rural electrification programme.

The main source of power is hydro. This is mostly generated at the Kafue Gorge and Kariba Dam in the south of the country. Electricity remains the second most important indigenous source of energy after wood fuel and contributes 12% to the national energy supply. Electricity as a key energy source for Zambia and is vital for rural development. Zambia is endowed with vast water bodies and includes rivers and water falls. The hydro power potential, which is estimated at 6,000 megawatts, has not been fully exploited. There are many reasons for this: the general lack of resources, distribution costs, road infrastructure, capacity, population density and non-productivity in some of Zambia's vast rural areas.

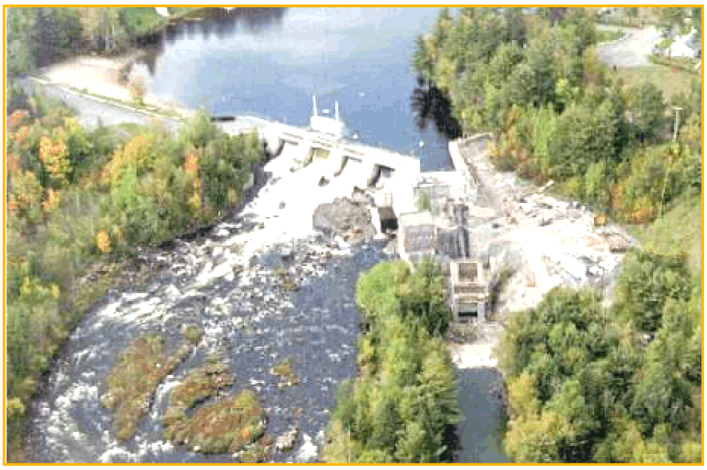
The mining industry is the major consumer of electricity and accounts for over 50% of production. This is not surprising as Zambia's main electricity production scheme was meant for the mining industry in the Copperbelt Province. It is estimated that urban areas consume 48% of the electricity whereas only 2% is consumed in the rural areas. On average, 25% of the total population has access to electricity. A huge part of rural Zambia still has no access to the national electricity distribution grid.

The development means that there should be exploration and identification of alternative sources of energy, renewable energy (solar, biomass fuel-wood, charcoal etc.) to meet energy requirements for rural energy shortfalls. Energy is indispensable for the quality of life of rural and urban populations as it enables them to meet their energy needs in a socially and environmentally sustainable manner. In Zambia, where access to hydro power is a privilege enjoyed mainly in the urban areas, alternative energy sources are important for rural connectivity services and other general uses. An integrated approach to rural electrification is required that will combine rural energy supply with achieving sustainable rural development and poverty alleviation goals. With this current urban energy bias, Zambia should seek to adopt best alternative practices from other countries and regions, and to create an integrated market- based approach towards providing energy to all of Zambia.

Examples of options for extending electricity to Zambia's rural areas include:

- **Extending the power grid to most rural remote areas**. However, it has been indicated that the government may not have adequate resources to do this in the near future.
- **Developing isolated grid (stand alone) small hydro power plants**. Developing mini-hydro power stations in potential areas may be one option but it will requires initial investments. The cost of investing in a 2.5 megawatts plant can be as much as 5 million US$. The investment will depend on the willingness of the government or the private sector to invest in hydro projects. The estimated mini-hydro potential is about 45 MW, mainly located in the North and North-Western parts of the country with the highest rainfall. The exploited proportion of a mini-hydro plant is still low, less than 10% of the potential.

Figure 8: Mini Hydro with high head; Photo credit: SNC lawalin: www.retscreen.net



Options for Rural Energy

There is therefore a need to identify appropriate and alternative energy sources to power rural connectivity services. Energy sources in Zambia can be obtained from isolated hydro power systems and renewable energy systems that include the use of biomass, solar energy, wind energy and wood fuel. If you opt for renewable sources, the recurrent costs will be less however it will require initial investments and will depend on natural sources. Each of these sources has its own technological, cost considerations and availability of resources in a given area. Most renewable energy technologies have not been fully explored in Zambia. However, no comprehensive study has yet been carried out to explore the viability of renewable energy technologies.

Table 5: Selected Sources of renewable energy companies in Zambia

Company	Type of source	Location
Zamcapitol	Windmills	Light industrial area, Luanshya Plot 5120, Road, Lusaka
Solaris Africa	Solar systems	117b,Chiparamba, Lusaka, solaris@microlink.zm
Behrens	Solar accessories	Light Industrial area, Lusaka
Chloride Zambia Ltd.	Solar systems	Kafue Roundabout, Cairo Road, P.O. Box 34281, Lusaka
Electrical Maintenance	Solar systems and electrical engineering	Plot 195, Luanshya Road, Box 31189, Lusaka. Tel: 235366/227824, hightec@emil-eis.com

Diesel plants and Biofuels

Zambia has been using fossil diesel for power generators in some rural districts. Due to the high maintenance cost of the generators, ZESCO has been phasing them out and replacing them with connections to hydro power grids. The depletion of fossil fuels and increasing costs have induced people to explore the use of biofuels for the diesel power plants. While it is necessary to consider maintenance costs and the cost of technology, nevertheless, diesel generators fuelled by biofuels are an alternative energy supply and can be used in hybrid energy systems, combining several renewable sources including solar power.

Biomass

Biomass is a source of energy and can be derived from agricultural residues, stalks, firewood, slurry, cow dung, fisheries waste or organic waste. The locally available biomass resources influence the selection of conversion technology. The Rural Electrification Authority (REA) is supporting biomass gasification located in Kaputa district in Northern Province, Zambia. The sources of Biofuels can be derived from plants and animals in the form of Biodiesel and Bioathenol. The common source of biofuels in Zambia is extracted from plants such as Jatropha, cotton seed, soy seed and sunflower. There are initiatives to promote biofuels in Zambia, although the energy policy of 1994 did not incorporate biofuels. In order to promote and develop the use of biofuels and other New and Reusable Sources of Energy (NRSE), the government set up, through on-going energy sector reforms, the Energy Sector Advisory Group to incorporate existing initiatives towards policy support on NRSE. There is an increase in the number of initiatives that rely on biofuels as a source of energy in Zambia. However, one interesting concept is the use of hybrid systems in rural areas. The use of solar/biofuels hybrid energy can also be explored in the absence of hydropower. Hybrid energy systems can be stand-alone energy sources in most rural areas of Africa. Biofuels are being promoted in Zambia through the Biofuels Association of Zambia, a non-governmental organisation located in Lusaka. The association supports individuals and organisations throughout Zambia that are involved in promoting and establishing biofuel crops.

Photovoltaic: stand-alone solar systems

Zambia is endowed with a variety of possible sources for renewable energy such as solar, mini-hydro and wind. Solar panels can provide energy to rural homes, offices and businesses. Solar energy is being used for a variety of purposes such as powering telecommunication equipment, water pumping, domestic water heating, refrigeration, lighting and drying.

There is a wide scope for the increased use of this renewable energy source. Zambia has, on average, 2,600-3,000 hours of sunshine per year. This gives an average annual solar isolation of about 4 kilowatt-hours per square metre per day (kWh/m'/day) with a peak of solar energy being received in October and November. This should therefore be taken into account when making solar applications. So far, efforts to harness the use of renewable energy resources have been minimal in Zambia.

Wood Fuel

Most of Zambia's rural populations depend on wood fuel in the form of firewood and charcoal. It is also the principal source of energy in the country, accounting for 68% of the total energy supply. Woodfuel consumption is dominated by households; they consume 88% of this energy source. When translated into wood, charcoal accounts for 44% of wood consumed for energy and firewood contributes 56%. Zambia's woodlands and forests are estimated at 50 million hectares. Woodfuel (firewood and charcoal) is currently a dominant source of energy in Zambia. However, the rate of deforestation in Zambia is at 900 hectares per year. Wood residue can be used instead of raw wood, for example wood that comes from the processing industries. Depending on raw wood for fuel will have a negative impact on the country's natural forests as it will result in deforestation. Government policy discourages dependence on raw wood for fuel. The conversion of wood to charcoal has been a source of concern due to its impact on the environment. Wood as a source of energy is increasingly under criticism from various quarters for being outdated, causing deforestation and having a negative impact on the environment.

Wind energy / mills

Wind is as a source of energy. Wind data is collected at a height of 9-10 m above the ground. Wind speeds vary from 0.1-3.5 meters per second (m/s) with an annual average of 2.5 m/s. The wind speeds in Zambia are mainly suitable for pumping water through windmills. There have been some efforts to use solar power and windmills to facilitate rural electrification. However, wind speeds in Zambia are not sufficiently adequate to provide enough power through windmills to generate electricity. As stated earlier, wind generates electricity and can be used directly, as in water pumping applications, and stored in batteries for household use when needed. Wind generators can be used in isolation, or they may be used as part of a hybrid system, in which case their output is combined with that of photovoltaics, and/or a fossil fuel generator. Hybrid systems are especially useful as a power backup for home systems where cloudy weather and windy conditions occur simultaneously. The average cost of equipment of a hybrid solar/windmill as a stand-alone is 6,555 euros depending on the source of the suppliers and the type of equipment. The equipment is mainly imported from outside. The source of windmill suppliers are Zamcapitol limited, a private company based in Lusaka.

Figure 9: Wind Mill

Considerations when selecting energy sources

Table 6: Basic guide for energy solutions in ICT projects

Energy Solution	Capital Costs & O&M	System Lifetime	Availability of Resources	Vulnerability to Damage from Natural Forces
Solar Photovoltaics	High capital costs, low operating costs	20-25 years	Widespread	Low
Generator Sets (diesel/gas)	Low capital costs, high operating costs	3-10 years	Widespread	Very low
Small Wind	Medium capital costs, low operating costs	10-15 years	Site specific	Moderate
Micro-hydro	Low-medium capital costs, low operating costs	50-100 years	Site specific	High
Battery Backup Systems	Battery backup systems can be used in a variety of situations. They are an essential complement to solar photovoltaics and wind systems. They can also supplement unreliable grid electricity.			

The total costs in this table do not include initial capital costs and energy system installation costs.

Small hydro power plants

There are a number of natural sites scattered throughout the rural areas of Zambia. They can be developed to support hydro power plants and extend energy sources to large segments of the population. You will need to gather a lot of technical information before any decision can be made to invest in hydro power investments. Two of the key areas are given below:

Hydro equipment

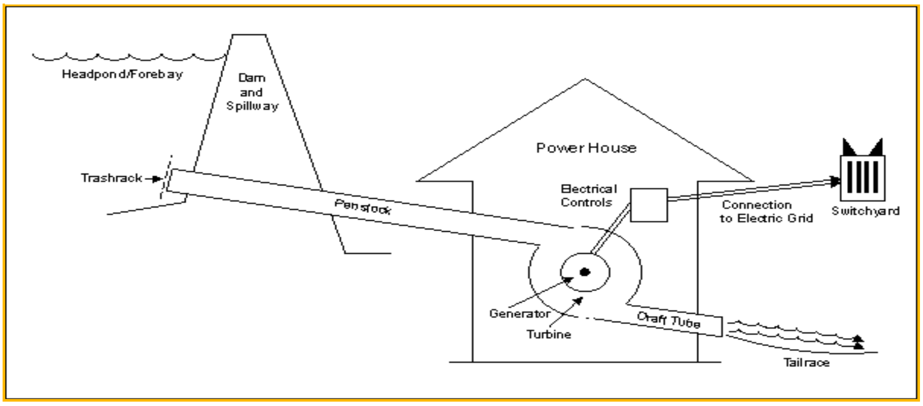
Small hydros are established to produce electricity for central and isolated grids as well as remote power supplies. They are reliable and have low operating costs. Small hydro power plants are classified and categorized into 'mini', 'micro' and 'small' indicating not just their electrical capacity but also whether they are low or high head. The type of equipment and related costs are depend of several factors. The typical sizes of hydro power plants are shown in the table below.

Table 7: Different sizes of isolated hydro power plants

Size	Typical Power	Water Flow	Type of registered Equipment supplier Runner Diameter
Micro	< 100 kW	< 0.4 m3/s	< 0.3 m
Mini	100 to 1,000 kW	0.4 to 12.8 m3/s	0.3 to 0.8 m
Small	1 to 50 MW	> 12.8 m3/s	> 0.8 m

Determining the type or size of equipment for a small hydro power plant depends on the area's natural environment. The key technical questions that determine the type of equipment are 'head' or height in metres of the waterfall and expected water flow of the area as shown in Fig. 8 below. High head equipment tends to be less costly. The higher the area in metres, the smaller the equipment and the more easy it is to bring the cost down further.

Figure 10: Descriptive diagram of a small hydro power. Source: RetInternational



Similarly, in a Pico-Hydro system, a process should be followed and thus creation of miniature dam in a water catchments area, regulation of water flow called a Forebay Tank. Then you can regulate the flow of water through a pipe called a penstock. The greater the height of the Forebay tanks from the actual turbine, the greater the force of the water. The larger the penstock and supply of water is, the stronger the flow. Both of these elements cause a greater amount of electricity to be produced. At the bottom of the penstock is an adjoining piece of pipe that also creates a narrow nozzle from which water will rush at high speeds. This section is called the Flow Shaping End Nozzle. Finally, the high pressure water hits the blade of the turbine, which turns the generator: electricity is produced. This is graphically illustrated below. More information on building a Pico-Hydro system can be obtained from: http://www.eee.ntu.ac.uk/research/microhydro/picosite/

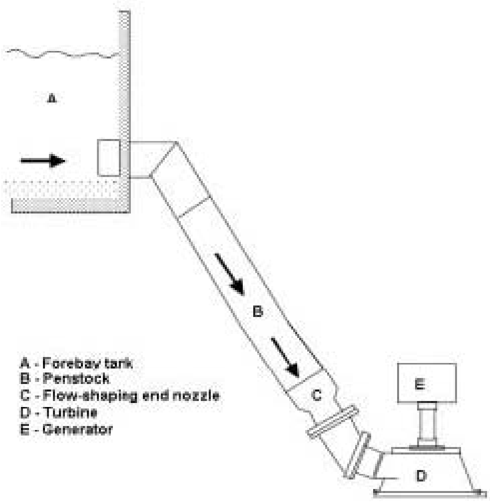


Figure 11: Standard Hydro Power Generation Setup (Source: www.tve.org)

Cost of power equipment

The cost of equipment is also determined by the above factors. If the mini hydro is installed using a Dam site, then the cost of investment will be higher because it will involve civil works and dam maintenance costs. The typical range of costs is from 1,200 US$ to 6,000 US$ per installed kW. The hydro power plants come in standard sizes and have standard rates. For example, rated 1 megawatt equipment will cost between 1 million USD to 2.5 million USD. Therefore, the better sites for the mini hydros are those located at small waterfalls as in Northern Province, Luapula and North-Western Provinces. To set up one 2.5 megawatts plant one would need make an initial outlay cost of 5 million USD.

Opportunities for using small hydros

There is a high potential for developing small hydros because of the water resources in some parts of Zambia. One megawatt mini hydro can provide power to a community centre or district and can be a source of energy requirements for a wider population without necessarily depending on the main ZESCO grid.

Given the availability of resources, micro-hydropower offers a proven and reliable source of electrical or mechanical power on demand, usually at a lower life cycle cost than diesel engine, wind, or PV systems. Using the energy of falling water, micro-hydropower systems supply mechanical energy that can be used directly or converted into electrical energy through a generator, for use in lighting, refrigeration, information and ICT (information and communication technology), or to run electric motors.

Micro-hydro systems typically produce more energy per rated kilowatt on a daily basis than wind energy or solar PV systems. This is possible as micro-hydro systems operate around the clock whereas solar and wind power systems generate power for only a few hours each day. For example, a 100 peak Watt solar PV system might produce 100 W * 4 hours = 400 Wh on a sunny day; a 100 W wind energy system might produce 100 W * 8 hours = 800 Wh per day; whereas a micro-hydro system of the same size can, in theory, produce 100 W * 24 hours = 2,400 Wh per day.

Hydropower plants with a capacity under 100 kW are generally categorised as ‘micro-hydro’. Plants in the range of 1–100 kW generally supply power through a mini-grid. Such plants mostly produce alternating current (AC) and as such the supply is not much different from the supply of electricity from the national grid. Very small micro-hydro systems of less than 1 kW – sometimes referred to as ‘pico-hydro’ – might be installed by a user who specifically wishes to power ICTs in an isolated rural area.

Wind energy

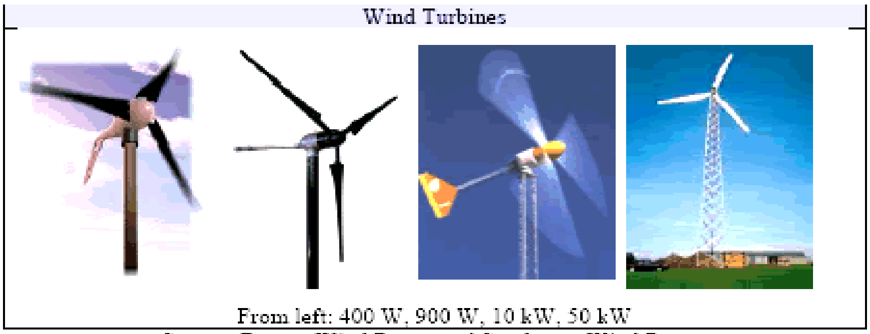
There are currently no wind power systems supporting a hydro power supply in Zambia. However, it is possible to fluctuate power levels and transmission and suitable to use wind energy for utility grids in cases of fluctuating water levels. The wind energy can therefore be used for isolated mini grids where wind/hydro are enough. There are research activities to examine whether wind and hydropower technologies can work together to provide a stable supply of electricity to an interconnected grid. There are also assertions that hydropower facilities may be able to act as a ‘battery’ for wind power by storing water during high-wind periods, however a detailed analysis examining regulations, load following, reserve, and generator and grid operations has not been performed.

The average total cost of procuring and installing a 5000 litre tank windmill for water pumping purposes for a basic home as obtained from Zamcapitol in Lusaka will cost 6,200 USD for equipment, with installation costs included, and is calculated based on the distance from the vendor. Hybrid systems are especially useful for power backup of home systems where cloudy weather and windy conditions occur simultaneously. The average cost of equipment for a hybrid solar/windmill as a stand-alone is 6,555 euros depending on the supplier’s source and the type of equipment. The equipment is mainly imported from abroad. The source of the windmill suppliers is Zamcapitol limited, a private company located in Lusaka.

The suitability of a particular site is affected by the duration and regularity of wind flows over the course of the day and the year. Large wind farms use complex computer models for siting. However, smaller wind turbines can be set up by using some rules of thumb, such as:

- The cubed relationship between wind energy and wind speed means that small increases in wind speed yield significant increases in energy output.
- Air flowing at 5 meters per second can yield twice the energy of air flowing at 4 m/s, and nearly 5 times the energy as air flowing at 3 m/s.
- It is not uncommon for wind speed to have very large daily and seasonal variations and to be influenced by local terrain and microclimates.
- If the wind is very strong only for a few hours a day or a few months a year, wind power alone may not provide enough continuous power to support an ICT facility that operates all year-round.

Figure 12: Wind power Turbines



Source: Bergey Wind Power and Southwest Wind Power

Basics on wind energy :

- **Determine the site or location plus the adequacy of the wind speed to generate power**. The location is of prime importance. In Zambia where wind speeds are low, it is advisable to choose a location without obstructions or on higher ground. The power generated from wind varies with the wind speed. If the wind speed doubles, the power of the wind increases eight times. For example, a 10 mile per hour wind has one eighth the power of a 20 mile per hour wind. (10 x 10 x 10 =1000 versus 20 x 20 x 20 = 8000).
- **Type and height of windmills.** The following technical specifications may provide useful information on what to look for when selecting windmills.

ZMK 4,000 = 1 USD

Rotor type	2.5 metres	3 metres	4 metres	5 metres
Costs less install (USD 2007)	4,152	4,562	4,682	4,765
Stroke	75 mm	75 mm	75 mm	75 mm
Size of rotor	2.5 m	3 m	4 m	5 m
Number of blades	18	18	18	18
Outlet blade angle	45	45	45	45
Turntable swing (degrees)	360	360	360	360
Height of tower	9 m	9 m	9 m	9 m

Table 8: Rotor types. Source: Zamcapitol Zambia Ltd., 2007

The smaller the rotor type the less generation obtained. For this kind of windmill, you may not get enough wind speeds to generate enough power. The height of the tower can be raised to over 15 metres to get a wind speed of 10 metres per second. The type of wind mills that can be obtained are more suitable for water pumping. Consistence in wind speeds may cause a problem as the average winds are from June to September where winds are about 6 to 7 m/s.

Consistency of the wind at times when required

Wind speed data is often available from local weather stations or airports. The site analysis is done with an anemometer or totalizer and careful observations. Installation of generators should be close to the battery bank to minimize line loss, and 30 feet higher than obstructions within a 300 foot radius. The tower should be well grounded.

One of the effects of the cube rule is that a site which has an average wind speed reflecting wide swings from very low to very high velocity may have twice or more the energy potential of a site with the same average wind speed which experiences little variation. This is because the occasional high wind packs a lot of power into a short period of time. Of course, it is important that this occasional high wind occurs frequently enough to keep the batteries charged. If you are trying to provide smaller amounts of power consistently, you should use a generator that operates effectively at slower wind velocities.

Wind Energy for Hydropower Applications

There are currently no wind power systems supporting hydro power supply in Zambia. However, it is possible to fluctuate power levels and transmission and suitable to use wind energy for utility grids in cases of fluctuating water levels. The wind energy can therefore used for isolated mini grids where wind/hydro are enough. There are research activities to examine whether wind and hydropower technologies can work together to provide a stable supply of electricity to an interconnected grid. There are also assertions that hydropower facilities may be able to act as a 'battery' for wind power by storing water during high-wind periods. However, a detailed analysis examining regulations, load following, reserve, and generator and grid operations has not been performed.

The total costs for procurement and installation of a basic 5.000 litre tank wind mills for water pumping purposes – based on quotations from Zamcapitol in Lusaka - will be some ZMK 25,000,000 (about 6,200 USD) for equipment and installations costs, based on the distance from the vendor.

Basic Components

The typical components of a small wind system include:

- A rotor comprising blades and the hub of the wind turbine. For small-scale ICT applications, rotors of less than four metres in diameter are usually sufficient.
- A generator is housed in the turbine to convert mechanical energy to electrical energy.
- A 10 to 20 metre-tall tower supports the turbine far above the ground to capture higher wind speeds. The tower should be high enough so that the bottom of the rotor is at least 10 m above any turbulence-producing object within 100 m.
- A solid foundation and/or guy wire to prevent the wind turbine from toppling over in high winds.
- A safety disconnect switch located between the generating components and the system electronics.
- A controller and/or regulator.
- A battery bank.
- An inverter to power AC loads, if necessary.

The wind turbines typically produce larger fluctuations in voltage and current than PV systems and they may require controllers and other system components designed specifically for small wind systems. Elevated areas such as hilltops receive more wind. Gentle sloping in the prevailing direction of the wind tends to increase wind speed but a very steep slope leads to turbulence that can impact the lifespan of the turbine. There should be no hindrance to the flow of wind about the turbine within a distance of about 100 times the diameter of the rotor. The bottom of the rotor should be at least 10 rotor lengths higher than any surrounding obstacles. Local vegetation can indicate the direction of a wind resource. .

Due to losses in efficiency from transporting energy over long distances, wind systems should be located within a reasonable distance of the point of energy use, i.e. within about 100 m for a typical school-sized system.

Operation and maintenance

Small turbines operate under normal conditions and require infrequent maintenance. In harsh environments they can require more robust designs and more expensive equipment, with a risk of increased maintenance costs as well.

Wind power is a clean, renewable source of energy that produces negligible pollutants during normal operations. As with PV systems, battery disposal and recycling is the main environmental issue. Large wind turbines are known to generate noise that may negatively affect nearby species of animals, and there are also instances of flying birds colliding with turbines. However, noise and bird collisions are not usually associated with the smaller systems discussed here.

Costs

Small wind turbines are relatively inexpensive due to manufacturing economies of scale. Typical prices for the turbine only are in the range of $1.90/Watt for a 500 W unit with a rotor 1.7 m in diameter, and $1.60/Watt for a 10,000 W unit with a 7 m rotor. The initial investment in a small wind system typically ranges from $2,000 to $8,000 per rated kW, including installation costs. Operating and maintenance costs tend to be in the range of $0.01 per kWh. Based on life cycle costs, wind is usually less expensive than PV for locations with an adequate wind resource. However, wind turbine efficiencies and cost per kilowatt vary from product to product.

Viability

The cost-effectiveness of a small wind system is dependent on the amount of wind available. Sites with average annual wind speeds of at least 3.5 m/s are more likely to be viable than those with lower than average wind speeds. Where there are sufficient energy resources to meet off-grid energy needs through either wind or PV systems, wind power tends to be the more cost-effective option. The more challenging aspects of a small wind project may include building the tower and maintaining a large area of clearance around the turbine throughout the lifetime of the system.

It is critical to assess the wind conditions at the proposed turbine site. Sites with an intermittent or irregular wind resource may benefit from the use of a hybrid energy system. A hybrid system integrates two or more energy generation technologies, such as wind power and solar PV, or wind power and a diesel generator.

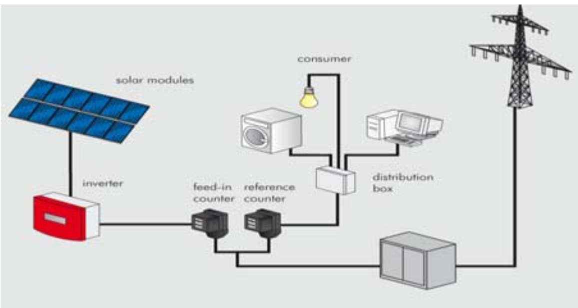
Ordinary vegetable oils can be used to power diesel engines in cars, trucks and generator sets. Restaurant waste oils can be used as fuel after filtering and treatment in a waste oil conversion system, or in a diesel engine that has been modified to treat the oil before injection. With some knowledge about which oils are most appropriate and how to operate and maintain the diesel engine to avoid corrosion and other problems, used cooking grease discarded by restaurants can become a cheap source of fuels.

Solar systems in rural ICT projects

Purpose of solar systems

Many countries, including Zambia, lack an energy infrastructure for a stable electricity supply. Solar systems are increasingly becoming common use in many areas of Zambia. Solar as a form of New and Reusable Sources of Energy (NRSE), as it is commonly referred to, can be used for water heating, water pumping, lighting, telecommunications, radio/television and drying. Solar energy is available everywhere and has the potential to improve the living conditions of the rural population. Solar systems can therefore be used to supply power communication services in rural areas.

Figure 13: Rural solar power grid:www.Solarpower.com



A lack of investment in demonstration projects and inadequate adaptive research on the use of NRSE technologies has slowed adoption in Zambia.

Technical information

Solar panels are rated in Watts. The watt rating is how much power (rated amps times rated voltage) the panel will produce in full sunlight in standard testing conditions (25C and 1000W/m^2). This is the industry standard for all PV panel ratings. However, that is a scenario, in actual real life on a year-round average you can expect about 10% less for most panels.

- A solar panel – which is also known as a Photovoltaic panel or PV panel - is basically a set of treated silicon cells that produce electric power when exposed to light.

Solar systems consist of four elements;

- Solar modules that convert sunlight directly into electrical power
- Battery systems that store power for use at night or during periods of bad weather. When the batteries are fully charged they supply power to the converter.
- Charge controllers that monitor the charging status of the battery and provide overcharge and deep discharge protection
- Inverters that convert direct current of the solar modules or battery systems into alternating current Panels, Batteries and inverters. The inverter converts power from Direct current to AC.

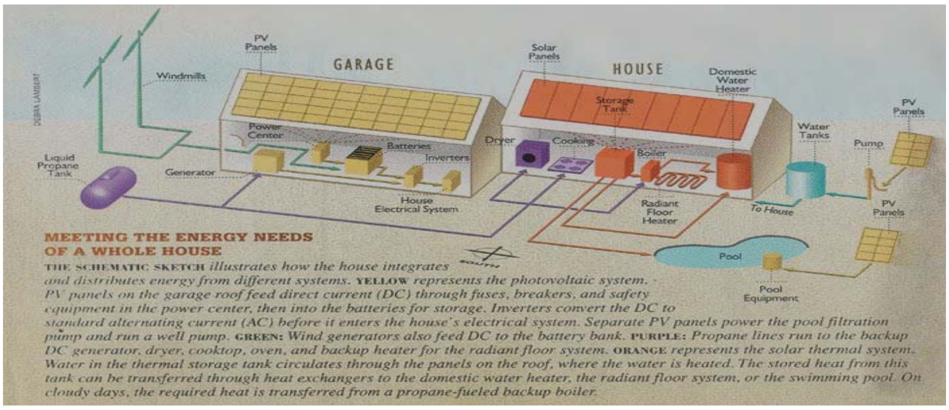


Figure 14: Multi uses of Solar systems, adopted from ' The Sol-Gen™ house' article in Sunset magazine, March 1996.

The batteries - when fully charged - send 12 volts of direct current to the inverter. The inverter converts the power to 220 volts AC. You can then put an extension socket from the converter to plug in your appliances. Solar panels work as long as there is sunlight. The more intense the sunlight the better they will work. On average, sunlight is available for 10 to 14 hours each day and solar panels can still work on cloudy or rainy days.

The bigger the solar panel the faster it charges the battery. Each appliance requires a certain wattage and the total wattage of all appliances determines the size of the inverter, capacity of the battery, and size of the solar panels. The requirement is determined by the total use of all electronic appliances such as television, video, energy-saving bulbs, stereo systems, computers, satellite systems, telephone exchanges, printers, small fans. However, inverters cannot be used for heavy-duty power consumption appliances such as cooker plates or welding geysers.

Costing the solar power system for rural ICTs

Table 9: Indicative costs of solar power system equipment from Solaris Africa Limited, Lusaka, Zambia.

Description	Required number of items	Required Power	Average Zk Cost/Unit	US$
Inverter	1	3000 watts	1,700,000	425
Batteries	1	100/Amp/hr	550,000	137
Solar panels	1	400 watts	2,700,000	675
Regulators	1	60 amps	350,000	87
Lighting system	1	E/S-DC bulbs	35,000	8
Lighting cable	1		185,000	46
Sundry costs			200,000	50

Many factors affect the cost of PV systems in Zambia. Today, an average commercial PV system, including installation, will cost from ZMK 32,000-ZMK 40,000 (8 to 10 USD) per watt; or 8,000 to 10,000 USD for a 1-kW (1,000 watt) system. Subsequently, a 3 KW system will cost approximately 30,000-45,000 USD.

Technical information and appropriate accessories can be obtained from the suppliers. Equipment of 3.0 KW is required to effectively power a community centre, school or a rural ICT enterprise. In this example, the solar systems will also require cables; the length of which depends on the building or the distance covering the building. The initial costs of equipment to power the equipment are some ZMK 181,909,000,000 or 45,000 USD.

Some suppliers offer an installation service but charge extra for this. Make sure that the offer takes all the costs into account, including all the basic installation costs as well as the replacement costs and the operational costs.
Go through the following process to find the actual costs of the system:

- Determine the consumption rate of each item of equipment that will be used in the ICT centre, for example: what is the energy consumption of the PC, printer, copier, lighting system/bulbs and any other equipments to be used in the centre or business premises.
- Find the total number of watts for all the equipment to be used
- Multiply the total wattage with the number of usage hours per day. You will get total wtt/hr.
- Determine the energy requirement per day.
- Determine the required battery size and the capacity and size of the solar panel
- For example, in a normal situation a PC or Desktop computer requires 200 watts, whilst that of a normal-sized printer is 50 watts. The energy requirement will be 200 + 50 = 250 watts; 250 x 4 hours = 1,000 watts/hr
- Divide the total by 12**:** 1000/12 = 83.3 Ah as energy required per day.

Table 10: Indicative costs of solar to power a telecentre with 10 PCs: Electrical Maintenance Limited, Lusaka

Description	Number of items of equipment required	Required Power	Average ZMK Cost/Unit	Total cost	In USD
Inverter	1	3000 watts	16,288,000	16,288,000	4,070
Batteries	20	100/Amp/hr	920,000	18,400,000	4,600
Solar panels	44	400 watts	2,920,080	127,600,800	31,900
Regulators	3	60 amps	2,232,000	6,696,000	1,674
Lighting system	4	E/S-DC bulbs	35,000	140,000	35
Lighting cab	1		185,000	185,000	46
Electrical Installation				12,600,000	3,150
Total				*181,909,000*	*45,000*

Calculate your load. To do this you need to know the power consumption of the appliances and the number of hours that the appliances will be used per day. Each appliance should be rated either with Watts or with the Maximum Current Load. You should also know the voltage; it is usually 220V. The watts are calculated as the Amps X Voltage. Therefore, if you have a PC that is rated at 1.2 Amp Maximum Current operating from normal supply power (220 V), then the Wattage is 220 V X 1.2 Amps = 264 Watts. However, it is highly unlikely that it will operate in this 'maximum current' state all the time. Therefore, it may be alright to assume 60%-70% of the maximum current as the regular operating current. This gives approximately 160 watts of power per computer.

Indications of the approximate energy needs of a few common appliances are as follows:

Table 11: Type of ICT equipment

Type of ICT equipment	**Power Requirements**
Laptop	75 Watts
Desktop PC	300 Watts
15" Monitor (Flat screen)	65 Watts
15" Monitor (old style)	500 Watts
Light bulb (standard – 40 W)	40 Watts
Light bulb (energy-saving – 20 W)	20 Watts
Laser Printer, small	550 Watts
Ink-jet Printer, small	100 Watts
Wireless router	50 Watts
V-SAT satellite Receiver	500–1,000 Watts

Now you can determine how many computers will be connected and how many hours per day they will be used. Let us assume there are 10 computers and the centre is open 8 hours a day. Based on experience, it is possible to judge how many hours, on average, each computer will be used. For example, each computer is used on average for 4 hours a day. This gives a load of 160 watts X 10 computers X 4 hours = 6,400 watt hours per day. Other appliances must be included in the calculation too.

Table 12: Load Calculation Worksheet

Appliance	**Quantity (1)**	**Watts (2) (Amps X Volts)**	**Hrs/Day (3) of usage**	**Watt Hrs per day (= 1 X 2 X 3)**
Computers	10	160	4	6,400
Lights	2	40	10	800
Total Watt Hours Per Day (4):				7,200
Total Watt Hours Per Month (4 X 30 days):				216,000
Total Kilowatt Hours per Month (above divided by 1000):				216

For example, in a normal situation a PC, or Desktop computer requires 200 watts, whilst that of a normal-sized printer is 50 watts. The energy requirement will be 200 + 50= 250 watts; 250x 4 hours = 1,000 watts/hr.

Divide the total by 12*:* 1000/12 = 83.3 Ah as energy required per day.

You will also need to determine the battery size by multiplying Amperage hours by 3 days of the week. The battery size will be 249.9 Ah. Therefore you will need 3 by 100 Ah batteries. Having a basic knowledge of the energy requirements for each item of equipment or appliance will help you to calculate the total cost of the system. However, most of the vendors supplying solar systems have technical experts who help with installing the system and calculating the required capacity.

Other key questions on solar systems are dealt with below:

The suitability of solar systems

There are two important factors in determining the potential for solar on any building:

- average annual daily sun hours determined by longitude and latitude
- Building orientation (north, south, east, west) and potential shading.

Space requirements

The general rule of thumb for calculating power output from a solar system is 1 kilowatt per 30 sq. metre of panel area. For example, a 10kW system requires 304 sq. metres of solar panels. So a typical 100 kW solar system (a medium-sized commercial application) requires approximately 3,048 sq. meters of panel area. Source: www.solarpower.com

Roofing that will work well

For the best all year round energy production the solar panels should face the direction of the sun at a pitch of 30° horizontally. The flat roof 'tilt up' mounting hardware is generally used. Solar power systems reduce the total dependence on electricity drawn from the utility grid.

Figure 15: Solar panels on Roof top

Hybrid systems or island grids

Self-sufficient local power grids are potential solutions for rural energy demands. They can be set up to supply power to hospitals, schools and agricultural research centres, to name but a few, through island innovative AC coupling technology.

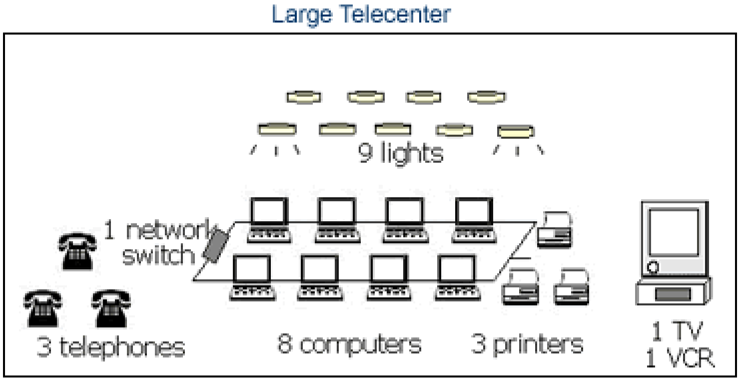
Hybrid systems can use solar systems in combination with other renewable sources of energy such as wind, biodiesel, biomass or even hydro power to ensure that there is a constant supply of power in case of power failures from the other energy source. It uses a combination of energy sources. The basic energy supply comes from a solar system, ideally with single axis sun-tracking. During peak load times and in cases of reduced sunlight and subsequent insufficient solar energy supply, the generator comes into operation. It has an electricity generator that operates on bio fuels such as Jatropha and stores energy in batteries.

The island grid can be upgraded to a three-phase system by coupling several inverter batteries. The overload capacity of the battery inverter ensures that electric motors with high start-up current can be started. Generators can be operated using either pure plant oil or diesel. Link: www.energiebau.de.

The island grid or hybrid can be effectively used in rural settings such as villages or large scale development projects to supply power to rural infrastructures such as ICT infrastructures. This type of energy application can be useful for areas where hydro power is not available. Self-sufficient local power grids can meet growing demands for power supply by implementing island grids with innovative AC coupling technology.

Figure 16: Community ICT/telecentre configurations to solar systems. The large telecentre consisted of eight computers, one inkjet printer, one dot matrix printer, one multi-functional printer/scanner/copier/fax, one network switch, one TV, one VCR, three telephones, and nine 15W compact fluorescent lights.

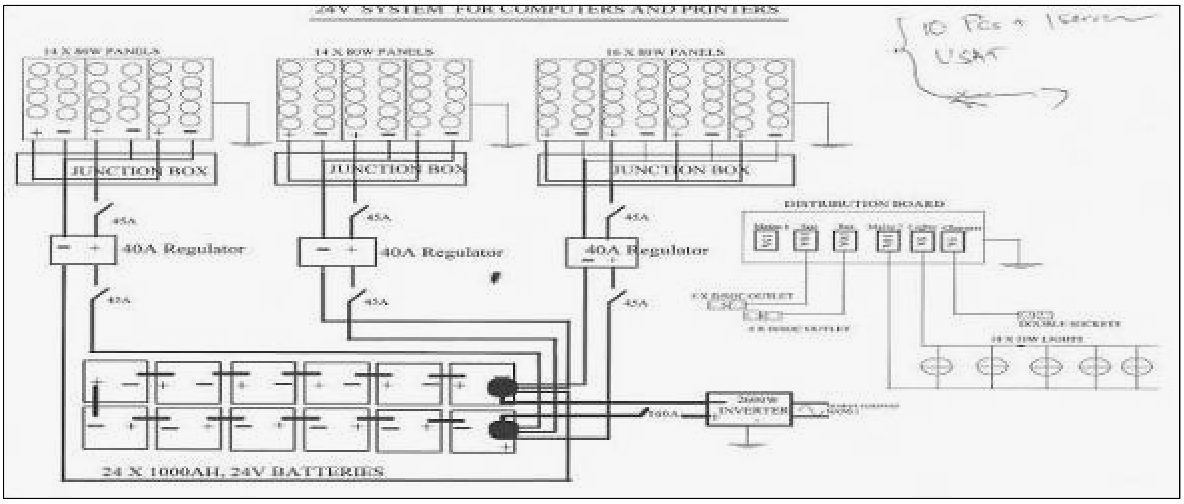
Large Telecenter



The cost and technology requirements are determined by the requirements of each configuration.

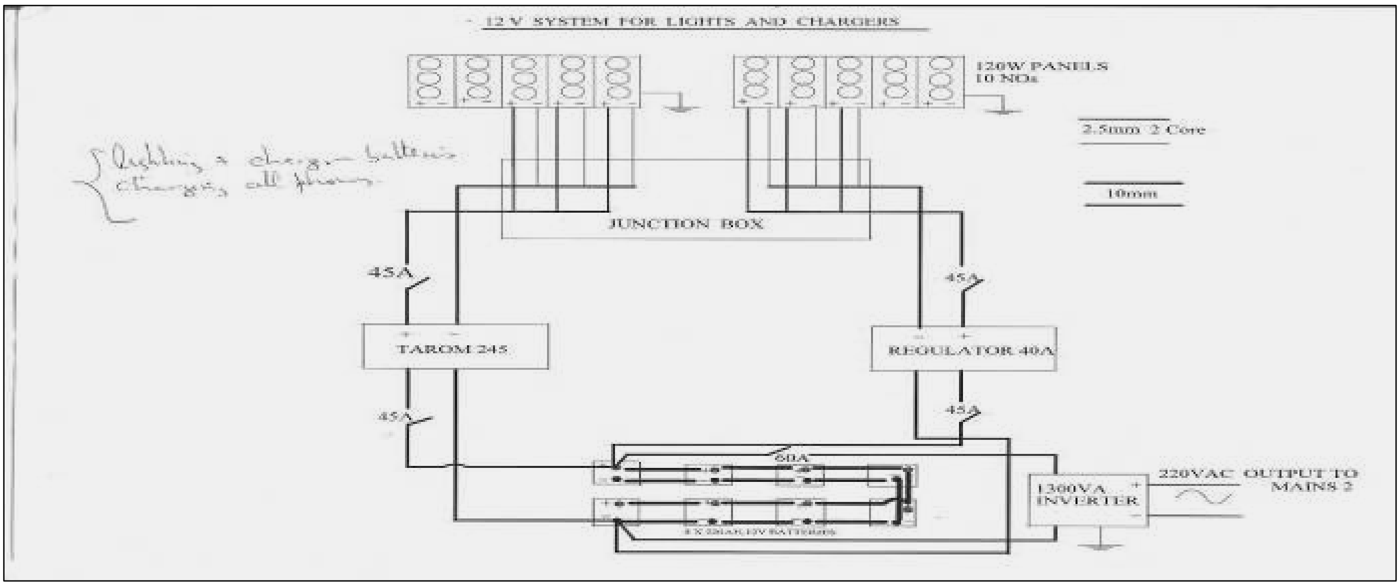
It should be noted that the higher the amount of current from panels, the bigger the regulator in terms of amperage. The two examples in the diagrams indicate that the batteries will also vary according to amount of current from the panels. The Chinyunyu ICT project shows that there is a large possibility of using solar systems to facilitate connectivity services in rural areas. Solar, hydro and/or diesel generators can also be used interchangeably as a hybrid system to support energy resources in rural areas that the ZESCO power grid cannot reach. The Chinyunyu will use VSAT connectivity technology with solar systems.

Figure 17: Example of rural telecentre equipment connection diagram in Zambia



The Telecentre is located 80 kilometres east of Lusaka. It is not connected to the main power hydro ZESCO grid, but will use solar panels instead. It is a community centre comprising of a school, health centre and an agricultural farmers' group. Figure 10 shows the solar power set-up. The current flows from the solar panels to a charge controller which charges the batteries. When the batteries are fully charged they supply power to the inverter and, in turn, the computers, printers and VSAT equipment are also powered. The model of this rural telecentre uses two separate power systems: one for the lights and one for telecentre equipment. Figures 16 and 17 show one power system for equipment and another for lighting.

Figure 18: An example of a rural telecentre connection diagram for lighting



A telecentre based in Central Province uses solar energy. Solar, hydro and/or diesel generators can also be used interchangeably to support energy sources in rural areas that cannot be reached by the ZESCO power grid.

Energy and connectivity services: general issues

As elaborated in other sections of this report, power is important for the purpose of enabling information and communications services to work more efficiently and effectively. However, caution should be exercised. For example, one should pay attention to issues such as the reliability of the power source and the importance of ensuring that there is a continuous, unbroken power supply. ICT equipment is sensitive and this should be remembered when considering different power options as the equipment can be easily damaged. Secondly, a steady power supply should be maintained at all times to ensure that the services are not interrupted.

In Zambia, particularly in the rural areas where intermittent power cuts are the order of the day, it is essential to consider alternative power backups either to protect your equipment or to use in case of load shedding and power interruptions.

For backup equipment, you can protect your equipment by securing UPS equipment. The UPS provides control over power fluctuations. It also prevents intermittent low and high voltage from the main grid from damaging ICT equipment such as PCs. One of the most common occurrences are sparks that go on to cause fires and burn the equipment. There are common brands that can be obtained from IT vendors for power backup.

Secondly, you can also opt to use heavy duty batteries for more long-term protection and extended power backup. Inverters are another form of power backup: they perform similar outputs but may be sensitive to ICT equipment.

There are times when power cuts last for more than a day so a combination of two power sources is necessary. Most people prefer to combine the grid connection with solar energy systems in the rural areas as this option may guarantee a sustained supply of power as the power tends to be irregular. The uninterrupted power supply for connectivity serves in case there is a cut from the other power source. The uninterrupted power supply also ensures that the ICT equipment will not break down. Some people in rural areas maintain solar systems in addition to a regular electricity grid line. This is to avoid breaks in the service supply.

There are instances where a rural telecentre or Internet café maintains just one power source. These are usually adversely affected by power cuts as a result of which their equipment is often damaged or destroyed. This not only causes business losses but also disrupts its services.

In the case of VSAT technology, which is known to be very stable, installation basically 'eats' electricity and produces connectivity. However, in the harsh environment of the rural areas, this technology must have an adequate power supply otherwise both its technology and level of connectivity will be unstable. This was the experience of a rural telecentre where the VSAT server hardware equipment became faulty and the hard disks and computer cards either failed or produced intermittent problems. This renders the technology costly due to travels, purchasing equipment, and replacing it with other spare hardware. Basically, the C-band VSAT seems to be 'off air' every six months with a major problem and, due to a combination of other problems, off air times can span periods of three to six weeks.

This means that there should be a selection of connectivity services that suit the needs of individuals, businesses and organisations; one that corresponds with an adequate, uninterrupted power source. Engaging ISPs for advice, coupled with a basic knowledge of the type of service and power source required, is crucial for effective and efficient operation of any type of connectivity.

Conclusions and recommendations

Connectivity and Internet services

Internet Service Providers and communication companies are not rushing into the rural areas as they are dissuaded from doing so by the lack of any basic infrastructure in these locations and the belief that it is not worth their while as there will probably be a very low volume of demand for their services. Consequently, people from rural communities need to master basic connectivity technicalities to ensure that the services they acquire are suitable. The current situation where connectivity services are concentrated in urban areas will remain so for some time unless other measures are taken. Rural areas are seen by some as uneconomical as rural people cannot afford connectivity services. The lack of an adequate telecom infrastructure in rural areas is a key factor. In addition, fixed telephone lines are either non-existent or in a poor state of repair.

The importance of Internet services is not yet fully appreciated by people in rural areas. There is also very little appreciation and technological know-how regarding the use of computers and their availability. As a result of this, the demand, management and general use of Internet services among entrepreneurs and home users in Zambia's rural areas is low.

The cost of access and infrastructure in rural areas is higher than in urban areas. There are more private telecentres such as Internet cafes in the urban areas than in the rural areas. The cost of Internet access for Internet cafes in the rural areas is five times higher than in the urban areas. In some cases, it costs between ZMK 500 – ZMK 1,000 to access the Internet (about 0.10 to 0.25 USD) in the rural areas compared to an average of ZMK 100.00 (0.025 USD) per minute in Lusaka and the Copperbelt.

Options for connectivity

Zambia currently has regions with low and high connectivity services. This means that rural areas located in regions with low connectivity have fewer connectivity services. Currently Dial-up, VSAT and mobile Internet services are the standard services available in the rural areas.

Urban areas in regions with higher connectivity have a greater prevalence of services and the choice of options is better. In these regions, high connectivity services exist and ISPs offer various types of Wireless broadband services; line-of-sight and non line-of-sight, DSL and ADSL, WiMaX, CDMA 2000 1x and Dial-Up services, mobile Internet such as GPRS and EDGE.

Wireless broadband is a service that is typically suitable for urban areas due to the high concentration of ISPs in these areas. Wireless broadband seems to be a traditional connectivity option for various types of customers located in the urban areas as it is readily available from existing ISPs. The critical issue is selecting a service that suits the unique requirements of the individual or business. In both cases, this should not be an automatic process. Rather it should be carefully thought out and a series of well-considered steps should be taken before selecting a suitable service that responds to the requirements of a home, organisation or company.

In any of the geographical locations, some of basic steps to identify a suitable service are:

Carry out a needs analysis

Capture your own situation; why you need a connection and Internet service and for what purpose. This will also help you to determine bandwidth requirements, speeds etc.

Budget limits

How much are you able to afford can enable you to select connectivity requirements that suit your home or business. This will determine whether you are able to afford initial and monthly payments for the service you intend to select. For example, Ku-Band equipment will cost less than C-Band for rural connectivity options, but its performance may not be suitable for a rural mining company. Similarly, a dial-up service will be recommended for a rural home that will need to send and receive emails.

Bandwidth assessment and management

Irrespective of whether you live in a location with low or high connectivity, you should be able to make an assessment of and understand the bandwidth requirements of your home or business. In the case of wireless broadband in urban areas, a variety of services exist with bandwidth options that people can choose from. Bandwidth management should also take into account bandwidth monitoring in order to know how much you are consuming and how much you are paying for so that you can remain within the limits of your budget. This will also help you to select a service that will perform to the best of your business needs as well as meet the future needs of your business or organisation.

In the case of rural community schools, colleges or health centres, low cost VSAT technologies are recommended as alternative connectivity technology options. The choice of VSAT will depend on a number of different factors such as the number of PCs, the level of usage and the number of people that will be using the facility. Sharing bandwidth can reduce the cost of accessing the Internet and is therefore encouraged.

A VSAT set-up can be installed at the district or community level whereby a group of villages connected through wireless services can share the bandwidth. Examples of this can be found in Ecuador and India where these technologies already exist. An average of 20 rural users can access a broadband VSAT Ku Band services at a cost of

ZMK 10,543,900 (approximately 2,500 USD). VSAT equipment and installations have monthly costs of ZMK 4,455,360 with 9 GB usage allowance. Similarly, VSAT C-Band can deliver services to a wider group of villages in a district at an average cost of ZMK 65,000-ZMK 80,000 (16,000-20,000 USD).

Rural energy

In Zambia, where vast rural areas do not have any access to electricity, there is an urgent need to investigate new sources of energy to support rural connectivity services. It is recommended that the increased exploitation of energy resource potential should be encouraged. It is overwhelming that renewable energy sources should be explored to meet the power needs for connectivity services in rural areas. However, some of the renewable energy resources that may not be suitable for rural connectivity services in Zambia. Wind energy, for example, may not be a good option due to prevailing wind speeds and the nature of the landscape. The current wind speeds that vary from 0.1-3.5 metres per second (m/s) with an annual average of 2.5 m/s may not be adequate. However, there are challenges of management, technology and applications to be considered when deciding upon the suitability of these rural energy resources.

Here are some of the energy sources recommended for Zambia's rural areas, including some of the key technical issues as suggested in this report:

The use of solar systems

Solar systems are increasingly becoming a common feature in many areas of Zambia. Solar can be effectively used for water heating, water pumping, lighting, telecommunications, radio/television and drying. Solar energy is available everywhere and has the potential to improve the living conditions of the rural population. Solar systems can therefore be used to supply power communication services in rural areas.

It is also recommended to use solar hybrid or grid with a combination of renewable energy sources to provide energy to various social and economic centres such as ICT info centres, rural clinics or hospitals and schools.

Suitability of solar systems

The average annual and daily sun hours should be determined. The orientation of the building (north, south, east, west) as well as potential shading should be used to determine where the solar panels should be placed.

Understand the technical applications of solar systems

Consult your suppliers and study the technical applications of the solar systems before installation takes place.

Understand the costing requirements

- Determine the consumption rate for each item of equipment that will be used, for example: what is the energy consumption of the PC, the printer, the copier, the lighting system/bulbs and any other equipment that will be used in the centre or business.
- Find the total number of watts for all the items of equipment to be used.
- Multiply the total wattage by the number of usage hours per day. You will get total wtt/hr.
- Determine the daily energy requirement.
- Determine the required battery size and the capacity and size of the solar panel

Small hydro power systems for rural energy

Though the initial investments for isolated hydro power systems are high, government and private entrepreneurs are encouraged to promote the development of these power systems as they can provide a long-term source of energy at a relatively low cost. Private Public Partnerships and financial cooperation should be encouraged for the establishment, development and management of these energy resources. Examples of these can be developed at Chishimba falls and other outlets in the Northern Province. Basic issues regarding isolated hydro power sources:

- **Type of Hydro equipment**: Small hydros are established to produce electricity for central and isolated grids as well as remote power supplies. They are reliable and have low operating costs. They are classified and categorized into mini, micro and small, which indicates not just their electrical capacity but also whether they are low or high head. The type of equipment and related costs depend on several factors.
- **Cost of power equipment**: The cost of equipment can be high depending on its size. The cost of a 2.5 megawatts plant investment can go up to 5 million USD.
- **Site and height in metres**: Mini hydros are normally constructed at low and high levels to ensure a rapid flow of water and generation of power. The higher the area in metres the smaller the equipment and the more the cost is further minimized. Be sure to get technical advice from the Rural Electrification Authority (REA), Ministry of Energy or an independent consultant.

Intensification of piloting biomass/biofuel development

It is also recommended to increase use of biomass in rural Zambia. Civil society, with support from cooperating partners and government, can catalyse investment in the production and provision of equipment as an energy alternative in rural areas. The production and use of Jatropha seed, for example, should be encouraged and initiatives to use biofuels in Zambia should be stimulated.

Annex 1: bandwidth monitoring and controlling tools

Some Useful Sites and Tools for Better Network Management

In general, network monitoring is a specialised task. It is usually recommended to hire a professional to adequately monitor your traffic and send you an analysis. Although this is an additional cost, you may find that ensuring that your bandwidth is monitored and controlled well in this way could save you more money than it actually costs to hire such a professional vendor.

However, there are many simple sites and tools available that you could use even if you are not very technically savvy. A simple search on Google will reveal hundreds, but here are a few that could be very useful:

To test your download speed

You can use this free tool to test your maximum bandwidth speed at the time of doing the test. If you are on a network, it is useful to do this test with only one virus-free PC connected. That way, you can find out what speed limits your ISP has in place. Go to: http://www.bandwidthplace.com/speedtest/

Download Utility

This utility helps you download files even if your connection is slow or intermittent. If, during a download, the connection is lost, the download will pause and resume automatically when the connection is restored. There are many such utilities; this is only one of them: http://www.tensons.com/products/downloadacceleratormanager/freeedition/

To monitor your 'up-time'

You can use a 'ping' program that simply records when a certain site is accessible. You can use this to test certain equipment in your network (such as your network printer), and equipment at your ISP (such as your gateway) as well as to monitor an international site to determine if you have connectivity. Therefore, if you cannot get onto the Internet, you may find that the link to the ISP is fine, but that the problem lies in the onward route.

Some up-time monitoring tools

For example, IPCheck Server Monitor by PAESSLER. A free version allows you to monitor up to 5 IP addresses at 15-minute intervals. The commercial version allows you to monitor more IP addresses at more frequent intervals.

See: http://www.paessler.com/ipcheck
FREEping by tools4ever. Similar to the above.
See http://www.tools4ever.com/products/free/freeping/
Graph-a-ping by Mata Luis. Similar to above with a nice graph.
See: http://www.mataluis.com/index.php?option=com_content&task=view&id=37&Itemid=36
Visual Ping by IT Lights Software. Similar to the above. See:
http://www.mataluis.com/index.php?option=com_content&task=view&id=37&Itemid=36

To monitor your bandwidth use

This becomes a little tricky because the PC you use to load the monitoring software should either be: in-between the external network and internal network – this means that the PC you use to do the monitoring should be the 'gateway' or 'firewall' of your network. All traffic between your ISP and your internal network must pass through this PC.

OR

be able to monitor a network interface that is SNMP-enabled. This means that the port that is being monitored should be able to relay needed data to your application. This is usually possible in mid-range and higher range routers and firewalls such as Cisco, Multi-Tech and so forth.

Some softwares that are useful are:

PRTG Traffic Grapher by PAESSLER. This is similar to MRTG but can run on a Windows PC and is easier to set up for people with little technical experience. There is a free version that is limited but helpful as well as a more commercial version. See: http://www.paessler.com/prtg
BMExtreme by LP23.com. This is a simple and cheap software (25 USD for home use and 50 USD for professional use) that can monitor bandwidth. See: http://www.lp23.com/bmextreme/
MING Bandwidth Monitor by MING Software. This is an affordable (15 USD with a 14-day free trial period) software that allows you to monitor overall traffic as well as traffic from each connected PC. In this way it is also useful in finding the PCs with unusually high traffic, such as those that are misusing the service or those that may be infected with a virus. See http://bandwidth.mingsoft.com/
Bandwidth Meter Pro. This is a 20 USD software that shows you impressive graphs of bandwidth usage. See: http://www.bandwidth-meter.net/index.htm

Tools to control bandwidth use in your network

Apart from the above tools that merely 'monitor' bandwidth usage, there are others that allow you to control bandwidth usage within your network. With these tools you should be able to allocate bandwidth to each user as per their requirement, allocate certain priority allocations for 'mission-critical' applications such as video-conferencing as well as limit or regulate types of usage, such as music downloading, chatting and so forth. All of these tools will only work if installed on the gateway computer. Here are a few:

Routix NetCom. This is a free software.
See: http://www.routix.net/netcom/
SoftPerfect Bandwidth Manager. This is a user-friendly utility. It costs 35 USD or 100 USD depending on enabled features.
See: http://www.softperfect.com/products/bandwidth/
JDSoft Bandwidth Manager. This software costs about 60 USD for a home edition version and 230 USD for an enterprise edition, although the home edition should suffice for most small networks.
See: http://www.easyfp.com/bandwidth-manager/index.html
Traffic Shaper XP is a free utility for Windows OS.
See: http://bandwidthcontroller.com/trafficShaperXp.html

Annex 2: Options and Costs of Connectivity - Zambia

A. Dial-Up service

ISP	Geographic coverage	Quality of service	Downtime compensation	Ease of Deployment	Initial /Equip cost	Bandwidth & recurrent cost
1. ZAMTEL Online Lamya House, Church Road Lusaka, Zambia. CELL Z House, Church Road, Lusaka, Zambia	Dial from all districts with telephone connection	From 32 kbps and affected by distance, affecting speed and quality	It is not easy to be offered compensation	Installations within 7 days. A service contract is also done with payment upfront	$36	From 32-kbps - $17 /month
2. ZAMNET Communication systems, COMESA centre, Ben Bella Road, P.O. Box 38299, Lusaka, Zambia. Tel: 1 225358. sales@zamnet.zm www.zamnet.zm	Offered in all districts where ZAMTEL has cables	Affected by distance, affecting speed and quality of copper cables	Offered	Installations within 7 days. A service contract also done with payment upfront	$24	$11/ month up to 56kbps
3. Micro Link, Central Park, Box 35681, Lusaka, Zambia. Tel: 222674.	Offered only in Lusaka	32 kbps	Offered	Easy installations within time of payment		
4. Coppernet Solutions, Ground floor, Mukuba Pensions House, Dedan Kimanthi Road	Service mainly available in urban areas (to be phased out)	As above	Offered	Within a few days of payment	Internet full connection with modem 246 $	From 32 kbps and above: ranges from $393 monthly
5. UUNET, 3rd Floor, National Savings and Credit Bank Building, Cairo Road, Lusaka, Zambia.	Available in Lusaka, Ndola, Kitwe, Kabwe and Livingstone	Around 56 kbps.	Pay as you dial. Dial outside treated as truck calls.	Installation upon payment. Immediate connection	Modem cost. No installation cost. 120 $	Monthly rates $35. Bills paid directly to ZAMTEL
6. Africonnect, Plot 59, Great East Road, Lusaka, Zambia iconnect.zm	Does not provide Dial-Up services	N/A	N/A	N/A	N/A	N/A

B. Wireless broadband

ISP	***Geographic coverage***	***Quality of service***	***Downtime compensation***	***Ease of Deployment***	***Initial / Equipment cost***	***Bandwidth & recurrent cost***
1. ZAMTEL Online	Lusaka within the radius of 10 km only	Speed between 64-1024 kbps	offered	Installations within 7 days, service contract and payment upfront	Equipment 3,912$ for corporate and $2,365 for domestic	Monthly Up-Link 256; $1260, 512; $2515, 1024; 5,026, 64- 128 $227
2. ZAMNET						
Non line-of-sight	Livingstone and Solwezi and virtual PoPs in Ndola, Luanshya and Mazabuka with drop-off point in Kabwe	Speed between 64-1024 kbps, offers multiple services depending on the customers service selection from Puku to Buffalo service	offered	Installations upon payment upfront	Modem $392, Router $140, installation cost $187	$81-$466 monthly depending on the bandwidth service selection. Puku $81-512 kbps single user to $466 for small and medium enterprises 9-12 users: 512 kbps
Line-of-sight	PoPs in Ndola, Luanshya and Mazabuka with drop-off point in Kabwe	Speeds from 64-512 kbps	as above	as above	$420 and $853/ Installation: $187	1 GB: $128 monthly, 64 kbps downlink, 1.5 GB: $221, up to 100 kbps, 3-7.5Gb: $407-$935 monthly
3. UUNET	Lusaka, Kitwe and Ndola	64 kbps to 2 Mbps	offered	as above	Equipment Home $582 Equipment Standard: $656, Installation: $137	From 64kbps: $52 standard service from 64 kbps: $145 USD SME: 128 kbps: $338

Wireless broadband continued:

ISP	Geographic coverage	Quality of service	Downtime compensation	Ease of Deployment	Initial /Equipment cost	Bandwidth & recurrent cost
4. Africonnect	Obtainable in major towns along the line of rail: within 30 km radius of Lusaka Kitwe, Kapiri Mposhi, Kabwe, Livingstone, Ndola,	64- 512kbps and over, depending on the choice	offered	Installation upon upfront payment	Business, Corporate plus $900	$250 installation, monthly up to 512 kbps, $94-$937 from 1 GB to 50 GB
5. Coppernet	Along the line of rail PoP in Choma, Solwezi and Kitwe	According to needs. Large bandwidth with high speeds: from 32kbps bandwidth to 256 kbps	offered	Installations upon payment	$1500 & $3,500 for Modem and Routers	Business Installation $786, Monthly, from 32 kbps to 256 kbps: from $582 to $3016 dedicated.
		From 128/256 kbps uplink and 34.6 mbps down per terminal for home users. Download speed 825 kbps and usage range of 15 GB or less P/m	offered	Installations upon full payment	No equipment payment for shared	Installation costs $194, Monthly: from $89 to $299
6. Micro link	Along the line of rail, that is within 20-30 km of the towns of Lusaka, Ndola, Kitwe, Solwezi, Livingstone, Chingola with PoPs in Kafue, Chingola and Ndola	64kbps to 512 kbps, Service usage between 1Gb to 36GB, with over 20 MB of bandwidth	offered	Installations upon full payment	Equipment $1,598, Installation ranges from $187-$264	Down 64-512 kbps; $300-$2,400, Uplink: 32-256kbps:$175-$1400,

C. VSAT Ku Band & C Band

ISP	Geographic coverage	Quality of service	Downtime compensation	Ease of Deployment	Initial /Equipment cost	Bandwidth & recurrent cost
1. ZAMNET						
C-Band	Anywhere in Zambia's rural areas.	High quality connection From 256 kbps	According to the SLA agreement	Depending on the distance, deployment in the range of 7 to 14 days.	Equipment costs $25,000 Installation $3,000	Monthly ranges form 256-256kbps: $2,000, 256-512; $4,000
Ku Band Any where in rural areas in Zambia.		Dedicated service, high quality, shared bandwidth, need more bandwidth subscription	offered	As above	Equipment cost $2,373 Installation: $262	Monthly rates depend on the choice of usage. Over $100 From 1 Gb upwards to over $1,000 monthly.
2. Micro link						
KU- Band	Any where in rural areas in Zambia. Lusaka and Kafue with E1 microwave in Chingola and Ndola	High quality services and speeds. Usage between 1Gb to 36GB, Up to 1 MB shared	offered	Installations within 7 days	Equipment from $3250, Installation: $677	Monthly bandwidth from down-link 64-512 kbps: $300-$2400 Up-link from 32-256kbps: from $175-$1400, license fee $562
3. UUNET						
Ku-Band	Anywhere in rural areas.	Transmit and up to 10 Mbps, 384kbps and 2-45MB or more. The service is of a high quality.	offered	Installations within days, depending on location	Equipment $4,735 installation cost $1,680 includes license fees	Monthly rates from 64-64 kbps: $327, 64-128; $519, 128-128; $629, 128-256; $997, 256-256; $1209, 512-512; $2,320
C-Band	Can be installed in any of the places in Zambia.	Transmit and up to 10 Mbps, 384kbps and 2-45MB or more, selection from customised services.	offered	Installation within a few days	Equipment $8,250, Installation: $1,600, License $800,	Monthly 64/64 kbps: $650, 64/128 kbps: $880, 128/128 kbps: $1,140,

VSAT KU- Band and C- Band continued						
ISP	**Geographic coverage**	**Quality of service**	**Downtime compensation**	**Ease of Deployment**	**Initial /Equipment cost**	**Bandwidth and recurrent cost**
4. Africonnect						
	C-Band Installed at any of the rural places in Zambia with no connectivity. Depending on the antenna size, it can cover the radius of 16 km.	High quality connection. Quality of service will depend on the number of shared PCs and service selected connected.	Offered, Customers can also refer to SLA.	Can be installed within a few days.	All costs including equipment from $25,000 including license and installation costs	Monthly rates from $770/1 Mbn and 256 kbps.
5. Coppernet						
Ku-Band, range from 1.2 m antenna receiver	Installed at any of rural places in Zambia with no connectivity. Depending on the antenna size.	High quality services	Offered	Can Installed in a few days depending on location.	Equipment $2,645, excluding license and installation fees	Monthly rates range from home users 256/128 kbps: $166 1 Gb usage up to corporate users 825 kbps: $2,463, 18 Gb
C-Band	Does not provide	N/A	N/A	N/A	N/A	N/A

D) DSL & ADSL

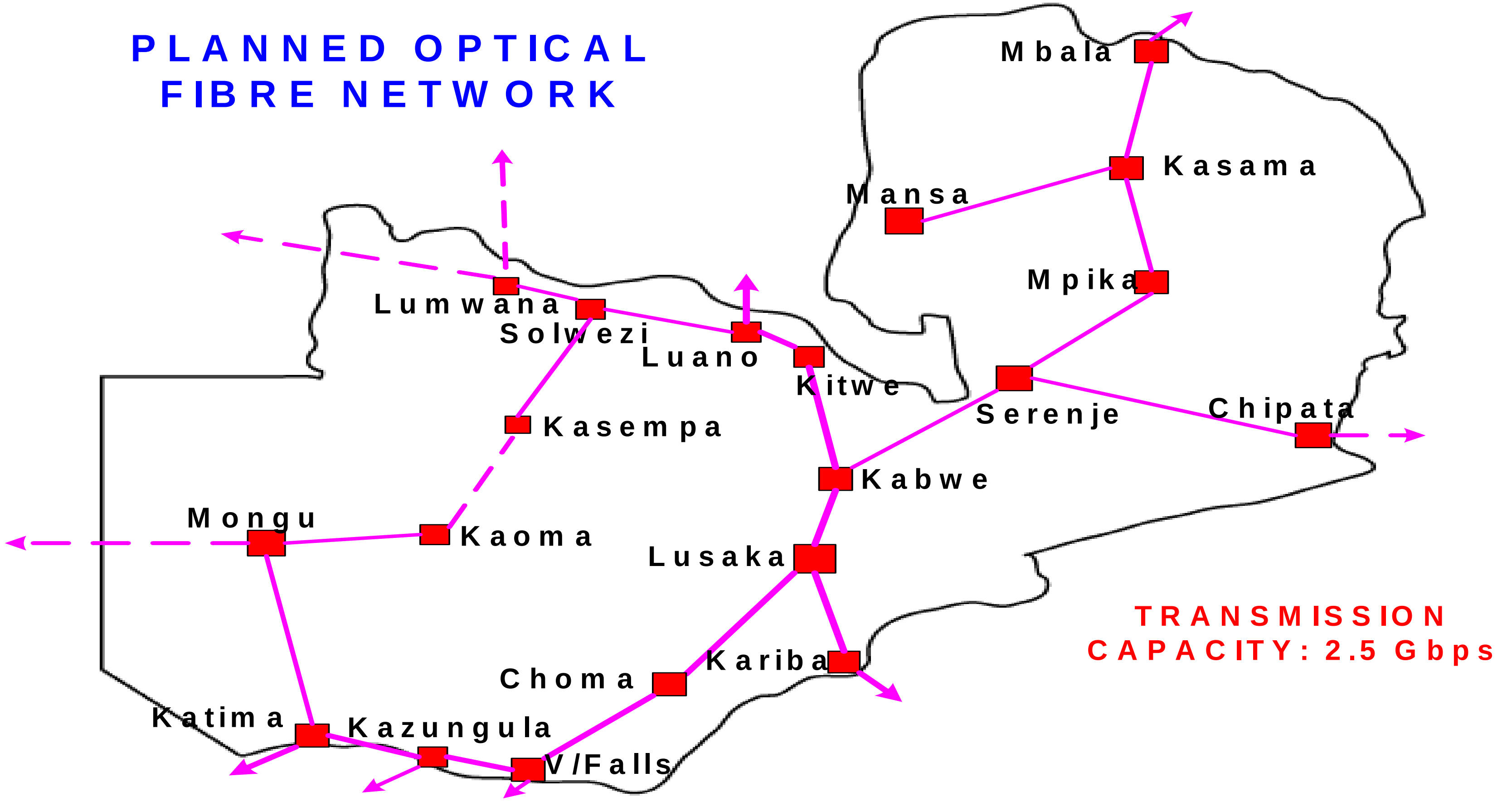
ISP	*Geographic coverage*	*Quality of service*	*Downtime compensation*	*Ease of Deployment*	*Initiall Equipment cost*	*Bandwidth and recurrent cost*
1. ZAMTEL Online						
DSL	Lusaka, Ndola and Kitwe, Lusaka and Kafue areas	64-1024kbps dedicated bandwidth	offered	Installation upon payment	$264 no initial set-up fees.	Monthly $91
ADSL	Lusaka and Ndola	From 64-64 64-512, 64-1064 kbps	offered	Within a few days upon upfront payment.	Equipment $294, Installation cost of $147	Monthly rates $318

CDMA 2000 1x	Lusaka, Mkushi, Lumwana, Solwezi, Kitwe,	Three times more than dial-up, up to 153kbps	offered	Ease of Deployment	WILL equipment, a handset, USB cable and software, instalation:$37,	Monthly rates: $88
2. UUNET						
DSL	Lusaka, Ndola and Kitwe and Kabwe	64kbps-512kbps	offered	As above	Local network line; up to $4,000	Monthly $950, ZAMTEL fee; $193
Mobile Technologies EDGE, GPRS						
Mobile company	*Geographic coverage*	*Quality of service*	*Downtime compensation*	*Ease of Deployment*	*Initial /Equipment cost*	*Bandwidth & recurrent cost*
CELTEL, Celtel House Nyerere Road, P.O. Box 320001, Woodlands, Lusaka, Zambia – www.celte.com						
GPRS	Available in all districts where Celtel has a presence in Zambia	The access speed ranges from 30 to 160 kbps.	No need for compensation. Service based on pre or post payments	Ready for use just after payment. Easy to access.	Need PC-card at $237 or USB at $292	No Monthly fees, you pay as you use. Usage costs $.4 per MB. Can also purchase bundles at $21 per bundle.
EDGE	Available within the Copperbelt, Lusaka and Livingstone	Higher speeds of up to 384 kbps	Based on Pay per use, no compensation.	As above	USB cards costs $292 and are referred to as SAMBA	Option to pay monthly and access Internet up to 100 Mb of information, top up as you require.

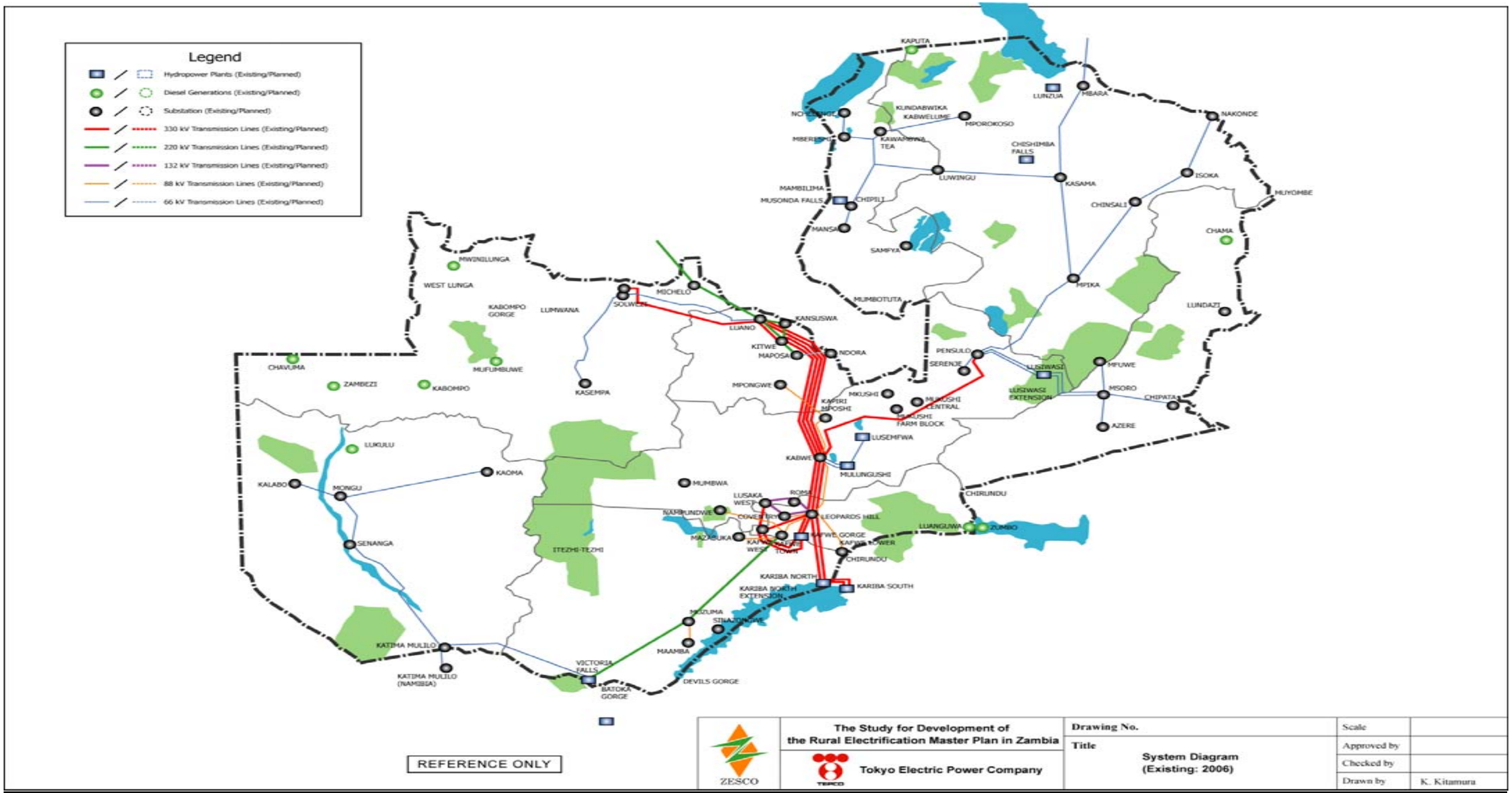
MTN 5033 Longolongo Road, P.O. Box 35464, Lusaka, Zambia
Tel: +26 (096) 750750, +26 (096) 761234, mtn@mtnzambia.co.zm, www.mtnzambia.co.zm

GPRS	Available along the line of rail.	Higher speeds up to 300 kbps.	Based on Pay per use, no compensation.	As above		Payment options exist

Annex 3: Optical Fibre Network for ZESCO



Annex 4: Geographical distribution of ZESCO power system in Zambia



Annex 5: List of references

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Development through energy supply *Solar power systems for the electrification of rural areas*	www.energiebau.de
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Electrical Maintenance Limited	www.eml-eis.com
Websites:	www.Celtel.com www.zamnet.zm www.coppernet.zm www.microlink.zm www.iconnect-online.org www.uunet.zm www.zamtel.zm mtn@mtnzambia.co.zm

Annex 6: List of organisations and individuals contacted

Ministry of Transport and Communications	Lloyd Mutambashi, Telecommunications Officer
Communications Authority of Zambia	Susan Mulikita, Senior Manager
Ministry of Energy	C. Saasa, Acting Assistant Director, Department of Energy Charles Mulenga, Assistant Director
UNIDO	Dr Lembalemba Nyirenda, Project Manager, GEF/UNEP
Biofuels Association of Zambia	Mr Chisambo, Board Member
Panos Southern Africa	Gillies Kasongo
Rural Electrification Authority	Fred Mushimbwa, Project Engineer
Rural Electrification Authority	Francis Mulenga, Projects Engineer
Africonnect Zambia Limited	Mark Bennet, Director
ZAMNET communications	Majorie Nalubamba, Business Development Manager Yolanda Chishimba, Sales and Marketing Executive
UUNet Zambia Limited	Elisha Nyangulu, General Manager
Microlink Zambia Limited	Jorretta Mwamba, Sales and Marketing Executive Esnart Zulu, Senior Executive
Zamtel Online	Mr Emanuel Kasela, Senior Telecommunications Officer
ZAMTEL Online	Mr Nyirenda Mr Martin Chishala, Internet Manager
CELTEL Zambia	Hussein Mussa Mogra, Products Developer
ZESCO	Chris Mubemba, Senior Manager Electro Technical Services
Coppernet Solutions	Silwliwanji Nakamba, Customer Support Officer
Electrical Maintenance Limited	Jean-Marrie Ilunga, Product Specialist Lusaka
Solaris Africa Limited	Mr V.P Ranchod, General Manager
Chinyunyu Community Telecentre	Mr Chilala
University of Zambia computer centre	Mr Moses Kholopa, Acting Manager, Consultancy and Training Unit

Annex 7: Profiles

About the author

Dean L. Mulozi has worked in various development positions for a considerable number of years under various rural foreign and local development projects in Zambia and abroad. His last position was as a United Nations Volunteer in the Islamic Republic of Maldives as a UNV Small Business Development Adviser under the UNDP/UNV Atoll Development Project. Mr Mulozi is currently involved in ICT4D promotional activities and is the Coordinator for a Zambian ICT NGO; the Zambia Association for Advancement of ICT (ZAA-ICT).

About ZAA-ICT

The Zambia Association for Advancement of Information and Communication Technology (ZAA-ICT) is a not-for-profit organisation that promotes the use of ICT for development. The ICT-RC aims to be a focal point for testing, innovating, implementing and providing support for new and 'appropriate' technologies in the field of IT. Its aim is to assist other organisations to meet their individual objectives more successfully by using IT in the most cost-effective, productive and sustainable way possible.

About eBrain

The report of this study is commissioned by eBrain Forum of Zambia (www.eBrain.zmorg), the national ICT for Development network involving government agencies, ministries, private sector, research and development organisations and NGOs. Activities focus on awareness raising, catalysing the engagement of civil society in the policy process, and membership support.

About IICD

The International Institute for Communication and Development (IICD) assists developing countries to realise sustainable development by harnessing the potential of information and communication technologies (ICTs).

The driving force behind IICD's activities is that local 'change agents' themselves identify and develop proposals for realistic ICT applications - local ownership forms the essential basis for sustainable socio-economic development.

Acting as a catalyst, IICD's three-pronged strategy is mainly delivered through a series of integrated Country Programmes. First, IICD facilitates ICT Roundtable Processes in selected developing countries, where local stakeholders identify and formulate ICT-supported policies and projects based on local needs. Second, working with training partners in each country, Capacity Development activities are organised to develop the skills and other capacities identified by the local partners. Third, IICD draws on its global network to provide information and advice to its local partners, also fostering local information exchange networks on the use of ICTs for development.

The best practices and lessons learned are documented and disseminated internationally through a Knowledge Sharing programme. In support of these activities, IICD invests in the development of concrete partnerships with public, private and non-profit organisations, thus mobilising knowledge and resources needed by IICD and its local partners. Country Programmes are currently being implemented in Bolivia, Burkina Faso, Ecuador, Ghana, Jamaica, Mali, Tanzania, Uganda and Zambia.

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