Sustainable Energy Services Delivery in East Timor

J. Fang, I. MacGill and H. Outhred
School of Electrical Engineering and Telecommunications
The University of New South Wales
Sydney NSW 2052
AUSTRALIA
E-mail: fangsg@yahoo.com, i.macgill@unsw.edu.au, h.outhred@unsw.edu.au

Abstract - *Since attaining full independence in May 2002, East Timor has to rebuild its war-torn infrastructure, laying the foundations for democratic governance and the national delivery of essential services. A major area of concern will be the reconstruction and expansion of East Timor's energy sector in the rural areas. Poverty in East Timor remains a vital rural issue and one characteristic of a typical poor rural household is inadequate or no electricity supply. The reliance on other energy sources, in particular firewood, has adverse consequences for the nation's ecology and environment. The rehabilitation and development of rural electricity supply is hampered by the limitations of conventional electricity supply options in remote rural areas due to demographic distributions, physical geography environment and climate/ meteorological conditions in East Timor. The research report will focus on the types and scale of energy services required in East Timor's rural areas and will be matched against possible renewable energy options. The research methodology will be based on literature research on East Timor's rural developments and suitable renewable energy technologies and a review of case studies on renewable energy implementation issues. Renewable energy policies and programs are about the possibility of using renewable energy in applications to match the needs and services of a community and inspiring the changes that can enhance the community's quality of life. East Timor can benefit from renewable energy applications, provided effective and relevant sustainable energy policies and programs looking into the technical, economical, social, environmental and institutional aspects can be incorporated to address the actual priorities and needs of East Timor's growing population.*

1. INTRODUCTION

Since attaining full independence in May 2002, the Democratic Republic of East Timor has strived to rebuild its war-torn infrastructure, laying the foundations for democratic governance and the national delivery of essential services. **Poverty reduction** and **sustainable development** have been deemed the East Timor government's paramount priorities in the nation-building process (UNDP, 2003). A major area of concern, as part of the nation-building process, will be the reconstruction and expansion of East Timor's energy sector in the rural areas. The violence of 1999, together with the departure of the engineering managers and technicians, has significantly affected East Timor's energy sector. This event seriously damaged the nation's 58 diesel-powered generators, resulting in a major disruption in electrical supply. So far, 31 generators have been restored to service, supplying electricity to Dili, 12 districts and 33 sub-districts (Kim et. al., 2003).

It has been estimated that 75% of the population live in rural areas, with about 48% of the population below the age of seventeen (UNDP, 2003). In 2001, it has been reported that a total population of about 790,000 reside in 498 villages (sucos) and 2,336 sub-villages (aldeias). Before the 1999 violence, almost 30% of these aldeias were electrified. In 2001, only 20% of them were electrified (SSTL, 2001).

Poverty in East Timor still remains a vital rural issue and one characteristic of a typical poor rural household is inadequate or no electricity supply (UNDP, 2003). The heavy reliance on other energy sources, in particular firewood, has substantial adverse consequences for the nation's ecology and environment. The rehabilitation and development of rural electricity supply is further hampered by the limitations of conventional electricity supply options in remote rural areas due to factors including demographic distributions, physical geography environment and climate/meteorological conditions in East Timor.

2. RESEARCH METHODOLOGY AND APPROACH

The research methodology of this project will be based on literature research on East Timor's rural developments and suitable renewable energy technologies and a review of case studies on renewable energy implementation issues. With this approach, rather than just looking at the technical and economical aspects of renewable energy options and their implementation in rural areas, the social, environmental and institutional aspects will also be covered in order to understand how to enhance sustainable energy services for East Timor's rural areas. Available information of suitable renewable energy technologies will be reviewed together with East Timor's environment and culture to ascertain its viability. An analysis of sustainable energy development in other developing countries has been done to better understand on their practical installations and implementation approaches.

This approach will attempt to address the technical, economical, social, environmental and institutional sustainability issues pertaining to enhancing sustainable energy services delivery to East Timor's rural areas. Given the analysis and assessment of the current geographic, demographic and environmental conditions and also reviewing the challenges of renewable energy resources, this research serves to understand the required energy services in East Timor's rural areas with the purpose of exploring and understanding different means of providing adequate electricity to improve and sustain their living conditions.

It is hoped that this will help better understand the rural energy needs and development options required for East Timor and assist the East Timor government in their formulation of policy decisions in regards to sustainable energy services and initiating these policy decisions to reach out to the poorer regions and more distant districts and sub-districts to support technical, economical, social, environmental and institutional developments.

3. SUSTAINABILITY ISSUES FOR RENEWABLE ENERGY IN EAST TIMOR

3.1 Technical Sustainability

Large economies of scales will be needed to help renewable energy implementation in rural areas through lower costs and bring significant and sustainable rural electrification (IEA, 2002). The renewable energy equipment and components need to be compatible with each other in order to provide adequate reliability and good quality for end-user efficiency. Common technical problems associated with PV can include poor equipment siting, shading of PV panel modules, poor adaptability between charge regulators and batteries, inefficient light bulbs with short lifetime and radio frequency interference (Richards, 2004).

Power generated from wind is constrained by the wind speed and the conversion efficiency. Wind turbines design are limited to places with suitable terrain types, wind conditions and have to match the relevant standards under which turbines are constructed according to survival wind speed values according to various geographic zones and adjustment factors (Coppin et. al., 2003). Such constraints will create potential inabilities to connect near to the load centre, bringing about significant network and transmission losses.

Renewable energy systems should be designed to suit East Timor's climate conditions and local conditions by seeing to the rural community essential needs and end-user requirements, not to budget and manufacturers' design preference and perceptions (Tukunga et. al., 2002).

Operations and maintenance of renewable energy systems, especially in parts replacement, needs to be addressed and this can be done through acquiring high quality renewable energy equipment. Effective installation and maintenance is possible through adequate user training, field research, incorporation of the rural communities' social and cultural needs, and availability of replacement parts, all of which can be crucial to the technical reliability of the renewable energy equipment (Tukunga et. al., 2002).

Hence, it is important that the local East Timor community acquires the technical competency, skills and knowledge to be able to self-handle renewable energy systems efficiently. This can be done through Technology Transfer which involves sharing knowledge and adapting technology to meet local conditions and strengthen human and technological capabilities (IEA, 2001)

Ghana Example – RESPRO *The Ghanaian government, in 1999, initiated the Renewable Energy Services Project (RESPRO) to address 11 districts' rural energy needs using PV. RESPRO takes charge of the design and specification of the PV components, installation and/or supervision of installation of systems and instructions to users in their operation. At the same time they also supervised the installation and dissemination of PV operation instructions to the end-users and provided maintenance and replacement parts for the PV systems. An operations centre was also incorporated as the principal staging and service centre to meet project implementation and operational requirements*

Public education on solar PV has built up great interest among the households. As a result, many households had PV systems installed to serve essential rural needs and the large economies of scales help bring down PV costs, comparable or much lower than grid extension.

Working with the Kwame Nkrumah University of Science and Technology's Solar Energy Laboratory and other project consultants, RESPRO is establishing a permanent test and training facility to extensively train all staff in all installation and operation aspects of the PV systems. This same facility will also have a quality and test program in which all equipment used in the project will be screened and evaluated as well as monitoring failures of equipment in the field and replacing existing equipment, if needed, to support future procurements. RESPRO also has a national skills base to train users in order to make the knowledge widely available and facilitate the spread of the renewable energy technology.

Extracted from: Abavana, C., 2002, 'Solar PV for Rural Electrification in Ghana', Renewable Energy World,November-December 2002 Issue, pp. 99-107.

Similar with Ghana, renewable energy in East Timor can be determined by looking into effective district-wide system installation and operation to acquire the critical mass of customers in order to have a viable and sustainable energy service (Abavana, 2002) while looking into providing efficient maintenance and parts replacement. Quality measures and testing facilities will be required to look into the technical and installation standards, as well as the continuous monitoring and assessment of renewable energy equipment, to ensure the high quality of the equipment.

Government policies will be needed to set positive opportunities for rural energy development using renewable energy by promoting the local manufacturing of renewable energy equipment, bringing about further expansion and technical opportunities in East Timor's manufacturing industries and joint collaboration energy research. In doing so, this will bring about technical sustainability for renewable energy. Furthermore, establishing a national skills program to increase Technology Transferring and wide-spread usage, together with an awareness program to disseminate the benefits and potential of renewable energy, can help East Timor create critical mass economies of scale that will significantly affect the initial costs, as well as overheads and operating costs, of the renewable energy systems.

3.2 Economical Sustainability

The economical viability of renewable energy for East Timor depends on how renewable energy can bring favourable economical and development benefits to run small businesses in the rural areas like market access, finance, communications, education and healthcare. Sustainable rural renewable energy is more likely in areas where economic development is already taking place (Martinot et. al., 2002). In East Timor, agricultural farming households, schools and health facilities seem to be an initial targeted area of potential renewable energy implementation (ONOF, 2002).

Due to East Timor's high poverty rate and the rural population majority being unable to afford the costs of renewable energy services (UNDP 2003), addressing the rural community's "willingness to pay" attitude will help increase the sustainability of renewable energy services. Factors that can influence the consumers' willingness to pay include:

- Reliability and operational efficiency of equipment and components
- Awareness of system capability
- Suitable credit services
- System incentives and support

(IEA, 2002)

Hence, a suitable long-term financial service is required and its affordability, other than taking into account East Timor's cultural, legal and financial factors, will depend on credit size, dependence on savings, payment frequency, lending terms and target group of loan users (Martinot et. al., 2002).

Kiribati Example – Solar Energy Company *The Kiribati government from the Pacific Islands established a Trust Fund to assist in the rural PV electrification projects. The initial project capital costs were subsidized by aid agencies. PV equipment and components were also exempted from import duties.*

The formation of Kiribati Solar Energy Company (SEC) operates in such a way that the company retains ownership of the installed renewable energy equipment in the customer's premises. SEC implemented the "Pay-for-Services" concept whereby customers pay for the electricity services provided and not the equipment capital costs. A financial mechanism is created to overcome the initial cost barrier to solar electrification, making it far more accessible and affordable to customers. SEC charges a monthly fee for replacement parts and maintenance. Most of the initial capital costs of purchasing and installation were being paid by the European Commission (EC) in the form of donor aid and new customers also need to pay a deposit of A$50. The EC's contributions represented about 50% of the capital costs for the equipment's 20-year life cycle period and the rest are contributed by the customers' monthly fee.

Extracted: Fairbairn, P. L.., 1998, 'A Regional View Towards Sustainable Renewable Energy Development In The Pacific', SOPAC Miscellaneous Report, Issue 311.

Strong economic policies are needed to promote local renewable energy developments in East Timor, which in turn bring down costs. Exemption of import duties on renewable energy equipment and components in East Timor will help reduce the initial capital and installation costs.

Aid and donor funding will still be needed to subsidize the initial–cost barriers to renewable energy projects and recover the initial losses incurred. It is essential that East Timor develop strong and transparent policies and mechanisms to promote regional and international cooperation so as to improve the inter-coordination and inter-consultation of donor countries (IEA, 2001).

Subsidies can be used to effectively build up market initial volume, local expertise, user awareness, technology adaptation, quality standards and entrepreneur activities. But they are unlikely to create sustainability unless they create conditions whereby they are no longer needed in the long run (Martinot, 2003).

Like Kiribati, East Timor will more likely benefit from an "energy service company" model whereby a rural energy cooperative is formed to provide electricity on a fee-for-service concept, taking ownership of the equipment and maintenance while the customers pay for the services. Furthermore, a suitable consumer credit program can address East Timor's rural communities' affordability to renewable energy services.

3.3 Social Sustainability

Renewable energy projects should focus on meeting the minimal levels of priority electricity services for East Timor which have been found to be **education, income, health and agriculture** (ONOF, 2002).

A typical rural school in East Timor requires renewable energy to provide efficient lighting to present a variety of subjects in a more appealing way, allowing more effective administrative tasks and other non-teaching functions. Outdoor lights make the rural school more accessible at night and can also be used for training purposes, adult education, cultural events, community meetings and other activities (Jimenez and Lawand, 2000). Renewable energy in rural schools will help provide drinking water and better sanitation facilities, hence providing a good source of clean water which is essential for operating any school, as well as food preparation and small refrigeration.

In rural households, renewable energy provides lighting for studying and family activities at night. The village community can experience more social, religious, sporting and cultural activities at night, resulting in community cohesiveness.

Renewable energy applications in water pumps and solar cooking will help provide safe drinking water and better hygienic conditions to help improve poor rural health conditions. Furthermore, rural hospitals and clinics will also benefit with storage facilities for preserving medical and vaccine supplies.

Swaziland Example – Mphaphati Solar Village *The Swaziland government, in 1998, initiated a demonstration project to develop a "Solar Village" using PV to provide basic services. A primary school in Mphaphati village, also used for community and church activities, was identified and provided with basic lighting and water tank facilities for educational, entertainment and security purposes.*

A solar committee comprising both school and community representatives was established to implement and run the project in defining the management structure, ownership of the system and financial requirements to maintain the project.

The key success to the project was the proactive involvement and cooperation of the village community and an extensive awareness raising and capacity building program among the community as well as the school children to bring about cultural acceptance.

Extracted from: Curren, J., 2003, 'Mphaphati Solar Village: Community PV in Swaziland', Renewable Energy World, March-April 2003 Issue, pp. 83 - 91.

The long-term sustainability of renewable energy will depend on the East Timor's rural community acceptance in incorporating such a feature and believing that it can help provide basic services and improve the quality of life, namely education, health, income and agriculture.

One approach for East Timor, as used by Swaziland, is to implement demonstration projects to show renewable energy applications bringing about positive social improvements in their daily activities, hence increasing the chances of community acceptance. Designs of such demonstrations projects may differ slightly, depending on the targeted group or activities within each district.

An important element of a successful project in East Timor will require effective policies that empower the local community to be pro-actively involved in all aspects of renewable energy project developments like tendering, installation, evaluation, ownership and maintenance.

3.4 Environmental Sustainability

PV application systems, being renewable sources of energy, are not known to produce emissions although they may cause some form of emissions during manufacturing of the PV modules or during decommissioning (Turkenburg, 2002). Replacements of parts like batteries and modules in PV systems may pose some form of environmental issues, especially in the area of recycling and disposal of these components. While PV systems generally have little or no GHG emissions during electricity production, the equipment does create possible increase in solid waste increase as the lead acid batteries, PV panel modules, controllers, light and switches all become solid wastes at the end of their working lives (Tukungka et. al., 2002).

For East Timor, wind or solar water pumps can help in the irrigation process for agricultural activities, resulting in increase in extended growing season, enhanced crop performance and increased productivity and yield sales. Therefore, this can lead to decreased slash-and-burn activities and reducing the chances of deforestation (Winrock, 1998).

Solar thermal technologies such as solar pasteurisation and solar water disinfection can effectively treat contaminated water, providing an alternative to boiling water on traditional stoves which require fuel.

Solar water distillation is a method to purify water by removing bacteria, salts and other pollutant types. It consists of a sloping transparent cover over a shallow basin of saline water. Solar radiation heats up to evaporate the saline water. Water vapour condenses on the underside of the transparent cover, free of salts and bacteria pollutants, and stored in containers which can be used for drinking, cooking and medical purposes (Jimenez & Lawand, 2000).

Solar cookers can be implemented in households, subjected to favourable conditions, to reduce dependence on firewood for cooking. It consists of insulated boxes with sloping glazed cover and a reflector, reducing fossil fuel or biomass energy load normally used for cooking meals (Jimenez & Lawand, 2000).

Kiribati And Tuvalu Example – Environmental Impacts *A PV follow-up programme, completed in 1995, had 250 PV lighting systems installed on the Kiribati outer islands, upgrading of 226 existing PV lighting systems in Tuvalu and 7 large pilot PV projects with domestic and vaccine refrigerators. The PV systems blended in well with the traditional building materials and style of housing on the outer islands, hence making visual intrusion insignificant.*

Services from PV electricity also provided are: Water pumping, treatment and desalination for clean drinking water, lighting, refrigeration and sterilization in medical centres for medical purposes, lighting for food preparation, consumption as well as refrigeration for storage and preservation purposes, lighting and video classes for lessons on sanitation,

Many of the PV system batteries are reaching or have already reached the end of their useful life and will be in need of parts replacement. Though the effects of battery disposal do not seem evident, addressing the issue of battery disposal is important and measures have to be taken to ensure their safe disposal and recycling.

Though the existing PV systems on the outer islands are mainly replacing the use of kerosene lights and dry cell batteries, there are plans to replace the diesel generators which are used for television, videos, projectors and other high-powered appliances. Currently, the small distributed PV systems have replaced the existing diesel-based mini-grids for lighting in local government buildings and other community buildings. The effect of replacing diesel-based systems with PV systems brings potential savings in local emissions of waste oil, noise and other exhaust and greenhouse gases.

Extracted from:

Wilkins, G., 1999, 'Evaluation of The PREP Component: PV Systems for Rural Electrification in Kiribati & Tuvalu', European Commission DGVIII Development Final Report, Issue 1, AEA Technology.

Renewable energy applications are considered "clean" energy and can play a key role in helping to alleviate the environmental concerns that are found to be associated with traditional sources of energy, especially in reducing GHG emissions.

East Timor's agricultural activities can also benefit from renewable energy applications with increased and better improved crop performances and season yield. The more important benefit will be to bring about a sense of permanent agricultural location rather than constant search for new farming land under the slash-and-burn activities, preventing potential soil degradation. Hence, the chances of deforestation can be minimized, bringing much needed conservation to the flora and fauna species.

Renewable energy applications in households can help to conserve firewood and hence contribute to reduction in deforestation as well as alleviating health-damaging pollutants arising from traditional firewood cook stoves and kerosene lamps. The issue of drinking water can also be addressed and can help prevention water-borne and water-related diseases.

Although renewable energy is known to not produce any significant GHG emissions, its equipment and components will create potential solid waste materials at the end of their life cycle. Hence, an effective recycling scheme should be considered in the areas of proper disposal of equipment and components or a scheme whereby old parts can be changed for new parts. To further improve on the environmental sustainability in East Timor, it is also recommended that a government-endorsed campaign on environmental issues alongside with rural education on environmental concerns be effectively disseminated.

3.5 Institutional Sustainability

East Timor's challenge is to create an environment to make use of existing government functions, together with international organizations, financial institutions and also Civil Society Organizations (inclusive of local communities, NGOs, industry players and consumers), to implement goals, strategies, policies and policy instruments to promote sustainable energy services delivery using renewable energy.

Close collaboration between East Timor and industrialised countries will be able to help improve the institutional capacity of renewable energy, especially in the areas of technological innovation, local capacity strengthening, increased training and information dissemination. Strengthening these relationships is an important driver for East Timor to harness a sustainable energy future for rural areas, using renewable energy, in the areas of technology development, field tests, technology maturation and market acceleration (Turkenburg, 2002).

An important area of cooperation between East Timor and the industrialised countries will need to involve the development of institutional capacity, technical and management skills and knowledge, as well as training and experience in renewable energy infrastructure, for effective and efficient implementation of sustainable energy services delivery. This kind of cooperation can possibly result in technical and financial support to create and strengthen regional centres for renewable energy, hence the need for technology transfer, training and dissemination of information has to be addressed (Turkenburg, 2002).

The effective promotion and implementation of renewable energy in East Timor should not be on the potential technologies and their economical characteristics but rather on the approach to the fragmented market in East Timor (Martinot et. al., 2002). Hence, a shift in paradigm thinking will be such that strong support and drive for renewable energy needs to be build up from the functional roles of the East Timor government, multilateral organizations, industry players, NGOs and CSOs to pursue renewable energy development agendas at National, District and sub-district levels.

Capacity development for East Timor's sustainable energy services delivery using renewable energy needs to involve the process of creating and mobilising, enhancing or upgrading and converting skills/expertise, institutions and contexts to achieve specific desired socio-economic outcomes in keeping up with the sustainable energy services (Bouille & McDade, 2002).

Kiribati Example – Institutional Approach *The Kiribati Government's medium term strategy in the energy sector emphasizes the need for greater utilization of renewable energy sources that were proven to be technically and economically viable. Its views had been transmitted through the Island Councils to the population at large, retaining high profiles in the daily activities of the rural communities and hence making clear their overall support for the implementation of PV rural electrification. This brought about a general positive response at all levels to the use of PV in the outer islands.*

The Kiribati Government had firm policies for outer island development with the aim of ensuring as much as possible that the existing residents of the outer islands are discouraged from migrating to the main island. With these aims in mind, the Kiribati Government had strongly supported the SEC with the implementation of PV projects and recognised them as being the unique centres of expertise with the responsibility of installing and maintaining the PV systems. With the appointment of senior public and bank officials to SEC's Board of Directors, SEC has been strongly established by the Kiribati Government. This level of political support provides international donors and equipment suppliers with confidence in the company, allowing the management team to operate effectively.

The sustainability of the PV Follow-up Programme would not have been achieved without assistance from the former Energy Division of the Forum Secretariat (FSED) and currently energy unit of the South Pacific Applied Geoscience Commission (SOPAC), as well as technical assistance and high-level guidance from the project consultant, SPIRE, whose experience, commitment and readiness to provide guidance has contributed to SEC's successful operations in Kiribati. Together with strong institutional support, the success and long-term sustainability of the PV utility scheme in Kiribati also heavily depended on SEC's strong implementation of institutional approaches.

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All of East Timor's institutional framework areas and activities are still in the very early stages of capacity development. The uphill task facing East Timor is to implement effective and efficient policy frameworks, together with the inter-coordination and inter-cooperation of key ministries, industry players, financial institutions, donor agencies and other relevant consultants to spearhead the development of sustainable energy services delivery in East Timor's rural areas using renewable energy.

East Timor is likely to benefit from a formation of a rural energy cooperative like Kiribati's SEC to promote the use of renewable energy applications in rural areas with the strong aim of implementing renewable energy sources to improve the quality of life and enhancing rural area development. The success and long-term sustainability of such an approach requires strong legislation and policies together with strong political support from the East Timor Government and the respective energy sector stakeholders.

Like the Kiribati government, the East Timor Government's strong interest in promoting renewable energy applications in rural areas will bring about a strong institutional sustainability framework for renewable energy. The East Timor Government's strategy in the energy sector is to initiate the drive for renewable energy applications and formulate policies to emphasize the need for greater utilization of renewable energy sources.

4. CONCLUSIONS

Although electricity in East Timor's rural areas is not considered an important priority, the basic services and rural activities that require electricity are listed as priorities, hence sustainable energy services delivery can possibly be enhanced significantly by considering rural capacity development factors.

Renewable energy policies and programs are not only about introducing new technologies or finding alternate sources order to reduce environmental impacts. It is about the possibility of using renewable energy in applications to match the needs and services of a community and inspiring the changes that can enhance the community's quality of life.

East Timor, like other successful projects in developing countries being mentioned, can benefit from renewable energy applications, provided effective and relevant sustainable energy policies and programs looking into the technical, economical, social, environmental and institutional aspects can be incorporated to address the actual priorities and needs of East Timor's growing population.

Countries like the Pacific Islands, South Asia and Africa share similar characteristics and situations as East Timor. Furthermore, East Timor can draw insights from their many years of experiences and lessons learnt from renewable energy projects to develop a sustainable framework with effective processes to implement renewable energy developments more efficiently to enhance sustainable energy services delivery in East Timor's rural areas.

This paper submission is taken from the full version report, submitted to the University of New South Wales, Australia, in fulfilment of the requirements of the degree of Master of Engineering Science (Electrical), by Jeff Fang entitled "Enhancing Sustainable Energy Services Delivery In East Timor's Rural Areas Using Renewable Energy",

Any comments/queries, please email: fangsg@yahoo.com

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