LO 1103/SF-GY

Unserved Areas Electrification Programme

Government of Guyana

Hinterland

Electrification Strategy

Executing Agency: Office of the Prime Minister

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GOVERNMENT OF GUYANA STRATEGY FOR HINTERLAND ELECTRIFICATION

1.0 BACKGROUND

The Government of Guyana (GoG) as part of its socio-economic development and poverty alleviation objective has embarked on a programme to extend electricity to unserved areas where extension of existing distribution networks is deemed to be economically feasible. To this end the Government has received a loan from the Inter-American Development Bank (IDB) to support its Unserved Areas Electrification Programme (UAEP).

Primarily, the UAEP focuses on expanding distribution grid along the more densely populated coastal belt, and inland areas of Bartica and Linden. These include: (i) long established villages; (ii) new housing schemes which were developed as part of the Government's intensified housing drive; and (iii) regularized squatter settlements. About 80% of Guyana's 750,000 inhabitants live along the coast which covers approximately 15% of the country's land space.

The UAEP also aims to examine ways in which hinterland areas could access electricity in the most cost effective and sustainable manner. Approximately 20% of Guyana's population lives in the hinterland in about 200 communities, each with about 200 – 2000 persons (40 to 400 households). The Hinterland Project Preparation Component of the UAEP provides for a study of possible energy sources for various situations in the hinterland and the implementation of a number of pilot electrification projects as the basis for a subsequent comprehensive hinterland electrification programme.

To this end, a study was conducted in 2005 by the consulting firm Projekt Consult of Germany which considered the options and technical, economic-financial, institutional-administrative, and socio-environmental requirements for viable hinterland electrification schemes (herein after referred to as the Hinterland Study). This strategy for hinterland electrification and the initial programme have been to a large extent developed based on the findings of that study.

Government is acutely aware of the need to introduce hinterland electrification along a path which is sustainable; that electrification whilst it is a catalyst for social and economic development must be related to the existing stage of social and economic development; that there is need to manage expectations and thus avoid the disappointment which may come from unrealistic expectations.

The majority of households in the hinterland are to some greater or lesser extent dependent on self subsistence with lesser or greater participation in a cash economy. It is expected that the participation in the cash economy will increase and electrification will aid this process. It seems that for those households where there is none or little participation in the cash economy the first step of electrification should be in the nature of a grant which would not need any cash from the beneficiary for three to five years. Government looks to as much grant funding as possible for hinterland electrification. In this regard Government has been and will continue to coordinate and combine the assistance from as many agencies as possible.

Government therefore looks towards:

i. Establishing some electrification in each village, before electrifying some villages totally; starting with social services and communal buildings, health posts, school buildings where they are to be used in the evenings; and other community buildings, where there may be libraries, sewing and handicraft production centers.

ii. Allowing private initiatives in supplying neighbours with electricity even to the whole village; prepared to provide support in the improvements and extension to the main grid, but not to challenge local initiative once local tariffs are not exploitative.

iii. Seek as much grant funding as possible, looking for all opportunities for leverage, and coordinate the various programmes so as to optimize their combined effect.

2.0 CHARACTERIZATION / DEFINITION OF HINTERLAND COMMUNITIES

Guyana's Hinterland is essentially areas outside the coastal belt, which covers about 85% of the country's territory. These areas are characterized by the following:

- Occupied mainly by Amerindians;
- Limited economic opportunities in some areas and residents exist by subsistence farming, fishing and hunting thus resulting in high levels of poverty. It should be noted that mining and logging operations are present in some hinterland areas;
- Infrastructure is yet to be developed compared to rural areas on the coastal plain;
- Access to electricity is limited as loads and demand are very low;

- The villages are widespread and houses are largely dispersed from each other in some cases by distances greater than 500 yards;
- High transportation cost from the coastal areas to the hinterland thereby resulting in the cost of goods and services being much higher than on the coast.

3.0 CLASSIFICATION OF VILLAGES FOR ELECTRIFICATION PURPOSES

The Hinterland Study divided the hinterland communities / villages into three (3) groups with recommendations for supply options based on certain characteristics:

Group 1 - Villages with existing mini-grids, relatively high number of households, significant local government institutions, and some amount of productive activities.

Recommended supply options: (1) improve and extend existing grids and (2) PV systems for remote dwellings on the outskirts.

Group 2 – Villages with some potential for development, which have secondary schools, hospitals and other Government institutions.

Recommended supply options: (1) install small grids for village core; (2) PV systems for remote users, and (3) battery charging service for small, outer dwellings.

Group 3 – Small villages with less than 1000 residents with primarily a subsistence economy. They have nursery and primary schools, small medical clinics and, usually, no other Government institutions.

Recommended supply options: (1) PV systems, and (2) battery charging service for outer dwellings.

4.0 PRIMARY ENERGY SOURCES

Due to its geographic location, climatic conditions and topography, Guyana has vast potential for renewable energy development particularly in the hinterland. The Hinterland Study first examined locally available energy sources (namely wind, solar, biomass, and hydro), but found that diesel based generation was the most competitive source of electrification except where fuel had to be transported by air. Nevertheless, Government intends to demonstrate representative technologies of locally available

energy sources to test the feasibility of using such technologies and energy resources for hinterland electrification.

The various energy sources are discussed below and an approach specified to test their viability for hinterland electrification.

4.1 Solar

Guyana is located near the equator and receives from the sun a daily average radiation of about 5 KWh/m^2/d on horizontal surfaces. As such, for many years, solar energy has been used for several purposes including drying agricultural produce and for electricity production. In several hinterland communities, solar electricity is used for electricity, water pumping, 2-way radio transmission and telecommunication. The Hinterland Study indicates that solar energy is probably the energy source for a majority of the hinterland communities, particularly in the Group 3 villages, given their remoteness and low, dispersed demand for electricity. Using solar as an electric energy source, Solar Home Systems (SHS) would facilitate the installation of individual, isolated systems avoiding the use of grids that would be costly due to long distribution lines to serve the characteristic dispersed housing arrangement in these communities.

As part of electricity demonstration projects, solar electricity will be implemented in selected Group 3 villages using an appropriate photovoltaic system in each home or building to provide lighting for after-dusk reading, studying and productive work; and power for a small radio for information and entertainment. Detailed consideration would be given to the use of DC appliances or 120Volts AC appliances in the various circumstances.

4.2 Hydropower

There are numerous sites in Guyana with potential for hydro-power development. Most of these sites were studied during the 1970's and 1980's by Monenco, Sweco and others. Monenco's study identified and listed 67 potential sites with a total output capacity of 7,000 MW, with the estimated capacity at sites ranging from a few kilowatts, to over 2,000 Megawatts.

The Hinterland Study indicates that some 30% of the villages studied have some degree of hydro-power resources. There is some information available on hydro-power resources in the vicinity of these villages by virtue of the Monenco and Sweco studies. But, new studies will have to be done in view of:

1) the recent development in technologies for hydro-power systems;
2) more recent emphasis on environmental protection;
3) steep rise in the costs for civil, and transmission and distribution grid constructions; and
4) the change in weather pattern that may have occurred over the past three decades that would affect energy output.

In keeping with the low power and energy demand in most hinterland villages, the GoG plans to implement pre-feasibility and feasibility studies on several sites, sufficiently close to villages, which show potential for small hydropower schemes. A preliminary estimate of energy production cost of a hydropower station at the Eclipse Fall was done during the Hinterland Study. It estimated the cost to be between 0.09 and 0.11 US$/KWh. The proposed pre-feasibility studies will present the opportunity to further investigate this and, in general for all sites, provide: (a) estimated power and energy outputs; (b) estimated capital costs; (c) information on any possible environmental and socio-economic impact; and (d) initial economic and financial analyses considering the available power markets. The pre-feasibility studies will also indicate if full feasibility studies are required based on the outcomes. These studies will be implemented over the medium to long term, and are not likely to be conducted during the period 2007 - 2009.

Meanwhile, the GoG will aim to implement a demonstration project for a micro or pico hydro system at an appropriate site for run-of-the-river technology. A suitable site will be identified, and the project will be developed and implemented with the assistance of an independent hydro-power expert. This project is expected to (1) demonstrate the use of micro-, or pico-hydro electric systems using run-of-the-river technology, with the use of pipes for waterway, where pondage and the resulting environmental impact is likely to be insignificant; (2) build the capacity of the engineers at the OPM/PIU to design and develop such systems; and (3) supply electricity to a nearby community for lighting, and/or power for productive activities.

The Government also proposes to support the Lethem Power Company Inc., a licensed public supplier operating in the hinterland area Lethem, in their efforts to contract the restoration of the Moco Moco Hydropower Station.

4.3 Wind

Wind power has been used along the coastline for battery charging, and in the hinterland areas for water pumping. Many of the wind chargers along the coast fell into disuse as diesel produced electricity became more reliable, whilst in the hinterland wind pumps fell into a state of

disrepair because of a lack of replacement parts and expertise to repair and maintain the equipment.

Long term wind flow measurements are required to assess the technical feasibility of large wind farms. However, for small systems such as battery charging and water pumping to overhead tanks, or for electricity generation in a small hybrid system, the need for such data can be relaxed as there is back-up in a small diesel generator or other suitable equipment. It is a common practice in small hybrid systems to include inverter and battery storage. Though these add to the cost, they contribute to the reliability of the operation.

The Hinterland Study identifies some villages with a history of utilizing wind energy. Nevertheless, further investigations are needed to determine, fairly accurately, the reliable energy that can be derived from wind in these villages. Orealla, which is classified as a Group 2 village, is one of the villages listed in the Hinterland Study as having some wind potential. It has primary and secondary schools, a hospital, a police Station, groceries and other shops, a guest house, a fruit-cheese factory, and possibilities for other productive activities. Grid electricity is suitable for this area.

As one of the demonstration projects, GoG plans to install a wind-diesel hybrid electricity generating system at Orealla with diesel being the reserve energy source. Additional instruments will be installed with the wind generator to provide data for any future consideration of increased wind generation in Orealla.

In addition, the GoG therefore proposes a programme of long term wind data collection in several communities that show some wind energy potential. For this, anemometers, data loggers, 60M towers and installation kits are required. Based on analyses of the data collected, wind power schemes will be developed in suitable areas.

4.4 Biomass and Biofuels

Wood and agricultural waste are abundant all across Guyana and must be addressed in any consideration of hinterland electrification. The approaches to utilizing wood and biomass as the energy source for electricity generation include:

1. Steam Raising: Firing a boiler and feeding steam to a reciprocating engine or turbine.

2. Gas Producers: Combustible gases produced by destructive distillation, gasification or fermentation of wood and biomass are fed to modified gasoline or diesel engines.

3. Biofuels: Alcohol may be blended in any proportion with gasoline to feed modified gasoline engines; vegetable oils with little or no modification may be fed in blends to diesel engines.

Wood and biomass were significant energy sources around the world up to about 100 years ago, but by the mid twentieth century equipment for small scale energy provision fell out of any serial production.

Guyana has had significant historical experience in utilizing biomass and biofuels in electricity generation. In Guyana today, there is large scale electricity generation at each sugar estate from burning bagasse and raising steam which is fed to turbines. Up to the 1950's the major electric utility purchased and burnt wood to raise steam. Wood gasification was the basis of electricity generation at BG Consolidated Goldfields in Mahdia in the 1950's and up to the 1970's at the then separate utility located in New Amsterdam, Berbice. Wood gasification was selected for the EU supported sawmill developed at Mabura in the late 1970's. However, this gasification project was a disappointing failure: partly because of the high tar content in the local wood. There are reports of small scale use of biofuels during World War II at various sugar estates located along the coast of Guyana.

As expected, the Hinterland Study found no proven reliable equipment in serial production to provide electricity at the small scale required (1 to 25Kw), and wrote off biomass and biofuels as an energy source to be considered. The GoG, however, wants to explore this energy sources for hinterland electrification, and has allocated a sum of money for at least one test project.

To that end, the Project implementation Unit at Office of the Prime Minister has been maintaining a search for re-emerging technologies and equipment for small scale energy and electricity generation utilizing wood, other types of biomass or biofuels. Of interest so far are:

1. A 5 Kw closed Rankine cycle driven generator fed by bottled propane, used at remote unattended telecommunication sites for a capital cost of about US$ 200,000; a wood burning unit being developed as an alternative to bottled propane may double the price;

2. A green charcoal producing unit. Charcoal is a less demanding fuel for gasifiers than the raw wood or biomass.

Search is continuing for –

3. Suitably sized steam reciprocating engine or turbine to be the basis for a small electricity generating station;

4. 5 – 25 KW gas producing generating units;

5. Improved methods for the utilization of wood for cooking and lighting so as to reduce pollution and to maintain sustainable quantities of wood to fuel electricity generation in hinterland communities which rely largely on wood as fuel.

6. Technology and equipment for small scale production of various vegetable oils and small-scale modification / processing to produce biofuel on site to fuel a diesel engine in whole or in a blend with diesel. Fuel ethanol production at a small scale seems at this time to be less attractive.

4.5 Diesel

The Hinterland Study concludes that diesel is the reserve option which must be bettered. Analysis shows that diesel is the most cost effective energy source where it can be supplied regularly and reliably by road or river.

Grid electricity systems established by the Regional Administration or private persons exist in some Group 1 and 2 villages. These villages include Santa Rosa, Mabaruma, Port Kaituma and Madhia. In these communities, electricity is supplied to residential, commercial and other buildings for 4 to 6 hours daily using diesel generation. Operations and maintenance costs for these systems are covered by monthly financial contributions from consumers and, in some cases, subsidies from the Regional Administrations. The amount each consumer contributes is based on appliances installed and not metered energy usage.

In some cases, these systems were first developed as localized systems to supply a few Government buildings or private businesses with electricity. In cases where there was excess capacity the distribution network was extended in an ad hoc manner to supply electricity to other residential and commercial buildings.

To improve the operations of these systems and in order to make electricity accessible to more residents in selected hinterland communities, the GoG proposes to: (a) upgrade the distribution networks based on the current and estimated medium term power demand, and (b)

optimise generation by providing new generators of suitable sizes, this may include relocating generators to other targeted areas based on the their needs. Energy meters will be installed; this allows for each consumer to pay an economic rate for the electricity consumed.

5.0 IMPLEMENTATION SCHEDULE FOR DEMONSTRATION PROJECTS

Government advocates that the Hinterland Component of the UAEP should be broadened to cater for improvement of hinterland electrification schemes in order to enhance the quality and reliability of electricity supplied and to make electricity supplies accessible to contiguous hinterland communities. This view has been strongly supported by the Consultants as stated on page 60 of the Hinterland Study. Many of the villages identified for improvement projects have substantial economic development potential and such upgrade, rehabilitation and improvement to existing electricity infrastructure in those villages will augment the efforts started by Government towards the development of hinterland electrification from its own revenues. In this regard the Government proposes to fund the demonstration and system improvement projects set out in the attached **Schedule B** from the US $3.2 M loan resources. These demonstration projects are scheduled to be implemented from the first quarter of 2007 to the third quarter in 2009 (see **Schedule B** attached).

The proposed projects could be summarized as follow:

- Installation of new diesel generation and distribution systems and upgrade and extension of existing distribution systems in selected Group 1 villages;
- Construction of new diesel generation systems or hybrid generation systems using diesel and wind, and installation of solar home systems in peripheral areas in selected Group 2 villages;
- Installation of solar home systems in several Group 3 villages;
- Development of a micro- or pico-hydro electricity system at an appropriate location for run-of-the-river technology.
- Co-financing for the restoration of the Moco Moco Hydro Power Station located in Region 9. This 0.5 MW power station was damaged in July 2003 following a landslide;
- Procurement of anemometers to collect long term wind data in hinterland areas which show potential for wind energy.

Initially, several demonstration projects using solar, diesel and micro-hydro technologies will be undertaken; see **Schedule A** attached hereto.

The feasibility and sustainability of the initial projects will be assessed over a six (6) to twelve (12) month period of operation of those projects and similar projects will be replicated based on the results of the assessment. A format for assessing the feasibility of the initial projects and the lessons learnt will be developed.

The following initial demonstration projects are recommended:

i **Solar** - Installation of solar systems in each home in Capoey, Region 2; Kurukabaru, Region 8; Yarakita, Region 1; and Muritaro, Region 10, all Group 3 villages.

The vast majority of hinterland villages are categorized as Group 3 villages. Economic, social and physical conditions vary widely across these villages, in comparison to villages in Groups 1 and 2. Therefore, the conditions in any one village cannot be truly representative of conditions in all Group 3 hinterland communities. The varying factors, including distance from the coast, whether the layout of households are clustered or spatial will impact the sustainability of the demonstrated schemes. As such, the lessons learnt from a project in one village may not be applicable for similar projects in all other villages. For these reasons the Government strongly recommends that the sustainability of the operations of solar electricity system be tested initially in at least four (4) Group 3 villages with vastly different conditions in order to arrive at reliable conclusions for the replication of similar projects.

ii **Diesel** - Establishment of a diesel generation electricity system at Port Kaituma, Region 1 to provide electricity to over 300 customers.

iii **Wind** - Installation of anemometers in several hinterland communities to collect wind data over two or more years period is proposed.

iv **Hydro** - Development of a micro- or pico-hydro electricity system at an appropriate location using run-of-the-river technology.

6.0 INSTITUTIONAL / ADMINISTRATIVE ARRANGEMENTS

The Project Implementation Unit at the Office of the Prime Minister will be responsible for the execution of all the demonstration and improvement projects, and the evaluation of the impact and success of these projects following implementation. To this end, the capacity has been strengthened with the skills of an experienced Electrical Technician seconded from the Guyana Energy Agency. The unit will also be

supported by a part time Independent Specialist to monitor the implementation of the projects and provide technical advisory services. Most projects will be carried out on a turn-key basis, where the contractor provides materials and labour.

6.1 Feasibility Analysis of Proposed Electrification Schemes

GROUPS 1 & 2 VILLAGES

The Hinterland Study found that the primary energy consumption in remote hinterland areas is for cooking and lighting. It is not anticipated that the proposed electrification projects will displace firewood as the primary cooking fuel. Electricity supplies in villages are expected to boost economic activities such as mining and forestry operations and cottage industries. In addition, electricity will contribute to social benefits in the areas of health, education, public works, communication, security and administration. This strategy proposes mini-grids to meet the electricity needs in these villages and solar home systems for the peripheral areas in some Group 2 villages.

The capital cost for the development of mini-grids or upgrade and expansion of existing grids in Groups 1 and 2 villages will be treated as a grant to the community, but consumers will have to pay an economic rate for the electricity to make the operations self-sustaining.

Appendix 2 to Schedule B shows preliminary technical and cost estimates for a grid system at *Port Kaituma* with an NPV analysis for a 10-year period. This analysis is also applicable to *Mahdia* which is a similar community. The analysis indicates a positive NPV with 300 consumers, each paying a fixed charge of G$424 per month plus an energy charge of G$55.01/KWh for the first year. In the NPV analysis, these charges were adjusted annually to compensate for inflation; an average annual inflation rate of 5% was used. The analysis also included the cost to replace the wooden distribution network structures and the generator after 10 years. The distribution and other hardware that will comprise the system usually have a life expectancy in excess of 30 years.

The Hinterland Study[1] shows that consumers at Port Kaituma pay a flat rate of $4,500 per month which is effectively about G$85/KWh when their average demand and the duration of the electricity supply are considered. Similar rates were deduced from the Mahdia situation. The

[1] Consulting Services for Options and Technical, Economic-Financial, Institutional-Administrative and Socio-Environmental Requirements for Hinterland Electrification (Final Report); pg. 82 – [Projekt Consult].

proposed new system would therefore offer lower rates, and consumers' monthly energy bill would be based primarily on metered energy usage. As such, prudent energy usage could result in lower energy bills for the consumers. The use of energy efficiency bulbs by energy users would be encouraged and assistance under the Government of Guyana / Government of Cuba energy efficiency programme will be explored for the distribution of compact florescent lamps to consumers free of charge or at a nominal cost. Use of L. E. D. lights would not be promoted at this time since the quality of the illumination is still to be proven. Other energy saving mechanisms will also be examined and fostered, including the possible use of hand crank radios.

The operations of the system could be sustained, as shown in the analysis in Appendix 2, if rates are adjusted annually based on inflation.

GROUP 3 VILLAGES

The Hinterland Study[2] shows that the average monthly expenditure on kerosene for lighting in hinterland communities is G$1,645 per month. The Study also shows that 94% of households interviewed indicated a willingness to pay at least G$1,000 per month for electricity. For the Solar Home Systems projects, a Net Present Value (NPV) analysis was done showing the expected financial contribution against the projected expenditure for maintenance from each household over a 25 year period (*shown in Appendix 1 to the Schedule*). The analysis shows a positive NPV with an initial monthly contribution of G$500 per household, with increments of $100 every five years. This is a good indication that the SHS operations can be affordable for most residents, and financially sustainable without need for any subsidies from the Government.

The project will fund all components of the SHS, the installation cost and the provision of sockets, compact fluorescent lamps and electrical outlets. Government will treat the capital cost for each project as a grant to the villagers but the beneficiaries are expected to contribute to the operation and maintenance of the systems by paying monthly fees within the range of what they would normally spend on energy for lighting with kerosene lamps or candles.

[2] Consulting Services for Options and Technical, Economic-Financial, Institutional-Administrative and Socio-Environmental Requirements for Hinterland Electrification (Final Report); pg. 31 – [Projekt Consult].

6.2 Management of Electrification Schemes

Grid electricity systems in Groups 1 and 2 villages will be vested to duly incorporated companies, similar to the Lethem Power Company in Region 9 or co-operative societies owned by the State. However, private participation and joint ownership will be encouraged especially in cases where private persons were involved in unregularised electricity generation and distribution.

Such legal entities will be governed by a broad based Board of Directors or Committee of Management as applicable, which comprise representatives from Regional Governmental Bodies and the community. As part of its strategy to regularize public suppliers, operators will be licensed under the Electricity Sector Reform Act 1999 (ESRA) to generate, distribute and supply electricity within a defined Area of Supply. Those licences will not contravene Guyana Power & Light, Inc.'s (GPL's) Licence which provides for other suppliers to be licensed in areas where GPL does not find it feasible or is unwilling to provide a service. In accordance with the provisions of ESRA the licences will cater for strict accountability and light handed regulation of supplier.

The hinterland operators will enter into individual contracts with consumers for the supply of electricity. The Public Electricity Supply Regulations which form the Third Schedule to ESRA and set out public suppliers and consumers rights and obligations will apply.

Training will be provided to local personnel in diagnosing and correcting technical faults and in commercial operations such as meter reading, billing and collections.

With regard to electrification projects in Group 3 villages, the solar home systems will be owned by the individual resident. However, the Village Council (in the case of an Amerindian Village) and / or the Regional Democratic Council (RDC) where the project was executed will be responsible for ensuring that the systems are properly maintained and are sustainable. Accordingly, the Council will enter into a Maintenance Agreement with the beneficiaries which provide for the payment of a fixed monthly sum. The monthly contributions from the beneficiaries will be placed in a fund to be managed by the Village Council and/or the RDC. The Council will be responsible for routine inspection of the systems and for replacement or repairs to components when necessary.

The batteries, in particular, will be monitored based on a charge/discharge rate profile established from manufacturers' specifications, to determine when the batteries are at the end of their useful life. The expired batteries will be removed and properly disposed of

in accordance with the Environmental Protection Agency guidelines and regulations. Relevant training will be provided to key persons from the villages, Village Councils and RDC's. Government will enter into a Memorandum of Understanding with the respective Council which reflects the above arrangement and provides for periodic submission of financial and operational reports.

7.0 SUMMARY OF STRATEGY

The demonstration projects are intended to test the feasibility of using specific technologies and energy resources for hinterland electrification. Feasible options will be replicated in other areas at a later stage.

The strategy for hinterland electrification and the programme for demonstration projects are summarized as follows:-

(a) Solar electricity demonstration projects are to be implemented in selected Group 3 villages using an appropriate photovoltaic system in each home, building (or cluster of building) to provide lighting for after-dusk reading, studying and productive work, and to provide power for small radios for information and entertainment.

(b) Development of a micro- or pico-hydro electricity system at an appropriate location, preferably on the Chiung River, using run-of-the-river technology during 2007 - 2009, and hydro-power pre-feasibility and feasibility studies to be done on several sites, sufficiently close to villages, which show potential for small hydropower schemes over a medium to long term period.

(c) Based on past analysis of wind energy, a wind-diesel hybrid electricity generating demonstration project is proposed for Orealla with diesel being the reserve energy source. Additional instruments will be installed with the wind generator to collect data for any future consideration of increased wind generation in Orealla. In addition, A programme of long term wind data collection in several communities that show some wind energy potential is proposed. For this, several anemometers, data logger, 60M tower and installation kit are to be acquired.

(d) The GoG proposes to demonstrate biomass and biofuels as energy sources for hinterland electrification, and is allocating a sum of money for one or more test installations. The Office of the Prime Minister will continue its search for: (1) re-emerging technologies and equipment for small scale energy and electricity generation utilizing

wood, other types of biomass and biofuels; (2) ways to improve burning of wood by villagers - improved methods would save wood to fuel electricity generation; (3) technology and equipment for small scale production of various vegetable oils and small-scale modification / processing to produce biofuel on site to fuel a diesel engine in whole or in a blend with diesel.

(e) Improvements to and expansion of existing electricity generation (diesel) and distribution systems in Groups 1 and 2 hinterland villages are proposed. The distribution networks are to be upgraded, and generation optimised by providing new generators of suitable sizes and by relocating generators to other targeted areas based on the present and future energy demand.

(f) Legal entities will be established (where they do not currently exist) to manage these electricity systems. Private participation in electricity generation and distribution in these areas will also be encouraged and permitted.

Schedule A showing Initial Hinterland Demonstration Projects

Diesel

Group 1 Village	Project Description	Approx. No. of connections	Cost (G$)	Tentative Start Date	Tentative Finish Date
Port Kaituma	Development of a new diesel generation and distribution system.	432	75M	March 2007	Jan 2008

Solar

Group 3 Village	Approx. No. of Households	Description of Projects	Cost (G$)	Tentative Start Date	Tentative Finish Date
Capoey	58	Installation of solar home systems.	23.5M	March 2007	July 2007
Kurukabaru	110	Installation of solar home systems.	44M	March 2007	July 2007
Yarakita	110	Installation of solar home systems.	44M	March 2007	July 2007
Muritaro	55	Installation of solar home systems.	22M	March 2007	July 2007

Micro/Pico Hydropower

Project	Cost (G$)	Tentative Start Date	Tentative Finish Date
Development of a Micro- or Pico-hydropower run-of-the-river system.	40M	Jun. 2007	Jun 2008

Wind Data Collection

Project	Cost (G$)	Tentative Start Date	Tentative Finish Date
Installation of a diesel / wind hybrid generation, and distribution system.	40M	Apr. 2007	October 2007
Wind data collection in areas that show some wind energy potential.	10M	Apr. 2007	Apr. 2009

Summary of Costs for initial demonstration projects (Note: Each project sum includes costs for capacity building.)

Development of the diesel generation electricity system at Port Kaituma –	G$75M (US$375,000)
Installation of Solar Home Systems at Capoey, etc. -	G$215M (US$1.075M)
Micro / Pico hydro development on Chiung River	G$40M (US$200,000)
Support Staff -	G$5M (US$25,000)
Wind / diesel system at Orealla	G$40M (US$200,000)
Wind Data Collection -	G$10M (US$50,000)
Contingencies -	G$7M (US$35,000)
Total:	**G$392M *(US$1.96M)***

Schedule B showing full list of Proposed Hinterland Demonstration and Improvement Projects

Group 1 Villages	Project Description	Approximate no. of connections	Cost (G$)	Tentative Start Date	Tentative Finish Date
Mahdia	Development of a new diesel generation and distribution system.	410	62M	Oct. 2008	July 2009
Port Kaituma	Development of a new diesel generation and distribution system.	432	75M	April 2007	Jan. 2008
Santa Rosa	Further the development of a new diesel generation and distribution system currently in progress.	> 250	20M	Jan. 2008	Mar. 2008
Mabaruma	Upgrade of current diesel generation and distribution system, and extension of distribution to Settlement.	> 500	25M	Jan. 2008	Mar. 2008
Lethem	Upgrade of current diesel generation and distribution system, and extension of distribution to designated Industrial Area.	> 500	28M	March 2008	Sept. 2008
		Total:	**210M** (US$1.05M)		

Group 2 Villages	**Project Description**	**Approx. No. of connect-ions**	**Cost (G$)**	**Tentative Start Date**	**Tentative Finish Date**
Orealla	Demonstration Project of a diesel / wind hybrid generation, and distribution system.	229	40M	April 2007	Oct 2008
Annai	Demonstration Project of a new electricity generation and distribution system using diesel generators & solar home systems.	80	20M	Apr. 2008	Oct. 2008
Aishalton	Demonstration Project of a new electricity generation and distribution system using diesel generators & solar home systems.	250	40M	Apr. 2008	Oct. 2008
St. Cuthbert's Mission	Further the development of a new electricity generation and distribution system currently in progress.	220	20M	Jan. 2008	May 2008
*Moraikobai	Upgrade and extent the existing distribution network.	> 60	10M	Jan. 2008	May 2008
		Total:	**130M** (US $0.65M)		

*This village was not included in the hinterland study, but has the characteristics of a Group 2 village.

Group 3 Villages	Approx. No. of Households	Description of Projects	Cost (G$)	Tentative Start Date	Tentative Finish Date
Capoey	58	Installation of solar home systems.	23.5M	March 2007	July 2007
Kurukubaru	110	Installation of solar home systems.	44M	March 2007	July 2007
Yarakita	110	Installation of solar home systems.	44M	April 2007	Aug. 2007
Muritaro	55	Installation of solar home systems.	22M	April 2007	Aug. 2007
One or more Upper Mazaruni villages.	N/A	Demonstration Project of a new electricity generation and distribution system using Biomass generators.	50M	Oct. 2008	Mar. 2008
Sebai Red Hill St. Deny's Monkey Mt. Kopinang Nappi Sand Creek Shulinab Shea Rockstone Wikki Calcuni Yupukari	48 34 65 126 100 94 143 76 80 50 75 80	Approximately 80 solar home systems to be installed in villages selected from the list in the left column.	31.5M	August. 2008	Dec. 2008
		Total:	**215M (US$1.075M)**		

Micro / Pico Hydro Development

Project	Cost (G$)	Tentative Start Date	Tentative Finish Date
Development of micro / pico hydro.	40M	June 2007	June 2009

Moco Moco Hydro Station Restoration

Project	Cost (G$)	Tentative Start Date	Tentative Finish Date
Restoration of Moco Moco Hydro Power Station	10M (Co-finance)	N/A	N/A

Wind Data Collection

Project	Cost (G$)	Tentative Start Date	Tentative Finish Date
Wind data collection in areas that show some wind energy potential.	14M	Apr. 2007	Apr. 2009

Summary of Costs for total demonstration projects (Note: Each project sum includes costs for capacity building.)

Group 1 Programme	-	G$210M (US$1.05M)
Group 2 Programme	-	G$130M (US$0.65M)
Group 3 Programme	-	G$215M (US$1.075M)
Micro / Pico Hydro System	-	G$40M (US$0.2M)
Moco Moco Hydro Restoration	-	G$10M (US$0.05M)
Wind Data Collection	-	G$14M (US$0.07M)
Contingencies	-	G$ 21M (US$0.105M)
Total:		**G$640M (US3.2M)**

Solar Home System Project NPV Analysis

Discount Rate: 4.00%

Year	Household Contributions	Present Value	Expenditure	Present Value	Explanation for Expenditure
25	$12,000.00	$4,501.40		$0.00	
24	$12,000.00	$4,681.46	$10,000.00	$3,901.21	Replacement of lamps.
23	$12,000.00	$4,868.72		$0.00	
22	$12,000.00	$5,063.46		$0.00	
21	$12,000.00	$5,266.00	$10,000.00	$4,388.34	Replacement of lamps.
20	$10,800.00	$4,928.98	$27,000.00	$12,322.45	Replacement of battery.
19	$10,800.00	$5,126.14		$0.00	
18	$10,800.00	$5,331.18	$10,000.00	$4,936.28	Replacement of lamps.
17	$10,800.00	$5,544.43		$0.00	
16	$10,800.00	$5,766.21		$0.00	
15	$9,600.00	$5,330.54	$37,000.00	$20,544.79	Replacement of lamps & battery.
14	$9,600.00	$5,543.76		$0.00	
13	$9,600.00	$5,765.51		$0.00	
12	$9,600.00	$5,996.13	$19,500.00	$12,179.64	Replacement of lamps & Charge Controller.
11	$9,600.00	$6,235.98		$0.00	
10	$7,200.00	$4,864.06	$27,000.00	$18,240.23	Replacement of battery.
9	$7,200.00	$5,058.62	$10,000.00	$7,025.87	Replacement of lamps.
8	$7,200.00	$5,260.97		$0.00	
7	$7,200.00	$5,471.41		$0.00	
6	$7,200.00	$5,690.26	$10,000.00	$7,903.15	Replacement of lamps.
5	$6,000.00	$4,931.56	$27,000.00	$22,192.03	Replacement of battery.
4	$6,000.00	$5,128.83		$0.00	
3	$6,000.00	$5,333.98	$10,000.00	$8,889.96	Replacement of lamps.
2	$6,000.00	$5,547.34		$0.00	
1	$6,000.00	$5,769.23		$0.00	
0		$0.00		$0.00	
		$133,006.17		$122,523.95	Note: Because the cost of photovoltaic system devices is constantly reducing, no inflation was considered in the expenditure.

Net Present Value: $10,482.22

Estimate of Diesel Generation and Investment Cost at Port Kaituma

Basic Data

Nominal Capacity	250 KVA (200KW)
Fuel Consumption	0.0475 gals / KWh
Fuel Cost per Gallon	$700.00
Hours of Operation (8 hours on weekdays; 10 hours on weekends).	60 Hrs. per Week
Estimated Load Factor	70%
Estimated Annual Gross Energy Production	436,800 KWh
Estimated System Efficiency	85%
Net Annual Energy Output	371,280 KWh
Minimum Expected Consumers (Domestic and Commercial)	300
No. of Households	432

Cost Estimates

Investment:	
Supply and Installation of Generator	$7,000,000
Construction of Distribution Network	$68,000,000
Total:	$75,000,000
Annual O&M Cost:	
Fuel	$12,345,060
Generator Maintenance	$210,000
T&D Maintenance	$550,000
Staff & Salaries	
2 Operators	$720,000
1 Meter Reader (Part Time)	$126,000
Billing Clerk	$360,000
3 Linesmen	$1,260,000
Overheads	$250,000
Management Cost	$1,200,000
Total O&M Cost:	**$17,021,060**
Energy Production Cost ($/KWh) *(* Capital cost is not a factor in this Calculation)*	$45.84
Energy Price after 20% markup	$55.01

New Capital Investment after 10 years

Investment Cost (at current prices) to replace wooden materials on network and the generator after 10 years.	$15,250,000
Average Annual New Investment Cost.	$1,525,000
Monthly Cost per Consumer	$424

Estimated Monthly Tariff:

Fixed Monthly Charges *(to cover new investments after 10 years)*	$424
Energy Charges ($/KWh)	$55.01
Total Estimated Annual Revenue *(from fixed and energy charges)*	**$21,950,513**

NPV Analysis

Discount Rate: 4.00%

Year	Energy Revenue	Present Value	Expenditure	Present Value
10	$34,052,450.17	$23,004,615.20	$50,063,006.00	$33,820,773.04
9	$32,430,904.93	$22,785,523.62	$25,147,857.76	$17,668,551.29
8	$30,886,576.12	$22,568,518.64	$23,950,340.72	$17,500,279.37
7	$29,415,786.78	$22,353,580.36	$22,809,848.30	$17,333,610.04
6	$28,015,035.03	$22,140,689.12	$21,723,665.05	$17,168,528.04
5	$26,680,985.74	$21,929,825.42	$20,689,204.81	$17,005,018.25
4	$25,410,462.61	$21,720,969.94	$19,704,004.58	$16,843,065.70
3	$24,200,440.58	$21,514,103.56	$18,765,718.65	$16,682,655.55
2	$23,048,038.65	$21,309,207.33	$17,872,113.00	$16,523,773.11
1	$21,950,513.00	$21,106,262.50	$17,021,060.00	$16,366,403.85
0		$0.00	$0.00	$0.00
		$220,433,295.68		$186,912,658.24

Net Present Value: $33,520,637.45

Notes:

1. The analysis is based on estimates of Sheet 1 of this appendix (Appendix 2).
2. The Expenditure and the Revenue was increased by 5% annually to cater for inflation.
3. No initial capital cost was considered in this analysis; Government is treating the investment as a grant.
4. In the 10th year, expenditure includes the cost to replace wooden structures and the generator (which is present cost $15,250,000 with an annual inflation rate of 5% over the period).
5. A rate of return of 4% was used to reflect the average prevailing interest rates from commercial banks on saving accounts.