



PROJECT CONCEPT AND REQUEST FOR PDF BLOCK B GRANT

Country	Zambia
Title	Renewable energy based electricity generation for isolated mini-grids in Zambia
GEF focal area	Climate change
GEF operational programme	OP 6 – Promoting the adoption of renewable energy
Requesting agency	UNIDO (Executing Agency with Expanded Opportunities)
National counterpart agency	The Department of Energy (DOE), Ministry of Energy and Water Development
Estimated starting date	September 2001
Total PDF funding required:	US\$ 430,000
• GEF Block-B funding requested	US\$ 325,000
• Co-funding of PDF activities:	US\$ 130,000
- UNIDO	US\$ 50,000 (cash)
- Government of Cuba	US\$ 55,000 (in kind)
Block-A grant awarded:	None
Duration:	12 months
Eligibility:	Zambia ratified UNFCCC on 28 May 1993

1. Background

1.1 Energy sector context

Zambia is endowed with abundant energy resources (except for petroleum products which are imported). Its hydropower potential is assessed at 6,000 MW and the biomass cover (covering 81% of total land area), though under increasing pressure, is still reasonably rich. Zambia has rather large coal reserves (estimated at 80 million tons) and operates its own pipeline-fed oil refinery (at Ndola, capacity 1.1 million tons per year). Of the total installed electric generating capacity of 1,778 MW, hydropower accounts for 1,670 MW (94%) in Zambia. In spite of surplus hydropower availability, the electricity grid penetration is still very low – about 20% of total population mostly in urban areas has access to electricity with a national grid that caters to only 2% of the households in rural areas.

Total annual energy consumption in Zambia is in the order of 4.5 mtoe with wood fuel meeting the bulk of the energy needs followed by electricity, petroleum products, and coal. At the sectoral level, wood fuel is basically a household fuel consumed in the form of firewood in rural areas and charcoal in urban areas while the consumption of petroleum, electricity and coal is dominated by commerce and industry,

particularly mines. Firewood is mainly used in rural areas, while charcoal meets primary energy needs in urban agglomerations and along the densely populated Copperbelt. According to a recent estimate (Energy Statistics Bulletin 2000), wood fuel accounted for 80% of the total energy consumed in 1999 and electricity accounted for 11% while other fuels like coal and petroleum products met the balance energy needs (9%) mostly in industry and transport sectors.

The current absence of reliable and affordable electricity in off-grid rural areas is one of the barriers hampering rural development in Zambia as electricity is an important input to the overall rural development (notably income generating activities such as agro-processing). The provision of electricity for industrial and commercial uses in non-grid areas is provided by diesel generator sets and their use is increasing. The renewable energy technologies are gaining acceptance but their contribution to the overall energy balance is still insignificant.

1.2 Government Energy Policy

The national energy policy of 1994 which articulates national priorities in the energy sector mainly focuses on promoting optimum supply and utilization of energy, especially indigenous forms, to facilitate the socio-economic development and maintenance of a safe and healthy environment. This first national energy policy still guides the development of the energy sector. The policy has not been updated since then, but it would be needed especially to guide further development of the restructured industry and define priorities and ways of rural and urban compound electrification. Although there is no specific national policy on rural electrification, the Zambian Government has created a Rural Electrification Fund (REF) in 1994 to increase rural access to electricity. This fund is replenished from a levy that is made on all electricity bills. Although the REF is in existence, there is considerable scope for improving its operations in terms of size, coverage, effectiveness, and efficiency.

The process to enact legislation necessary for a competitive energy economy has been initiated. Zambia has already introduced the concept of Independent Power Producers (IPP), though the still existing monopoly of the state utility (ZESCO) over the transmission grid limits the independence of the IPPs. The concept of Energy Service Company (ESCO) is being tried in the PV solar energy field in the East of the country (Nyimba). Smaller renewable energy demonstration projects, e.g. in the field of solar energy, biogas and improved cook stoves have mostly been funded by various international cooperation programmes.

A study was commissioned by UNIDO in the course of the preparation of energy related deliverables for the Interactive Thematic Session on Energy at the Third UN Conference on Least Developed Countries in Brussels in May 2001. The study, conducted in cooperation with the Ministry of Energy and Water Development, Government of the Republic of Zambia, and Energy Regulation Board in Lusaka, identified several areas for potential cooperation and provided a good base for the formulation of this GEF proposal. The UNIDO mission jointly with Government of Zambia in April 2001 could identify a number of key policy (for example a strategy for rural electrification is absent), institutional, technical and financial barriers that impede the development of renewable energy based electricity generation for isolated grids, thereby substituting diesel power. It became clear during the mission that without addressing these barriers effectively, it would be difficult to promote sustainable energy alternatives in Zambia.

1.3 Link to ongoing activities

Zambia has no GEF assisted activities yet on climate change. While a number of Multi/bilateral agencies and donor as well as civil society partners such as World Bank, SIDA, DANIDA and Care International

are working towards enhancing the national energy security in Zambia, most of the work is being done in harnessing hydro power and introducing reforms in power sector with emphasis on privatization and energy conservation. Areas that require immediate attention, among others, include integrated energy policy planning; developing proper regulations and policies for renewable energy development; capacity building of national institutions, and encouraging private sector participation in supporting decentralized local energy systems.

The proposed GEF project would build on the work already done, and contribute directly to these themes, in varying degrees. Overlaps have been avoided at the design stage. During the implementation, the other projects will be monitored, to make full use of project outcomes, complement their activities and again to avoid overlaps. It concerns the following ongoing and/or planned initiatives:

- *Power Rehabilitation Project*: This project involves large scale hydropower rehabilitation like power stations (Victoria Falls, Kafue, Kariba), dams, distribution systems, policy and institutional development, funded by multilateral grant/loan funding;
- *Rural Electrification Programme*: Virtually out of operation, requires re-planning and fresh funding;
- *Construction of new hydropower schemes (Kafue Lower and Itezhi-Tezhi)*: New generation capacity is earmarked for private funding in various funding modalities;
- UNIDO has, parallel to the here proposed initiative, also prepared a PDF B proposal requesting for GEF support entitled '*Innovative approaches to energy conservation and efficiency in small and medium size enterprises*'.

Beyond the above, several small scale energy projects, mostly funded by Zambian bilateral development partners, require attention in terms of studying their outputs, experiences and lessons learned, as well as good coordination. Given the fact that Zambia is a SADC member state, it will be necessary to harmonize project activities with regional SADC policies and activities in the sustainable energy field.

2. GEF Alternative

2.1 Problem statement

The Zambian Government aims to provide electricity to all rural households in Zambia, in order to improve their standard of living and provide opportunity to generate more income. Most of these rural households are in far flung areas, and hence cannot be reached economically through grid extension. Renewable energy based isolated mini grids provide a viable option to provide the electricity and energy services to remotely located rural households on sustainable basis. Linking decentralized mini grids based on renewable energy with income generation activities would accelerate rural industrial development, which in turn would ensure returns on the investment and sustainability of the mini grids.

2.2 Baseline

Only 20% of the Zambian population has access to electricity. In rural and urban areas, the electricity access rate is 2% and 35% respectively. A combination of factors, namely the isolated and dispersed location of rural settlements and the high costs of establishing and maintaining grid distribution networks have prevented the majority of the rural households to get connected to the national electricity grid. Furthermore, the electricity grid is mainly confined to middle/high income households and the mining sector.



The current absence of reliable and affordable electricity in off-grid areas is one of the barriers hampering rural development, as electricity is an important input to rural industrial development (notably activities related to agro-processing). Further, the provision of electricity could also facilitate commercial activities (trading centres, information/ICT), improve the quality of public sector activities (health, education and public administration) and it can improve the quality of live in the domestic sector. However, it is important to note that the entry point for the here proposed initiative is the provision of electricity to facilitate rural industrial development as it is expected that such activities generate sufficient income to pay for the energy services and hence make the service sustainable. For public sector activities, public sector funding will be targeted to pay for the energy services and as local purchasing power increases, the extension of services to other (paying) end-users could be considered.

Many parts of Zambia including the north and northwestern provinces have a large potential for developing micro hydro systems in the range of 10-1000 kW to meet the local energy needs through developing local grids. Although some agencies, including UNOPS, have carried out a study on the potential of micro hydro systems ranging from 2-10 MW, no reliable data is available on the potential of micro hydro systems (up to 1 MW) in the country. These micro hydels have the potential of replacing diesel sets being used to supply electricity in remote rural areas where electricity generation costs are as high as US\$ 30-35 cts/kWh. Currently approximately 5 MW diesel-based generation capacity is installed in the country, but this is likely to grow in off-grid areas if viable alternatives based on renewable energy technologies are not provided soon.

When deliberating further developments in the Zambian energy sector, conventional energy wisdom has to be adapted to the specific Zambian context. Although the hydropower will remain the mainstay of the energy sector in the near future, coal as an energy carrier does have justification on the Zambian heat market, and it is the fact that the same market will depend on charcoal for a long time to come. While the size of the Zambian market place allows for some economies of scale, its capitalization, the purchasing power and even the monetization of Zambian economic subjects remains low. In the rural areas, the private sector is still underdeveloped, the human resource base is still limited, and the penetration of grid remains very low.

Decentralized renewable energy technologies and markets do offer opportunities; but they would need support, including targeted policies, capacity building, adequate financial resources to meet high up-front costs, and special efforts to link-up with income generation activities. Although solar PV systems were introduced in Zambia in the early 80's, and about 7,000 solar PV lighting systems and 20 solar water heaters have already been installed so far, the feed back from beneficiaries is not very encouraging. In addition, PV systems offer too limited power for (small) industrial processes.

Biomass resources in Zambia are still abundant, although under pressure as a result of agricultural extension, logging operations and charcoal making. The potential of various renewable technologies needs to be assessed on priority, and on a case-by-case basis, on the background of their social acceptance and economics. For the time being, any investment in rural energy markets proves to be risky, if it is to work on commercial terms alone.

In the baseline (without support of GEF) it is expected that this ad-hoc approach to renewable energy development will continue in Zambia. Renewable energy use will be limited to poorly maintained stand alone renewable technologies (i.e. solar systems installed so far) and isolated grids installed on an ad hoc basis by the Government, bilateral agencies and civil society. The here proposed GEF initiative would focus on harnessing the potential that renewable energy sources - mainly hydro and biomass - present for electricity generation for isolated mini-grids in rural areas of Zambia.

2.3 Barriers

During the earlier mentioned mission undertaken by the UNIDO's Industrial Energy and Climate Change team, resulting in the 'Sustainable Energy Programme Proposal for Zambia', the following barriers to renewable energy development were jointly identified with the Department of Energy, Govt. of Zambia:

2.3.1 Policy barriers

- Absence of an integrated policy and regulatory framework that would encourage rural mini grids based on renewable energy sources for rural electrification or grid augmentation is the main policy barrier;
- Suitable policies and regulations are yet to be enacted to provide a level play field to renewable sources of energy to enable the public utility and businesses to supply renewable electricity for rural electrification and grid support on a commercial basis; and
- Strong up and downstream policies as well as institutional linkages between rural electrification programme and income generation activities are weak and/ or non-existing.

2.3.2 Financial barriers

- The high capital cost of renewable energy products and projects is a main barrier to the increased use of renewable energy sources for the provision of modern energy services;
- Although dedicated financing in the form of a Rural Electrification Fund exists, substantial improvements of its operations are required for it to become a successful (policy) instrument for rural electrification;
- The capacity to appraise renewable energy proposals is limited or non-existing;
- Government budgets are limited and the demand for financing various national priority areas is great;
- The currently small and dispersed size of the Zambian renewable energy market does not facilitate benefits such as economies of scale.

2.3.3 Institutional barriers

- ZESCO (the National Utility) still depends on the national budget for implementation of activities, which creates uncertainties in allocation of project financing as well as time delays;
- The capacity to work on energy related economics, market development, marketing, technical issues, etc. is not to be found in one place/existing institution;
- Generally speaking, government agency decision-makers (who have access to and control the budget) have little interaction with operational levels. Operational lines of communication between operation and decision making levels is subject to improvement within government agencies;
- Renewable energy based provision of modern energy services is dealt with by various ministries, agencies and institutions, making good coordination between them a necessity to efficiently make use of limited human and financial resources in this area. Also this is subject to improvement;
- Although IPP's are allowed to operate, the distribution and transmission network access is still a monopoly of ZESCO, which creates access barriers for IPP's;
- Limited spatial distribution of suppliers limit access to renewable energy technologies (hardware);
- A large fraction of the energy economy (fuelwood, charcoal) operates outside of the boundaries of the formal economy.

2.3.4 Technical barriers

- Bulk procurement of renewable energy technologies is limited due to the current small market for renewable energy based modern energy services. Hence the (technical) infrastructure to support renewable energy development does not exist;
- Local manufacturing and/or assembly of renewable energy technology components is currently mostly lacking;
- Limited technical capacity to design, install, operate, manage and maintain renewable energy based modern energy services, mainly as a result of lack of past activities in this (new) field;
- The technical skills, including conclusive data comparing energy technologies for equivalent energy services, is limited;
- Norms and standards in terms of renewable energy performance, manufacture, installation and maintenance are weak and/or non-existing.

2.3.5 Information, awareness and human resource barriers

- Limited availability and access to existing renewable energy resource information. A central information point does not exist, instead information is scattered among various sectors; e.g. public sector, private sector (including consultancy firms), development assistance, R&D centres and academia;
- Availability of renewable energy resources is very site specific, requiring detailed analysis of the local specific conditions;
- There is a limited knowledge on the renewable energy market potential (lack of detailed market surveys);
- There is a lack of public awareness on renewable energy technologies other than that they exist. Knowledge on for example the fact that life cycle costs of renewable energy technologies are often competitive or even lowest cost options is mostly absent;
- The provision of energy is often perceived as a social service, not an economic activity that carries a price tag. Furthermore it is often perceived from the 'comfort of living' point of view, neglecting its role as a facilitator in rural and economic development - both by consumers and decision makers;
- Rural electrification is often assumed to be panacea to all energy problems, pre-supposing that it provides all energy needs;
- Little empirical knowledge of the costs and benefits of the range of technologies available for providing renewable energy based modern energy services exists, and thus it has not been extended to policy and decision makers;
- Limited in-country capacity for renewable energy data collection and analysis is an important barrier for renewable project development.

It is clear that without addressing above barriers, it will be difficult to promote sustainable energy alternatives to increase rural access in Zambia. At the same time, Government and other institutions in Zambia have little capacity – financial, technical or institutional – to address these barriers. Hence, the present request for GEF assistance.

2.4 GEF alternative

2.4.1 Overall project objectives

Mini grids based on renewable sources of energy will contribute to the Zambian Government's objective of providing electricity and energy services to rural areas, and improving their standard of living through income generation activities. The project will: (a) establish isolated mini grids to provide electricity and energy services to rural households and communities that cannot be reached economically by the grid;

and (b) link renewable electricity mini grids with income generation activities to accelerate rural industrial development.

The project will identify, evaluate and prioritize the barriers preventing increased uses of renewable energy sources for the generation of electricity for isolated mini-grids, and to design activities for their reduction/removal.

The project is based on the following strategic principles (developed during the UNIDO's mission to Zambia in April 2001 and agreed with the Department of Energy and Energy Regulation Board, Government of Zambia):

- Pilot installations (mini grids) based on renewable energy will be established in remote rural areas where they are most needed, and will be designed to test, monitor and evaluate assessment methodologies, maintenance, financing, ownership, operations and monitoring.
- Mini grids will meet local energy needs on a commercial basis, using public utility as well as businesses with all ownership forms.
- Communities, individual consumers, public utility and investors will actively contribute to and participate in the mini grids program.
- The Government and cooperating agencies will act as a market enabler, putting in place the laws, decrees, regulations, and building capacity for replication of mini grids based on renewable electricity.
- The access of rural mini grids to soft credit and other financial incentives will be increased to improve financial viability of public utility, businesses and affordability to consumers.
- Financial incentives will be provided, in recognition of social and environmental benefits, but will be used carefully to build capacity and support sustainability.

2.4.2 Project components

UNIDO and The Department of Energy (DOE), Ministry of Energy and Water Development, Government of Zambia have agreed on a number of activities supporting pilot mini grids based on renewable electricity and their linkages with income generation activities in rural areas, removing barriers and developing capacities for rural energy markets that will form an integral part of the project.

The following are the possible components of the full project envisaging barrier removal activities and reducing implementation costs of pilot mini grids based on renewable electricity as well as developing local capacities for rural energy markets in Zambia:

– ***Pilot Installations (decentralized Mini Grids) Based on Micro Hydro and Biomass Gasifier Technologies***

About four pilot installations (decentralized mini grids) based on micro hydro and biomass gasifier technologies (or hybrid systems) with productive loads would be set up to demonstrate effectiveness of decentralized local energy grids on commercial basis.

Technical assistance (TA) would be provided to set up local grids that are designed to test, monitor and evaluate suitable technologies, assessment methodologies, maintenance, financing, ownership, operations and billings, connections, tariffs, non-payments and consumption allocation. Efforts will be made to provide linkages with community based or individual household level activities, cooperatives or mini-utility businesses, as well as stimulate rural industrial and income generating activities, which are essential for viability of the mini grids.

The pilot mini grids will be set up in relatively high concentration of demand to demonstrate the critical role local decentralized grids and markets based on renewable energy technologies can play in supporting income generation activities in sectors such as agriculture, irrigation, fishing, poultry and cottage industry in rural areas. In brief, these pilot mini grids would:

- i) Demonstrate the key role of decentralized renewable energy grids in supporting productive, income generation activities in rural areas;
- ii) Introduce cost effective designs, standards and management procedures for renewable energy technologies leading to low unit costs for consumers;
- iii) Illustrate models of efficient public as well as private sector participation in developing renewable energy markets and cost recovery in rural areas and their replication; and
- iv) Meet energy requirements of the community institutions like rural development/health centers, agricultural extension centers and residential schools.

– ***Renewable Energy Mini Grids Developers/Energy Service Companies***

Technical assistance would be provided for enabling the renewable energy mini grid developers i.e. Public Utility, Independent Power Producers (IPPs) and Energy Service Companies (ESCOs) to set up and operate local grids based on renewable electricity in rural areas. The first step would be to strengthen functional/existing ESCOs as well as to create enabling conditions for facilitating new IPPs and ESCOs to operate decentralized rural grids. This would be followed by establishment of transparent and streamlined approval and contractual processes; packaging identified mini grids projects; designing award procedures and offering sites to interested developers; disseminating information and providing business development services to prospective developers, and identifying ways to make available long-term financing including the possible use of guarantees to extend loan terms. Investment would be stimulated from investors, commercial banks and other sources including multi/bilateral agencies to ensure sustainability and replication of the project.

Experiences with the existing Rural Electrification Fund will be assessed, and used as a starting point to establish financing mechanisms that are appropriate to the likely delivery models in a given context (i.e. cooperative association, private power developer or public utility etc.) and educate financiers about mini grids investments. TA will be provided for imparting technical, business and financial training for mini grid developers/owners/operators.

– ***Renewable Technology Adaptation/Market Development in Rural Areas***

Technical assistance would be provided for technology adaptation and up-gradation, skills development and markets linking mini grids based on renewable energy technologies with income generation activities in rural areas.

Special efforts will be made to validate sustainable business models for mini grid development, operations, and maintenance that can be replicated given quantified inputs like social subsidies and market linkages.

Suitable linkages will be developed between local, national and international institutions to facilitate technology up-gradation and adaptation in Zambia keeping in view the ground realities. Capacity of identified institutions will be built to undertake R & D and maintenance activities relating to renewable mini grids and markets.



– *Policy Planning, Management and Institutional Mechanisms*

Technical assistance will be provided to assist with government policies to promote mini grids, such as (i) their integration into rural development programmes; (ii) identification and provision of levels of public subsidies equivalent to those given to grid connected consumers; (iii) mechanisms to put renewable energy on a more equal basis with fossil fuels if they are subsidized; and business incentives and other forms of support for developers / or cooperatives/ or public utility.

TA will be provided to update the National Energy Policy of 1994, and incorporating a special chapter on renewable energy development in rural electrification programme. The project will assist policy-planning mechanisms that will treat mini grids, off grid systems and central grid extension in an integrated fashion delineating the proper role and geographical base of each type of application within an overall framework of providing rural electricity access.

Special efforts will be made to educate consumers about the constraints and characteristics of mini grids to enable informed and appropriate social/policy arrangements for connections, tariffs, non-payments and consumption allocations. A renewable energy information system will be put in place in a suitable institution to collect, analyze and disseminate information on renewable energy technologies and practices on regular basis.

The project will build national capacity by providing training to the policy makers, mini grid developers and local institutions, and assist communities and entrepreneurs to develop income generation activities (i.e. development of small scale industry through cluster approach developed by UNIDO) in conjunction with mini grid operations.

2.4.3 Estimated project cost

Although the final figures will be arrived at/ or firmed up during the PDF phase, total estimated financing required for the full project will be in the range of about US \$ 10.0 million. The tentative funding break-up source wise could be as follows:

Government	\$1.0 million
GEF funding	\$4.0 million
Public/Private sector	\$4.0 million
Other donors	\$1.0 million
Total	\$10.0 million

2.4.4 Project execution

For the GEF, UNIDO is the executing agency with expanded opportunities, whereas the national counterpart agency is the Department of Energy (DOE) of the Ministry of Energy and Water Development.

UNIDO and the Department of Energy (DOE) will jointly set up a Project Management Unit (PMU) at DOE to coordinate and execute the project activities. A Project Steering Committee (PSC) will be set up to oversee the project development and implementation. Furthermore, the project steering committee comprising of key Government agencies (including Ministry of Energy and Water Development, Ministry of Environment and Natural Resources, Ministry of Industry, Ministry of Finance, Energy Regulation Board, Environmental Council of Zambia, local administration etc.), financial community, public utility, civil society and the private sector, would advise on sector development issues and assist in inter-



ministerial coordination and cooperation, besides serving as a platform for sharing information on the project's progress.

The Planning and Information Department of the Ministry of Environment and Natural Resources, which hosts the GEF Operational Focal Point will follow the progress of the project closely, and facilitate coordination with other rural development and infrastructure programs being implemented by the Zambian Government and donor agencies.

2.4.5 Project stakeholders

The key stakeholders involved in the project will be the national government ministries (Ministry of Energy and Water Development, Ministry of Environment and Natural Resources, Ministry of Industry, Ministry of Finance, Energy Regulation Board, Environmental Council of Zambia); local administration; public utility (ZESCO), businesses and ESCOs who will participate in investment, installation and equipment supply, operation and maintenance of mini grids, financial institutions and banks; NGOs (Care International etc); Centre for Energy, Environment and Engineering (Zambia) Ltd. (CEEEZ), National Institute for Scientific and Industrial Research; Universities (Technical Development and Advisory Unit and School of Natural Sciences, University of Zambia) and consumers (rural households, small businesses, community institutions).

2.4.6 Sustainability and replicability

The sustainability and replicability of this project are especially strong because in contrast to many renewable energy projects implemented so far in Zambia, this project is not merely a demonstration of a renewable technology based on one-off implementations. This project is based on developing market-based rural mini grids through strong stakeholders participation and institutional linkages, and will not rely on continued support from outside funding source. This is possible because there exist economically viable options for using renewable energy based mini grids in rural households and enterprise applications in Zambia. The project has strong national ownership as it has been developed in accordance with the national energy priorities and rural development strategies, and the Zambian Government has made a commitment to the full project.

The goals of linking income generation activities and rural markets with mini grids based on renewable electricity for rural industrial development in a sustainable manner, both through the assured supply of energy services and creation of new enterprises/small businesses as well as strengthening of existing institutions will be a central concern in any activity implemented under the project. Therefore it is intended that the barrier removal activities and pilot mini grids based on renewable technologies designed in the project will lead to the sustainability of local energy grids and creation of viable and sustainable business plans in rural areas after the main implementation phase. Furthermore, any planned fuel substitution initiatives for the rural industrial sectors will be strongly intended to increase their relative profitability, as well as the environmental sustainability of their operations. The proposed initiative will focus on the design of a successful pilot programme as well as putting in place the enabling conditions for the replication of the pilot programme beyond the selected target areas.

Sustainability will be addressed in the design of each project component. For example, the pilot mini grids component would focus on supporting micro hydro and gasifier systems, which are among the cost effective and most affordable sources of off-grid electricity supply. Experience gained and lessons learned at Nyimba in supporting rural household electrification based on solar PV systems would be particularly useful in identifying and involving ESCOs. During the course of discussions with policy makers and stakeholders at Lusaka and Nyimba, three main areas emerged that needed special focus and attention to enhance sustainability of local renewable grids. These were (i) an integrated policy and regulatory



framework, (ii) strengthening of the institutional set-up to support renewable grids, and (iii) a suitable financial mechanism to meet high up-front costs and establishing strong linkages with rural industrial development. As part of a pilot and field studies undertaken by UNIDO, these three areas have been focus of attention, and will remain so during the implementation of the full phase of the project.

For the mini grids connected rural areas, a standardized power purchase agreement will be developed during the full phase. This will provide an ongoing market for renewable electricity from public utility / independent producers. To support the introduction of this market based standard agreement, UNIDO will work closely with ZESCO, Energy Regulation Board and businesses to bring all key stakeholders including finance institutions, investors and project developers on a common plate form to adopt the market driven approach. In the long run, strong linkages between mini grids and rural industrial clusters will enhance the sustainability.

The explicit focus of this project is replication with the project aiming to create self-sustaining markets for mini grids based on renewable energy technologies in rural areas throughout Zambia. Given the fact that there is very low penetration of electricity grid in rural households (less than 2%), successful pilot interventions will act as a model in building demand for renewable electricity based mini grids in Zambia and neighboring countries in the region.

In designing the activities for GEF support in Zambia, lessons learned from the experience of various Multi/Bilateral agencies involved in supporting renewable energy technologies in countries of this region – Zimbabwe, Kenya, Tanzania, Botswana and South Africa etc. – have been taken into consideration. These lessons include:

- Integrated policy and legal framework needed to promote mini grids based on renewable electricity in rural areas;
- Local capacity building and strong institutional set up needed to link energy services with rural industrial development;
- Robust rural markets and linkages needed including willingness and capacity of consumers to pay, before implementing decentralized renewable energy projects;
- Local participation, up and down stream linkages and market based approaches are pre-requisite to ensure sustainability of local grids projects through income generation activities; and
- Strong financial intermediation including providing micro-finance options needed for renewable technologies with high front-end costs.

3. Justification of the PDF Grant

3.1 Country Eligibility

The Government of Zambia ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 28 May 1993. The proposed project is consistent with the GEF Climate Change Operational Programme 6 ‘Promoting the adoption of renewable energy by removing barriers and reducing implementation costs’. In addition, Zambia is a UNIDO member country.

The Government of Zambia is strongly committed to the environmental sustainability in the country. For instance, the Centre for Energy, Environment and Engineering (Z) (CEEEZ), Lusaka and UNEP Centre on Energy and Environment, Riso National Laboratory, Denmark jointly developed a Zambia Country Study under Climate Change Mitigation Programme in Southern Africa, which included a least-cost Greenhouse Gas Abatement Strategy for Zambia.

There are several other projects/studies related to climate change, renewable energy, environment capacity building and natural resource management undertaken in Zambia such as Small Hydropower Pre-Investment Study - North-Western Province, Zambia by UNOPS, Energy Service Companies using PVs for Rural Energy Provision in Eastern Zambia by the Stockholm Environment Institute and Zambia Country Report in "A Climate of Trust Report" by National Environmental Trust, which have been financed and implemented by Multi/bi-lateral organizations. Also, the Ministry of Energy and Water Development has prepared a report on Poverty Alleviation - the Energy Perspective: An Input to the Poverty Reduction Strategy Paper for Zambia which would lay foundations for the proposed GEF project.

3.2 Relevant GEF operational Program

The proposed project falls in GEF Operational Program 6 on Climate Change - promoting the adoption of renewable energy by removing barriers and reducing implementation costs. The project is part of a long-term national approach to strategically develop Zambia's renewable energy sources, especially through decentralized mini grids based on mini micro-hydro and biomass gasifier technologies, on a sustainable basis, providing these resources with a key role in Zambia's rural electrification and development strategy.

3.3 Rationale for PDF support

PDF support is required to identify and define the scope of activities and the steps to be undertaken to ensure effective implementation of the envisioned GEF supported project. The intended full project, the design and development of which will be funded by the requested PDF B grant, would directly contribute to removal of barriers for setting up and replication of mini grids based on renewable electricity in rural areas of Zambia.

The proposed PDF B activities are targeted for a fully consultative and participatory approach. Based on the identified barriers, the PDF phase will assist in developing the detailed project activities for each component (see 2.4). Specifically the PDF phase activities will identify, evaluate, and design meaningful avenues to reduce/remove financial, institutional, technical, information and human resource barriers hampering the increased use of renewable energy sources for the generation of electricity for isolated mini-grids.

Further, the PDF phase would aim at establishing the incremental cost of the full project, and facilitate development of a full-size proposal that supports the renewable energy based electricity generation and distribution via isolated mini-grids in Zambia. Initial activities will focus on a carefully selected pilot region/areas, from where replication activities will be designed for implementation of similar programmes in other appropriate areas in Zambia.

3.4 Execution

For the GEF, UNIDO is the executing agency with expanded opportunities, whereas the national counterpart agency is the Department of Energy (DOE) of the Ministry of Energy and Water Development. A local Programme Management Unit (PMU) will be jointly set-up and staffed at the Department of Energy.

A Project Steering Committee (PSC) will be set up to advise UNIDO and DOE on the direction of project development and implementation.

3.5 Description of Proposed PDF Activities and Outputs

Activity 1: Renewable energy supply assessment - This assessment will build on the outcomes of earlier work done in this area i.e. by UNOPS, and start with the collection of relevant secondary renewable energy supply data. Data gaps will be identified and appropriate data collection and analyses methods will be selected to collect and analyze missing and necessary data. The focus of the data collection should be on ensuring that sufficient data is available for the proper selection and design of pilot projects. By no means it is intended to complete the renewable energy supply balance for Zambia.

The main renewable energy sources with a potential for rural electricity generation that can facilitate rural industrial developments are the following:

- Hydro resources for run-off river micro hydro schemes, mostly in the range of 50-500 kW;
- Woody biomass in the form of waste streams of saw mills, forest logging activities, etc.;
- Agricultural residues, mainly as a result of (large) centralized agro-processing activities.

Activity 2: Demand assessment for isolated rural grids - This assessment will build on the outcomes of earlier work done in this area (by ZESCO), and will start with the collection of relevant secondary data. Data gaps will be identified and appropriate data collection and analyses methods will be selected to collect and analyze missing and necessary data. The focus of the data collection should be on ensuring that sufficient data is available for the proper selection and design of pilot projects. Main focus will be on those demand centres where there is a) good potential for local agro-processing, b) good potential for other rural industrial activities, c) (future) concentration of public sector activities (health, education, administration), d) currently existing demand centres serviced by (expensive) diesel-based electricity. In general, the principle of full cost recovery of renewable energy based electricity generation will be applied. Thus in addition to the willingness to pay for electricity services in these demand centres also the ability to pay will have to be assessed and ascertained.

Activity 3: Renewable energy technology assessment - A range of internationally available renewable energy technologies exists that can be applied to convert woody biomass, agro waste and hydro resources into reliable electricity. For the case of hydro, Zambia has a wealth of experience in the large-scale range, but very limited experience with micro-hydro systems in the range of 50-500 kW. It is this latter capacity range that will be the focus of the hydro renewable energy assessment. Making use of biomass for electricity generation can be done in different ways, but here it is intended to make use of gasification systems that run in a dual fuel mode as this is expected to be the most cost-effective system when making use of biomass as a fuel for electricity generation. The gasifier will produce a gas that will be cleaned and fed to a diesel engine/generator set, replacing diesel consumption up to 70%, thus total fuel consumption will be 30% diesel and 70% producer gas. Although this technology is working satisfactorily in for example India in various locations, it needs to be mentioned that in addition to the technology transfer package (hardware) sufficient focus will have to be put on putting in place the conditions necessary for gasification systems to be applied successfully (fuel handling and storage, gasifier operation and frequent filter cleaning, O&M of the diesel gen-set and general operations management). Sizes of gasification systems to be considered here are 100 kWe modular systems and possibly larger systems up to 500 kWe although operational experience with these larger systems is quite limited.

For both type of technological systems an assessment will be made, making use of technical and cost data available through secondary sources such as project documentation, supplier information, consultant knowledge and experience, internet etc. Based on this, a selection will be made and the specifications of technology packages will be prepared for the pilot projects to facilitate procurement during the full-size project. This will be complemented with a shortlist of 3-5 equipment suppliers.

Activity 4: Feasibility studies - A maximum of 4 detailed feasibility studies will be carried out to develop site specific pilot mini grid projects to be implemented under the full-size programme. In essence, the feasibility studies combine the outcome of the work done under activities 1, 2 and 3; i.e. using available renewable energy sources through making use of the most appropriate renewable energy conversion technologies to meet (potential) demand for rural electricity. Technical, cost-benefit, institutional and environmental issues need to be detailed to the extent possible and the feasibility study needs to include a detailed financing plan for the pilot projects. Part of the feasibility study will have to look into the design and implementation of local distribution networks, especially for those cases where new generation capacity and institutions (IPPs/ESCOs) will be introduced/strengthened. Important criteria to be used for the selection of the site specific pilot projects would, among others, include

- a) resource availability,
- b) demand for rural electricity at demand centres that can pay full-cost for the electricity service that will be provided,
- c) technology availability and accessibility,
- d) cost-effectiveness,
- e) willingness of the local stakeholders to participate in the pilot project,
- f) availability of financing, and
- g) replication potential

One of the criteria to be used for the selection of the pilot projects will be the replication potential of similar type of projects throughout Zambia. Therefore, it is necessary that a rapid assessment is made of this replication potential during the PDF phase. However, this will not entail detailed national assessment on the replication potential, but merely an exercise to be carried out to properly select pilot projects and moreover to justify (the level of) GEF funding for the full-size phase.

Activity 5: Review of policy and regulatory framework - Under this activity, all existing policies, legislation, and regulations will be reviewed and assessed to identify policy barriers/gaps to the development of renewable energy systems and policy changes that would facilitate accelerated development. Especially the 1994 Energy Policy will be assessed with the aim to recommend changes and/or updates to also tailor for national renewable energy development and more specifically rural electrification based on renewable energy sources as only 2% of the rural population is supplied with electricity. The assessment will include at minimum the consideration of

- a) energy pricing, tariffs,
- b) electric utility regulation,
- c) tax/financial incentives and disincentives for renewable and conventional energy,
- d) public sector procurement guidelines,
- e) design and installation norms and standards and
- f) equipment standards, codes and regulations.

Furthermore, this activity will also investigate meaningful avenues and suitable financial mechanisms to increase the availability of financial resources for enhanced investments in renewable energy systems. A project component to support the introduction of these policy and institutional changes by the Government of Zambia will be designed for the full phase.

Activity 6: Information dissemination and public awareness - This activity will begin with a survey of target audiences to determine what renewable energy information is currently lacking in Zambia and therefore acting as a barrier to renewable energy development. Potential renewable energy customers, academia, R&D centres, renewable energy firms and entrepreneurs, financial institutions, policy makers and electric utilities will be targeted. Then the current availability of renewable energy information and demonstration projects in Zambia and in the SADC region will be documented. Gaps between what

information is needed and that which is available will be identified. Finally, this activity will determine what institution could serve as a focal point for collecting, analyzing, and disseminating renewable energy information under the full-size programme.

Activity 7: Capacity building and training needs assessment - This activity will assess training needs and develop a renewable energy capacity building programme for implementation under the full-size project. It will begin with a needs assessment to identify priority areas for capacity building in the renewable energy field and to determine how best to build capacity in these areas. Candidate targets for capacity building include policy makers, renewable energy firms and entrepreneurs, utilities, engineers, R&D institutions, academia and financial institutions. Once these priorities have been established, this activity will proceed to survey and review relevant training or capacity building programmes, manuals and modules, from Zambia and the SADC region, and assess the feasibility of their application in Zambia. Finally, this activity will design a capacity building programme for the priority areas, including the preparation of an implementation plan, curricula and training manuals and modules, either original or modified from existing sources.

Activity 8: Project development workshops - For the above activities 1 to 7, the actors involved need to be identified as well as their respective roles. In this regard it is important to organize a national workshop to discuss issues related to the preparation of the full-size project in the initial phase of the implementation of the PDF B activities to inform national stakeholders about the here proposed GEF initiative. Likewise, at the end of the PDF B activities to present the outcomes and receive feedback to be incorporated to reflect national interest and concerns. It is anticipated that representatives of national financial institutions, international investors, donor community, international NGOs, suppliers, vendors, end-users, and government are present at such a workshop. Besides, there is a strong need to ensure that the sufficient technical representation is there to highlight the technical issues related to renewable energy based electricity generation as well as the technical risks involved in the project.

Activity 9: Preparation of the full-size project brief- A project brief that includes all the required GEF criteria, notably the estimation of baseline and incremental cost, the logical framework, CO₂ calculations and a methodology for monitoring and evaluating the full-size GEF intervention will be prepared. In addition to the preparation of the project brief, the co-financing arrangements for the full-size project will have to be detailed and secured to the extent possible.

Co-financing for the full-size project (typically 4-6 years) is expected to come mainly from bi- and multilateral donors active in Zambia (estimated at US\$ 1.0 million), from investors/developers (estimated at US\$ 4.0 million) and from the Zambian Government (estimated at US\$ 1.0 million; cash and in-kind combined), but is not necessarily limited to this. Anticipated GEF financing for the full-size project will be about US\$ 4.0 million. Hence the total size of the full project is estimated to be around US\$ 10 million. However, these figures are very preliminary at this stage, and will be firmed up during the PDF B activities.

During the implementation of the PDF B, a list of potential national, the SADC region and international consultants will be prepared to facilitate short-listing of institutions, consultancy firms and/or individuals for inclusion in the implementation of the full-size project.

3.6 Monitoring and evaluation

All the activities proposed under PDF B will be completed in a period of 12 months (September 2001-August 2002). The implementation of the project will be monitored by the UNIDO Headquarter staff (Industrial Energy and Climate Change Branch) as well as by the UNIDO Regional Office in Zimbabwe covering Zambia. Standard evaluation of the project will be carried out according to the well established



UNIDO Evaluation Procedures and GEF guidelines. Additional evaluation can be performed as and when required by the GEF.

3.7 National level support

The Zambian Government is committed to providing assured and reliable energy services in rural areas as brought out clearly in a report on Poverty Alleviation - the Energy Perspective; An Input to the Poverty Reduction Strategy Paper for Zambia prepared by the Ministry of Energy and Water Development. The Government has accorded a priority to the development of renewable sources of energy in overall national energy policy and programmes. The Department of Energy, ZESCO and several ESCOs have shown willingness to collaborate in setting up of mini grids based on renewable electricity, and to promote ESCOs and mini grid developers and facilitate preparation of the standardized small power purchase agreements. Further more, during a UNIDO mission (April 2001) and subsequently at the Interactive Thematic Session on Energy at the Third UN Conference on Least Developed Countries in Brussels in May 2001, the Government of Zambia reiterated its support for renewable energy based electricity generation for mini grids to enhance rural access to sustainable energy.

3.8 Summary of project preparation work outputs

The main outputs of the PDF B activity are summarized as follows:

- A GEF project brief for a full-size project, that addresses the activities required for assisting the reduction/removal of identified barriers for increased use of renewable energy based electricity generation for isolated mini-grids;
- A financing plan has been developed as an integral part of the project brief and co-funding for the full-size project has been committed to the extent possible;
- The foundation has been laid for the realization of four pilot mini grid projects as well as the activities identified for replication of these pilots;
- Indicators and a methodology for monitoring and evaluation of the GEF intervention during the implementation of the full-size project;
- An agreed upon institutional set-up and implementation arrangements of the full-size project as well as a preliminary draft work plan, including time and activity schedule;
- Workshops held to initiate, review and revise the (draft) project brief preparation process; and
- A pool of national, regional, and international resource persons, institutions and consultants identified for implementing the full-size project

3.9 Costs

The total budget proposed for the PDF Block B phase activities is US\$ 430,000 with a GEF contribution to the tune of US\$ 325,000, co-funding amounting to US\$ 50,000 from UNIDO and in-kind/cash contribution in the amount of US\$ 55,000 from the national counterpart agency (DOE) and other Zambian institutions as appropriate.



The break up of the PDF budget - activity wise (in US \$) is as under:

PDF Block B Activities	GEF	Co-funding (UNIDO)	In-kind/cash contribution (Govt. of Zambia)	TOTAL
1. Renewable energy supply assessment	20,000	10,000	5,000	35,000
2. Demand assessment for isolated grids	20,000	10,000	5,000	35,000
3. Renewable energy technology assessment	20,000	10,000	5,000	35,000
4. Feasibility studies on pilot interventions (four studies)	100,000	10,000	10,000	120,000
5. Review of policy and regulatory framework	20,000	5,000	5,000	30,000
6. Information dissemination and training needs	20,000	5,000	5,000	30,000
7. Incremental cost calculations	40,000			40,000
8. Project development workshops (three workshops)	35,000		10,000	45,000
9. Preparation of the full-size project brief	50,000		10,000	60,000
TOTAL	325,000	50,000	55,000	430,000

3.10 Timing

September 2001 to August 2002 (12 months)

3.11 Other donor involvement

During UNIDO's preparatory mission in April 2001, considerable donor involvement was seen in energy sector in Zambia. The World Bank is involved in the power sector reforms and investments, while SIDA and DANIDA are supporting a number of capacity building initiatives as well as renewable energy pilot activities. Lessons learned and experience gained from these projects will be incorporated into the GEF full project development.

UNEP has supported preparation of a Zambia Country Study under Climate Change Mitigation in Southern Africa that included a least-cost Greenhouse Gas Abatement Strategy for Zambia. SIDA and DANIDA have expressed strong interest in supporting renewable energy development, and linking with income generation activities in Zambia, together with UNIDO. It is expected that the proposed GEF project will help in coordinating activities of various donor agencies working in Zambia in the field of renewable energy development to avoid duplication, and would facilitate synergy between various initiatives to maximize their impact.