## OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

## DISCLAIMER



## FAIR USE POLICY



## CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

23063

**FINAL REPORT – May 14, 2004**

**Submitted to**

**United Nations Industrial Development Organization (UNIDO)**

---

| | |
|---|---|
| **Project Title:** | Sustainable Energy Project Development in the Caribbean |
| **Activity:** | Final Report |
| **Location:** | Caribbean Island States of Dominica, Grenada & St. Lucia |
| **Submitted by:** | Climate Institute and partners in the Global Sustainable Energy Islands Initiative (GSEII) |

---

Table of Contents:

## 1. Summary

The Climate Institute received a planning grant from United Nations Industrial Development Organization (UNIDO) to support its Global Sustainable Energy Islands Initiative (GSEII). The main focus of the grant was to generate a highly selective pipeline of potential clean energy investment opportunities in the three island nations of St. Lucia, Dominica and Grenada and help prepare for financing arrangements. A number of projects were identified and screened by using a selection criteria to short list selected projects on which further analysis was performed. Detailed profiles have been developed for each of these projects that include both technical and financial due diligence. In addition a number of regulatory, institutional and technological barriers are identified for each of these projects and recommendations are presented for future action. A detailed project document for the second phase of this project has also been developed as a result of the planning phase activities. This document lists activities to be undertaken that will be required to remove the various barriers and help implement the identified projects.

## 2. Background

Most Small Islands States have significant natural resource of non-fuel energy, including abundant supplies of solar, wind, geothermal, hydro and biomass resources that can be used on a cost competitive basis for power, heat and cooling applications. Island nations are particularly well suited to become global showcases for renewable energy given their small size and isolated locations, the dominance of the tourism sector for economic development, their locally available resources and their positive and progressive political attitudes. However, the majority of the small island nations depend on imported petroleum for more than 90% of commercial energy. This high level of dependence, coupled with volatile commodity prices and fluctuation in export earnings, has thwarted plans for economic growth.

The Climate Institute and its partners in the GSEII, at the request from the Alliance of Small Islands States (AOSIS) launched this international initiative and are currently assisting three island states in the Caribbean for the development and implementation of their Sustainable Energy Plans (SEPs). The SEPs for the Island States of Dominica, Grenada and St. Lucia have been developed and are in different stages of implementation. A number of activities have been identified in these islands that if implemented would transform their energy systems from a fossil fuel base to renewables. This project focused on assisting these three island states in the implementation of their Sustainable Energy Plans.

## 3. Objectives

The main objectives of the project are:

- Identify and assess the policy, financing and institutional barriers that hinder the deployment of renewable technologies and energy efficiency practices;
- Identify the technical, managerial and financing resources that could mitigate these barriers and define the relevant capacity building and institutional framework requirements;
- Provide recommendations for the energy policy and the energy sector regulatory reforms;
- Identify and prioritize potential investment opportunities in renewable energy and energy efficiency technologies and define viable project-specific financing mechanisms and arrangements.

## 4. Project Description

The Climate Institute/GSEII team worked closely with UNIDO to carry out various tasks outlined in the project document. These tasks include:

- Identification and documentation of Candidate Projects
- Screening and Prioritization of Candidate Projects
- Targeted Project Support
- Phase II Implementation Plan

The main activities undertaken during this project included two missions to the Caribbean during the Summer and Fall of 2003 to meet the objectives of the project. During these missions detailed meetings were held with the Government agencies, utilities, key stakeholders and potential project developers and detailed data was collected on various potential project opportunities. This resulted in identification of a pipeline of clean energy projects in the three island nations of Dominica, Grenada and St. Lucia. Annex-B lists the projects identified during the June-July 2003 Caribbean mission. A list of meetings held during this mission is included in this report as Appendix A.

A second Caribbean Mission in Nov-Dec 2003 further evaluated and screened this pipeline of projects to short-list and identify a few projects that may be developed further and prepared for implementation during the second phase of this project. The criteria used for the identification and selection of renewable energy and energy efficiency project included potential of renewable energy resource, specific demand for energy services, technical and commercial feasibility, interested project developers, utilization of sustainable business models, potential in overcoming existing market, policy, financial, technical barriers and potential for replication in other AOSIS member nations. A scoring matrix used is included in this preliminary report, as Appendix C.

These projects include a three island Solar Water Heaters Financing project, and at least one major project from each of the participating islands. The profiles cover project description, technical due diligence, financial due diligence, identifies barriers for implementations and give recommendations for next steps. Detailed profiles of selected pipeline projects as completed by GSEII and UNIDO are attached in Annex-D.

*Summary of the Identified Projects*

A promising opportunity to promote the use of solar hot water technology in the Caribbean was one of the major new outcomes of these two missions. The GSEII-UNIDO team met with the Co-operative Credit Leagues in Dominica, Grenada, and St. Lucia to discuss a potential program to reduce the cost of solar hot water systems to the public, by providing low-cost, long-term financing for such technology through the countries' credit unions. The leadership of the Leagues welcomed the idea as an effective vehicle for making renewable energy technology more readily available to the public, as well as an excellent opportunity for improving the institutional capacity of the credit unions.

The GSEII-UNIDO team also met with manufacturers and retail distributors of solar hot water systems in these countries, all of which expressed significant interest in this program. This project includes a training program for the lenders, structuring of financial programs, and a consumer education campaigns in the three participating countries. The project is designed to leverage over US $1.6 Million from the credit unions for financing the purchase of Solar Hot Water Systems (SHWS) in six years.

In addition to the 3 country Solar Water Heaters Finance Program, the major projects identified during these mission are given in the Table 1. While GSEII will provide technical assistance and policy support for all the identified projects, only those projects that are in bold will be developed further and brought to a financial closure during the Phase II, 2004-2007 time period.

Table 1. Identified potential projects in Dominica, Grenada and St. Lucia

| | |
|---|---|
| **Dominica** | ▪ DOMLEC Utility Micro Hydro Project<br>▪ **Energy efficiency improvements of DOMLEC distribution system**<br>▪ **Dominica Cooperatives League and Credit Unions Solar Hot Water Heating Financing Programme**<br>▪ Large Scale Geothermal Project Pre-feasibility Development |
| **GRENADA** | ▪ 225 kW Wind Turbine on Carriacou island<br>▪ **Grenada Nutmeg Biomass Combustion and Solar Drying Project**<br>▪ **Grenada Cooperatives League and Credit Unions Solar Hot Water Heating Financing Programme**<br>▪ PV system for Grenada Chocolate Company energy supply |
| **St. Lucia** | ▪ **300kW Methane-to Energy Project**<br>▪ **Poultry Litter-to Energy Project**<br>▪ LUCELEC 1.4 MW Wind Farm<br>▪ **St. Lucia Cooperatives League and Credit Unions Solar Hot Water Heating Financing Programme**<br>▪ Sulphur Springs Geothermal Project<br>▪ Water Utility Energy Efficiency Retrofit |

During Phase II, the GSEII team will work closely with UNIDO and focus on advancing the development of selected clean energy projects and bringing them to financial closure. This will entail to identify all project-specific barriers and, working with governments, utilities and local stakeholders, to devise appropriate mitigation measures. In order to facilitate financing for these projects, the GSEII is having discussions with private investors, credit unions, and also working with the Caribbean Renewable Energy Development Project (CREDP) and other entities active in the region to establish a renewable energy funding facility in the region.

## 5. Barriers to Implementation of Renewable Energy Projects

The opportunity that renewable energy sources offer in displacing expensive imported fossil fuel for the provision of modern energy services, in particular electricity, and the importance of energy efficiency improvement and the benefits that would stem from that, have been acknowledged by small island developing States and many have demonstrated positive and progressive political attitudes. Nonetheless, the utilization and development of renewable and sustainable energy technologies in small island developing States has been limited to date and basically restricted to international assistance programmes. This has been due to a number of barriers including: lack of understanding of the costs, benefits and applications of these technologies; lack of adequate expertise to assess and validate technology options; policy and regulatory climates that favor environmentally damaging fossil fuels and hinder development of clean options; lack of in-country institutions able to coordinate and monitor all aspects of clean energy project design, development, implementation and operation; a power utility structure resistance to transitioning away from conventional fossil fuel generation to cleaner energy options; lack of available, affordable financing for clean energy projects; limited project identification and development expertise.

The conditions for the creation of a small island developing States-driven development of renewable and energy efficiency technologies are not in place yet. External support from donors and international development agencies is still required, now more than ever in the light of the efforts that many small island States have been recently making to orient their future energy development towards renewable resources and sustainability.

Although small island nations are ideal candidates for utilizing renewable energy, energy efficiency and other sustainable energy technologies to meet their energy needs, there has been limited use of these options to date. This is due to a number of barriers including:

- ***Awareness:*** Lack of understanding of the costs, benefits and applications of these technologies.
- ***Technical and Analytic Capacity:*** Lack of analytic tools and skilled expertise to assess and validate technology options, manage and up-grade planning capabilities and recommend appropriate policy options.
- ***Policy***: Current policy and regulatory climates that favor environmentally damaging fossil fuels and hinder development of clean options.

- ***Institutional***: Lack of in-country institutions for all aspects of clean energy project design, development, implementation and operation. This is further heightened by a utility structure resistance to transitioning away from conventional fossil fuel generation to cleaner energy options.
- ***Finance:*** Lack of available, affordable financing for clean energy projects.
- ***Project Preparation***: Limited project identification and development expertise, including information on clean energy project opportunities, resource data, business planning information, pre-feasibility and feasibility support and partner data.

The specific barrier that are in the way of successful implementation of the projects as identified during this planning phase and recommendations on how to overcome them are given in each of the project profiles as attached with this report in Annex-D.

## 6. Country Progress Reports

Brief reports on the GSEII team during the project period and some background on each of the three countries included in this project is given below:

### 6.1 St. Lucia

St. Lucia was the first island state and country to announce its commitment to become a Sustainable Energy Island Nation. Since the ratification of the Sustainable Energy Plan by Cabinet, Saint Lucia has been working on specific strategies to achieve the targets and expectations described in the Plan. The Sustainable Energy Plan for St. Lucia commits the country to the incorporation of renewables totaling 7% of its installed capacity by 2005, and 20% by 2010. Likewise, the Plan establishes targets of 5% and 15% reductions in consumption through energy efficiency measures by 2005 and 2010. The overall reduction in greenhouse gas emissions as a result of achieving these targets is estimated at 35% from the prior baseline. Many tools for reaching these targets have been created, including policy, regulatory, capacity building, and public outreach measures

The GSEII-UNIDO team met with the Ministry of Planning in St. Lucia, the utility company, LUCELEC, and with local private sector companies to identify small and large renewable energy projects that could be implemented as part of the country's sustainable energy plan. These projects are listed in the following matrix and being further developed in the next few weeks.

One of the key projects identified in St. Lucia include the 4.25 MW Wind Energy Project that is being undertaken by the local utility, LUCELEC. LUCELEC will begin resource assessments by first quarter of 2004, and it is hoped that the project will be developed to its full potential and integrated into the local grid by the year 2007.

The second major project where GSEII could assist the Government is Landfill Gas to energy project near the city of Castries. At least two sites have been identified with potential for methane production for energy generation and need further investigation.

In addition, a poultry litter to energy project was also considered for St. Lucia, more details on which are given in the following matrix.

## 6.2 Dominica

Dominica is a country of approximately 75,000 inhabitants and the island covers 746 square kilometres, resulting in one of the lowest population densities in the region. Currently, diesel generators fuelled by imported oil and hydropower plants generate Dominica's electric power. However, Dominica possesses considerable natural resources to provide for its energy needs with a combination of renewable energy technologies – hydro, wind, biomass, geothermal, and solar – and increased energy efficiency.

Dominica's Sustainable Energy Plan lays out a strategy by which the energy production and use in Dominica may be transformed, becoming more economically and environmentally sustainable. This plan GSEII assisted in development of the Sustainable Energy Plan, which is in the final stages of approval by the Cabinet. However, the implementation on various fronts has already begun.

The GSEII-UNIDO team visited Dominica and met with key stakeholders including the Government, the utility and local private sector and the Credit Unions. A number of initiatives were identified as a result of this mission. These include micro-hydro projects and energy efficiency projects, such as transmission line efficiency and replacement of transformers on the existing grid.

Further information is being gathered from Dominica and will be incorporated in the development of the project profiles. The attached matrix lists the potential project opportunities and their details.

In addition, GSEII is also assisting the government in the development and potential concession of its geothermal resources. The Government, DOMLEC, and private companies have all expressed an interest in constructing a geothermal plant in order to provide low cost electricity to Dominica and eventually export electricity to Guadeloupe and Martinique.

## 6.3 Grenada

The draft Sustainable Energy Plan has also been prepared for Grenada after stakeholder consultations that were held with all the stakeholders. During this planning phase, the GSEII-UNIDO team visited Grenada and met with several private sector entities in addition to the Government and the Credit Unions.

Grenada consists of the islands of Grenada, Carriacou, and Petit Martinique, and the population of Grenada is 89,227 (July 2001 est.). Approximately one-half of all earning from domestic exports is used for the purchase of fossil fuel and energy imports constitute approximately 11% of total imports. This primarily is used to serve the electricity and transportation sectors. Grenada currently has no over-arching policy, plan or strategy regarding energy use. It was determined by the Government of Grenada that this is a priority issue and, accordingly, the Government, with the assistance from GSEII and together with input from key stakeholders from all sectors of society, has developed this Sustainable Energy Plan (SEP). The Sustainable Energy Plan lays out a strategy by which the energy sector in Grenada may become more economically and environmentally sustainable. As result of the crosscutting nature of energy, the plan is decidedly integrated in its approach, impacting all sectors (agriculture, industry, tourism, residential, etc.) and aspects of life (health, education, economy, etc.). In keeping with the priorities of the nation, the key goals of this strategy are increased economic development, poverty reduction, and improved environmental protection.

While the SEP in Grenada has still not passed through the formal process of Cabinet approval, implementation of some of the recommendations in the plan have already begun. This includes policy reforms and reassessment of the regulatory environment governing the local utility, GRENLEC.

The GSEII-UNIDO mission to Grenada was able to identify small and medium size renewable energy projects after detailed discussions with the Ministry of Works, GRENLEC and several private sector entrepreneurs and local Credit Unions. These include a small wind project on the island of Carriacou, where the transport costs of diesel to the existing facility make it favourable for the utility to consider other options. In addition, a nutmeg shells combustion project and solar photovoltaic for a chocolate factory in Grenada are also being proposed. The details of these projects including partners, costs and energy generation potentials are given in the following matrix.

## 7. Conclusion

During this planning phase, GSEII-UNIDO missions were successful in engaging the local private sector and the utility companies, and to identify small and medium size renewable energy projects on these islands. In addition, the major development was identification of local resources and developing a partnership with several credit unions on the islands that are now prepared to participate in the Caribbean Solar Finance Program.

During the Phase II, GSEII and UNIDO will be working further with these island states by assisting the various entities involved in carrying out feasibility studies and making financial arrangements to facilitate the implementation of the short-listed projects.The island states of St. Lucia, Grenada and Dominica have developed ambitious plans for themselves and to free them from the burden of imported fossil fuel. It is hoped that the GSEII-UNIDO assistance will help further this process and these activities will be replicated in other member nations of the AOSIS.

## APPENDIX - A

**Mission Meetings - November 24, 2003 to December 12, 2003**

| Country | Firm | Contact(s) | Title(s) | E-mail/telephone | Meeting Date | GSEII Rep(s) in Mtg | Topics Discussed |
|---|---|---|---|---|---|---|---|
| St. Lucia | Ministry Of Planning, Development, Environment, and Housing | Bishnu Tulsie Judith Ephraim | BT-Chief Sustainable Development & JE-Environment Officer | 758-468-4459 jephraim@planning.gov.lc /btulsie@planning.gov.lc | Nov-24 | J. Ryan | Summarised status of GSEII and discussed new project ideas. Contacts given for quarry owner interested in developing re capacity and for two ESCOs. |
| St. Lucia | Energy & Advanced Control Technologies (EACT) | Frederick Isaac | Executive Chairman | 758-453-7844 isaccf@candw.lc | Nov-24 | J. Ryan | Discussions held on capital requirements for developing the solar hot water side of EACT's business. Request made for data for business brief to be provided prior to next meeting. |
| St. Lucia | Solar Dynamics | Flavien Rodolph & Roger Moffat | FR-General Manager/RM-MC Group Finance Director | 758-458-8400 solarec@candm.lc | Nov-24 | J. Ryan | Summarised status of GSEII and discussed carib. solar finance program. SD strongly supports the CSFP and agreed to be a partner. |
| Dominica | OAS | Paul Brown | Director | 767-448-2842 oasdominica@cwdom.dm | Nov-25 | M. Matteini, J. Ryan | Outlined visit, discussed projects, and briefed on appointments. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dominica | Domlec | Murray Rogers | Director | 767-449-9917<br>murray.rogers@domleconline.com | Nov-25 | M. Matteini, J. Ryan | Discussed technical details on grid system with emphasis on T&D losses and potential for support from ee project focusing on improvements in T&D system. Also discussed status of Domlec and relationship with govt. |
| Dominica | Domlec | Mark Riddle | Engineering Services Manager | 767-448-2681<br>mark.riddle@domleconline.com | Nov-26 | M. Matteini, J. Ryan | Discussed two potential T&D efficiency projects: transmission line & transformer replacement |
| Dominica | Marinor Enterprises Ltd | Michael Astaphan | President | 767-449-1575<br>mastaphan@marinorsolar.com | Nov-26 | M. Matteini, J. Ryan | Discussed feasibility study funding for a waste-to-energy project & CSFP. Agreed CSFP makes sense and will be a partner. |
| Dominica | J.W. Edwards Hardware | Brian Bruney | President | 767-235-2595<br>brian_bruney@hotmail.com | Nov-27 | M. Matteini, J. Ryan | Discussed CSFP. Agreed program makes sense and will be a partner. |
| Dominica | Domlec | Rawlins Bruney | Power Production Manager | 767-448-2681<br>rawlins.bruney@domleconline.com | Nov-27 | M. Matteini, J. Ryan | Discussed Padu-Newtown project and Padu hydro retrofit. |
| Grenada | Organisation of American States | Francis McBarnette | Director | 473-440-2439<br>oasgrnda@caribsurf.com | Dec-1 | M. Matteini, O. Coto, J. Ryan | Outlined visit, discussed projects, and briefed on appointments. |
| Grenada | Spice Island Beach Resort<br>Carib. Alliance for Sus. Tourism | Royston Hopkin | Chairman (both) | 473-444-4423<br>spiceisl@caribsurf.com | 1-Dec | M. Matteini, O. Coto, J. Ryan | Briefed us on the PA consulting work with the small and medium-sized hotel sector in the Carib. |
| Grenada | National Development Foundation | Eton Gravesande | Executive Director | 473-440-5506<br>NDF@caribsurf.com | Dec-2 | M. Matteini, O. Coto, J. Ryan | Discussed potential opportunities for programs in processing sector. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Grenada | Grenada Cocoa Association | Mr. Parris | Chairman, BoD | 473-440-2234<br>parrisg@caribsurf.com<br>gca@caribsurf.com | Dec-2 | M. Matteini, O. Coto, J. Ryan | Detailed discussion on the possibilities for technological assistance in improving efficiencies in processing facilities. Organised facility visits. |
| Grenada | Grenada Public Service Co-op Credit Union | Lucia Livingston Andall | General Manager | 473-440-1759<br>landall@caribsurf.com | Dec-2 | M. Matteini, O. Coto, J. Ryan | Described CSFP, CU provided input and agreed to partner. |
| Grenada | Communal Co-operative Credit Union Ltd. | M. Brian Campbell | General Manager | 473-440-1755<br>comcreditunion@caribsurf.com | Dec-2 | M. Matteini, O. Coto, J. Ryan | Described CSFP, CU provided input and agreed to partner. |
| Grenada | Grenada Co-op Nutmeg Assoc. | Terrence Moore et al. | General Manager | 473-440-2117<br>GCNA.nutmeg@caribsurf.com | Dec-3 | M. Matteini, O. Coto, J. Ryan | Met with GCNA management team and then spent day touring production facilities. |
| Grenada | Grenlec | Clive Hosten et al. | Power Production Manager | 473-440-0910<br>chosten@grenlec.com | Dec-4 | M. Matteini, O. Coto, J. Ryan | Discussed Carriacou wind project and nutmeg gasification project. |
| Grenada | Grenada Cocoa Association Processing Facility | Mr. Smith | Operations Manager | 473-442-4770 | Dec-4 | M. Matteini, O. Coto, J. Ryan | Toured production facility |
| Grenada | Grenada Chocolate Company | Mark Green | Owner | 473-442-0050 | Dec-4 | M. Matteini, O. Coto, J. Ryan | Toured production facility and discussed augmentation of capacity. |
| Grenada | Ministry of Communications, Works & Public Utilities | John Auguste | Senior Energy Officer | 473-440-2271<br>psworks@caribsurf.com | Dec-4 | M. Matteini, O. Coto, J. Ryan | Briefed on potential project opportunities examined and discussed future possibilities. |
| St. Lucia | R+G Quarry | Reno Ghajandar | President | 758-484-3312<br>cieltd@candw.lc | Dec-5 | M. Matteini, O. Coto, J. Ryan | Visited quarry operations and discussed potential for developing waste-to-energy projects. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| St. Lucia | SL Solid Waste Management Authority | Laurianus Lesfloris | Operations Manager | 758-453-2208<br>sluswma@candw.lc | Dec-5 | M. Matteini, O. Coto, J. Ryan | Visited Deglos site and discussed potential waste-to-energy project at Ciceron site. |
| St. Lucia | Ministry Of Planning, Development, Environment, and Housing | Judith Ephraim and Cornelius Fevrier | CF & JE- Environment Officers | 758-468-4459<br>jephraim@planning.gov.lc<br>cfevrier@planning.gov.lc | Dec-5 | M. Matteini, O. Coto, J. Ryan | Briefed on potential project opportunities. |
| St. Lucia | Solar Dynamics | Flavien Rodolph | General Manager | 758-458-8400<br>solarec@candm.lc | Dec-8 | M. Matteini, O. Coto, J. Ryan | Discussed CSFP |
| St. Lucia | Organisation of American States | Alphonsus Antoine | Director | 758-452-4330<br>oasslu@candw.lc | Dec-8 | M. Matteini, O. Coto, J. Ryan | Outlined visit, discussed projects, and briefed on appointments. |
| St. Lucia | EACT | Frederick Isaac | Executive Chairman | 758-453-7844<br>isaccf@candw.lc | Dec-8 | M. Matteini, O. Coto, J. Ryan | Discussed opportunities to work in support of EACT as well as CSFP. |
| St. Lucia | Fresh Eggs Ltd | Urban Wilson | Owner | 758-455-9000/485-3700 | Dec-9 | M. Matteini, O. Coto, J. Ryan | Visit eggs production farm, currently with 11,000 laying hens. Discussions on possibilities for using thermal energy/electricity from poultry litter at the site. Data gathered for initial calculations on resource assessment and technology assessment. |
| St. Lucia | St Lucia Co-operative League Limited | Terrance Charlemagne | President | 758-452-5467/6690/7387<br>slucll@candw.lc | 9-Dec | M. Matteini, O. Coto, J. Ryan | Presented GSEII initiative and described the CSFP. League was very interested in CSFP and will partner on the project |
| St. Lucia | Point de Caille Wind Site Visit | | | | Dec-9 | M. Matteini, O. Coto, J. Ryan | Visited site to have a physical recognition of salient terrain features of proposed wind project. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| St. Lucia | Organization of Eastern Caribbean States (OECS) | Mr. Keith E. Nichols | Program Officer. Biodiversity Management and protected Areas Env & SD Unit | 758-453-6208 Ext 30 kenichols@oecsnrmu.org | Dec-10 | M. Matteini, O. Coto | Discussion on the activities of OECS in RE and EE. Conducted study on EE and energy audits in EC countries, currently expecting ESMAP support for project on regulations and energy sector reform in EC countries |
| St. Lucia | LUCELEC | Gilroy Pultie, Victor Emmanuel | Transmission and Distribution Engineer, Generation Engineer | 758-457-4701, 758-457-4641, gpultie@lucelec.com, venemanuel@lucelec.com | Dec-10 | M. Matteini, O. Coto | Lucelec expressed interest in looking at RE and EE. Not interested in directly developing the Ciceron LFG to Energy Project, but interested in purchasing power if arrangements are clear within the regulatory order of SL. Lucelec is pursuing the development of 6-7 MW of wind power in a series of sites in the country, and has just concluded the negotiations (or about to) with the Point de Caille site for installation of anemometers to conduct a 6-12 months wind regime study. T&D Chief Engineer Pultie expressed interest in efficiency improvements in the T&D side of the business, especially transformer and power factor improvements. |
| St. Lucia | EMPAC Services LTD. | John Chrlery | Manager | 758-453-6722 empac@candw.lc | Dec-11 | M. Matteini, O. Coto | EMPAC is an electrical/mechanical consulting firm operating in the local market, providing design services. Interested in entering the EE and ESCO type activities, although does not have experience in the field. Interested in starting Business Plan Development by conducting initial assessment of local possibilities |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| St. Lucia | Suntech Solar Ltd. | Gilberth Joseph | Managing Director | 758-452-6343<br>suntechsolar@candw.lc | Dec-11 | M. Matteini, O. Coto | Suntech staes that they currently sell approx. 60 solar hot water systems in the SL market, retailing systems from HelioAckmimega Sun products imported from Greece. Systems have a international certification. Current market interests of Suntech include expanding their market share in SL and also considering the potential assembling of systems under license from the manufacturers. |
| St. Lucia | Caribbean Environment Health Institute (CEHI) | Camille Roopnarine | Sanitary Engineer | 758-452-2501 Ext 232<br>cehi@candw.lc | Dec-11 | M. Matteini, O. Coto | CEHI conducts leachate testing for the Ciceron Landfill in SL , do not work on RE/EE projects, mostly concentrating on chemical and microbiological analysis of effluent waters. CEHI is sponsored by CARICOM and work in all EC states. |
| St. Lucia | Right Angle Imaging Allied Consultancy Services | Adolphus C. Small | Engineering Consultant | 758-453-6018/453-6002<br>24hrs: 758-518-0818<br>rightangle@candw.lc | Dec-12 | M.Matteini | Mr. Small provides EE retrofit services mainly to the hotel sector in St. Lucia as well as in other OECS islands. He is currently working for a USAID project targeted to the small hotel sector in the Caribbean. Within this project 200 energy audits have been carried out. Mr. Small sees in the lack of financing of small hotels the major barrier to an expansion of EE retrofit. |
| St. Lucia | St. Lucia Hotel and Tourism Association (SLHTA) | Rodinald Soomer // Carl Hunter | Executive Vice President SLHTA // St. James's Club, Director of Engineering | 758-452-5978 //<br>758-450-2511 Ext: 347<br>eng.sjcmb@candw.lc | Dec-12 | M.Matteini | SLHTA does not promote EE directly, but it acts as focal point for the initiative of the Caribbean Alliance for Sustainable Tourism. Mr. Hunter has implemented a comprehensive energy and water conservation programme at St. James's Club that achieved 25% savings |

ANNEX-B

## Deal Pipeline Matrix

### Project Summary

| Island | Name | Location | Type of project or enterprise | Promoter | Brief Description | Project: capacity & generation potential Enterprise: current & expected profits (yr)* | Estimated Capital Requirement* | Est. Debt Requirement* | Est. Equity Requirement* | Partners | Contact Specifics | GSEII Assistance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grenada | *Cocoa Drying* | Mt. Horn, Carleton, &/or St. Davids | solar drying | Grenada Cocoa Association (GCA) | GCA interested in developing a solar drying at processing facilities. | 2.5 to 3.5 million lbs dried per year. 1.2 million lbs dried with electric dryers. Approx. US $25,000 paid in electricity bills per year by total of 3 facilities for drying. US $0.26 per kWh | TBD | TBD | TBD | NA | Andrew Hastick<br>General Manager<br>Grenada Cocoa Association<br>tel: (473) 440-2933<br>gca@caribsurf.com | Technical feasibility report should be developed by UNIDO. ESG will help develop business plan. |
| Grenada | *Eggcetera Energy* | Bailes Backlot, St. Davids | poultry litter to energy | Eggcetera. Ltd | Entrepreneur seeking to develop project converting poultry litter to heat and electricity. | Convert est. 45 cubic meter per day in biogass generated by poultry .375 tonnes of litter per day from 3,000 laying hens into thermal/electric energy to power refrigeration unit, irrigation, lighting, etc. 3X revenues incr. with refrigeration. Est. 400 kW biogass plant. Currently pays US $ .26 per kWh and spends US$ 150 per month for 577kWh for lighting. | US $600,000 | US$ 400,000 | US$ 200,000 | National Development Foundation | Garvin Hosten President<br>Eggcetera<br>tel: (473) 440-8257 | Technical feasibility report should be developed by UNIDO. ESG will help develop business plan. |
| Grenada | *Grenlec Carriacou wind project* | Carriacou | wind turbine | Grenlec | Grenlec interested in ascertaining viability of developing a wind power project for small island grid | 225 kW (initial est.) | US $454,933 | US $341,000 | US$ 114,000 | NA | Ahmin Baksh<br>Planning & Engineering Manager<br>Grenlec<br>tel: (473) 444-0910<br>abaksh@grenlec.com | Technical feasibility report to be developed by UNIDO. ESG will work to leverage climate change-related funding. |
| Grenada | *Grenlec hydro set* | Castaigne, Birch Grove, Gouyave, Concord, & Marquis River | micro hydro | Grenlec | Grenlec interested in ascertaining viability of developing a set of mini hydro projects. | Castaigne = 495kW, Birch Grove = 507 kW, Gouyave = 578 kW, Concord = 517 kW, Marquis River = 226 kW | TBD | TBD | TBD | NA | Ahmin Baksh<br>Planning & Engineering Manager<br>Grenlec<br>tel: (473) 444-0910<br>abaksh@grenlec.com | Technical feasibility report should be developed by UNIDO. ESG will help develop business plan. |
| Grenada | *Nutmeg combustion & drying cluster* | Grenville, Gouyave, & Victoria | biomass combustion & solar drying | Grenada Nutmeg Co-op Assoc. (GCNA) | Project 1: GCNA executes nutmeg shells to electricity project. Project 2: GCNA executes nutmeg shells and/or solar drying project. | Approx. 3 million lbs of shell per year with 2.4 million available as fuel. US$ 2,641 per month in electricity bills. US $ .26 per kWh. Losses in sales from mold due to restricted ability to dry total approx. US$ 200,000 per year. | TBD | TBD | TBD | NA | Terence Moore<br>General Manager<br>GCNA<br>tel: (473) 440-2117<br>GCNA.nutmeg@caribsurf.com | Technical feasibility report should be developed by UNIDO. ESG will help develop business plan. |
| Grenada | *Solar H2O Finance Initiative* | multiple | solar hot water heating | Grenada Co-op League Ltd (GCLL) and Carib. Conf. Credit Unions (CCCU) | CCCU, GCLL, & ESG are seeking to develop a three-tier Initiative consisting of a subsidized credit line, finance officer training, and public awareness campaign. | Engineer market expansion from 249 systems per year to 349 systems per year by offering pilot low-cost, long-term financing package, finance officer training, and consumer awareness campaign. Program is designed to leverage local financing for solar H2O from credit unions. | US$ 208,000 loan @ 2%. US$ 35,000 for training & TA managed by CCCU and ESG. | US$ 208,000 | TBD | (1) GCLL<br>(2) CCCU<br>(3) Hubbards<br>(4) Creative Constructions | Floyd Telesford<br>General Manager GCLL<br>tel (473) 440-2903<br>gccul@caribsurf.com | ESG will serve as program architect working towards securing credit line, designing finance officer training program, and developing awareness campaign. Program would be managed by GCLL (credit line) and ESG and CCCU (training and TA). |

**Deal Pipeline Matrix**

**Project Summary**

| Island | Name | Location | Type of project or enterprise | Promoter | Brief Description | Project: capacity & generation potential Enterprise: current & expected revenue (yr)* | Estimated Capital Requirement* | Est. Debt Requirement* | Est. Equity Requirement* | Partners | Contact Specifics | GSEII Assistance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dominica | *Coco estate Green Power* | Delices (Southeast coast of Dominica) | Biogas Plant | Dominica Sustainable Energy Corporation | Pig unit biogas plant providing fuel to power an agro-processing plant and supply excess electricity to the grid | 25 kW | TBD | TBD | TBD | Nature Isle LLC | Bevin Etienne CEO - DSEC US 301 853-2711/DOM-767 446-1707 betienne@dsecinc.com | Secure climate change-related funding for project. |
| Dominica | *Marinor Enterprise Expansion* | multiple | ESCO and solar hot water heating | Marinor Enterprises Ltd. | Entrepreneur seeking working capital and management assistance for expansion of business. | Est. increase in revenues from US$ 460,000 in 2002 to US$920,000 in 2007. by 2007 averaging approx. 11% per year. | US $150,000 | NA | US$ 150,000 | NA | Michael A. Astaphan President Marinor Enterprises Ltd. (767) 449-1575 mastaphan@ marinorsolar.com | ESG will discuss provision of working capital with NDF, CREDP, E+Co, and others. Interested in working capital provided in the form of equity from agen with understanding of, and interest in helping develop, a renewable energy and ESCO business. |
| Dominica | *Padu-Newton Pipeline Micro-Hydro Project* | Botanical Gardens, Roseau | micro-hydro | DOMLEC | Domlec is interested in working with DOWASCO on developing a micro-hydro project at the site to supply electricity to grid. The water conveyance system is already in place however need financing for the project. | one 225 kW pelton turbine | US$ 455,000 | US$ 341,000 | US$ 114,000 | DOWASCO | Rawlins Bruney Power Production Manager DOMLEC T: (767) 448-2681 rawlins.bruney@ domleconline.com | Initial financial model completed by ESG ESG will help seek financing for project and then work to secure climate change-relate funding. Discuss investment with CRED. |
| Dominica | *Solar H2O Finance Initiative* | multiple | solar hot water heating | Dominica Co-operative Societies League Ltd. (DCSLL) and Carib. Conf. of Credit Unions (CCCU) | CCCU, DCSLL, & ESG are seeking to develop a three-tier Initiative consisting of a subsidized credit line, finance officer training, and public awareness campaign. | Engineer market expansion from 164 systems per year to 264 systems per year by offering pilot low-cost, long-term financing package, finance officer training, and consumer awareness campaign. Program is designed to leverage local financing for solar H2O from credit unions. | US$ 208,000 loan @ 2%. US$ 35,000 for training & TA managed by CCCU and ESG. | US$ 208,000 | NA | (1) DCSLL (2) CCCU (3) Marinor Enterprises Ltd (3) Aadat Engineering Ltd. (4) J.W. Edwards Hardware | Ackroyd W. Birmingham Manager, DCSLL T: (767) 448-4051 birmingham@cwdom.dm | ESG will serve as program architect working towards securing credit line, designing finance officer training program and developing awareness campaign. Program would be managed by DCSLL (credit line) and ESG and CCCU (training and TA). |
| Dominica | *Soufriere & Wotten Waven Geothermal Project* | Soufriere Wotten Waven | geothermal | Govt reviewing candidates for development of resource | TBD firm to complete resource assessment and drilling. If resource proves viable firm will prob. develop a small scale geothermal project to meet domestic needs and medium to large scale project for export to other islands via underwater cable. | Resource assessment phase MWs are TBD (est. 2.5 MW domestic) (est. 20-100 MW export) | TBD | TBD | TBD | EDF (potential) | TBD | OAS and ESG provided advisory services to Government of Dominica in dealing with bidders. OAS seeking to secure funds for test well drilling through GEF. ESG will help to secure climate change related funding for project(s). |

**Deal Pipeline Matrix**
**Project Summary**

| Island | Name | Location | Technology | Promoter | Brief Description | Project: capacity & generation potential Enterprise: current & expected profits (yr)* | Estimated Capital Requirement* | Est. Debt Requirement* | Est. Equity Requirement* | Partners | Contact Specifics | GSEII Assistance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| St. Lucia | *Ciceron* | near Castries | methane-to-energy | SLSWMA (Saint Lucia Solid Waste Management Authority) | LUCELEC, SLSWMA, and Komex to develop methane to electricity in project at sealed landfill. Landfill already set-up for methane extraction. | est. 1 MW | US$ 2 million | US$ 1.75 million | US$ 500,000 | LUCELEC and Komex International (Canada) | Geraldine Lendor General Manager SLSWMA tel: (758) 453-2208 sluswma@candw.com | Seeking financing and full-scale technical feasibility study. ESG will help develop business plan. |
| St. Lucia | *Energy & Advanced Control Technologies, Inc. (EACT)* | multiple | solar hot water heaters and DSM | EACT | New enterprise looking for equity infusion to expand initial work in energy eff. and solar H2O sector. | Est. increase in net annual income from US$ 166,568 in 2003 to US$ 307,628 by 2007 averaging approx. 11% per year. | US $ 94,739 | NA | US $ 94,739 | NA | Frederick Isaac Executive Chairman EACT tel: (758) 453-7844 isaacf@candw.lc | ESG will discuss provision of working capital with NDF, CREDP, E+Co, and others. Interested in working capital provided in the form of equity to develop a renewable energy and ESCO business. |
| St. Lucia | *Fresh Eggs/Wilrock Quarry* | near Lamborie | poultry litter-to-energy | Fresh Eggs | Entrepreneur to develop poultry litter to heat and electricity | Convert est. 180 cubic meter per day in biogass generated by poultry 1.5 tonnes of litter per day from 12,000 laying hens into thermal/electric energy to power refrigeration unit and help meet the needs of the quarry. Est. 1.6 MW biogass plant to displace diesel in operation at the quarry. | US$ 2.4 million | US$ 1.8 million | US$ 600,000 | TBD | Urban Wilson President Fresh Eggs and Wilrock Quarry tel: (758) 452-9000 | Technical feasibility report should be developed by UNIDO. ESG will help develop business plan. |
| St. Lucia | *Pointe de Caille* | Pointe de Caille (6.5 km northeast of Vieux Fort) | wind farm | LUCELEC | LUCELEC and PB Power Ltd exploring the possibility of a wind farm supplying electricity to grid. | est. two 500 to 660 kW each (pilot). Anticipated scale-up with additional turbines 500 to 660 kW each for total est. installed capacity of 4-5 MW (full project) | TBD | TBD | TBD | PB Power Ltd (UK) | Trevor Louisy Chief Engineer LUCELEC tel: (758) 457-4601 tlouisy@lucelec.com | ESG will work with PB Power Ltd and LUCELEC to source climate change-related funding for pilot. Once pilot is proven, GSEII team will work/LUCELEC and PB Power Ltd to access preferential financing for scale-up. LUCELEC wants PB Power to conduct the feasibility study. |
| St. Lucia | *Solar H2O Finance Initiative* | multiple | solar hot water heaters | St. Lucia Co-op League Ltd (SLCLL) and Carib. Conf. Credit Unions (CCCU) | CCCU, SLCLL, & ESG are seeking to develop a three-tier Initiative consisting of a subsidized credit line, finance officer training, and public awareness campaign | Engineer market expansion from 377 systems per year to 477 systems per year by offering pilot low-cost, long-term financing package, finance officer training, and consumer awareness campaign. Program is designed to leverage local financing for solar H2O from credit unions. | US$ 132,000 loan @ 2%. US$ 35,000 for training & TA managed by CCCU and ESG. | $187,327 | NA | (1) SLCLL (2) CCCU (3) Solar Dynamics | Terrence Charlemagne President SLCLL tel: (758) 452-5467/6690 | ESG will serve as program architect working towards securing the credit line, designing finance officer training, and developing awareness campaign. Program would be managed by SLCLL (credit line) and ESG and CCCU (training and TA). |
| St. Lucia | *Sulphur Springs Geothermal* | near Soufriere | geothermal | LUCELEC | A number of firms have collected data and analysis but no consensus on extent of resource or best location for plant. | est. 6 - 10 MW | TBD | TBD | TBD | TBD | Trevor Louisy Chief Engineer LUCELEC tel: (758) 457-4601 tlouisy@lucelec.com | OAS submitted application to GEF for resources to perform more thorough exploration in order to further define resources and locate site. |

## Deal Pipeline Matrix

### Project Summary

| Island | Name | Location | Technology | Promoter | Brief Description | Project: capacity & generation potential Enterprise: current & expected profits (yr)* | Estimated Capital Requirement* | Est. Debt Requirement* | Est. Equity Requirement* | Partners | Contact Specifics | GSEII Assistance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| St. Lucia | ***Ciceron*** | near Castries | methane-to-energy | SLSWMA (Saint Lucia Solid Waste Management Authority) | LUCELEC, SLSWMA, and Komex to develop methane to electricity in project at sealed landfill. Landfill already set-up for methane extraction. | est. 1 MW | US$ 2 million | US$ 1.75 million | US$ 500,000 | LUCELEC and Komex International (Canada) | Geraldine Lendor General Manager SLSWMA tel: (758) 453-2208 sluswma@candw.com | Seeking financing and full-scale technical feasibility study. ESG will help develop business plan. |
| St. Lucia | ***Energy & Advanced Control Technologies, Inc. (EACT)*** | multiple | solar hot water heaters and DSM | EACT | New enterprise looking for equity infusion to expand initial work in energy eff. and solar H2O sector. | Est. increase in net annual income from US$ 166,568 in 2003 to US$ 307,628 by 2007 averaging approx. 11% per year. | US $ 94,739 | NA | US $ 94,739 | NA | Frederick Isaac Executive Chairman EACT tel: (758) 453-7844 isaacf@candw.lc | ESG will discuss provision of working capital with NDF, CREDP, E+Co, and others. Interested in working capital provided in the form of equity to develop a renewable energy and ESCO business. |
| St. Lucia | ***Fresh Eggs/Wilrock Quarry*** | near Lamborie | poultry litter-to-energy | Fresh Eggs | Entrepreneur to develop poultry litter to heat and electricity | Convert est. 180 cubic meter per day in biogass generated by poultry 1.5 tonnes of litter per day from 12,000 laying hens into thermal/electric energy to power refrigeration unit and help meet the needs of the quarry. Est. 1.6 MW biogass plant to displace diesel in operation at the quarry. | US$ 2.4 million | US$ 1.8 million | US$ 600,000 | TBD | Urban Wilson President Fresh Eggs and Wilrock Quarry tel: (758) 452-9000 | Technical feasibility report should be developed by UNIDO. ESG will help develop business plan. |
| St. Lucia | ***Pointe de Caille*** | Pointe de Caille (6.5 km northeast of Vieux Fort) | wind farm | LUCELEC | LUCELEC and PB Power Ltd exploring the possibility of a wind farm supplying electricity to grid. | est. two 500 to 660 kW each (pilot). Anticipated scale-up with additional turbines 500 to 660 kW each for total est. installed capacity of 4-5 MW (full project) | TBD | TBD | TBD | PB Power Ltd (UK) | Trevor Louisy Chief Engineer LUCELEC tel: (758) 457-4601 tlouisy@lucelec.com | ESG will work with PB Power Ltd and LUCELEC to source climate change-related funding for pilot. Once pilot is proven, GSEII team will work/LUCELEC and PB Power Ltd to access preferential financing for scale-up. LUCELEC wants PB Power to conduct the feasibility study. |
| St. Lucia | ***Solar H2O Finance Initiative*** | multiple | solar hot water heaters | St. Lucia Co-op League Ltd (SLCLL) and Carib. Conf. Credit Unions (CCCU) | CCCU, SLCLL, & ESG are seeking to develop a three-tier Initiative consisting of a subsidized credit line, finance officer training, and public awareness campaign | Engineer market expansion from 377 systems per year to 477 systems per year by offering pilot low-cost, long-term financing package, finance officer training, and consumer awareness campaign. Program is designed to leverage local financing for solar H2O from credit unions. | US$ 132,000 loan @ 2%. US$ 35,000 for training & TA managed by CCCU and ESG. | $187,327 | NA | (1) SLCLL (2) CCCU (3) Solar Dynamics | Terrence Charlemagne President SLCLL tel: (758) 452-5467/6690 | ESG will serve as program architect working towards securing the credit line, designing finance officer training, and developing awareness campaign. Program would be managed by SLCLL (credit line) and ESG and CCCU (training and TA). |
| St. Lucia | ***Sulphur Springs Geothermal*** | near Soufriere | geothermal | LUCELEC | A number of firms have collected data and analysis but no consensus on extent of resource or best location for plant. | est. 6 - 10 MW | TBD | TBD | TBD | TBD | Trevor Louisy Chief Engineer LUCELEC tel: (758) 457-4601 tlouisy@lucelec.com | OAS submitted application to GEF for resources to perform more thorough exploration in order to further define resources and locate site. |

**ANNEX-C**

| Competence | Classification |
|---|---|
| Level 1 | Does not have sufficient basic skill set to execute the project |
| Level 2 | Capacity exists to form project team but requires significant assistance from GSEII to develop the project |
| Level 3 | Sufficient experience + expertise to execute the project with minor inputs from GSEII |
| Level 4 | Sufficient relevant experience + expertise to execute the project with minor support from GSEII |
| Level 5 | Sufficient relevant experience + expertise to execute the project without inputs |

| Technical Concept | Classification |
|---|---|
| Level 1 | Project at idea stage, insufficient info to judge technical merits |
| Level 2 | Technology + resource identified but not quantified therefore difficult to asess merits w/o feasibility study |
| Level 3 | Sufficient data to estimate size + technology but requires further detailed assistance |
| Level 4 | Sufficient data to specify site specific technology and requires minor assistance |
| Level 5 | Project fully defined + no known technical barriers |

| Financial Concept | Classification |
|---|---|
| Level 1 | Project at idea stage, insufficient info to judge financial merits |
| Level 2 | Technology + resource identified but not quantified therefore difficult to asess financial merits w/o feasibility study |
| Level 3 | Sufficient data to estimate size + technology costs + financial viability but requires detailed assistance |
| Level 4 | Sufficient data to specify site specific financials and requires minor assistance |
| Level 5 | Project fully defined + no known financial barriers |

| Context | Classification |
|---|---|
| Level 0 | Policy &/or regulatory framework does not allow such a project to move forward at present |
| Level 1 | Project at idea stage, insufficient info to judge context |
| Level 2 | Policy, regulations, + support networks are not defined |
| Level 3 | Assistance required to develop an appropriate structure to fit within existing context |
| Level 4 | Precedence exists that proves such projects have a fair chance of moving forward in the country |
| Level 5 | Project fully defined + no known contextual barriers |

## ANNEX D: PROFILES OF IDENTIFIED SCREENED CLEAN ENERGY PROJECTS

**Project name: Grenada Nutmeg Shell to Energy Project**

**Location: Grenada**

**Context**

The nutmeg industry is and will continue to be very important in the economy of Grenada since it impinges on the lives of thousands of Grenadians. Grenada produces an average of around 5,200 tons of wet nutmeg every year, producing and processing nutmeg and mace for exports to the international spice markets. The nutmeg shell is a biomass residue that potentially can be used as an energy carrier to deliver energy for different types of end energy users in the country. This project brief aims at considering the techno-economic aspects involved in the potential use of nutmeg shell for electricity generation to be provided to the grid in the country. Although there are other potential energy uses for nutmeg shell, such as the production of briquettes for the local markets, production of carbon black, etc; this project brief concentrates on electricity production from the residue.

**Project description**

The project looks at a 50 KW capacity plant using nutmeg shells, and using steam cycle technology for the generation of electricity and perhaps process heat as a combined heat and power (CHP) plant to be used in conjunction with an upgrade to the existing nutmeg refinery already installed in northern Grenada.

**Technical Due Diligence**

Biomass Resource Availability: Current Grenada nutmeg production averages 5,203 tons/year of green nutmeg. Out of this production, installed processing capacity is currently producing an average of about 2,534 tons of dry nutmeg kernel and around 840 tons of dry nutmeg shell per year. The dry nutmeg shell is currently a small proportion of the total, finding use as fuel for an existing nutmeg distillery and essential nutmeg oil refinery installed in the northern part of the country, consuming an estimated 15-20 % of the shell; as well as some small percentage that is used for plant bedding. Production of nutmeg is spread through the year with two predominant peaks occurring in March and August. Production figures indicate that on average the ratio of nutmeg production from peak month to average month is about 3.3. The mass balance of green wet nutmeg indicates that 60% is the pods, 2-3% is the mace and around 37% is the kernel (including the nutmeg shell).

The nutmeg shell is a highly oily residue that according to a FAO publication has a higher calorific value of 24.6 MJ/kg (moisture free). Non certified tests conducted at a private laboratory in Costa Rica, based on a single sample taken from dry nutmeg shell in Grenada, indicated a calorific value of 21 MJ/kg (at a moisture content of 12 %). No proximate or ultimate analysis of nutmeg shell has been investigated, collected from literature or experimental tests conducted so as to have a more precise data base on thermo-chemical cracking or combustion of this residue.

Nutmeg shells are available in Grenada on the order of 840 tons/year, of which there is an estimated use of about 200 tons/year. Current use of the nutmeg shell in the existing distillery in northern Grenada has been estimated at about 165 tons/year (assuming 5 days a week/ 8 hours a day, with a consumption of about 86 kg/hour taken from boiler system characteristics in the distillery). Therefore for the purpose of running a conservative estimate, captive uses of nutmeg shell in-country are estimated at 200 tons/year, considering a small portion for local uses as plant bedding material, etc.

Biomass residue availability is therefore in the range of 640 tons/year, indicating an average monthly figure of 45 tons/month (available for 11 months of the year) and peak-month availability in the order of 120 tons/month (during the peak of harvest). Any plant design will need eventually to consider the need to size a power plant based on average supply of residues and taking into account peak supplies. For the purpose of this initial exercise, it is to be considered that the plant will be working with average supply of biomass year round that is around 45 tons/month of nutmeg shell.

Representative Power Plant Characteristics: If a power plant is to be operational with an 80% operation factor, that is producing electricity for 25 days/month for 24 hours a day; the biomass rate consumed will be in the order of 75 kg/hour, fuel with an equivalent energy in the order of 1,575 MJ/hour.

Energy conversion efficiencies of electricity producing equipment based on steam cycle at the proposed levels of plant capacities tend to be low and in the range from 7-10%. Using such a range, the available energy to be produced as electricity will be in the range from 110-157 MJ/hour; which is equivalent to an installed power capacity in the range from 30-43 KW. Taking into account such a range, a power plant of 45 KW is selected as target for consideration.

The electricity generation of the proposed facility operating 80% of the year (7000 hours average) will be in the order of 315,360 KWh for a facility to be located in Grenada. It has to be indicated that the overall electricity production of the facility will be very dependent on the overall energy conversion efficiency of the installed equipment. The literature offers a wide range ranging running on average from 7-10 %, the latter figure having being used in the analysis carried out. Supplier specific information indicate values as low as 4% or high as 14% for overall conversion efficiency.

**Technology Assessment**

Electricity generation from biomass residues in the range of up to 50 KW may involve the following arrangements:

- Steam Engine/Generator for electricity production or CHP plant
- Steam Turbine/Generator for electricity production or CHP plant
- Gasifier/Generator

The use of steam turbine arrangements presupposes the use of increased operating pressures on the steam generating side of the project, therefore increasing prices fairly substantially, therefore reducing the choice of technology to standard steam engine arrangements or gasifier technologies. Gasifier technologies tend to be at present in the experimental mode and their costs tend to be fairly expensive, especially if sourced from reliable developed country markets. Taking into account the field conditions in Grenada, it is believed that care needs to be exercised in sourcing technologies through technology transfer packages at this in time.

Some of the *operational characteristics of steam engine/generator* sets are:

- High reliability
- Medium to high complexity, especially if high pressure systems are selected
- Safety requirements associated with steam operation
- Start-up/shut-down times in the range of 1-3 hours

- Straightforward operation using skilled personnel, especially if there is sufficient experience in-industry for the operation of boiler systems.

**Cost Indication / Structure**

Tentative cost structures for a project of this nature need to recognize that:

1. Cost indicators tend to change radically from technology sourced in developed or developing countries. Several published studies on costs of power generating equipment indicate that cost ratios between developed and developing countries can be up to 3. For the purpose of this initial technology brief, sensitivity analysis has been conducted using cost structure ranges available from published literature, and taking into account consultations conducted with equipment suppliers in Germany and Brazil.
2. Total project costs and evaluations of cash flows in project operation tend to be very sensitive to technology costs, as well as cost of biomass residue at plant gate (related to transportation cost of nutmeg shell in this case), as well escalating costs of electricity generated in the local grid. No estimation of those two parameters has been included initially in this analysis.

Cost structures for small scale electricity generating technology can be as follows:

*For developed country sourcing of technology* (in range up to 100 KW)[1]:

Steam Engine/ Generator including boiler and feed water systems plus representative ancillary and installation/commissioning costs: up to US$ 4,000 per kW

Gasification Technology: up to US$ 3,500 per kW

Steam Engine based systems tend to be more expensive due to higher capital costs as well as the somewhat lower efficiencies attained in such systems as compared to gasification, in case the residue is appropriate for gasification.

*For developing country sourcing of technology* (in range up to 100 KW)[2] :

Representative Steam Engine/Generator including boiler and feed water systems plus representative ancillary and commissioning costs: up to US$ 2,500

No indicative costs for developing country technology sourcing of integrated gasification plus generator systems has been made available for biomass residues.

*Estimated total project costs for a 45 KW steam engine/generator/medium pressure boiler will therefore be in the range from US$ 112,500 (for developing country technology sourcing) up to US$ 180,000 (for developed country sourcing of technology).*

**Financial due diligence**

Financial simulations in support of the project have been carried out for a variety of conditions. The most important variables included are cost of technology (including the distinction between developed/developing country sourcing), interest rates, tenor of the loan, avoided cost of electricity to the nutmeg association, and other aspects related to debt/equity structure, etc.

---

[1] Energy from Biomass: A review of combustion and gasification technologies. World Bank Technical Paper No 422. World Bank. March 1999.

[2] Survey of equipment for small-scale motive power and electricity generation from wood and agricultural residues. Natural Resources Institute. UK. 1993.

A simple Excel worksheet detailing the project financials has been used (presented in the annex to this brief) in order to assess some of the merits of the project and to analyze sensitivity to key variables. Please note there are a number of assumptions that govern the simulations, these are specified in the Excel worksheet. The engineering team did not discover any price reductions benefits to scale on equipment up to 100 kW therefore the financial simulations appear the same for a 15 and 45 kW project. Further exploration of possible returns to scale will be made in the feasibility study stage. *In addition, a number of factors such as taxes, land expenses, transmission and distribution-related costs, etc. have not been priced in the simulations. It was beyond the scope of the project identification mission to price all these factors. Please be aware that the inclusion of other factors will reduce - sometimes substantially - the projected returns on these projects. The projected returns on these proposed projects appear very high in these initial workups.* The worksheet has been set-up in such a way that these costs can be easily inserted and their impact determined.

**Simulation Summary Table**

| KEY PARAMETERS FOR FINANCIAL SIMULATION | **15 & 45 kW**<br>**Technology sourced from a developing country**<br>**US$ 2,500/kW installed** | **15 & 45 kW**<br>**Technology sourced from an OECD country**<br>**US$ 4,000/kW installed** |
|---|---|---|
| 10 years loan<br>8% interest rate<br>80%/20% debt/equity<br>US$.26 per kW<br>VER Sales | Project IRR: **63.26%**<br>Equity IRR: **262.9%**<br>Avg. debt service coverage: **6.04** | Project IRR: **29.71%**<br>Equity IRR: **127.5%**<br>Avg. debt service coverage: **3.50** |
| 10 years loan<br>8% interest rate<br>80%/20% debt/equity<br>US$.13 per kW<br>VER Sales | Project IRR: **17.45%**<br>Equity IRR: **85.4%**<br>Avg. debt service coverage: **2.68** | Project IRR: **negative**<br>Equity IRR: **22%**<br>Avg. debt service coverage: **1.39** |

The results obtained from the initial financial simulation clearly indicate that the project is sensitive to both the cost of the technology and to the price considered for the offset. Under standard assumptions of an 80%/20% debt to equity gearing ratio and a ten year loan at 8% interest the project illustrates financial strength when the technology is sourced from a developing country and the nutmeg producers are able to offset current payments for electricity. The nutmeg producers coop currently pays the utility the EC$ equivalent of US$. 26. When simulated at even half the price currently paid to the utility for electricity (US$ .13) a project sourcing technology from developing countries yields a respectable rate of return and solid debt coverage ratio. Given the market niche held by the nutmeg cooperative projects with a Project IRR over 25 % should be sufficient to attract the interest of investors even when all the other costs are factored into the project.

## Implementation arrangements

Grenada Nutmeg Cooperative Association as the developer for the project. No engineering and/or procurement contractor or technology partner has been yet identified in the project.

**Project barriers**

The proposed project faces several barriers:

Regulatory/Institutional: proper attention must be given to the procedure/negotiations needed for interconnecting a project in the Grenada grid.

Technological: sourcing of the technology is critical for this kind of project, and great care should be exercised in arranging the technology transfer package, most likely requiring the assembling of international support for such transfer to take place.

Common practice: although there is local experience in Grenada with related boiler capacity projects for industrial process heat applications, the local developer GCNA will require support to increase its skills in managing and servicing such an installation.

GCNA should consider linking the proposed project with its own strategic view on the development of secondary and tertiary markets for nutmeg based products. Such potential development may include the increased use of process heat and/or combined heat and power, creating an internal within industry need for energy carriers from the nutmeg shell. Such consideration will give a more direct and internal market for the implementation of a project serving the needs of the future Grenada nutmeg industry.

**Recommended activities:**

It is recommended to continue the implementing follow up activities related to the execution of a feasibility study for the proposed project.

Special attention should be paid at the time of conducting a feasibility study to the following:

1. Implement a detailed technology sourcing based on consultation with companies both in developed and developing countries to assess cost structures in detail. Such cost structures will be very dependent on the boiler selected pressures, which at the pre-feasibility level have been defined at medium pressure boilers.
2. Detailed consideration must be given to the determination in-situ of appropriate cost figures for nutmeg shell residues at the gate of the proposed site for the plant (including transportation cost).
3. Detailed consideration must be given to the consideration of the avoided cost of electricity generation in Grenada, in order to assess the change patterns that may affect the economic/financial behavior of a proposed nutmeg shell to electricity project.
4. Detailed consideration should be given to the issue of viability of providing surplus power in the Grenada electricity distribution system.
5. Local project proponents should consider the possibility of assessing additional project opportunities related to the use of nutmeg shell based on the implementation of other industry related project opportunities involving to secondary or tertiary investment opportunities concerning the use of nutmeg products. Such strategic investments may create new opportunities for the thermal use of energy from nutmeg shell, apart from electricity production for the grid. Project proponents should be aware that there may be also additional opportunities in Grenada for the provision of thermal/boiler/furnace fuels based on briquetting of nutmeg shell that may represent an economic interest for the local nutmeg producers. Appropriate consideration must be given to a broader range of possibilities associated to the use of biomass residues in the country.

**Project name: Caribbean Solar Financing Program**

**Location: Dominica, Grenada and St. Lucia**

**Context**

One of the key preconditions for the development of a vibrant market for solar hot water systems (SHWS) in the Caribbean Islands of Dominica, Grenada, and St. Lucia is the availability of sufficient and reliable financing made possible through an educated and informed financing infrastructure. In 2002, the estimated combined sales for the two firms that supply the majority (over 90%) of the SHWS in these three islands was 540 systems with 337 systems sold in St. Lucia, 105 systems sold in Grenada, and 98 systems sold in Dominica. Although one bank in St. Lucia and both of firms have at various times in the past offered short-term credit options to finance the purchase of SHWS such financing packages have failed to attract buyers from the middle-income elements of the population. Discussions with the two firms and their distributors, local credit unions and banks, and government officials indicate that middle income customers require medium-term financing to make SHWS affordable and prefer to access credit for purchases through the credit unions where the majority meet their other banking needs.

The two solar firms and their distributors that supply the bulk of the SHWS in the three islands estimate that the market for SHWS will increase by at least 100 systems per island if a long-term, low-cost financing package can be made available to the middle-income segment of the population through the credit unions. However loan officers in credit unions lack access to and experience with the methodology to assess the risks of lending for SHWS. While it is widely acknowledged that this lack of capacity in the financial community is a major constraint on the growth of SHWS markets, it is equally true that the lack of awareness among middle-income consumers as to the benefits of solar hot water heating is a major impediment to the development of the market in the three islands.

**Project description**

The Caribbean Solar Finance Program (CSFP) is designed to measurably reduce the constraints on, and increase the capacity for, financing of SHWS in the three islands while at the same time helping build awareness among the middle income segments of the population on the benefits of SHWS. The CSFP team proposes activities in *three* thematic areas to address the challenges to developing a sustainable market for SHWS in Dominica, Grenada, and St. Lucia: 1.) training lending personnel, 2.) provision of long-term credit, and 3.) a consumer awareness campaign. A brief description of each proposed activity is provided below:

*1.) Training Lending Personnel:* The CSFP team will execute an education and training program on issues relevant to financing SHWS for lenders and other financial professionals. These will be one-day short courses on the technology, economic, and financing issues pertinent to SHWS. This is different than training technicians, who are expected to go out and make installations. With financial professionals, the task is to get them up the learning curve to the point that they begin asking the right questions and have a context for understanding the answers they receive. The goal is to make lenders more comfortable with SWHS technology and more confident in their own abilities to assess financing situations.

Training sessions targeting lenders in the credit unions will be organized in partnership with the Caribbean Confederation of Credit Unions (CCCU) and the local credit leagues. Each session would include a familiarization module designed to introduce finance professionals to the technical and economic aspects of SHWS, a finance module that instructs the bankers in the methods for lending for SHWS, and a case study module that details actual structures and presents experiences of financiers and customers. The CSFP team proposes to implement seminars designed to train approximately 35 financiers per island on issues relevant to financing solar hot water systems. An initial cost estimate of US $60,000 is anticipated for the proposed training program for the three islands.

*2.) Provision of Long-term Credit:* The CSFP team will work with the credit union leagues in each of the countries to structure financing programs that support the purchase of SHWS by the target clientele. Initial discussions indicate that lines of credit of approximately US$ 137,000 must be made available for six years to each league if an increase in sales of 100 systems per island is to be achieved. It is hoped that once there is sufficient experience base in lending for SHWS as a result of on-lending the initial line of credit the leagues and member credit unions will make credit available for the purchase of such systems for their members from their own financial assets.

The CSFP team has reviewed the financial performance of the credit union leagues and member credit unions in each of the three islands. Each league has sufficient experience to administer a loan in the US $137,000 range. Further details on the financial position of the leagues and their member unions are available upon request.

*3.) Consumer Education Campaign:* It is widely acknowledged that while the lack of financing is a major constraint on the growth in the use of SHWS, it is equally true that the lack of awareness among middle income consumers is a major impediment to the development of the market. Further studies that articulate the technical and commercial benefits of SHWS will not solve the problem. Only well orchestrated consumer education campaigns targeted specifically at building awareness in key consumer groups will cause the market to take shape. To this end, the CSFP team, working together with partner government offices, will undertake a set of communications and outreach activities designed to increase consumer awareness of the benefits of SHWS. The campaign will specifically target the middle-income elements in the population that belong to the credit unions. The CSFP team will work with partner government offices and local public relations firms in the region to design radio and television spots and brochures to raise awareness of the benefits of SHWS in each of the three islands. Specific attention will be given to the economic benefits achieved by a conversion from electric to solar hot water heating. A cost of US $35,000 is estimated for the education campaign.

*Impact Assessment*: Estimates that the impact of the proposed CSFP activities will include:

- **60 financiers trained** in issues relevant to providing financing to consumer for purchase of SHWS.
- At least **six credit unions** (two in each island) providing credit for the specific purpose of promoting consumer access to financing for SHWS.
- A **100 unit** increase in the market for SHWS in each of the three islands as a direct result of the lending, training, and awareness campaign offered under the Program
- A leveraged increase of **at least 100 units per year** per island after the first two years of the Program as a result of increased market for and financing institution comfort with the technology and its associated risks and rewards.
- Over **US $1.6 million leveraged** from the credit unions for financing the purchase of SHWS in six years as a result of the institutional mechanisms established under the Program.

## Technical Commercial Experience Base and Supporting Networks

The solar resources of the Eastern Caribbean islands of Dominica, Grenada, and St. Lucia have been mapped consistently over time and are well understood. For many years, solar energy conversion (thermal and electric) technologies have been design and installed in the Eastern Caribbean. Solar thermal systems are available in the local markets through a series of suppliers/commercialization chains that have been operating in the different islands.

During the field visit in December 2003, detailed discussions were held with the two firms that fabricate SHWS in the Eastern Caribbean and supply 90% of the systems in the market in subject islands. In addition, in June and December 2003 brief discussions were held with the distributors for these two firms as well as a few of the distributors for European manufacturers selling product in the region. A brief overview of the two fabricators and their products and services is provided below:

### ***Solar Dynamics (EC) Ltd.***

Solar Dynamics (EC) Ltd. was established and commenced operations in St. Lucia in 1993 as a subsidiary company of the M & C Group of Companies, with Solar Dynamics Ltd of Barbados having minority interest. Solar Dynamics manufactures and installs SHWS for both the domestic and commercial markets. Through overseas distributors, Solar Dynamics (EC) Ltd. currently serves the entire eastern Caribbean as well as Jamaica.

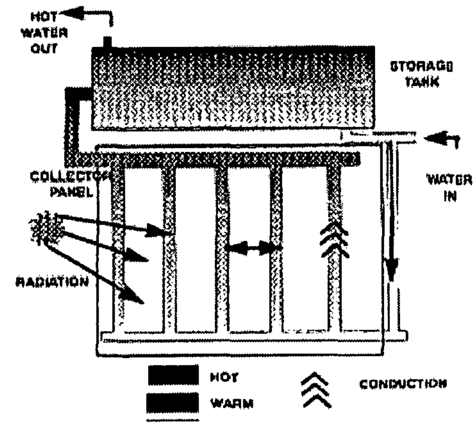
SOLAR DYNAMICS (EC) LTD.
P.O. Box BJ 0093
Odsan Industrial Estate
Cul-de-Sac, Castries, **St. Lucia**, W.I.
Tel: 758-458-8400/1
Fax: 758-451-0535
Web: www.solardynamicsltd.com
E-mail: solarec@candw.lc

*Products*

Solar Dynamics uses state-of-the-art technology and materials specifically designed for high performance and long life in Caribbean conditions. All systems are made with appropriately sized collector areas to produce a given temperature. In normal weather conditions, a temperature of between 54 and 60 degrees Celsius (135F to 140F) is attained daily. The Solar Dynamics Hot Water System is sold with a performance guarantee of 130F to 140F (62C). Higher temperatures are generally recorded and are available to suit specified requirements. Sizing is based on an allocation of 15 to 20 gallons of hot water per person per day, at a temperature of 130F to 140F. For the typical family of four persons, an 80-gallon Hot Water System, providing a temperature of 140F is required for showers, kitchen use and laundry. The following table lists several of the solar hot water systems sold by Solar Dynamics. Pricing varies by country.

| UNIT # | System | Price (US$) – St. Lucia |
|---|---|---|
| 5221 | 52 gallon tank w/ one 7 x 3 panel | $ 1157.73 |
| 5225 | 52 gallon tank w/ one 5 x 5 panel | $ 1216.98 |
| 6625 | 66 gallon tank w/ one 5 x 5 panel | $ 1296.22 |
| 6633 | 66 gallon tank w/ one 7 x 5 panel | $ 1395.47 |
| 6642 | 66 gallon tank w/ two 7 x3 panels | $ 1524.15 |
| 8033 | 80 gallon tank w/ one 7 x 5 panel | $ 1454.71 |
| 8042 | 80 gallon tank w/ two 7 x 3 panels | $ 1611.32 |
| 8063 | 80 gallon tank w/ three 7 x 3 panels | $ 1712.07 |

*Technology*




The Solar Dynamics Hot Water System operates on a thermosyphon basis. Cold water enters the bottom of a tank and passes from the tank into the collector. As the copper collector absorbs the radiation from the sun, heat is transferred by conduction to the water in the tubes. This heated water then rises from the collector to the storage tanks by convection. This thermosyphon action continually circulates all day long, producing the highest performance. All systems are fitted with user controlled back-up electrical boosters for use in periods of inclement weather, if required.

*St. Lucia Sales*

Solar Dynamics controls more than 90% of the market for SHWS in St. Lucia. In St. Lucia, retail sales are done through in-house sales executives.

| St. LUCIA SALES | | | | |
|---|---|---|---|---|
| **Model Number** | **2000** | **2001** | **2002** | **3 Year Total** |
| **52/21** | 26 | 15 | 13 | **54** |
| **52/25** | 7 | 19 | 46 | **72** |
| **66/25** | 22 | 48 | 64 | **134** |
| **66/33** | 5 | 22 | 45 | **72** |
| **66/42** | 22 | 1 | 17 | **40** |
| **80/33** | 100 | 125 | 114 | **339** |
| **80/42** | 121 | 38 | 31 | **190** |
| **80/63** | 24 | 9 | 7 | **40** |
| **Total units sold annually** | **327** | **277** | **337** | **941** |

*Grenada Sales*

Solar Dynamics is the primary provider of SHWS in Grenada with a 90% market share. Solar Dynamics' two main retail distributors in Grenada are Creative House Ltd. and Jonas & Browne Hubbard's, which control roughly 15% and 75% of the market respectively

| GRENADA SALES | | | | | |
|---|---|---|---|---|---|
| **Model Number** | **1999** | **2000** | **2001** | **2002** | **4 Year Total** |
| **52/25** | 0 | 23 | 48 | 50 | **121** |
| **52/30** | 23 | 8 | 0 | 0 | **31** |
| **66/25** | 0 | 18 | 19 | 15 | **52** |
| **66/33** | 0 | 0 | 4 | 10 | **14** |
| **66/42** | 6 | 16 | 0 | 0 | **22** |
| **80/33** | 0 | 15 | 28 | 30 | **73** |
| **80/42** | 21 | 22 | 0 | 0 | **43** |
| **80/63** | 0 | 1 | 0 | 0 | **1** |
| **Total units sold annually** | **50** | **103** | **99** | **105** | **357** |

*Dominica Sales*

Solar Dynamics sells its products in Dominica through J.W. Edwards, a hardware company that controls roughly 20% of the market. Solar Dynamics' primary competitor in Dominica is Marinor Enterprises.

| DOMINICA SALES | | | | | |
|---|---|---|---|---|---|
| **Model Number** | **1999** | **2000** | **2001** | **2002** | **4 Year Total** |
| **52/21** | 3 | 5 | 0 | 0 | **8** |
| **52/25** | 0 | 2 | 9 | 10 | **21** |
| **66/42** | 3 | 8 | 5 | 6 | **22** |
| **80/63** | 0 | 0 | 2 | 7 | **9** |
| **Total units sold annually** | **6** | **15** | **16** | **23** | **60** |

***Marinor Enterprises Ltd***

Marinor Enterprises Ltd. (MEL) is a limited liability manufacturing company established in 1988. MEL designs, manufactures and retails three models of solar water heaters, all of which are fully manufactured at their plant in Dominica.

The thermosiphon MEL model is their most popular unit, which consists of a tank and separate panel. They also offer a compact unit called the AZTECH SOLAR model, which incorporates the tank and panel into one unit. Last year they introduced the ACTIVE SYSTEM, which utilizes a solar pump.

MARINOR ENTERPRISES LTD.
P. O. Box 505, River Estate Works
Roseau, **Dominica**
Tel: 767-449-1269 / 1575
Fax: 767-449-2369
Email: info@marinorsolar.com
Web: www.marinorsolar.com
Managing Director: Michael Astaphan

Marinor's revenues from the sale of SHWSs in 2002 was roughly EC$ 420,000. The majority of their sales are domestic, with export markets in St Lucia, Tobago, Antigua and Montserrat. The tables below provide information on Marinor Enterprises' products and sales.

| MARINOR ENTERPRISES - SOLAR WATER HEATERS | | | |
|---|---|---|---|
| **Model No.** | **Description** | **Recommended number of persons** | **Price (US$) Dominica** |
| AZ - 5014 | 50 gallon without booster | 3 - 4 persons | $ 742.31 |
| AZ - 5014B | 50 gallon with booster | 3 - 5 persons | $ 825.00 |
| MS - 4015 | 35 gallon, 1 panel system | 2 - 3 persons | $ 992.31 |
| MS - 6526 | 65 gallon, 1 panel system | 4 - 5 persons | $ 1238.46 |
| MS - 6530 | 65 gallon, 2 panel system | 4 - 5 persons | $ 1344.23 |
| MS - 8030 | 75 gallon, 1 panel system | 5 - 6 persons | $ 1436.54 |
| MS - 8045 | 75 gallon, 3 panel system | 7 - 8 persons | $ 1653.85 |
| MS - 8052 | 75 gallon, 2 panel system | 7 - 8 persons | $ 1788.46 |

| MARINOR SOLAR WATER HEATER SALES | | | | |
|---|---|---|---|---|
| **Model** | **2002** | | **2001** | |
| | **Local** | **Export** | **Local** | **Export** |
| Marinor Solar | 68 | 25 | 81 | 6 |
| Aztech Solar | 6 | - | 6 | - |
| Active System | 1 | 2 | | 2 |
| Subtotal | 75 | 27 | 87 | 8 |
| **TOTAL** | **103** | | **95** | |

### Cost Indication / Structure

There is a range of costs for the solar hot water technology available in the region. As presented in the preceding section there is a variation of costs for systems supplied by different manufacturers and their distributors for systems serving similar thermal loads. In most cases sales packages include installation charges and also maintenance services for certain key components of the systems.

Based on a set of initial interviews with suppliers of SHWS, the team has developed the following specifications for a reference SHWS to be financed under the CSFP. Actual systems will vary in accordance with demand.

In order to define a reference SHWS the following assumptions have been made: i) household of 4 persons; ii) Electric Water Heater (EWH) power = 3.3 kW; iii) temperature variation produced by the EWH = 13 °C. Based on these assumptions it has been estimated that the daily energy and water consumption of a household of four persons for hot water use for shower is 3.3 kWh and 58 gallons respectively.

Based on these calculations the following two systems could be considered as SHW reference system:

Solar Dynamics - Model 66/33 - 66 gallons storage tank and 33 $ft^2$ collector surface

Marinor Enterprises - Model MS 65/30 - 65 gallons storage tank and 30 $ft^2$ collector surface

Different size systems and systems from other manufacturers would be eligible for finance under the proposed program, the reference systems are selected purely for modeling purposes.

For the purpose of analysis, an average price of US$ 1,370 (equivalent to EC$ 3,630) has been selected. The calculation of the price is based on the average of US$ 1344.23 quoted by Marinor for the MS 65/30 system and US$ 1395.47 quoted by Solar Dynamics for the Model 66/33.

**Financial due diligence and arrangements**

Initial conversations with management and lending officers in the credit unions and the credit union leagues in each of the three islands indicate that at least 20% of member households in each of the three islands (a total over 6,000 households) use electric water heating systems with capacities of 3.3 kW or greater for approximately 1 hour per day to generate hot water for showers. Therefore each household utilizes approximately 1,204 kWh per year to meet their bathing needs. The approximate average annual payment for hot water for showers for subject member households are therefore as follows:

- Dominica EC$0.71 per kWh (US$0.26) ≅ US$ 313.17
- Grenada: EC$0.60 per kWh (US$ 0.22) ≅ US$ 264.88
- St.Lucia: EC$0.60 per kWh (US$ 0.22) ≅ US$ 264.88

Provided a six year line of credit of US $137,000 were made available to each of the three leagues at an interest rate of 3% in local currency and that loans were made to the members of credit unions at 6%, the cost of a US $1,370 SHWS capable of meeting the requirements for hot water could be brought to approximately US$ 278 per year for the six year period of the loan, after which there would only be minimum costs associated with operating and maintaining the system.

According to the leagues, payments of approximately US$ 25 per month for a SHWS are well within the acceptable range for member middle-income professionals such as teachers and government employees. When taken on a ten year life-cycle basis the cost per year for approximately hot water from the SHWS would be approximately US $167 as there would be no fuel or finance and minimum equipment and O&M charges after year six. In comparison, when taken on a ten-year life-cycle basis the cost per year for producing hot water with the typical 3.3 kW electric heater would be approximately US$ 321 in Dominica and US$ 265 in Grenada and St. Lucia.

The partner co-operative credit leagues in each of the three islands represent the credit unions that are owned and operated by their members. In 2002 the Grenada Co-operative League Limited represented 21,347 members with savings of US$ 31,471,070. The constituent credit unions made loans totaling US$ 29,408,323 and held a total asset base of US$ 38,638,400. The St. Lucia Co-operative League Limited represented 39,044 members with savings of US$ 40,408,434 in 2002. The constituent credit unions made loans totaling US$ 41,583,222 and held a total asset base of US$ 55, 889,880. The Dominica Co-operative League Limited represented 70,739 members with savings of US$ 27,842,530 in 2001. In 2001 the constituent credit unions made loans totaling US$ 25,765,874 and held a total asset base of US$ 34,747,922. The leagues and key member credit unions have experience with, and a successful track record in, lending a sufficient volume of capital to handle a US$ 137,000 line of credit.

**Implementation arrangements**

In order to help address the barriers in scaling-up the market for SHWS, eight organizations propose to work together under the Global Sustainable Energy Islands Initiative (GSEII) to execute the CSFP. The Caribbean Confederation of Credit Unions (CCCU) and the credit union leagues in each of the three islands will join with GSEII team members including the Organization of American States, Energy and Security Group, United Nations Industrial Development Organization (UNIDO), and the

Climate Institute. The GSEII team offers expertise in and a comprehensive knowledge of the policy, finance, institutional, capacity building, and technological variables necessary to design and manage the training, consumer education, and finance program to support the introduction of SHWS in the three island nations. When the GSEII expertise is combined with the experience base of the three co-operative credit leagues and their member unions capabilities and their proven track record in lending in the target markets to the target clientele the team offers the skill set and know-how necessary to achieve the objectives of the Program.

**Project barriers**

Several types of barriers may be present to a program of this nature. Some of those barriers and removal strategies have been considered in the activities to be undertaken in the areas of long-term debt availability, consumer education and training of lending personnel.

Other types of barriers that may be present are related to technical aspects of the solar system packages as they pertain to O&M services, conditions of contracts and guarantees and commercial aspects of the sales packages. A market increase signal will undoubtedly have an effect on local suppliers as to improve some technical aspects of their technologies, which would require supporting consultancy networks, development of strategic alliances, etc.

**Recommended activities**

Initiate the activities of the CSFP as outlined in the **Project Description** section. The first steps would include developing an implementation plan, timeline, and scopes of work and contracts for the various parties.

**Comments**

During the fact-finding mission the UNIDO-GSEII team had preliminary discussions with officials of national utilities. One operating problem that each utility has to deal with, although to different extent, is the low average transformer load factor. Beside the inefficient use of the transformer, a low average transformer load factor contributes to increase the energy and power losses in the distribution system. A low average transformer load factor can be partially due to improper sizing of the transformer but it is also consequence of a daily power demand profile that presents wide gaps between base load and peak load time. Electric water heaters play a major role in determining the peak power demand as a DOMLEC engineer reported considering that rated power of electric water heaters presently used ranges from 3.3 kW to 10 kW. Under these conditions there is minor scope for optimal sizing but major potential for demand side management interventions. The dissemination of SWHS could represent one of such intervention.

It would be important to involve national utilities in the CSFP with the following task: the utility should track the changes in the daily power demand profile of those residential areas in which electrical water heaters will be replaced with SWHS and analyse the impact on transformers load factor and losses. An ideal scenario would be 5-10 SWHS installed in a limited residential area that is under the same distribution transformer. Provided that the utilities are interested in undertaking the exercise, the allocation of some resources to support such activity within the CSFP will be taken into consideration.

**Project name: St. Lucia Ciceron Landfill Gas to Energy Project**

**Location: St. Lucia**

### Context

The Ciceron landfill in St. Lucia closed at the beginning of year 2003 after more than 11 years of operations. The landfill has been acclaimed internationally for its technical operations as well as because of procedures employed for its technical closure. St. Lucia solid management authorities are interested in exploiting the electricity generation potential of the site at Ciceron, in order to generate electricity that could be fed to the electricity grid, assisting sustainable energy development of the island. At the same time, the proposed project would be the first of its kind in the Caribbean island states, representing a first opportunity for the transfer and installation of such technologies. The project aims also at getting recognition through the marketing of certified emission reductions under the Clean Development Mechanism as part of the Kyoto Protocol for mitigation of Greenhouse Gas Emissions.

### Project description

The Ciceron Landfill Gas to Energy will be using methane generated in the Ciceron Landfill in order to generate up to 400 KW of power to be interconnected in the electricity grid in St. Lucia. The project will consist of landfill gas (LFG) collection system, which would benefit from an existing LFG venting system already installed in the landfill, coupled to an internal combustion engine in order to generate electricity through the combustion of collected methane flows. Expected project life of the project ranges in the order of up to 15 years. Optimized use of the methane will include the drilling of vertical wells and ancillary installation of a blower system in order to pump the methane and also the installation of condensate collection and gas treatment systems at the site. Since the Ciceron landfill is located near to the generation center of LUCELEC, interconnection of the electricity generation plant is expected to occur at the "electricity dispatch bus bar" of LUCELEC, located about 1 mile from the landfill site.

### Technical Due Diligence

*Availability of Waste at the Ciceron Landfill*

Waste composition at the site has been monitored providing the relative percentage composition presented in Figure 1. Waste accepted at the site has included domestic waste, commercial waste and solid non-hazardous materials amongst others. Organic composition of the waste at the site is in the order of 55 %. Table 1 presents information on waste tonnage received at the site over the last 4 years before its closure[3], indicating average annual waste reception on the order of around 48,000 tons per year. Several estimates have been performed on the total amount of waste in the landfill over the operating life of the site. Estimations conducted in 2003 under the request of the St. Lucia Solid Waste Management Authority and conducted by a private consulting company[4] indicate that approximately 750,000 tons of waste is in place at the site. More conservative estimates of the available tonnage of waste at the site indicate an average of about 40,000 tons average per year (taking

[3] Data from SLSWMA 2001-2002 Annual Report. It has to be noted that values in tons of waste yearly disposed at Ciceron from 1998, quoted in Table 1, were calculated based on estimated volume of waste transported by vehicle entering the Ciceron site.

[4] Komex International Ltd. Potential landfill gas utilization project at the Ciceron landfill. Canada, June 2003

into account the sites capacity development over time), representing a total over the period of operational lifetime of 11-12 years in the order of 440,000 – 480,000 tons of waste at the site, which is around 28% - 23% lower than the more optimistic values, but considered more representative of the available waste in place at the site.

**Figure 1. Composition of Waste at the Ciceron Landfill**

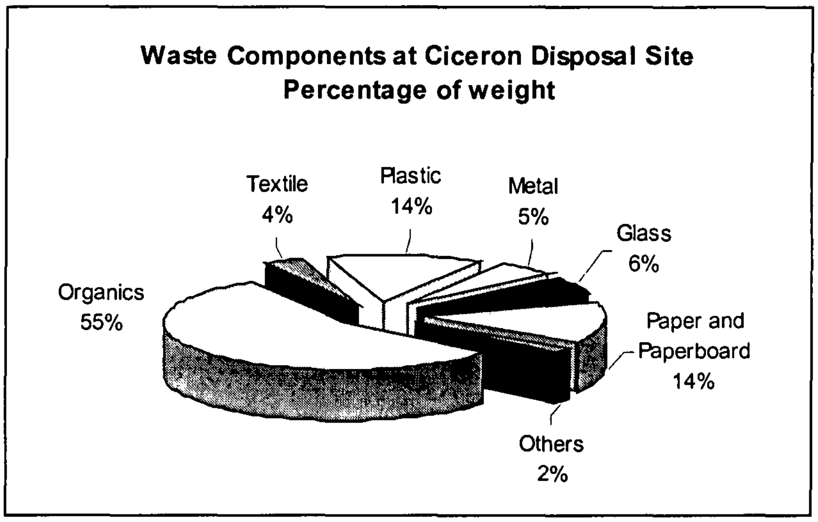



**Table 1. Waste received at Ciceron Landfill (tons/year)**

| Year | Waste tonnage |
|---|---|
| 1998 | 36,597 |
| 1999 | 47,939 |
| 2000 | 55,864 |
| 2001 | 51,239 |

*Estimation of LFG and methane availability at the site*

Following a site visit, estimations have been conducted on availability and decay of landfill gas from the Ciceron Landfill, using a First Order Decay Model, as used internationally for initial approximations to the understanding of the dynamics of landfill gas generation. The following assumptions have been used for the development of the decay model used for the estimation of LFG generated at the site:

Volume of LFG generated by pound of waste over the entire biodegradation period[5]: 1.6 $ft^3$/lb

Life of entire waste biodegradation process: 20 years

Life of LFG to Energy generation project: 15 years

Calorific value of LFG: 17,661 BTU/$m^3$

Selected heat rate of internal combustion engine used for generation: 12,000 BTU/kWh

Amount of waste available for LFG production at the site: 450,000 tons[6]

[5] USEPA normally recommends a value of 2.72 ft3/lb of waste over the entire biodegradation period, but in this case a more conservative value has been selected based on a more recent World Bank publication: "Guidance note on Recuperation of Landfill Gas from Municipal Solid Waste Landfills," L. M. Johannessen, Sept. 1999.

The most important results obtained can be summarized as follow in Table 2.

**Table 2. LFG generation rates at the Ciceron Landfill using USEPA First Order Decay Model**

| Year of operation of the LFG to energy project | Time since landfill opened | Time since landfill closed | Volume of LFG collected per year ($m^3$) | LFG hourly flow rate ($m^3$/hour) | Estimated Gross Power generation capacity on an hourly base (KW) |
|---|---|---|---|---|---|
| 1 | 11 | 1 | 3,171,113.5 | 362.0 | 532.8 |
| 2 | 12 | 2 | 2,869,342.1 | 327.6 | 482.1 |
| 3 | 13 | 3 | 2,596,288.1 | 296.4 | 436.2 |
| 4 | 14 | 4 | 2,349,218.6 | 268.2 | 394.7 |
| 5 | 15 | 5 | 2,125,660.9 | 242.7 | 357.1 |
| 6 | 16 | 6 | 1,923,377.5 | 219.6 | 323.2 |
| 7 | 17 | 7 | 1,740,344.0 | 198.7 | 292.4 |
| 8 | 18 | 8 | 1,574,728.3 | 179.8 | 264.6 |
| 9 | 19 | 9 | 1,424,873.1 | 162.7 | 239.4 |
| 10 | 20 | 10 | 1,289,278.5 | 147.2 | 216.6 |
| 11 | 21 | 11 | 1,166,587.4 | 133.2 | 196.0 |
| 12 | 22 | 12 | 1,055,572.0 | 120.5 | 177.4 |
| 13 | 23 | 13 | 955,121.0 | 109.0 | 160.5 |
| 14 | 24 | 14 | 864,229.2 | 98.7 | 145.2 |
| 15 | 25 | 15 | 781,987.0 | 89.3 | 131.4 |
| **Total** | | | **25,887,721.3** | | |

Estimations of methane production at the site will be very important if consideration is to be given to potential validation of a landfill gas to energy project under the provisions of the Clean Development Mechanism. Taking the assumption that the methane content of LFG is about 50%, it is possible to estimate the $m^3$ of methane from the predicted volumes of collected LFG per year (presented in Table 2 above). Using adequate values for methane density[7] it is possible to estimate that the average methane collection over the selected 15 year period operation is 477.5 tons $CH_4$/year. Taking into account the Global Warming Potential of methane (21 times that one of carbon dioxide) as defined by the Intergovernmental Panel for Climate Change, the $CO_{2equivalent}$ emissions on a yearly average from the Ciceron landfill will be in the order of 10,027.5 tons $CO_{2equivalent}$. Such amount of reductions could in principle be claimed as avoided emissions if a landfill gas to energy plant is installed at the site, therefore mitigating emissions that would have happened from the landfill in the absence of a climate change mitigation project (such as the one proposed). Burning of methane also results in a small percentage of $CO_2$ emissions due to the combustion of the methane, fraction that needs to be deducted from the overall claim of avoided emissions.[8] The total estimated methane avoidance expected from the proposed project would therefore be on the order of 8,713.6 tons $CO_{2equivalent}$/average year.

[6] In this case a conservative value has been selected, based on understanding of the operation curve of the landfill over its lifetime.

[7] Methane density of the gas phase (1.013 bar and 15 °C) =0.68 kg/$m^3$

[8] Recent analysis conducted by the CDM Meth Panel indicate that estimation should be done on the basis of CO2 equivalent emissions = methane emissions*(21-2.75) in order to estimate the net emissions avoided.

*Estimation of project power capacity and electricity generation*

Taking into account the calorific value of LFG and an indicative heat rate for the conversion of energy into electricity in internal combustion engines, representative of the types of scales associated with this project; Table 2 presents an estimate of the power plant installed capacity that could be extracted based on the simple approximation model that is based on a first order decay model. Taking into account that the decay model predicts a decay in the LFG generation in the landfill (due to the chemical/degradation processes that take place at the site), the power extractable per year tends also to decrease with time, reaching production peaks immediately after landfill closure.

Determining the optimum size for a landfill gas to energy project requires a careful balance between maximizing electricity production and use of the available landfill gas, and minimizing the risk of insufficient gas supplies in later years of the operation of the project. There seem to be at least three different types of strategies for such size determination:

- Minimum gas flow design: in which the electric generation equipment is sized based on minimum expected gas flows over the life of the project. This design ensures a system running at or near its maximum availability, putting a premium on constant and reliable electrical output. In this fashion, for the operation of the Ciceron landfill a recommended power capacity will be in the range of around 145 KW (averaging the last few years of operation). The main drawback of this selection is that LFG will go unused in years when gas is plentiful, creating a lost opportunity to generate electricity and create cash flows for the project.
- Maximum gas flow design: basing the design on maximum flow rates of the LFG in the Ciceron landfill (again by averaging the initial years of operation availability of LFG) indicates that a 480 KW installed capacity is possible at the site. In this mode of operation, it is possible that in some percentage of hours in different years, there may be insufficient gas flow to run at nominal power capacity. This strategy of sizing the power plant puts a premium on full utilization of the available landfill gas.
- Changing gas flow design: in this strategy for sizing the system, a series of smaller modular electric generating equipment is installed or removed over time as gas flow rates developed in the LFG gas collection system. A changing gas flow design may incur in higher installation costs over time, and in the case of reductions in gas flow as predicted in Ciceron, designers must consider what to do with modular equipment as the LFG dwindles over time.

Proper consideration to the final selection criteria to be used should be an important concern during the execution of full feasibility studies, especially since in the case of Ciceron, LFG testing wells must be drilled in order to validate the existence and determination of indicative real LFG flow rates.

Indicative sizing of the power plant has been done taking into account the rate of reduction in the LFG generation and opting for a compromise between the maximum and minimum gas flow designs. *A size of 400 KW has been selected for analyzing the project at Ciceron.*

Taking into account the predictable and regular nature of expected LFG production in a landfill, a high plant factor is anticipated for the operation of a project of this nature (plant factor of up to 90%). *The expected average annual electricity generation over the project's lifetime is on the order of 2,111,037 kWh (3,090,528 kWh max. and 1,015,119 kWh min.).*

The prediction models employed for the determination of expected LFG availability at a landfill indicate a significant change in yearly LFG availability that is also reflected on the predicted hourly LFG flow rates. Table 2 indicates that such flow rates in the latter part of the operational life of a LFG to energy project may be as low as 25% from the predicted flow rates available during the early years of the project (when waste would be decomposing at a faster rate).

The reduction of the annual LFG generation rate has been taken into account in sizing the potential power plant and the most conservative approach has been used in estimating electricity generation figures, since estimations were performed by considering the variability of yearly LFG collected over the project lifetime.

The generation of electricity in most countries entails the emission of a given amount of $CO_2$ emissions due to the burning of fossil fuels. Electricity generated from the burning of landfill gas tends to be cleaner than other existing fossil fuel burning technologies; therefore a project of this nature can be claimed as a contribution to the displacement of emissions generated in an electricity grid. In the case of St. Lucia, the local utility (LUCELEC) operates a set of high efficiency thermal plants that provide electricity to the island. Average estimated CO2 emission intensity factors are likely to be on the order of 0.9 Ton $CO_2$/MWh[9] of electricity generated. Therefore an initial estimation on potential emissions reductions of the St. Lucia grid via the incorporation of the proposed project is in the order of 1,523 tons $CO_2$/year (average over the 15 year lifetime of the project).

*Taking into account both potential sources of mitigation of GHG emissions, the Ciceron Landfill Gas to Energy Project could potentially mitigate up to 10,247 tons $CO_2$/year (average).*

**Technology Assessment**

The most suitable technology used in landfill gas to energy projects is likely to be 4-stroke lean burn internal combustion (IC) engines, operating under increased excess air delivery in order to attain higher efficiency and reach appropriate combustion of the LFG at the same time of minimizing NOx emissions. Several IC engine producers are currently able to deliver LFG combustion engines for use in this type of projects.

A very important issue to consider in the application of IC engines in this type of projects comes from the permissible levels to be accepted at the site on NOx emissions. There is available technology from international suppliers offering LFG burning IC engine technology delivering less than 1.0 grams NOx/brake horsepower hour (equivalent to around 3.2 lb NOx/MWh generated)[10].

Implementation of a landfill gas to energy project includes the sizing, selection and installation of gas collection equipment, drilling of extraction wells and installation of gas cleaning ancillary systems, for which there is international availability of suppliers of the technologies as well as consultancy services. Technology transfer packages need to be integrated and it is most likely that a suitable figure for the participation of the denominated EPC (engineering procurement and construction) services seems to be a most likely way to arrange for the implementation of the technology.

**Cost Indication / Structure**

Cost structures for projects of this type have to consider the following items:

1. IC Engine Capital Costs: for engine sizes in the range of 350 KW cost are up to US$ 1,400/KWh[11]
2. Gas Collection System: up to US$ 600/KW

[9] Based on information available from the United Nations Convention on Climate Change available at http://cdm.unfccc.int

[10] Although no written confirmation was received by the project team from a sample of suppliers that has been contacted in relation to NOx levels from available IC engines in the range up to 350 KW.

[11] Capital cost figure including engine, auxiliary equipment,, emission controls, gas compressors, engineering costs and also denominated soft costs (up front owner's costs, interest during construction, contingencies, etc.)

3. Installation cost and overall project contingencies and pre-investment work:up to 20-25% for a total of up to US$ 600/KW

Total project capital costs for this project are estimated to be in the range of up to US$ 2,600/KW.[12]

Relevant operating and maintenance costs (O&M) can vary significantly among projects due to different equipments and gas treatment options installed. Information gathered from other projects in the process of installation at other sites in the Central American region indicate the following cost for O&M:

O&M Cost on the energy conversion equipment: US$ 0.015/KWh generated

O&M cost for the gas collection system: US$ 0.005/KWh generated

Table 3 presents a summary of the expected cost structures for the project.

**Table 3. Relevant Indicative Cost Structures of the Ciceron Landfill Gas to Energy Project**

| Data/Variable | Unit | Value | Comment |
|---|---|---|---|
| Total Expected LFG Collection | $m^3$ | 25,887,721 | First Order Decay Models have a prediction accuracy of ± 50%. Model indicates a maximum year of 3,171,113 $m^3$ and a minimum year of 781,987 $m^3$ |
| Installed Capacity | kW | 400 | Based on averaging the first 7 years of available LFG, and using a criteria of compromise between maximum and minimum gas flow designs |
| Expected Average Annual Electricity Generation on 15 year project lifetime | kWh | 2,111,037 | Based on a 90% operation factor as a base load plant |
| **Cost Items** | **Unit** | **Value** | **Total Cost** |
| **Capital Cost**<br>Energy Conversion System<br>Gas Collection System<br>Installation, contingencies and pre-investment work | <br>$/KW<br>$/KW<br>$/KW | <br>1,400<br>600<br>600 | <br>560,000<br>240,000<br>240,000 |
| **O&M Costs ①**<br>Energy Conversion System<br>Gas Collection System | <br>US$/KWh<br>US$/KW | <br>0.015<br>0.005 | <br>31,665<br>10,555 |
| **Total Capital Cost** | US$<br>EC$[13] | | 1,040,000<br>2,808,000 |
| **Annual O&M Costs** | US$/year<br>EC$/year | | 42,220<br>113,994 |

① Reference is made to the average annual electricity generation

[12] This figure is consistent with estimated preliminary costs submitted by Komex International Ltd. To the St. Lucia Solid Waste Management Authority in June 2003, as part of documentation on preliminary evaluation of the potential project at the Ciceron site.

[13] Using a currency exchange of 1 US$ = 2.7 EC$.

## Financial due diligence

Financial simulations have been conducted in a variety of conditions for the project. The most important variables included are cost of technology, interest rates, tenor of the loan, avoided cost of electricity in the LUCELEC grid, and other aspects related to debt/equity structure, etc.

A simple Excel worksheet detailing the project financials has been used (presented in the annex to this brief) in order to assess some of the merits of the project and to analyze sensitivity to key variables. Please note there are a number of assumptions that govern the simulations, the technical ones are specified in the Excel worksheet. *A number of factors such as taxes, land expenses, transmission and distribution-related costs, etc. have not been priced in the simulations. It was beyond the scope of the project identification mission to price all these factors. Please be aware that the inclusion of other factors will reduce - sometimes substantially - the projected returns on these projects. The projected returns on these proposed projects appear very high in these initial workups.* The worksheet has been set-up in such a way that these costs can be easily inserted and their impact determined.

**Simulation Summary Table**

| KEY PARAMETERS FOR FINANCIAL SIMULATION | **Ciceron 400 kW**<br>**Technology sourced from an OECD country**<br>**US$ 2,600/kW installed** | **Ciceron 400 kW**<br>**Technology sourced from a developing country**<br>**US$ 1,500/kW installed** |
|---|---|---|
| 10 years loan<br>8% interest rate<br>80%/20% debt/equity<br>Avoided Cost US$.095 per kW<br>VER Sales | Project IRR: **10.86%**<br>Equity IRR: **58.8%**<br>Avg. debt service coverage: **1.10** | Project IRR: **43.33%**<br>Equity IRR: **178.8%**<br>Avg. debt service coverage: **2.16** |
| 10 years loan<br>8% interest rate<br>80%/20% debt/equity<br>Avoided Cost US$.095 per kW<br>No VER Sales | Project IRR: **3.60%**<br>Equity IRR: **31.1%**<br>Avg. debt service coverage: **.9** | Project IRR: **33.57%**<br>Equity IRR: **140.2%**<br>Avg. debt service coverage: **1.82** |

For the proposed ten year period of the loan, the project is sensitive to both the cost of the technology and the market for VERs. When the scenarios are run taking into account a lower capital cost for the project based on figures available from other land fill gas developers in Central America, the project's financials present a more interesting proposition. Under standard assumptions of an 80%/20% debt to equity gearing ratio and a ten year loan at 8% interest the project illustrates the greatest financial strength when the technology is sourced from a developing country and sells electricity at LUCELEC's avoided cost. Given the proximity to the LUCELEC generating facility and transmission lines the Ciceron project, with a Project IRR over 25 %, should attract the interest of investors even when all the other costs are factored into the project.

It should be noted that the proposed project's evaluation show large changes and sensitivities, especially with respect to electricity generation. Technology choice and the kWh yield for the financials were run on reasonably conservative gas flow rate estimates. However validation of actual gas flow rates becomes a major issue to consider in sorting out the most likely scenario for electricity generation, since it has a major impact on project performance. Other variables that will merit more detailed evaluations will be related to assessing common practice and more detailed evaluations of cost structures for a project like the one at Ciceron; as well as monitoring the behavior of carbon transactions in the international climate change emerging markets, as to assess more in depth the final impact that those transactions may have in project performance.

Climate change related transactions associated to the project have a positive influence on project performance, contributing to a substantial increase the IRR of the project. Although this effect may be seen positive, project developers as well as local government organizations and institutions dealing with emerging climate change mitigation markets must be aware of the effect of high transactions costs in registering such a project in the emerging markets.

**Financing arrangements**

Financing arrangements probably call for the integration of a project team to be organized at the St. Lucia Solid Waste Management Authority. As it is likely to happen, from experience in other landfill gas to energy projects, local solid waste authorities may open up a bidding process for the development of the project. Local/international groups may qualify for the development and operation of the project. Consideration should be given to the adequate structuring of EPC contracts and associated IC engine supplier financing in making the project a reality. The relative small-scale nature of the project may open up the possibility for local/regional private capital to become interested in participating in a project structure. Management of risk associated with early testing of the available flow rates of LFG is a critical activity to be undertaken in the project.

**Implementation arrangements**

St. Lucia Waste Management Authority, in collaboration with other local authorities in the country must decide on a viable legal mechanism/figure for the development of a project, especially related to legal binding aspects of resource assessment and control. Clarity on such aspects is critical in order to attract interest from private/regional sources for investing in the project. Special care must be exercised in defining the arrangement of participation of contractors in the project. In order to qualify for CDM transactions, the local authorities in St. Lucia must follow procedures for the inscription of the project as a CDM related project activity, status that will be very critical in making the potential project an interesting investment for private sector participation.

**Project barriers**

Resource assessment validation: as it has been explained in this document, prediction models used ex-ante tend to have low accuracy in predicting gas flow availability in landfills. Although there is adequate historical information in St. Lucia with respect to the operation of the landfill, no tests have been conducted on availability of LFG after technical closure of the landfill. This in turn may result on a resource assessment risk for the project.

Institutional/regulatory/market: c areful m onitoring m ust be done on the electricity situation in the island. The local utility as well as the government authorities has expressed an interest in diversifying generation sources. Although a small project like this one is not likely to displace capacity additions in the near future, relevant market aspects as pertaining to ownership, dispatch and price regulations must be addressed carefully.

**Recommended activities**

1. Conducting a feasibility study is recommended for this project.
2. Gas extraction tests must be conducted at the site in order to validate representative quantities and flow rates of LFG in different portions of the landfill, in order to evaluate sizing strategy for the power plant and also to refine the electricity generation prediction to be employed in the economic simulation.
3. Detailed legal definitions must be undertaken on the potential provisions for exploitation of LFG, transferring of rights to use such a resource; and definition of a figure by which the local solid waste management authority will either develop the project or allow for the participation of third parties for the project.

**Comments**

The Ciceron Landfill Gas to Energy project is representative of a type of small-scale projects that can serve very strategic objectives for linking energy and sustainable development. Those projects in the context of St. Lucia are not restricted to this site, but to other two landfill sites under development/operation. The potential impact of climate change related transactions is critical for the financial development of the project. Small Island States can arrange for analyzing the feasibility of implementing "umbrella type" projects of this nature in order to assist their sustainable energy development.

**Project name: St. Lucia Point de Caille Wind Farm Project**

**Location: St. Lucia**

### Context

The eastern side of the island of St. Lucia has been well known for the strong winds that prevailed for most part of the year. The Government of St. Lucia as well as the local utility, LUCELEC, has shown interest for some time in the potential development of a wind farm in the island. Several sites have been apparently studied over time, indicating that there is an interesting wind resource available. A site in the South Eastern part of the island, Point de Caille has been visited as part of a preparatory visit to St. Lucia in December 2003, in order to assess pre-feasibility aspects of a potential wind farm to be installed in the area.

### Project description

The project looks at the installation of around 4,250 KW of wind based generation power capacity in an area site locate at Point de Caille, on the South Eastern tip of St. Lucia. Initial size considerations have been determined based on a rapid site assessment conducted by a UNIDO team in December 2003, and also on some initial information from previous preliminary siting exercises undertaken in St. Lucia[14]. LUCELEC, the local utility in St. Lucia is intending to apply for planning permissions to operate a wind farm at the site. The project is likely to be constructed in a staged manner, with two turbines initially to be installed as demonstration units. After testing the technical, financial and operational aspects (related to dispatch ability of wind power in the local grid), further capacity additions are plan to be incorporated to the wind farm in order to reach the target installed capacity. The project will be located adjacent to the coast, at a distance of about 6 km north-east of View-Fort, getting interconnected into either the 66 kV or 11 kV electrical transmission/distribution system in the island, both of which pass close to the site and adjacent to the main road that runs north from View-Fort. The project intends to use state of the art commercially available wind technology, although at this point in time no decision has been taken on the relative size of turbine (per machine installed capacity). It is technically possible to consider turbines in the range of 600-850 kW. Initial turbine position determination indicates that the available land at the site can allow the installation of 5 turbines, then permitting a total installed capacity on the order of 4,250 kW.

### Technical due diligence

*Site and Wind Resource Assessment*

The proposed site for the project is in the area of Point De Caille, on the southeastern side of St. Lucia. The site is one of the few relatively flat areas suitable for wind farm development in St. Lucia. Other interesting sites have been considered for wind development in the country, but information on those has not being available during the site visits to St. Lucia in December 2003.

The site appears to have sedimentary sandstone geology with volcanic rocks in evidence. The nearest major contour includes small rolling hills and almost no landscape intercepting features that could disrupt the predominant wind direction and pressure on the available wind resource, with a gentle slope towards the east coast. There are some small trees, up to approximately 4-5 meters in height that show significant flagging. Access to the site is good, through earth and narrow roads that have no steep gradients or very tight bends. The site is located not far from the Pointe Sable National Park and

[14] Scoping document on a Wind Farm in St. Lucia. Prepared by PB Power. Authorship and date unknown.

the A nse G ear P rotected Landscape, and within close vicinity is the starting point of the National Trail.

Identification of tree flagging during the field visit to the site, resulted in the initial indication of the type of resource available. Matching of tree flagging with the Griggs-Putman Index of Deformity[15] indicates a wind resource of Class III or IV, with representative average wind speeds in the range 5-7 m/s (at a representative height of 10 m).

Estimated available wind speeds at the site have also being consulted using the N ASA S SE D ata available from http://eosweb.larc.nasa.gov/sse/ , using the geographical coordinates of the proposed site. This set of data resulted on a prediction of annual wind speed at 10 m. in the order of 6 m/s. Although these data sets are to be taken in a preliminary exercise like the one developed in this brief, it is important to determine more precise data based on the implementation of a wind-monitoring program at the site. Such monitoring should result in other parameters associated to wind speed, wind direction, wind gusts, and relevant Weibull distribution parameters needed for properly specifying a wind regime for technology applications.

Simulation of the wind regime at the site has been conducted with the preliminary average wind speeds reported by NASA and using a simulation model denominated RETSCREEN available from www.retscreen.net , program that has also been used for the purpose of conducting preliminary evaluations of the proposed project.

*Expected Power Capacity and Electricity Generation at the Site*

The RETScreen software is an internationally available model that can be used for sizing, and evaluation of wind farm projects, especially at the pre-feasibility level, as is the case in the Point de Caille site in St. Lucia. The program is comprised of several modules that include energy, technology, cost and financial modules. For the purpose of using the model, and taking into consideration the proposed installed capacity in the order of 4,000 kW, representative turbine models in the range of 850 kW have been selected for running the simulations. Therefore, total installed capacity of 4,250 kW is to be obtained by the installation of 5 turbines at the site. Representative data[16] for these turbines have been selected from the product database available from RETScreen, in order to conduct the evaluations of electricity generation and plant capacity factors. Taking into account the range of wind speeds reported through the NASA site (based on correlations of general atmospheric models), and the preliminary site investigation; and the no availability of a wind-monitoring program at the site, calculations on the wind regime have been conducted for 5 and 6 m/s.

Table 1 presents the results of the wind regime simulations and their effect on the expected energy generation at the site. Expected electricity generation at the proposed site, could range up to 32% depending on the average wind speed available. This factor has a very predominant impact on the viability of a proposed wind farm, being the reason for the implementation of wind monitoring programs at any proposed wind farm site. Further evaluations presented in this project brief will be carried out for the representative data generated for 5 and 6 m/s average wind speed.

[15] Wind Power for Home and Business. Real Goods Independent Living Book. Chelsea Green Publishing Company, 1993.

[16] Output rated power of 850 kW, hub height of 60 m, rotor diameter of 52 m, providing curves for power and eenrgy as a function of the available wind speed. Wind data has been corrected for height from the available data at 10 meters to wind speed at the hub height of the proposed turbine type.

**Table 1. Expected electricity generation at Point de Caille Wind Farm, as function of average wind speed for a representative 850 kW turbine for a 4,250 KW Installed Power Capacity**

| Indicator | Unit | Average Wind Speed at 5 m/s | Average Wind Speed at 6 m/s | Average Wind Speed at 6.2 m/s |
|---|---|---|---|---|
| **Gross Energy production** | KWh | 9,695,000 | 13,639,000 | 14,377,000 |
| **Losses Coefficient** | | 0.89 | 0.89 | 0.89 |
| **Specific yield** | $KWh/m^2$ | 808 | 1,137 | 1,198 |
| **Wind Plant Capacity Factor** | % | 23 | 32 | 34 |
| **Renewable Energy Delivered** | KWh | 8,582,000 | 12,073,000 | 12,726,000 |

It is important to mention that no optimization criteria have being used in this preliminary evaluation on the final matching of the specific type of turbine (either a 600 KW or a 850 KW machine) to the wind distribution available at the site. The selection of an 850 KW typical machine has been done on the upper installed power capacity indicated by the local developers. Expected electricity generation from the site using different types of turbines or nominal power of turbines will vary somewhat from the results presented here in a preliminary fashion.

The generation of electricity in most countries entails the emission of a given amount of $CO_2$ emissions due to the burning of fossil fuels. In the case of St. Lucia, the local utility (LUCELEC) operates a set of high efficiency thermal plants that provide electricity to the island. Average estimated CO2 emission intensity factors are likely to be on the order of 0.9 Ton $CO_2$/MWh[17] of electricity generated. Therefore an initial estimation on potential emissions reductions of the St. Lucia grid via the incorporation of the proposed project is in the range from 7,723 to 10,865 tons CO2/year (for the expected electricity generation of the wind farm for 5 and 6 m/s average wind speed). As will be discussed in the financial section, at an international price of US$ 4 per ton CO2, the project could benefit from an additional stream of revenues that could serve to make it more attractive for investment.

## Technology assessment

Wind Farm development has increased sharply worldwide over the last few years. A combination of factors has contributed to the growth and maturity of the wind industry. The different networks that are needed to support wind energy have grown consistently, contributing to its steady development. Technology reliability and assembling of design and implementation packages assures good engineering practices. Regulatory and market entry barriers have been reduced somehow due to the need to diversify and include renewable energy electricity. Innovative financing and project participant credit have also contributed to make wind energy to be a fast financial closure technology to the eyes of relevant investment and financial institutions.

Relevant experience on wind farm development is available in the World and Latin America region, although to a lesser extent in the Caribbean Region. Costa Rica, for example, has around 70 MW of wind installed; Mexico is currently designing several wind farm projects aiming at capacity contributions in the order of up to 1,000 MW. Experience in the Caribbean is emerging in places like Jamaica and other island states where there is on going design and financing work underway for wind energy projects.

[17] Based on information available from the United Nations Convention on Climate Change available at http://cdm.unfccc.int

Supporting networks for wind development are critical for its implementation. Know-how exchange, regulatory and dispatch aspects, project management and financing requirements required for a developer to develop strategic alliances with financing/consultancy/technology supplier companies in order to assemble the technology transfer packages.

**Cost indication / structure**:

The international practice of wind farm development and status of the technology indicate Capital Costs per Kilowatt installed in the order of US$ 1,000/KW. Reviewing the experience of different projects in the field indicate that from this international figure, developing country installations have normally resulted in capital costs in the range from US$ 1,200 to about US$ 1,600 depending on the experience curve available locally for dealing with technology and project management issues. In order to make a more conservative estimation in the economic evaluation of this project, both values on the range of cost of technology have been used here.

Typical cost structures of wind farm projects include the following:

- Feasibility Studies: 7%
- Project Development: 15%
- Engineering Design: 15%
- Equipment: 30%
- Balance of Plant: 25%
- Miscellaneous: 8%

Based on the above cost structures, costs associated with the investment at a wind farm at the proposed site could be as follows:

Total Project Costs for a 4,250 KW installation: US $ 5,100,000 to US$ 6,800,000

Operation and Maintenance Costs in the order of 3% per year, resulting in an O&M levelized cost of US$ 0.017-0.02 /KWh.

**Financial due diligence**

Financial simulations have been conducted in a variety of conditions for the project. The most important variables included are cost of technology, interest rates, tenor of the loan, avoided cost of electricity in the LUCELEC grid, and other aspects related to debt/equity structure, etc.

A simple Excel worksheet detailing the project financials has been used (presented in the annex to this brief) in order to assess some of the merits of the project and to analyze sensitivity to key variables. Please note there are a number of assumptions that govern the simulations, the technical ones are specified in the Excel worksheet. *A number of factors such as taxes, land expenses, transmission and distribution-related costs, etc. have not been priced in the simulations. It was beyond the scope of the project identification mission to price all these factors. Please be aware that the inclusion of other factors will reduce - sometimes substantially - the projected returns on these projects. The projected returns on these proposed projects appear very high in these initial workups.* The worksheet has been set-up in such a way that these costs can be easily inserted and their impact determined.

**Simulation Summary Table**

| KEY PARAMETERS FOR FINANCIAL SIMULATION | **PdC 4.25 MW**<br>**23% Capacity Factor** | **PdC 4.25 MW**<br>**34% Capacity Factor** |
|---|---|---|
| 10 years loan | Project IRR: **negative** | Project IRR: **negative** |
| 8% interest rate | Equity IRR: **negative** | Equity IRR: **31.5%** |
| 80%/20% debt/equity | Avg. debt service coverage: **.42** | Avg. debt service coverage: **1.59** |
| Avoided Cost US$.095 per kW | | |
| VER Sales | | |

The results obtained clearly indicate that the project is very sensitive to the wind regime available at the site. These results immediately call for the project developers to pay special attention to the implementation/ confirmation of a wind-monitoring programme at the site to reduce the risk of wind resource availability prior to the conduction of a full feasibility study.

The initial simulations indicate that the project is not a sound financial proposition. Given the costs not taken into account in these simulations there is little evidence that this project will be financially viable.

## Financing arrangements

Several financing arrangements may be appropriate for the development of the project. A combination of innovative financing schemes can be open to wind power development. Furthermore and pending on detailed barrier analysis on the implementation of wind energy in St. Lucia and in general in the Caribbean, may create the opportunity to access GEF type resources to assist in the removal of incremental costs associated to wind farm development.

Other possible alternative is to consider the possibility to develop a wind facility based on the organization of leasing schemes provided by non-regulated branches of utilities/suppliers of equipment in the international market. A major issue to consider relates to the proposed structuring of a project participants team as it relates to ownership interests and also on project management control.

## Implementation arrangements

The project developer for the Point de Caille Wind Farm project is likely to be LUCELEC. The company needs to receive appropriate permits and rights for the exploitation of wind resources in the proposed site.

Taking into account the project development experience of LUCELEC, it is likely that a project development structure will be set up for the coordination of project development activities. It is recommended that the project structure must include an internationally reputable wind energy consulting company with experience in developing projects like the one proposed.

There are suitable commercial/technology suppliers interested in participating in wind energy projects at different stages of development.

**Project barriers**

Access to relevant support networks: the project needs to integrate adequate support for the feasibility/design and financing stages, otherwise it may incur higher costs for sourcing the technology packages required for delivery of wind electricity in the local grid.

Technological: pending the implementation of the wind monitoring programme, there are no other perceived technical barriers, except from the important consideration to be given on how dispatch of wind will take place in the context of the St. Lucia transmission and distribution system.

**Recommended activities**

1. Implement a wind monitoring/confirmation programme at the site, involving the relevant technical personnel at LUCELEC, in order to reduce perceived uncertainties on wind resource assessment affecting the estimation of electricity production from the proposed wind farm.
2. Start a support programme for wind project development, project implementation aimed at reducing the perceived thermal generation "path dependencies" that are typical of small countries with a long history of fossil fuel generation, with the objective of assisting innovation in areas such as dispatch criteria, portfolio development, etc.
3. Based on the above, develop full feasibility studies linking with the experience of well qualified providers of engineering/consultancy/design services that are available internationally as part of the wind industry support networks.

**Project name: Fresh Eggs Ltd. Poultry Litter to Energy Project**

**Location: St. Lucia**

## Context

Many small and rural enterprises in St. Lucia are feeling the high cost of electricity as part of their production costs. Potential utilization of different types of biomass or waste products from production processes seems like an interesting proposition for business managers in the country. Sub-products like poultry litter can have a small but relevant contribution to end use energy service provision for process heat as well as for small captive power generation.

## Project description

The project is to be hosted by Fresh Eggs Ltd, a local producer of eggs, located in the Laborie area of southern St. Lucia. The production facility at Laborie houses 11,000 laying hens, producing year round, housed at a single building where production takes place. Near by to the egg production facility, the firm has a small warehouse facility where storage and preparation of eggs takes place. The project aims at considering the use of poultry litter generated in order to assist the production of energy services for the generation of captive power that will substitute the imports of grid electricity (used in a chiller and for water pumping loads) into the facility. To a smaller extent, but of importance is the consideration given by the local developer to the possibility of obtaining process heat for a potential addition of a small chicken nursery to be located at the site where young chicken will be kept as part of the rotation and animal management system to be implemented in increasing the volume of production.

Potential consideration has been given to different types of bio-energy conversion technologies, especially bio-digestion and gasification of the poultry litter available at the site. The project looks at the size of up to 7 kW, making it characteristic of small-scale and on-farm technology type. Based on the technology assessments carried out for such small size type of technologies, it is recommended that project activities should be based on bio-digestion technologies coupled to small IC engines (diesel engines with potential application in dual fuel conditions).

## Technical Due Diligence

*Availability of Poultry Litter*

Initial information was gathered for this project brief during a field visit conducted through a visit to the facility in December 2003. Fresh Eggs has an 11,000 laying hens under production at a single facility located outside of Laborie. The production of poultry litter depends on different factors, amongst which the amount of feedstock supply, and other characteristics of the animal management system are very important. On the basis of discussions had with Fresh Eggs manager during the field visit, the daily production of poultry litter ranges between 90 and 95 grams/bird. This value is slightly lower than values commonly quoted in the literature and relevant experience elsewhere. In the case of the facility considered, an average of 92 grams/bird/day is used for estimative purposes. It follows that the available resource is on the order of 1.012 tons of droppings per day. On a yearly fashion the expected production of poultry litter is on the order of 369 tons of poultry litter.

*Power Capacity and Energy Needs at the Plant*

Fresh Eggs consumes electricity and diesel. Electricity is mostly used for a chiller that cools the storage space for the warehouse where eggs are kept as well as for some water pumping used for the cleaning and washing operations at the facility. Although there is a lighting load, it is very small in comparison to the other ones. Diesel is supplied to a 6 kW diesel engine that operates as prime mover of an electricity generator used for the feeding system. In Table 1 a list of Fresh Eggs power requirements and energy consumption are quoted.

**Table 1 Power requirements and energy consumption**

| Load | Power [kW] | Operating cycle | Yearly energy consumption [kWh] | Yearly cost [EC$] | Yearly cost [US$] |
|---|---|---|---|---|---|
| Chiller | 0.75 | 24 hour/day, 7day/week | 6,570 | 3,942[18] | 1,460[19] |
| Pump | 2.25 | 6 hours every other day | 2,470 | 1,482 | 549 |
| Diesel motor | 6 | 8 minutes, 7 times a day | 2,190 | 1,437[20] | 532 |
| **Total** | **6.75** | | **11,230** | **6,861** | 2,541 |

Taking into account the load profiles as well as hours of operation, the power requirements are estimated on the order of 7-10 kW depending upon loads concurrence of utilization.

*Energy Conversion Technologies for Poultry Litter and expected power/electricity output*

There are two main possible technological paths for the energy conversion of different types of biomass (included poultry litter) at the scale of small-scale and on farm type applications in the range of up to 20 kW. Most of the energy conversion processes require a double process of conversion that starts at a chemical/thermal process that could be an anaerobic digestion or a gasification process, that results in a given producer gas (with different energy contents in the case of digestion and gasification). The produced flow rate of gas could then be used to drive an internal combustion engine (adapted to use the gas or operating in a dual fuel basis, that is burning gas and diesel).

*Anaerobic Digestion of Poultry Litter*

Some information was gathered on the technical aspects of the production of biogas from laying hen litter from www.britishbiogen.co.uk as part of a Good Practice Guidelines for Anaerobic Digestion Publication.

The aforementioned manual indicates that the dry matter content of poultry litter is in the order of 30 %, with a biogas yield ranging from 90-150 $m^3$/ton of feedstock and a calorific value in the range from 23-27 MJ/$m^3$ of biogas. It is also indicated that it normally takes about 8,000-9,000 laying hens to produce 1 ton/day of litter (which is slight higher than estimations done at the site visit where it was estimated that 11,000 hens would be producing around 1.012 tons/day).

Another important parameter to be considered relates to the energy output from each $m^3$ of biogas. The experience in anaerobic digestion indicates as a rule of thumb that it is possible to obtain for each $m^3$ at an average energy content of 20 MJ/m3 the following:

1. Electricity only: 1.7 kWh of electricity (assuming a conversion efficiency of about 30%)
2. Heat only: 2.5 kWh of heat (assuming a conversion efficiency of 70%)

---

[18] Electricity is currently supplied from the St. Lucia grid at a cost of EC$ 0.60/kWh.

[19] 1 US$ = 2.7 EC$

[20] This is the cost of diesel used. Assumptions:

- Diesel net heating value = 36.23 MJ/l (http://www.chevron.com/prodserv/fuels/bulletin/diesel/L2_4_6_rf.htm)
- Diesel engine plus electrical generator efficiency = 30%
- 1kWh = 3.6 MJ; 1 gallon = 3.7854 liters; Diesel cost = EC$ 7.50/gallon

3. Combined heat and power: 1.7 kWh of electricity and about 2 kWh of heat for process applications.

Taking into account those values available from the Good Practice Guidelines for Anaerobic Digestion, in the case of the Fresh Eggs facility it is possible to determine that in a project intended to generate small amounts of electricity the following parameters are likely to be obtained:

- Number of laying hens: 11,000 animals
- Daily production of litter: 1.012 tons/day
- Daily biogas production: 91-152 $m^3$/day
- Expected daily electricity generation: 155-258 kWh
- Expected yearly electricity generation: 45,260-75,336 kWh[21]

Supposing a 24-hour a day use of electricity at the site in order to supply the chiller and other uses of electricity, the power capacity of the proposed plant in St. Lucia would be in the range from around 7-11 kW. The biogas obtained would be more than sufficient to meet the energy needs and power requirements of Fresh Eggs facility.

Results reported in the aforementioned document on Good Practices for Anaerobic Digestion indicate that the capital costs for small digester/engine arrangements are in the order of US$ 5,000 to US$10,000 per kW.

The values obtained will be very dependent on the actual technology selected for the proposed site. Information has been received through UNIDO on the performance of small-scale poultry litter to energy plants in India[22]. Experience gained in India in such applications has indicated the following results from actual projects:

- Number of laying hens: 11,000 animals
- Daily production of litter: 1.65 tons/day (based on an 150 g droppings / day / bird)
- Actual Daily biogas production: 70-75 m3
- Expected daily electricity generation: up to 120 kWh
- Expected yearly electricity generation: up to 35,040 kWh23
- Power capacity: biogas generated able to run a 7.5 KVA diesel engine for about 10 hours
- Cost of the technology package: US$10,000 including engine (in India)

In this case, taking into account the minor amount of litter produced by Fresh Eggs facility, the power capacity that could be supported on a 24-hour a day basis would be in the range of 3-4 kW. However, considering that the chiller has a power requirement of 0.75 kW and the feeding system operates for just a hour per day, the biogas obtained could be sufficient to meet the energy needs and power requirements of Fresh Eggs facility. The price to pay would be a variable and non-optimal loading profile for the diesel engine.

The benchmarking expected results in term of electricity generation could be up to 45% higher than the results obtained with simple anaerobic digestion technologies (as demonstrated by the exemplified

---

[21] Capacity factor considered for the digestor/engine system = 80%

[22] Marco Matteini, UNIDO. Personal communication on the performance of floating dome design anaerobic digestors for poultry litter in India. January 27, 2004.

[23] Capacity factor considered for the digestor/engine system = 80%

technology from India). It is then possible that the biogas obtained could potentially not deliver enough energy to substitute the entire electricity used by the Fresh Eggs facility.

It is necessary to stress that expected electricity production from a digester/engine arrangement will be very dependent on the technology package selected/implementation capabilities and experience in the operation of such types of plants.

*Gasification of Poultry Litter*

Up to date there are no farm scale litter fired power generation systems using gasification technology employing poultry litter. A recent review of gasification technologies in the Indian context presents a comprehensive analysis of applications, barriers and interventions on the relevant issue of scaling up biomass gasifiers[24]. Gasification technology to utilize a variety of biomass type wastes is still not available, although there are ongoing efforts for utilizing a variety of feedstocks. Two relevant on-going experiences in the field of poultry litter gasification are:

1. A 500,000 Btu/hour[25] gasification system is currently being developed by Community Power Corporation (CPC), under a project with funding support from the U.S. Department of Energy's Small Business Innovative Research program, with technical assistance provided by the Foundation for Organic Resources Management (FORM) and others. The litter-fired system will employ a gas production module providing producer gas as fuel for existing commercial propane/natural gas-fired furnaces used in poultry houses and/or as fuel for a 15 kW engine/generator set. CPC's system will include a gas clean-up component (i.e., for tar reforming, catalytic reduction of ammonia, and particle filtration). A full-scale system will be field tested at the University of Arkansas' full-scale broiler research facility during the 2003~2004 heating season.
2. Biomass Technology Group is running and testing in its laboratory a complete "biomass-to-electricity" chain. This chain includes the biomass feeding, a fluidized-bed gasifier, catalytic tar removal, gas cooling and gas engine+generator. Maximum capacity is about 25 kg of biomass per hour (100 - 150 kWth). A large number of different feedstocks have been tested in this installation as e.g. wood, energy crops and dried chickens manure. A demonstration CHP plant based on this technology has been erected in The Netherlands. In that particular case dried chicken manure from 42,000 animals producing around 5 ton/day of droppings is used as the feedstock. The power capacity is about 60 kWe. The unitary feedstock consumption per unit electricity generated on a 24-hour basis is on the order of 3.4 kg of litter per kWh produced. Such "first-of-its-kind" installation has had high investment costs (€ 450,000).

In India, many different types of gasifiers have been designed, tested and implemented for several types of feedstocks at the small scale level, and benchmarks indicate that performance parameters for 100% producer gas based systems will consume in the order of 1.5 kg of biomass/kWh generated (although no specific information has been gathered of relevant experience in gasification of poultry litter). Taking into account the state of the art in this area, it is recommended that in the case of Fresh Eggs, consideration should be given to the anaerobic digestion conversion technology. Unless specific support from international donors is received, it is hard for a small rural enterprise in a developing country to be able to manage the risks, financing requirements and design challenges required for

[24] Scaling up biomass gasifier use: applications, barriers and interventions. Debyani Ghosh et al. The Energy and Resources Institute (TERI) and TERI School for Advanced Studies and Harvard University. November 2003.

[25] Assuming that this value represents the fuel input capacity and that the poultry litter HHV on wet basis is 10,000 Btu/kg, the litter supply required by this gasification system is equal to 50 kg/hour.

innovation in the gasification field, especially since no commercially available technology packages have been identified during the development of this pre-feasibility evaluation.

### Technology Assessment

Any decision to establish an Anaerobic Digestion (AD) Project will be based on an assessment by the farmer or the developer of the marginal increased costs (if any) set against the additional benefits and opportunities created. AD will generally be a more expensive capital option for farmers seeking solutions to their residue and/or pollution problems, or seeking the generation of energy services in-farm. It is most likely that linkages need to be established by the farmer in the way of thinking on the energy value of a feedstock and the alternatives costs of waste management. A list of key questions available from www.britishbiogen.co.uk exemplifies the dilemmas faced by a local farmer:

- What are the capital costs involved?
- What are the O&M recurrent costs?
- What are the relevant permits and regulatory frameworks?
- Do we need special training for operation?
- Do the extra benefits from the process and the opportunities for possible income or savings warrant spending extra?
- Does the farmer have the time, inclination and necessary skills to consider AD conversion technologies?

Some of the characteristics of AD are presented as follows:

**Table 2. Technology Assessment of Anaerobic Digestion Technologies**

| Option | Merits | Problems | Conclusions |
|---|---|---|---|
| **Anaerobic Digestion** | • Good odor control<br>• Possible energy generation<br>• Valuable digestate: fiber (soil conditioner), and liquor (liquid fertilizer)<br>• Continuous flow process<br>• Improves storability<br>• Ease of handling<br>• Reduces spreading costs<br>• Reduces methane emissions | • High capital costs for full systems<br>• Operational costs may be high if experimenting stability problems<br>• Needs to be integrated into the whole business perspective (as an investment is very different form the purchase and use of diesel engines for example)<br>• Requires daily management of the process and assessments related to performance | • Comprehensive<br>• Management driven<br>• Most suitable for producers that are facing specific waste management problems and are prepared to give extra commitment to overcome problems (not necessarily just interested on an energy service problem or cost) |

Source: Good Practice Guidelines on Anaerobic Digestion of farm and food processing residues. Available from www.britishbiogen.co.uk

*Commercial aspects*

No commercial supplier of AD technology has been identified in St. Lucia at this time. Information has been sparsely gathered on a couple of attempts to introduce AD small scale technologies in the island, mainly through the action of agricultural extension programs with the participation of government agencies or NGO's, although it has not been possible to assess the extent of what kind of technology was used or the commercial/demonstrative aspects of it.

*Experience*

Through the development of this scoping exercise it has not been possible to assess relevant experiences on anaerobic digestion available in St. Lucia or this part of the Caribbean. It is important top mention that in the context of the development of indigenous renewable energy, a growing experience on the use and implementation of digesters, Cuba has been conducting testing and implementation of rural small scale systems in different types of agricultural applications; experience that may be relevant to the context of other small islands in the Caribbean.

*Availability*

It has not been possible to assess the availability of commercial packages of anaerobic digestion in this part of the Caribbean. It is likely that most of the applications so far have been of a demonstrative type, with special "design tailoring" to particular types of residues.

*Supporting Networks*

The development and implementation of anaerobic digestion technologies requires the local availability of supporting networks for design, operation, training and program development. The non-existence of those networks may create a one of a kind project where the local developer may indeed face barriers that would not permit the efficient operation of a system in the field. In most countries where AD is a viable technology, such networks are present. In the context of developed countries, the presence of consultants and design groups as well as suppliers is critical. In most developing countries, like India and China, proper networks on appropriate technology and design of bio-digestors are normally present. Without such networks, it is very hard to manage the associated risks of the technology; an issue that is critical if a local developer is in the need for debt capital to finance an AD facility.

*Technology Transfer*

AD is a technically viable technology that requires careful integration of transfer packages, especially in relation to design, manufacturing and operation. It is likely that unless the proposed size of a facility is sufficiently large to merit the individual undertaking of the development, programmatic development of projects at the national level will be required in order to assess the merits and dissemination of AD.

## Cost Indication / Structure

Based on the limited available experience in the Caribbean in the field of AD technologies, but taken into account the experiences on costs structures relevant for the deployment of AD, a broad range of capital costs for the proposed project has been identified in the literature and market information.

Such capital costs can be in the range from US$ 1,500/kWe (for small systems in India) up to the US$ 10,000/kW found in the European context. It is likely that the higher range is applicable to systems where very rigorous standards on emissions are applied as well as requirements on system integration characteristics. Taking into account the availability of the resource at Fresh Eggs Ltd, that indicated a system with a targeted 7 kW installed capacity, the following structures have been used for developing economic evaluations of the project:

- Proposed project size: 7 kW
- Electricity generation: 32,850 – 55,850 kWh/year
- Capital costs: US$ 10,500- US$ 45,000

- Installation costs: 20% of the capital costs
- Avoided cost of buying electricity in the grid: US$ 0.222 (based on a cost of electricity to the final user in the order of EC$ 0.60/kWh in St. Lucia.

The main parameters for the evaluation of the project are:

- Interest rate: 9 %
- Debt Repayment period: 5-10 years

**Financial due diligence**

Financial simulations in support of the project have been carried out for a variety of conditions. The most important variables included are cost of technology (including the distinction between developed/developing country sourcing), interest rates, tenor of the loan, avoided cost of electricity to the nutmeg association, and other aspects related to debt/equity structure, etc.

A simple Excel worksheet detailing the project financials has been used (presented in the annex to this brief) in order to assess some of the merits of the project and to analyze sensitivity to key variables. Please note there are a number of assumptions that govern the simulations, the technical ones are specified in the Excel worksheet. *A number of factors such as taxes, land expenses, transmission and distribution-related costs, etc. have not been priced in the simulations. It was beyond the scope of the project identification mission to price all these factors. Please be aware that the inclusion of other factors will reduce - sometimes substantially - the projected returns on these projects. The projected returns on these proposed projects appear very high in these initial workups.* The worksheet has been set-up in such a way that these costs can be easily inserted and their impact determined.

**Simulation Summary Table**

| KEY PARAMETERS FOR FINANCIAL SIMULATION | **Poultry Litter 7 kW**<br>**Technology sourced from India**<br>**US$ 1,500/kW installed** | **Poultry Litter 7 kW**<br>**Technology sourced from Europe**<br>**US$ 10,000/kW installed** |
|---|---|---|
| 10 years loan<br>8% interest rate<br>80%/20% debt/equity<br>Avoided Cost US$.095 per kW<br>VER Sales | Project IRR: **26.12%**<br>Equity IRR: **114.7%**<br>Avg. debt service coverage: **3.25** | Project IRR: **negative**<br>Equity IRR: **negative**<br>Avg. debt service coverage: **negative** |

The project is sensitive to the capital costs of the proposed technology. The project is attractive if technology can be sourced from India or the transfer of the know-how and designs from India can be arranged. However if the current state-of-the-art technology being produced and piloted in Europe is considered the project is in no way financially viable.

Under standard assumptions of an 80%/20% debt to equity gearing ratio and a ten year loan at 8% interest the project illustrates financial strength when the technology is sourced from India and the poultry operation is able to offset current payments for electricity. The poultry company currently pays the utility the EC$ equivalent of US$. 22. Considering the price currently paid to the utility for electricity a project sourcing technology from India yields a respectable rate of return and solid debt coverage ratio. Given the financial strength of the parent company a Project IRR over 25 % should be sufficient to attract the interest of investors even when all the other costs are factored into the project.

**Financing arrangements**

It is not possible to assess the financing arrangements of this project. Conversations have to be initiated with the developer, as to assess the view on recognition of benefits, risks and costs of such a project. A farmer would normally require to know more about a commercial package related to AD technologies, or to know about the local support network in place for the development of a project. It is not excluded that the developer may want and is willing to undertake the associated risks for the development of the project. It is likely that local credit, available from the local banks may be available for the financing of this kind of project.

**Implementation arrangements**

The identified project developer for this project is:

Fresh Eggs Limited.

Person of Contact: Urban Wilson.

Tel: 758 455 9000

No partners have been identified as additional project participants/suppliers of technology.

**Project barriers**

No current commercial applications of AD technology are available in St. Lucia. This relative lack of experience in designing AD reactors, may have a major influence on the development of the project, and weather or not the project reaches adequate levels of electricity generation, in order to achieve adequate performance indicators.

Support networks are not available at this time in the country in order to provide appropriate consultation and development services for a project of this nature.

**Recommended activities**

GSII may consider providing support for the development of a comprehensive undertaking related to assess the merits and potential for the implementation of anaerobic digestion conversion technologies in island states.

It is necessary to conduct an assessment of current developments in the Caribbean with respect to the development and commercialization of technology packages related to anaerobic digestion. Local support will be needed to assess capabilities, training needs for the transferring of internationally available technologies.

**Comments**

Anaerobic digestion can potentially provide a large contribution to small scale rural energy service provision in developing countries. At the same time it faces major entry barriers, requiring from the establishment of coordinated actions supporting the development/adaptation and commercialization of the technology. Synergies must be exploited in relating energy service provision and waste management alternatives at the farm level. Sustainable development platforms and energy policy should consider country-wide objectives that may link bio-energy potential with the mainstreaming of the energy sector.

**Project name: Energy and Power Losses Reduction Program in DOMLEC Distribution System**

**Location: Dominica**

### Context

Electricity distribution in Dominica is operated by the national power utility, Dominica Electricity Services Limited (DOMLEC). According to the national Electricity Supply Act, DOMLEC holds the sole exclusive license for the generation, transmission, distribution and sale of electricity in the island. Grid coverage is about 97%. In 2002 DOMLEC operating performance was as follow:

| | |
|---|---|
| Gross generation: | 80,132 MWh (44.8% hydro; 55.2% diesel) |
| Sales: | 63,981 MWh |
| Own consumption: | 1,508 MWh |
| Energy losses: | 14,643 MWh (18.3% of gross generation) [26] |

DOMLEC is currently having big problems with the Government, which tried to make them insolvent. The World Bank has recently stepped in as mediator. Due to the uncertainty of the situation DOMELEC is going through a period of lack of financial resources because no bank is willing to lend money[27].

### Project description

The project looks at interventions aimed to reduce energy and power losses in DOMLEC distribution system. Two major interventions are proposed: (i) efficiency improvements in the distribution system through power factor correction, transformer replacement and demand side management, and (ii) construction of a 66 kV transmission line.

### Technical due diligence

*Generation*

Total generating installed capacity amounts to 20.44 MW: 7.6 MW hydro and 12.84 MW diesel. Firm capacity is 3.2 MW for hydro (during the dry season) and 10 MW for diesel. The three micro hydro plants are located at Laudat, Trafalgar and Padu and have all been developed along the Roseau river basin. The two diesel plants are located at Fond Cole` and Sugar Loaf.

*Distribution system*

DOMLEC grid does not have a transmission system. There is just a distribution system with a backbone line at 11 kV. In 2001 energy losses exceeded 19%. In 2002 losses were 18.3% of gross generation, 18.6% of net generation[28], for a total wasted energy of 14,643 kWh.

Losses are calculated according to the following formula:

*Energy losses = Gross generation – Electricity sales – DOMLEC's own consumption*

How these losses split in technical and non-technical losses, so-called commercial losses[29], is difficult to state. Estimates provided by DOMLEC officials place technical and commercial losses somewhere

[26] All figures are from 2002 DOMLEC Annual Report.

[27] Murray Rogers, CDC Globelec Investment Manager

[28] Net generation = Gross generation – DOMLEC's own consumption = 80,132 – 1,508 = 78,624 MWh

around 10% and 8% respectively. However, the reliability of these figures is uncertain. On the one hand the existing metering system consists of devices more than 20 years old and some metering errors have been discovered during a survey carried out recently. On the other hand, technical losses have been estimated using Load-Flow and a recently adopted System Control and Data Acquisition System (from EDSA) that is still not in full operation. Taking into account the topology and characteristics of the grid in Dominica, Grenada and St. Lucia, and comparing the respective operating performance, DOMLEC's technical energy losses are likely to be significantly higher than 10%. In the present brief it is assumed that in 2002 technical and commercial losses respectively amounted to 14% (11,200 MWh) and 4.6% (3,443 MWh) of net generation.

Energy losses

As mentioned before DOMLEC energy losses in 2002 were 18.3% of gross generation. In a small electrical system, like Dominica's one, transmission and distribution (T&D) losses should be in the 4 to 6 percent range. In general losses are particularly high at the end of the distribution system, especially in low-tension feeders and distribution transformers.

As for technical energy losses, from preliminary discussions with DOMLEC engineers, the following information has been collected.

Power factor. DOMLEC average power factor is approximately 0.82 while recommended values would be 0.95 or higher. DOMLEC has recently planned to bring online some capacitors banks to improve power factor.

Installed transformer capacity. DOMLEC peak power demand in 2002 was 13.043 MW while total installed transformer capacity is 43 MVA. In some residential areas the average transformer load factor sinks low to 30% when the optimal load factor, from an efficiency standpoint, is 70-80%. Further analysis is needed in order to assess if the installed transformer capacity to power peak demand ratio is appropriate or is too high. Besides the inefficient use of transformers, such low transformer load factor tends to reduce and therefore worsen the power factor situation. DOMLEC has decided to optimize and wherever appropriate reduce the installed transformer capacity through a transformer replacement program.

Maintenance of distribution system: DOMLEC does not do any maintenance or monitoring work on transformers and distribution lines. Whenever a transformer fails, it is simply replaced (transformers replaced in a year are 6/7 out of 705 stock and the average transformers lifetime is about 10 years[30]). Diagnostic measurements of line impedance are not taken.

As for commercial losses, DOMLEC officials have not mentioned episodes of electricity theft, therefore commercial losses seem basically to be traced back to the obsolete and worn out existing metering system. Some metering errors have been discovered during a survey carried out recently by DOMLEC.

## Technology assessment

The industry of electricity transmission and distribution is a worldwide mature industry with acknowledged best practices on system network planning, monitoring and management. Typical technical interventions aimed to reduce energy and power losses in T&D systems include the provision of adequate capacity in overloaded T&D systems; the addition of power factor correction

[29] Non-technical or so-called commercial losses reflect the failure of the utility to meter and/or bill consumers and its failure to control illegal connections.

[30] Mark Riddle, DOMLEC Engineering Service Manager

capacitors or overexcited synchronous motors to correct the power factor; the reduction of harmonics; the use of low loss distribution transformers; balancing load-sharing between phases in three-phase systems; changing distribution system design and etc.

DOMLEC network development and operations are managed by the Engineering Services Department (ESD), which is responsible for the planning, design and analysis of the network, and the Power Production Department (PPD), responsible for the power generation. Given present network operating practices as well as human resources, it is expected that external technical expertise will be required to support DOMLEC engineers in the implementation of most of the intervention targeted to reduce energy and power losses in the distribution system.

**Energy efficiency improvement and retrofit of the distribution system – cost indications**

There are several interventions that can improve performance and efficiency of DOMLEC distribution system.

*Power factor correction*

Reactive compensation represents one of the most cost-effective interventions for reducing energy and power losses in poorly performing transmission and distribution systems. DOMLEC has planned to bring online capacitors banks to improve the power factor of the distribution system. The objective is to take the actual average power factor from 0.82 to 0.95. In Table I are quoted the data of the capacitors that the ESD has planned to add.

**Table 1. Data of ESD reactive compensation program**

| Capacitor Reactive Power [kVAr] | Rated Voltage [V] | Switched (S), Connected (C) | Number of Units | Unit Cost (EC$) | Unit Cost (US$) |
|---|---|---|---|---|---|
| 150 | 6,582 | C | 13 | 3000 | 1,112 |
| 300 | 6,582 | C | 3 | 3300 | 1,222 |
| 400 | 6,582 | C | 6 | 3900 | 1,444 |
| **Tot. 5,250** | **Total** | | **22** | **63,390** | **26,786** |

The total reactive power planned to be added by ESD engineers is that needed to bring the power factor to 0.95 during peak power demand conditions. These capacitors will be connected at bus bars of generating stations since DOMLEC is presently monitoring the power factor only at these points (however, it has recently started to plan the introduction of additional power factor monitoring points).

It has to be pointed out that compensating for low power factor at the generating station bus bars is not as effective in reducing distribution losses as compensating at the point of connection of the low power factor loads to the grid. Although a number of considerations complicate the application of the general principle of installing compensation at the source of reactive demand, it is important to investigate the possibility of connecting some of the new capacitors along distribution feeders as energy and power losses reduction would significantly increase.

DOMLEC has not provided an estimate of expected losses reduction but some estimates can be done. Provided to place capacitor banks close to their theoretically optimal location, technical energy losses can be expected to decrease from 14% to 12.5% or less depending upon the distribution of reactive loads on the grid. In absolute terms electricity saved in 2002 would have been more than 1,200,000 kWh and yearly savings from avoided costs of production and distribution would have amounted to US$ 192,000.

However, in order to place capacitor banks close to their optimal location a detailed analysis of the loads distribution and the loading patterns of the grid should be conducted. It has to be noted that compensating at the source of reactive power demand imply the need of more small capacitor banks and less big units as well as the use of switching capacitor banks.

Hereinafter a tentative cost breakdown of a power factor correction program is shown. With respect to the equipment costs the estimate has been done by taking into account the total capacitive reactive power demand quoted in Table 1; the base, average and peak load of DOMLEC distribution network and assuming that only 150 kVAr units will be needed.

| | | |
|---|---|---|
| Technical due-diligence and design of the PFC Program | US$ 60,000 | EC$ 162,000 |
| Procurement cost and freight | US$ 42,000 | EC$ 113,400 |
| Installation and commissioning | US$ 10,000 | EC$ 27,000 |
| Civil works and circuit upgrades | US$ 30,000 | EC$ 81,000 |
| Total | US$ 142,000 | EC$ 383,400 |

In order to improve the power factor, beside these purely technical interventions, DOMLEC should also undertake the reform of its tariff regime and introduce, for industrial and commercial customers, a penalty geared to their power factor performance. With the present tariff regime commercial and industrial customers are charged for their energy consumption plus only a fixed fee for the installed nameplate power. The consequence is that households are likely paying for distribution losses mainly caused by commercial and industrial customers.

*Transformer replacement programme*

DOMLEC total installed transformer capacity to peak power demand ratio is 3.3 at the moment. Further analysis is needed in order to assess if this ratio is appropriate or is too high. In the latter case the transformers average load factor would be lower than it could be. In some residential areas transformers load factor gets to 30% when the optimal level would be 70-80%. Investigations are needed to determine if such low load factor is just a consequence of very poor transformer load profiles or partially due to over-dimensioned transformers. Table II provides the inventory of actual transformers installed.

**Table 2. Current DOMELEC transformer inventory**

| Transformer Rated Power [kVA] | Transformer Rated Voltage [kV] | Transformer Type (Single/ Three Phases) | Number of Units |
|---|---|---|---|
| 5 – 30 | 11 | Single | 389 |
| 31 – 75 | 11 | Single / Three | 195 |
| 76 – 150 | 11 | Single / Three | 67 |
| 151 – 300 | 11 | Three | 27 |
| > 300 | 11 | Three | 27 |
| | | **Total** | **705** |

In order to improve the average transformer load factor DOMLEC has designed a transformer replacement programme that aims to replace improperly sized low power transformers (331 units in the 5-30 kVA range). The estimated costs of the programme, with cost of capital and insurance included, are the following:

| | | |
|---|---|---|
| Procurement cost and freight | US$ 285,185 | EC$ 770,000 |
| Testing, installation and commissioning | US$ 66,667 | EC$ 180,000 |
| Civil works and circuit upgrades | US$ 148,148 | EC$ 400,000 |
| Total | US$ 500,000 | EC$ 1,350,000 |

Through this programme DOMLEC would expect to achieve a 1 % reduction in energy losses and subsequent yearly savings for US$ 128,000.

*Demand side management*

It has been aforementioned that the average transformers load factor gets to 30% in some residential areas. It is important to note that this low value is not just due to likely oversized transformers but it is also due to the peculiar profile of the daily power demand, which presents a wide gap between the base load time and the peak load time. Since transformers are sized to meet the peak power demand within their rated capability, as a consequence, the average load factor would be poor even for optimally sized transformers (see Fig.1). Taking this into account, DOMLEC should consider the possibility to adopt, in these residential areas, some demand side management measures. A technically and commercially viable intervention would be the dissemination of solar water heating systems. The displacement of the electric water heating systems actually in use in residential areas would have a great impact on the power peak demand (less on the energy consumption) considering that the power requirement of a single system ranges from 3.3 to 10 kW.

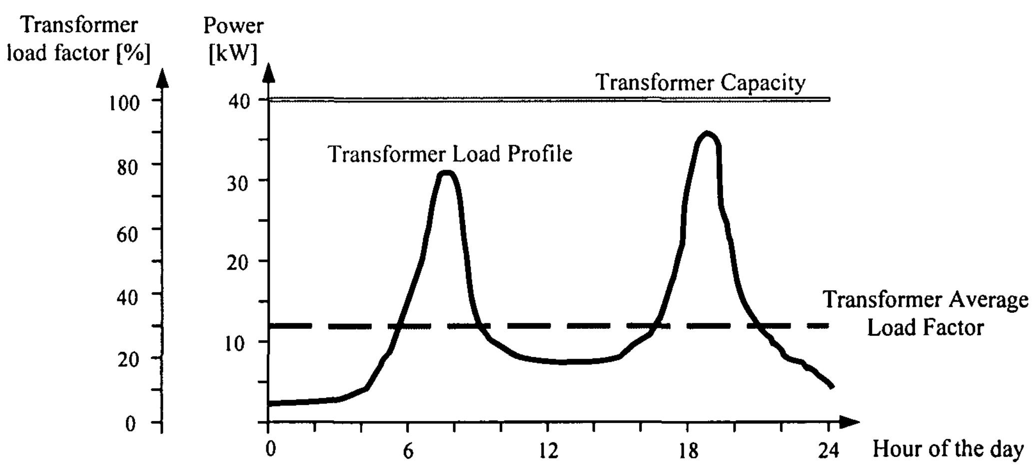



Fig.1 Effect on transformer average load factor of huge peaks in transformer load profile.

*Metering system retrofit*

Although this intervention would not bring on any reduction of technical energy losses it is mostly needed in order to have a reliable estimate of commercial and technical losses. DOMLEC has already started a meters replacement programme. The programme plan provides for the substitution of 4,000 meters annually, at a cost of approximately EC$ 600,000, and aim to replace approximately 16,000 meters over the next four (4) years.

### Construction of a transmission line – cost indications

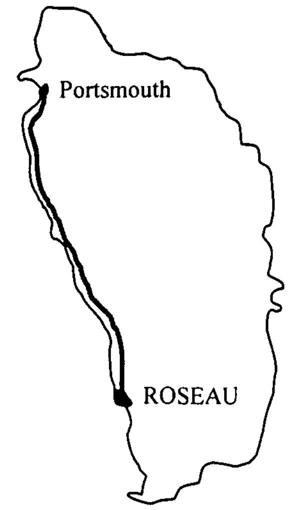


Fig.2 Transmission line route

DOMLEC already explored, about 5 years ago, the possibility to construct a transmission line between Roseau, the capital, and Portsmouth. At that time a strip of land for the transmission line was identified and cost estimates were asked to a constructor (Fig.2).

For a 33 kV 45 km long transmission line the estimated costs were as follow:

| | |
|---|---|
| Design, erection, site test and commissioning | US$ 4,016,700[31] |
| Substations –indoor switchgear | US$ 2,643,958 |
| Total | US$ 6,660,658 |

For a 66/69 kV 45 km long transmission line the overall estimated costs were 17% (or 30%) higher, which means US$ 7,792,970 (or US$ 8,658,855).

Because of financial constrains, present DOMLEC development plans provide for a 33 kV transmission line. However, the 66/69 kV option would guarantee DOMLEC against the risk of load saturation, even in the longer term and it would be more cost-effective from the perspective of possible future inter-island grid connection, since in the rest of the Caribbean islands the standard voltage for transmission line is mainly 66kV.

Through the realization of the transmission line DOMLEC expects to bring down technical energy losses to 10%. With reference to 2002 this would have meant 3,200,000 kWh saved. Assuming that the cost of production and distribution per kWh is about 16 US cents[32], yearly savings from avoided costs would have amounted to US$ 512,000.

### Financial due diligence

Financial due diligence will be carried out in the next phase of the GSEII project.

### Implementation arrangements

DOMLEC has sufficient relevant experience and expertise to execute the project with some technical assistance from the GSEII project. In case DOMLEC should prefer not to execute some of the projects / interventions, ESCO, EPC or technology partners will have to be identified.

### Project barriers

Lack of financial resources. DOMLEC has recently had severe problems in borrowing money as consequence of its legal and institutional problem with the government.

Technical expertise. Technical expertise is available but some assistance and training will be needed, particularly within the distribution planning and management department, where there seems to be a problem of limited engineering resources.

---

[31] Exchange rate considered: 1 US$ = 2.7 EC$

[32] This value has been worked out from DOMLEC data and the breakdown of LUCELEC cost of electricity production

Institutional climate. The institutional climate between the government and DOMLEC, should not improve in the future, could represent the very main obstacle to any project or intervention because of its repercussions on DOMLEC's possibility to access loans.

**Recommended activities**

Electrical network reinforcement and efficiency improvements are interventions that should be always carried out maintaining a comprehensive perspective of the network and following a consistent and systematic procedure. This includes also the availability of reliable and precise data and information about the network, i.e. loads distribution, load profiles of biggest customers, loading patterns at selected locations of the distribution system, impedance value of sampled line sections, etc. The reliability of such data become of paramount importance when software packages with user-defined network models are used to estimate technical energy and power losses in the network, since the results of software simulations will represent the starting point of any economic analysis of possible network reinforcement and efficiency improvement measures. Taking this into account, any interventions targeted to reinforce and improve efficiency of DOMLEC network should be preceded by an independent technical study, including field measurements, of DOMLEC network operating performance. Possibly, such preliminary study should be combined with training of DOMLEC personnel, where appropriate, in data collection, management and automation.

As for the **efficiency improvements of DOMLEC distribution system** recommended activities are the following:

1. Undertake independent technical due diligence of power factor improvement and transformer replacement interventions. This exercise would represent a major component of the aforementioned preliminary technical study of DOMLEC network. Taking into account the cost and benefit indications of the power factor correction intervention it is suggest to consider the possibility to include the technical study of DOMLEC network operating performance in this intervention.

As for the **transmission line construction** recommended activities are the following

1. Discuss with DOMLEC potential financial and implementation arrangements, etc;
2. Explore Government interest in supporting the project (by streamlining legal and administrative cases related to land ownership and sale; by providing tax concession on procured equipment; etc;)
3. Identify potential financing sources and explore interest in the project;
4. Pre-feasibility or feasibility study done by an international transmission line EPC contractor

**Comments**

1) With regard to the potential improvements in transformer load factor that could be achieved through demand side management measures, it would important to involve DOMLEC in the Caribbean Solar Finance Programme (CSFP). DOMLEC should track the changes in the daily power demand profile of those residential areas in which electrical water heaters will be replaced with solar water heaters (SWH) and analyse the impact on transformers load factor and losses. The ideal scenario would be 5-10 SWHs installed in a limited residential area that is under the same distribution transformer. It is suggested to consider the allocation of some financial resources to such activity within the CSFP.

2) With regard to the transmission line construction project synergies could and should be eventually established with the Eastern Caribbean Geothermal Development Project and EDF in

particular. Connecting Martinique and Guadalupe via Dominica will almost certainly require the construction of a transmission line in Dominica.

3) The Caribbean Association of Electric Utilities (CARILEC) in collaboration with KEMA Consulting has started in Fall 2003 the first ever Caribbean Electric Utility Benchmark Study. The objectives of the Study are the following

- Identify, measure and benchmark performance indicators for each participating Caribbean electric utility with regard to its: technical, commercial and organizational performance;
- Identify international "Best Practices" of the electricity industry for the most relevant indicators selected to determine the standing of island systems against the international practices;
- Conduct an appraisal of the performance profile of the participating Caribbean electric utility for future improvement strategies and targets;
- Compare the performance of the electric utility against the regional and international best practices;
- Make recommendations to the Chief Executive Officer of each electric utility on the issues which have been identified as most occurring weak points;
- Use the findings of the study to establish a performance monitoring system for the company.

In the light of such initiative and its objectives the proposed interventions on DOMLEC network are mostly relevant to and supportive of efforts made at regional and national levels within the energy industry. Collaboration and synergies with CARILEC's initiative should be pursued.

**Estimate of potential savings and CER revenues from energy efficiency improvement in the DOMLEC distribution system in the light of the "Simplified modalities and procedures for small-scale CDM project activities" recently issued**

*Annual savings*

In 2002 DOMLEC's total energy losses amounted to 14,643 MWh, equal to 18.6% of net generation. The energy losses in a small network like the one of a small island should not exceed 5-6%. If it is assumed that technical energy losses amounts to 14% (commercial losses 4.6%) and a target of 6% it is set, it follows that approximately 6,400 MWh of energy will be saved.

Assuming that DOMLEC cost of electricity production and distribution per kWh is 16 US cents – value deducted by LUCELEC electricity cost breakdown and DOMLEC electricity price – savings in 2002 would have been:

$$0.16 * 6,400,000 = \text{US\$ } 1.024 \text{ million}$$

*CDM and CER revenues*

Activities targeted to improve energy efficiency of T&D systems can be qualified as Small Scale CDM project as long as energy savings are less than 15 GWh (15,000,000 kWh) per year. This means that the Dominica T&D system upgrade could be qualified as such.

Assuming that the value of a certified emission reduction (CER) is 5 US$, that the emission factor is calculated according to par. 29 (b) of the Appendix B of the simplified modalities and procedures for small-scale CDM project activities and that a single crediting period of 10 years is chosen, the CER revenues from the project would be the following:

Annual energy saving: 6,400 MWh

Emission factor (t $CO_2$equ/MWh): 0.606

Annual avoided GHG emissions: 3,878 t $CO_2$equ (≅ 6,400 * 0.606)

Annual CER gained: 3,878

Assumed CER value: 5 US$

Ex-post crediting (US$): 193,900 (=3,878 * 5 * 10)

Discount rate r: 8%, 10%

Net Present Value (r = 8%): 89,813 US$ ( $NPV = \frac{193,900}{(1+0.08)^{10}}$ [1])

Net Present Value (r = 10%): 74,765 US$ ( $NPV = \frac{193,900}{(1+0.10)^{10}}$ )

It has to be noted that calculation have been made assuming constant yearly energy savings over a decade. But taking into account that the energy demand increases, energy savings will also increase. The CDM provides for dynamic baseline.

## ANNEX D: FINANCIAL WORK-UPS OF IDENTIFIED SCREENED CLEAN ENERGY PROJECTS

**Project name: Grenada Nutmeg Shell to Energy Project**

| 15 kW GRENADA NUTMEG SHELL-TO-ENERGY PROJECT | |
|---|---|
| IPP Model | 11-Mar-04 |
| | |

| SECTION I. ASSUMPTIONS | | all figures in US$ |
|---|---|---|
| | | |
| A. CAPITAL STRUCTURE | | |
| Total Project Assets (land not included) | | $ 37,500 |
| Equipment & Civil Costs | | $ 37,500 |
| Transformer Cost | | $ - |
| Transmission Cost | | $ - |
| Equity Capital | 20% | $ 7,500 |
| Loan | 80% | $ 30,000 |
| | | |
| B. LOAN DETAILS | | |
| Loan amount | | $ 30,000 |
| Interest | Annual Rate | 8.00% |
| Repayment Period (years) | | 10 |
| Annual repayment amount | | $ 3,000 |
| | | |
| C. GENERATION DETAILS | | |
| Installed Capacity | kW | 15 |
| Days Generating | days | 365 |
| Hours Generating Per Day | hours | 24 |
| kWh per year | | 105,120 |
| Rate per kWh (50% of Grenlec price) | $/Unit | 0.13 |
| Gross annual revenue for generation | | $ 13,666 |
| Capacity Factor | % of installed capacity | 80.00% |
| | | |
| D. OTHER ASSUMPTIONS | | |
| Management Costs | % of total proj cost | 2.00% |
| Equipment + Civil Cost | per KW installed | $ 2,500 |
| Transmission costs | per meter | $ - |
| Transmission line required | meters required | 0.00 |
| O&M | % of total proj cost | 4.00% |
| Land Expenditure | | $ - |
| Income Tax Rate | % per year | 0.00% |
| Insurance Expense (construction) | % of total proj cost | 2.00% |
| Insurance Expense (T&D) | % of total proj cost | |
| Inflation Factor | 5% per year | 105.00% |
| VERs Generated (.9 kg CO2/kWh) | metric tonnes per year | 94.61 |
| VER rate (US$ per metric ton) | per VER | $ 3.00 |
| Depreciation Rates: | | |
| - buildings and generation unit | % per year | 2.90% |
| - transmission and distribution | % per year | 7.00% |

**All changes in assumptions to be made above this line. Section below is linked to the above assumptions.**

| | | YEARS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | Expected revenue (KWh sales) | 13,666 | 14,349 | 15,066 | 15,820 | 16,611 | 17,441 | 18,313 | 19,229 | 20,190 | 21,200 |
| 2 | Expected revenue (CC-related) | 255 | 268 | 282 | 296 | 310 | 326 | 342 | 359 | 377 | 396 |
| 3 | Management Costs | 750 | 788 | 827 | 868 | 912 | 957 | 1,005 | 1,055 | 1,108 | 1,163 |
| 4 | O&M Costs | 1,500 | 1,575 | 1,654 | 1,736 | 1,823 | 1,914 | 2,010 | 2,111 | 2,216 | 2,327 |
| 5 | Land Expense | 0 | | | | | | | | | |
| 6 | Insurance | 788 | 827 | 868 | 912 | 957 | 1,005 | 1,055 | 1,108 | 1,163 | 1,222 |
| 7 | Transmission Line | 0 | | | | | | | | | |
| | Project Revenues | 10,884 | 11,428 | 11,999 | 12,599 | 13,229 | 13,890 | 14,585 | 15,314 | 16,080 | 16,884 |
| 8 | -37,500 | 10,884 | 11,428 | 11,999 | 12,599 | 13,229 | 13,890 | 14,585 | 15,314 | 16,080 | 16,884 |
| Project IRR | 17.45% | | | | | | | | | | |
| 9 | Depreciation | 1,088 | 1,056 | 1,025 | 996 | 967 | 939 | 911 | 885 | 859 | 834 |
| | - buildings and generation unit | 1,088 | 1,056 | 1,025 | 996 | 967 | 939 | 911 | 885 | 859 | 834 |
| | - transmission and distribution | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Interest on loans | 2,400 | 2,160 | 1,920 | 1,680 | 1,440 | 1,200 | 960 | 720 | 480 | 240 |
| 11 | Profit Before Tax | 7,396 | 8,212 | 9,054 | 9,923 | 10,822 | 11,752 | 12,714 | 13,709 | 14,741 | 15,809 |
| 12 | Taxation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | Profit After Tax | 7,396 | 8,212 | 9,054 | 9,923 | 10,822 | 11,752 | 12,714 | 13,709 | 14,741 | 15,809 |
| 14 | Net Cash Accrual | 8,484 | 9,268 | 10,079 | 10,919 | 11,789 | 12,690 | 13,625 | 14,594 | 15,600 | 16,644 |
| 15 | Principal Payments | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| | -7,500 | 5,484 | 6,268 | 7,079 | 7,919 | 8,789 | 9,690 | 10,625 | 11,594 | 12,600 | 13,644 |
| Equity IRR | 85.4% | | | | | | | | | | |
| 14 | Debt Service Coverage Ratio | | 2.21 | 2.44 | 2.69 | 2.98 | 3.31 | 3.68 | 4.12 | 4.62 | 5.21 |
| | Average D/S Coverage | 2.68 | | | | | | | | | |

**SECTION III. LOAN REPAYMENT SCHEDULE:**

| Description/ Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| OPENING BALANCE | 30,000 | 27,000 | 24,000 | 21,000 | 18,000 | 15,000 | 12,000 | 9,000 | 6,000 | 3,000 |
| PRINCIPAL REPAYMENT | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| CLOSING BALANCE | 27,000 | 24,000 | 21,000 | 18,000 | 15,000 | 12,000 | 9,000 | 6,000 | 3,000 | 0 |
| INTEREST RATE | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% |
| **INTEREST** | 2,400 | 2,160 | 1,920 | 1,680 | 1,440 | 1,200 | 960 | 720 | 480 | 240 |

**Technology from OECD Countries**

| 15 kW GRENADA NUTMEG SHELL-TO-ENERGY PROJECT | |
|---|---|
| **IPP Model** | **11-Mar-04** |

| **SECTION I. ASSUMPTIONS** | | **all figures in US$** |
|---|---|---|
| | | |
| **A. CAPITAL STRUCTURE** | | |
| Total Project Assets (land not included) | | **$ 60,000** |
| Equipment & Civil Costs | | **$ 60,000** |
| Transformer Cost | | **$ -** |
| Transmission Cost | | **$ -** |
| Equity Capital | 20% | **$ 12,000** |
| Loan | 80% | **$ 48,000** |
| | | |
| **B. LOAN DETAILS** | | |
| Loan amount | | **$ 48,000** |
| Interest | Annual Rate | 8.00% |
| Repayment Period (years) | | 10 |
| Annual repayment amount | | **$ 4,800** |
| | | |
| **C. GENERATION DETAILS** | | |
| Installed Capacity | kW | 15 |
| Days Generating | days | 365 |
| Hours Generating Per Day | hours | 24 |
| kWh per year | | **105,120** |
| Rate per kWh (50% of Grenlec price) | $/Unit | 0.13 |
| Gross annual revenue for generation | | **$ 13,666** |
| Capacity Factor | % of installed capacity | 80.00% |
| | | |
| **D. OTHER ASSUMPTIONS** | | |
| Management Costs | % of total proj cost | 2.00% |
| Equipment + Civil Cost | per KW installed | $ 4,000 |
| Transmission costs | per meter | $ - |
| Transmission line required | meters required | 0.00 |
| O&M | % of total proj cost | 4.00% |
| Land Expenditure | | $ - |
| Income Tax Rate | % per year | 0.00% |
| Insurance Expense (construction) | % of total proj cost | 2.00% |
| Insurance Expense (T&D) | % of total proj cost | 33.00% |
| Inflation Factor | 5% per year | 105.00% |
| VERs Generated (.9 kg CO2/kWh) | metric tonnes per year | **94.61** |
| VER rate (US$ per metric ton) | per VER | $ 3.00 |
| Depreciation Rates: | | |
| - buildings and generation unit | % per year | 2.90% |
| - transmission and distribution | % per year | 7.00% |

**All changes in assumptions to be made above this line. Section below is linked to the above assumptions.**

| Sl. No. | Description | | YEARS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Expected revenue (KWh sales) | | 13,666 | 14,349 | 15,066 | 15,820 | 16,611 | 17,441 | 18,313 | 19,229 | 20,190 | 21,200 |
| 2 | Expected revenue (CC-related) | | 255 | 268 | 282 | 296 | 310 | 326 | 342 | 359 | 377 | 396 |
| 3 | Management Costs | | 1,200 | 1,260 | 1,323 | 1,389 | 1,459 | 1,532 | 1,608 | 1,689 | 1,773 | 1,862 |
| 4 | O&M Costs | | 2,400 | 2,520 | 2,646 | 2,778 | 2,917 | 3,063 | 3,216 | 3,377 | 3,546 | 3,723 |
| 5 | Land Expense | | 0 | | | | | | | | | |
| 6 | Insurance | | 1,260 | 1,323 | 1,389 | 1,459 | 1,532 | 1,608 | 1,689 | 1,773 | 1,862 | 1,955 |
| 7 | Transmission Line | | 0 | | | | | | | | | |
| | Project Revenues | | 9,061 | 9,514 | 9,990 | 10,489 | 11,014 | 11,564 | 12,143 | 12,750 | 13,387 | 14,057 |
| 8 | | -60,000 | 9,061 | 9,514 | 9,990 | 10,489 | 11,014 | 11,564 | 12,143 | 12,750 | 13,387 | 14,057 |
| Project IRR | -5.58% | | | | | | | | | | | |
| 9 | Depreciation | | 1,740 | 1,690 | 1,641 | 1,593 | 1,547 | 1,502 | 1,458 | 1,416 | 1,375 | 1,335 |
| | - buildings and generation unit | | 1,740 | 1,690 | 1,641 | 1,593 | 1,547 | 1,502 | 1,458 | 1,416 | 1,375 | 1,335 |
| | - transmission and distribution | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Interest on loans | | 3,840 | 3,456 | 3,072 | 2,688 | 2,304 | 1,920 | 1,536 | 1,152 | 768 | 384 |
| 11 | Profit Before Tax | | 3,481 | 4,369 | 5,277 | 6,208 | 7,163 | 8,143 | 9,148 | 10,182 | 11,244 | 12,338 |
| 12 | Taxation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | Profit After Tax | | 3,481 | 4,369 | 5,277 | 6,208 | 7,163 | 8,143 | 9,148 | 10,182 | 11,244 | 12,338 |
| 14 | Net Cash Accrual | | 5,221 | 6,058 | 6,918 | 7,801 | 8,710 | 9,644 | 10,607 | 11,598 | 12,619 | 13,673 |
| 15 | Principal Payments | | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 |
| | | -12,000 | 421 | 1,258 | 2,118 | 3,001 | 3,910 | 4,844 | 5,807 | 6,798 | 7,819 | 8,873 |
| Equity IRR | 22.0% | | | | | | | | | | | |
| 14 | Debt Service Coverage Ratio | | | 1.15 | 1.27 | 1.40 | 1.55 | 1.72 | 1.92 | 2.14 | 2.40 | 2.71 |
| | Average D/S Coverage | | 1.39 | | | | | | | | | |

**SECTION III. LOAN REPAYMENT SCHEDULE:**

| Description/ Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| OPENING BALANCE | 48,000 | 43,200 | 38,400 | 33,600 | 28,800 | 24,000 | 19,200 | 14,400 | 9,600 | 4,800 |
| PRINCIPAL REPAYMENT | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 |
| CLOSING BALANCE | 43,200 | 38,400 | 33,600 | 28,800 | 24,000 | 19,200 | 14,400 | 9,600 | 4,800 | 0 |
| INTEREST RATE | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% |
| **INTEREST** | 3,840 | 3,456 | 3,072 | 2,688 | 2,304 | 1,920 | 1,536 | 1,152 | 768 | 384 |

**Technology from Developing Contries**

| 45 kW GRENADA NUTMEG SHELL-TO-ENERGY PROJECT | |
|---|---|
| IPP Model | 11-Mar-04 |

| SECTION I. ASSUMPTIONS | | all figures in US$ |
|---|---|---|
| | | |
| A. CAPITAL STRUCTURE | | |
| Total Project Assets (land not included) | | $ 112,500 |
| Equipment & Civil Costs | | $ 112,500 |
| Transformer Cost | | $ - |
| Transmission Cost | | $ - |
| Equity Capital | 20% | $ 22,500 |
| Loan | 80% | $ 90,000 |
| | | |
| B. LOAN DETAILS | | |
| Loan amount | | $ 90,000 |
| Interest | Annual Rate | 8.00% |
| Repayment Period (years) | | 10 |
| Annual repayment amount | | $ 9,000 |
| | | |
| C. GENERATION DETAILS | | |
| Installed Capacity | kW | 45 |
| Days Generating | days | 365 |
| Hours Generating Per Day | hours | 24 |
| kWh per year | | 315,360 |
| Rate per kWh (50% of Grenlec price) | $/Unit | 0.13 |
| Gross annual revenue for generation | | $ 40,997 |
| Capacity Factor | % of installed capacity | 80.00% |
| | | |
| D. OTHER ASSUMPTIONS | | |
| Management Costs | % of total proj cost | 2.00% |
| Equipment + Civil Cost | per KW installed | $ 2,500 |
| Transmission costs | per meter | $ - |
| Transmission line required | meters required | 0.00 |
| O&M | % of total proj cost | 4.00% |
| Land Expenditure | | $ - |
| Income Tax Rate | % per year | 0.00% |
| Insurance Expense (construction) | % of total proj cost | 2.00% |
| Insurance Expense (T&D) | % of total proj cost | |
| Inflation Factor | 5% per year | 105.00% |
| VERs Generated (.9 kg CO2/kWh) | metric tonnes per year | 283.82 |
| VER rate (US$ per metric ton) | per VER | $ 3.00 |
| Depreciation Rates: | | |
| - buildings and generation unit | % per year | 2.90% |
| - transmission and distribution | % per year | 7.00% |

**All changes in assumptions to be made above this line. Section below is linked to the above assumptions.**

| | | YEARS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | Expected revenue (KWh sales) | 40,997 | 43,047 | 45,199 | 47,459 | 49,832 | 52,323 | 54,940 | 57,687 | 60,571 | 63,599 |
| 2 | Expected revenue (CC-related) | 766 | 805 | 845 | 887 | 931 | 978 | 1,027 | 1,078 | 1,132 | 1,189 |
| 3 | Management Costs | 2,250 | 2,363 | 2,481 | 2,605 | 2,735 | 2,872 | 3,015 | 3,166 | 3,324 | 3,490 |
| 4 | O&M Costs | 4,500 | 4,725 | 4,961 | 5,209 | 5,470 | 5,743 | 6,030 | 6,332 | 6,649 | 6,981 |
| 5 | Land Expense | 0 | | | | | | | | | |
| 6 | Insurance | 2,363 | 2,481 | 2,605 | 2,735 | 2,872 | 3,015 | 3,166 | 3,324 | 3,490 | 3,665 |
| 7 | Transmission Line | 0 | | | | | | | | | |
| | Project Revenues | 32,651 | 34,283 | 35,997 | 37,797 | 39,687 | 41,671 | 43,755 | 45,943 | 48,240 | 50,652 |
| 8 | -112,500 | 32,651 | 34,283 | 35,997 | 37,797 | 39,687 | 41,671 | 43,755 | 45,943 | 48,240 | 50,652 |
| Project IRR | 17.45% | | | | | | | | | | |
| 9 | Depreciation | 3,263 | 3,168 | 3,076 | 2,987 | 2,900 | 2,816 | 2,734 | 2,655 | 2,578 | 2,503 |
| | - buildings and generation unit | 3,263 | 3,168 | 3,076 | 2,987 | 2,900 | 2,816 | 2,734 | 2,655 | 2,578 | 2,503 |
| | - transmission and distribution | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Interest on loans | 7,200 | 6,480 | 5,760 | 5,040 | 4,320 | 3,600 | 2,880 | 2,160 | 1,440 | 720 |
| 11 | Profit Before Tax | 22,188 | 24,635 | 27,161 | 29,770 | 32,467 | 35,255 | 38,141 | 41,128 | 44,222 | 47,428 |
| 12 | Taxation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | Profit After Tax | 22,188 | 24,635 | 27,161 | 29,770 | 32,467 | 35,255 | 38,141 | 41,128 | 44,222 | 47,428 |
| 14 | Net Cash Accrual | 25,451 | 27,803 | 30,237 | 32,757 | 35,367 | 38,071 | 40,875 | 43,783 | 46,800 | 49,932 |
| 15 | Principal Payments | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 |
| | -22,500 | 16,451 | 18,803 | 21,237 | 23,757 | 26,367 | 29,071 | 31,875 | 34,783 | 37,800 | 40,932 |
| Equity IRR | 85.4% | | | | | | | | | | |
| 14 | Debt Service Coverage Ratio | | 2.21 | 2.44 | 2.69 | 2.98 | 3.31 | 3.68 | 4.12 | 4.62 | 5.21 |
| | Average D/S Coverage | 2.68 | | | | | | | | | |

**SECTION III. LOAN REPAYMENT SCHEDULE:**

| Description/ Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| OPENING BALANCE | 90,000 | 81,000 | 72,000 | 63,000 | 54,000 | 45,000 | 36,000 | 27,000 | 18,000 | 9,000 |
| PRINCIPAL REPAYMENT | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 |
| CLOSING BALANCE | 81,000 | 72,000 | 63,000 | 54,000 | 45,000 | 36,000 | 27,000 | 18,000 | 9,000 | 0 |
| INTEREST RATE | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% |
| **INTEREST** | 7,200 | 6,480 | 5,760 | 5,040 | 4,320 | 3,600 | 2,880 | 2,160 | 1,440 | 720 |

## Technology from OECD Countries

| 45 kW GRENADA NUTMEG SHELL-TO-ENERGY PROJECT | |
|---|---|
| IPP Model | 11-Mar-04 |

| SECTION I. ASSUMPTIONS | | | all figures in US$ |
|---|---|---|---|
| | | | |
| A. CAPITAL STRUCTURE | | | |
| Total Project Assets (land not included) | | $ | 180,000 |
| Equipment & Civil Costs | | $ | 180,000 |
| Transformer Cost | | $ | - |
| Transmission Cost | | $ | - |
| Equity Capital | 20% | $ | 36,000 |
| Loan | 80% | $ | 144,000 |
| | | | |
| B. LOAN DETAILS | | | |
| Loan amount | | $ | 144,000 |
| Interest | Annual Rate | | 8.00% |
| Repayment Period (years) | | | 10 |
| Annual repayment amount | | $ | 14,400 |
| | | | |
| C. GENERATION DETAILS | | | |
| Installed Capacity | kW | | 45 |
| Days Generating | days | | 365 |
| Hours Generating Per Day | hours | | 24 |
| kWh per year | | | 315,360 |
| Rate per kWh (50% of Grenlec price) | $/Unit | | 0.13 |
| Gross annual revenue for generation | | $ | 40,997 |
| Capacity Factor | % of installed capacity | | 80.00% |
| | | | |
| D. OTHER ASSUMPTIONS | | | |
| Management Costs | % of total proj cost | | 2.00% |
| Equipment + Civil Cost | per KW installed | $ | 4,000 |
| Transmission costs | per meter | $ | - |
| Transmission line required | meters required | | 0.00 |
| O&M | % of total proj cost | | 4.00% |
| Land Expenditure | | $ | - |
| Income Tax Rate | % per year | | 0.00% |
| Insurance Expense (construction) | % of total proj cost | | 2.00% |
| Insurance Expense (T&D) | % of total proj cost | | 33.00% |
| Inflation Factor | 5% per year | | 105.00% |
| VERs Generated (.9 kg CO2/kWh) | metric tonnes per year | | 283.82 |
| VER rate (US$ per metric ton) | per VER | $ | 3.00 |
| Depreciation Rates: | | | |
| - buildings and generation unit | % per year | | 2.90% |
| - transmission and distribution | % per year | | 7.00% |

**All changes in assumptions to be made above this line. Section below is linked to the above assumptions.**

| | | YEARS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | Expected revenue (KWh sales) | 40,997 | 43,047 | 45,199 | 47,459 | 49,832 | 52,323 | 54,940 | 57,687 | 60,571 | 63,599 |
| 2 | Expected revenue (CC-related) | 766 | 805 | 845 | 887 | 931 | 978 | 1,027 | 1,078 | 1,132 | 1,189 |
| 3 | Management Costs | 3,600 | 3,780 | 3,969 | 4,167 | 4,376 | 4,595 | 4,824 | 5,066 | 5,319 | 5,585 |
| 4 | O&M Costs | 7,200 | 7,560 | 7,938 | 8,335 | 8,752 | 9,189 | 9,649 | 10,131 | 10,638 | 11,170 |
| 5 | Land Expense | 0 | | | | | | | | | |
| 6 | Insurance | 3,780 | 3,969 | 4,167 | 4,376 | 4,595 | 4,824 | 5,066 | 5,319 | 5,585 | 5,864 |
| 7 | Transmission Line | 0 | | | | | | | | | |
| | Project Revenues | 27,183 | 28,542 | 29,969 | 31,468 | 33,041 | 34,693 | 36,428 | 38,249 | 40,162 | 42,170 |
| 8 | -180,000 | 27,183 | 28,542 | 29,969 | 31,468 | 33,041 | 34,693 | 36,428 | 38,249 | 40,162 | 42,170 |
| Project IRR | -5.58% | | | | | | | | | | |
| 9 | Depreciation | 5,220 | 5,069 | 4,922 | 4,779 | 4,640 | 4,506 | 4,375 | 4,248 | 4,125 | 4,005 |
| | - buildings and generation unit | 5,220 | 5,069 | 4,922 | 4,779 | 4,640 | 4,506 | 4,375 | 4,248 | 4,125 | 4,005 |
| | - transmission and distribution | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Interest on loans | 11,520 | 10,368 | 9,216 | 8,064 | 6,912 | 5,760 | 4,608 | 3,456 | 2,304 | 1,152 |
| 11 | Profit Before Tax | 10,443 | 13,106 | 15,832 | 18,625 | 21,489 | 24,428 | 27,445 | 30,545 | 33,733 | 37,013 |
| 12 | Taxation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | Profit After Tax | 10,443 | 13,106 | 15,832 | 18,625 | 21,489 | 24,428 | 27,445 | 30,545 | 33,733 | 37,013 |
| 14 | Net Cash Accrual | 15,663 | 18,174 | 20,753 | 23,404 | 26,129 | 28,933 | 31,820 | 34,793 | 37,858 | 41,018 |
| 15 | Principal Payments | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 |
| | -36,000 | 1,263 | 3,774 | 6,353 | 9,004 | 11,729 | 14,533 | 17,420 | 20,393 | 23,458 | 26,618 |
| Equity IRR | 22.0% | | | | | | | | | | |
| 14 | Debt Service Coverage Ratio | | 1.15 | 1.27 | 1.40 | 1.55 | 1.72 | 1.92 | 2.14 | 2.40 | 2.71 |
| | Average D/S Coverage | 1.39 | | | | | | | | | |

**SECTION III. LOAN REPAYMENT SCHEDULE:**

| Description/ Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| OPENING BALANCE | 144,000 | 129,600 | 115,200 | 100,800 | 86,400 | 72,000 | 57,600 | 43,200 | 28,800 | 14,400 |
| PRINCIPAL REPAYMENT | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 |
| CLOSING BALANCE | 129,600 | 115,200 | 100,800 | 86,400 | 72,000 | 57,600 | 43,200 | 28,800 | 14,400 | 0 |
| INTEREST RATE | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% |
| **INTEREST** | 11,520 | 10,368 | 9,216 | 8,064 | 6,912 | 5,760 | 4,608 | 3,456 | 2,304 | 1,152 |

## Project name: Caribbean Solar Financing Program

| Caribbean Solar Finance Program | 11-Mar-04 |
|---|---|

| | | |
|---|---|---|
| **FINANCIAL OVERVIEW** | | |
| **LINE OF CREDIT** | | |
| Average Unit Cost | US$ | $1,370.00 |
| Number of Units Per Island | | 100.00 |
| Loan Amount Required Per Island | US$ | $137,000.00 |
| Total Amount Required | US$ | $411,000.00 |
| | | |
| **TERMS** | | |
| Interest Rate - Wholesale | | 3.00% |
| Cost of Delivery by Credit Leagues/Unions | | 3.00% |
| Total Interest Rate - Retail | | 6.00% |
| Tenor | years | 6.00 |
| **REPAYMENT** | | |
| Annual Repayment* | US$ | $83,582.04 |
| | | |
| **COMPARISON** | | |
| **A. SOLAR HOT WATER SYSTEM** | | |
| Average system cost | US$ | $1,370.00 |
| Annual Repayment Per System | US$ | **$278.61** |
| Monthly Repayment Per System | US$ | **$23.22** |
| Estimated total payment over ten years** | US$ | $1,671.64 |
| Estimated annualized payment over ten years* | US$ | **$167.16** |
| | | |
| **B. CONVENTIONAL WATER HEATING SYSTEM - DOMINICA** | | |
| Annual electric consumption (per household @1hr use per day w/3.3kW system) | kWh | 1204.50 |
| Cost per year for electricity (US$. 26 x kWh) | US$ | $313.17 |
| Annualized cost of two systems (US$41 x 2) | US$ | $8.20 |
| Estimated annual payment | US$ | **$321.37** |
| Estimated monthly payment | US$ | **$26.78** |
| Estimated total payment over ten years*** | US$ | $3,213.70 |
| Estimated annualized payment over ten years | US$ | **$321.37** |
| | | |
| **C. CONVENTIONAL WATER HEATING SYSTEM - ST. LUCIA & GRENADA** | | |
| Annual electric consumption (per household @1hr use per day w/3.3kW system) | kWh | 1204.50 |
| Cost per year for electricity (US$. 22 x kWh) | US$ | $264.99 |
| Annualized cost of two systems (US$41 x 2) | US$ | $8.20 |
| Estimated annual payment | US$ | **$273.19** |
| Estimated monthly payment | US$ | **$22.77** |
| Estimated total payment over ten years*** | US$ | $2,731.90 |
| Estimated annualized payment over ten years | US$ | **$273.19** |

**Notes**

This comparison excludes O&M costs

*Repayment of the line of credit is configured on an annual basis

**There are no finance or equipment costs after year five

***Fuel costs occur each year plus a one time replacement cost for the electric heater

**Project name: St. Lucia Ciceron Landfill Gas to Energy Project**

| 400 kW CICERON LFG PROJECT | | |
|---|---|---|
| **IPP Model** | **12-Mar-04** | |
| | | |

| **SECTION I. ASSUMPTIONS** | | **all figures in US$** |
|---|---|---|
| | | |
| **A. CAPITAL STRUCTURE** | | |
| Total Project Assets (land not included) | | **$ 1,040,000** |
| Equipment & Civil Costs | | **$ 1,040,000** |
| Transformer Cost | | **$ -** |
| Transmission Cost | | **$ -** |
| Equity Capital | 20% | **$ 208,000** |
| Loan | 80% | **$ 832,000** |
| | | |
| **B. LOAN DETAILS** | | |
| Loan amount | | **$ 832,000** |
| Interest | Annual Rate | 8.00% |
| Repayment Period (years) | | 10 |
| Annual repayment amount | | **$ 83,200** |
| | | |
| **C. GENERATION DETAILS** | | |
| Installed Capacity | kW | 400 |
| Days Generating | days | 365 |
| Hours Generating Per Day | hours | 24 |
| kWh per year (Year 1 to 5) | | **3,083,520** |
| kWh per year (Year 6 to 10) | | **2,102,400** |
| Rate per kWh (avoided cost LUCELEC) | $/Unit | 0.095 |
| Gross annual revenue for generation (Yr 1 to 5) | | **$ 292,934** |
| Gross annual revenue for generation (Yr 6 to 10) | | **$ 199,728** |
| Capacity Factor (Yr 1 to 5) | % of installed capacity | 88.00% |
| Capacity Factor (Yr 6 to 10) | % of installed capacity | 60.00% |
| | | |
| **D. OTHER ASSUMPTIONS** | | |
| Management Costs | % of total proj cost | 2.00% |
| Equipment + Civil Cost | per KW installed | $ 2,600 |
| Transmission costs | per meter | $ - |
| Transmission line required | meters required | 0.00 |
| O&M | % of total proj cost | 4.00% |
| Land Expenditure | | $ - |
| Income Tax Rate | % per year | 0.00% |
| Insurance Expense (construction) | % of total proj cost | 2.00% |
| Insurance Expense (T&D) | % of total proj cost | 33.00% |
| Inflation Factor | 5% per year | 105.00% |
| VERs Generated (5.59 kg CO2/kWh)* | metric tonnes per year | 17236.88 |
| VER rate (US$ per metric ton) | per VER | $ 3.00 |
| Depreciation Rates: | | |
| - buildings and generation unit | % per year | 2.90% |
| - transmission and distribution | % per year | 7.00% |

**All changes in assumptions to be made above this line. Section below is linked to the above assumptions.**

| | | YEARS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | Expected revenue (KWh sales) | 292,934 | 307,581 | 322,960 | 339,108 | 356,064 | 209,714 | 220,200 | 231,210 | 242,771 |
| 2 | Expected revenue (CC-related) | 46,540 | 48,867 | 51,310 | 53,875 | 56,569 | 59,398 | 62,367 | 65,486 | 68,760 |
| 3 | Management Costs | 20,800 | 21,840 | 22,932 | 24,079 | 25,283 | 26,547 | 27,874 | 29,268 | 30,731 |
| 4 | O&M Costs | 41,600 | 43,680 | 45,864 | 48,157 | 50,565 | 53,093 | 55,748 | 58,535 | 61,462 |
| 5 | Land Expense | 0 | | | | | | | | |
| 6 | Insurance | 20,800 | 21,840 | 22,932 | 24,079 | 25,283 | 26,547 | 27,874 | 29,268 | 30,731 |
| 7 | Transmission Line | 0 | | | | | | | | |
| | Project Revenues | 256,274 | 269,088 | 282,542 | 296,669 | 311,503 | 162,925 | 171,072 | 179,625 | 188,606 |
| 8 | -1,040,000 | 256,274 | 269,088 | 282,542 | 296,669 | 311,503 | 162,925 | 171,072 | 179,625 | 188,606 |
| **Project IRR** | **10.86%** | | | | | | | | | |
| 9 | Depreciation | 30,160 | 29,285 | 28,436 | 27,611 | 26,811 | 26,033 | 25,278 | 24,545 | 23,833 |
| | - buildings and generation unit | 30,160 | 29,285 | 28,436 | 27,611 | 26,811 | 26,033 | 25,278 | 24,545 | 23,833 |
| | - transmission and distribution | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Interest on loans | 66,560 | 59,904 | 53,248 | 46,592 | 39,936 | 33,280 | 26,624 | 19,968 | 13,312 |
| 11 | Profit Before Tax | 159,554 | 179,898 | 200,858 | 222,466 | 244,756 | 103,612 | 119,169 | 135,112 | 151,461 |
| 12 | Taxation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | Profit After Tax | 159,554 | 179,898 | 200,858 | 222,466 | 244,756 | 103,612 | 119,169 | 135,112 | 151,461 |
| 14 | Net Cash Accrual | 189,714 | 209,184 | 229,294 | 250,077 | 271,567 | 129,645 | 144,448 | 159,657 | 175,294 |
| 15 | Principal Payments | 83,200 | 83,200 | 83,200 | 83,200 | 83,200 | 83,200 | 83,200 | 83,200 | 83,200 |
| | -208,000 | 106,514 | 125,984 | 146,094 | 166,877 | 188,367 | 46,445 | 61,248 | 76,457 | 92,094 |
| **Equity IRR** | **58.8%** | | | | | | | | | |
| 14 | Debt Service Coverage Ratio | | 1.88 | 2.07 | 2.29 | 2.53 | 1.40 | 1.56 | 1.74 | 1.95 |
| | Average D/S Coverage | 1.68 | | | | | | | | |

**SECTION III. LOAN REPAYMENT SCHEDULE:**

| Description/ Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| OPENING BALANCE | 832,000 | 748,800 | 665,600 | 582,400 | 499,200 | 416,000 | 332,800 | 249,600 | 166,400 |
| PRINCIPAL REPAYMENT | 83,200 | 83,200 | 83,200 | 83,200 | 83,200 | 83,200 | 83,200 | 83,200 | 83,200 |
| CLOSING BALANCE | 748,800 | 665,600 | 582,400 | 499,200 | 416,000 | 332,800 | 249,600 | 166,400 | 83,200 |
| INTEREST RATE | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% |
| **INTEREST** | 66,560 | 59,904 | 53,248 | 46,592 | 39,936 | 33,280 | 26,624 | 19,968 | 13,312 |

**Project name: St. Lucia Point de Caille Wind Farm Project**

**Wind Farm Capacity factor = 23%**

| **4.25 MW POINTE de CAILLE WIND FARM (23% CF)** | |
|---|---|
| **IPP Model** | **11-Mar-04** |
| | |

| **SECTION I. ASSUMPTIONS** | | **all figures in US$** |
|---|---|---|
| | | |
| **A. CAPITAL STRUCTURE** | | |
| Total Project Assets (land not included) | | **$ 5,100,000** |
| Equipment & Civil Costs | | **$ 5,100,000** |
| Transformer Cost | | **$ -** |
| Transmission Cost | | **$ -** |
| Equity Capital | 20% | **$ 1,020,000** |
| Loan | 80% | **$ 4,080,000** |
| | | |
| **B. LOAN DETAILS** | | |
| Loan amount | | **$ 4,080,000** |
| Interest | Annual Rate | 8.00% |
| Repayment Period (years) | | 10 |
| Annual repayment amount | | **$ 408,000** |
| | | |
| **C. GENERATION DETAILS** | | |
| Installed Capacity | kW | 4250 |
| Days Generating | days | 365 |
| Hours Generating Per Day | hours | 24 |
| kWh per year | | **8,562,900** |
| Rate per kWh (avoided cost LUCELEC) | $/Unit | 0.095 |
| Gross annual revenue for generation | | **$ 813,476** |
| Capacity Factor | % of installed capacity | 23.00% |
| | | |
| **D. OTHER ASSUMPTIONS** | | |
| Management Costs | % of total proj cost | 2.00% |
| Equipment + Civil Cost | per KW installed | $ 1,200 |
| Transmission costs | per meter | $ - |
| Transmission line required | meters required | 0.00 |
| O&M | % of total proj cost | 3.00% |
| Land Expenditure | | $ - |
| Income Tax Rate | % per year | 0.00% |
| Insurance Expense (construction) | % of total proj cost | 2.00% |
| Insurance Expense (T&D) | % of total proj cost | 33.00% |
| Inflation Factor | 5% per year | 105.00% |
| VERs Generated (.9 kg CO2/kWh) | metric tonnes per year | **7706.61** |
| VER rate (US$ per metric ton) | per VER | $ 3.00 |
| Depreciation Rates: | | |
| - buildings and generation unit | % per year | 2.90% |
| - transmission and distribution | % per year | 7.00% |

**All changes in assumptions to be made above this line. Section below is linked to the above assumptions.**

| | | YEARS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | Expected revenue (KWh sales) | 813,476 | 854,149 | 896,857 | 941,700 | 988,785 | 1,038,224 | 1,090,135 | 1,144,642 | 1,201,874 |
| 2 | Expected revenue (CC-related) | 20,808 | 21,848 | 22,941 | 24,088 | 25,292 | 26,557 | 27,885 | 29,279 | 30,743 |
| 3 | Management Costs | 102,000 | 107,100 | 112,455 | 118,078 | 123,982 | 130,181 | 136,690 | 143,524 | 150,700 |
| 4 | O&M Costs | 153,000 | 160,650 | 168,683 | 177,117 | 185,972 | 195,271 | 205,035 | 215,286 | 226,051 |
| 5 | Land Expense | 0 | | | | | | | | |
| 6 | Insurance | 102,000 | 107,100 | 112,455 | 118,078 | 123,982 | 130,181 | 136,690 | 143,524 | 150,700 |
| 7 | Transmission Line | 0 | | | | | | | | |
| | Project Revenues | 477,283 | 501,148 | 526,205 | 552,515 | 580,141 | 609,148 | 639,605 | 671,586 | 705,165 |
| 8 | -5,100,000 | 477,283 | 501,148 | 526,205 | 552,515 | 580,141 | 609,148 | 639,605 | 671,586 | 705,165 |
| **Project IRR** | **-18.15%** | | | | | | | | | |
| 9 | Depreciation | 147,900 | 143,611 | 139,446 | 135,402 | 131,476 | 127,663 | 123,961 | 120,366 | 116,875 |
| | - buildings and generation unit | 147,900 | 143,611 | 139,446 | 135,402 | 131,476 | 127,663 | 123,961 | 120,366 | 116,875 |
| | - transmission and distribution | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Interest on loans | 326,400 | 293,760 | 261,120 | 228,480 | 195,840 | 163,200 | 130,560 | 97,920 | 65,280 |
| 11 | Profit Before Tax | 2,983 | 63,777 | 125,639 | 188,633 | 252,825 | 318,285 | 385,085 | 453,300 | 523,010 |
| 12 | Taxation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | Profit After Tax | 2,983 | 63,777 | 125,639 | 188,633 | 252,825 | 318,285 | 385,085 | 453,300 | 523,010 |
| 14 | Net Cash Accrual | 150,883 | 207,388 | 265,085 | 324,035 | 384,301 | 445,948 | 509,045 | 573,666 | 639,885 |
| 15 | Principal Payments | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 |
| | -1,020,000 | -257,117 | -200,612 | -142,915 | -83,965 | -23,699 | 37,948 | 101,045 | 165,666 | 231,885 |
| **Equity IRR** | **-8.8%** | | | | | | | | | |
| 14 | Debt Service Coverage Ratio | | 0.71 | 0.79 | 0.87 | 0.96 | 1.07 | 1.19 | 1.33 | 1.49 |
| | Average D/S Coverage | 0.86 | | | | | | | | |

**SECTION III. LOAN REPAYMENT SCHEDULE:**

| Description/ Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| OPENING BALANCE | 4,080,000 | 3,672,000 | 3,264,000 | 2,856,000 | 2,448,000 | 2,040,000 | 1,632,000 | 1,224,000 | 816,000 |
| PRINCIPAL REPAYMENT | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 |
| CLOSING BALANCE | 3,672,000 | 3,264,000 | 2,856,000 | 2,448,000 | 2,040,000 | 1,632,000 | 1,224,000 | 816,000 | 408,000 |
| INTEREST RATE | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% |
| **INTEREST** | 326,400 | 293,760 | 261,120 | 228,480 | 195,840 | 163,200 | 130,560 | 97,920 | 65,280 |

**Wind Farm Capacity factor = 34%**

| 4.25 MW POINTE de CAILLE WIND FARM (34% CF) | |
|---|---|
| **IPP Model** | **11-Mar-04** |
| | |

| **SECTION I. ASSUMPTIONS** | | **all figures in US$** | |
|---|---|---|---|
| | | | |
| **A. CAPITAL STRUCTURE** | | | |
| Total Project Assets (land not included) | | $ | **5,100,000** |
| Equipment & Civil Costs | | $ | **5,100,000** |
| Transformer Cost | | $ | - |
| Transmission Cost | | $ | - |
| Equity Capital | 20% | $ | **1,020,000** |
| Loan | 80% | $ | **4,080,000** |
| | | | |
| **B. LOAN DETAILS** | | | |
| Loan amount | | $ | **4,080,000** |
| Interest | Annual Rate | | 8.00% |
| Repayment Period (years) | | | 10 |
| Annual repayment amount | | $ | **408,000** |
| | | | |
| **C. GENERATION DETAILS** | | | |
| Installed Capacity | kW | | 4250 |
| Days Generating | days | | 365 |
| Hours Generating Per Day | hours | | 24 |
| kWh per year | | | **12,658,200** |
| Rate per kWh (avoided cost LUCELEC) | $/Unit | | 0.095 |
| Gross annual revenue for generation | | $ | **1,202,529** |
| Capacity Factor | % of installed capacity | | 34.00% |
| | | | |
| **D. OTHER ASSUMPTIONS** | | | |
| Management Costs | % of total proj cost | | 2.00% |
| Equipment + Civil Cost | per KW installed | $ | 1,200 |
| Transmission costs | per meter | $ | - |
| Transmission line required | meters required | | 0.00 |
| O&M | % of total proj cost | | 3.00% |
| Land Expenditure | | $ | - |
| Income Tax Rate | % per year | | 0.00% |
| Insurance Expense (construction) | % of total proj cost | | 2.00% |
| Insurance Expense (T&D) | % of total proj cost | | 33.00% |
| Inflation Factor | 5% per year | | 105.00% |
| VERs Generated (.9 kg CO2/kWh) | metric tonnes per year | | **11392.38** |
| VER rate (US$ per metric ton) | per VER | $ | 3.00 |
| Depreciation Rates: | | | |
| - buildings and generation unit | % per year | | 2.90% |
| - transmission and distribution | % per year | | 7.00% |

**All changes in assumptions to be made above this line. Section below is linked to the above assumptions.**

| | Sl. No. | Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | YEARS | | | | | | | | |
| | 1 | Expected revenue (KWh sales) | 1,202,529 | 1,262,655 | 1,325,788 | 1,392,078 | 1,461,682 | 1,534,766 | 1,611,504 | 1,692,079 | 1,776,683 |
| | 2 | Expected revenue (CC-related) | 30,759 | 32,297 | 33,912 | 35,608 | 37,388 | 39,258 | 41,221 | 43,282 | 45,446 |
| | 3 | Management Costs | 102,000 | 107,100 | 112,455 | 118,078 | 123,982 | 130,181 | 136,690 | 143,524 | 150,700 |
| | 4 | O&M Costs | 153,000 | 160,650 | 168,683 | 177,117 | 185,972 | 195,271 | 205,035 | 215,286 | 226,051 |
| | 5 | Land Expense | 0 | | | | | | | | |
| | 6 | Insurance | 102,000 | 107,100 | 112,455 | 118,078 | 123,982 | 130,181 | 136,690 | 143,524 | 150,700 |
| | 7 | Transmission Line | 0 | | | | | | | | |
| | | Project Revenues | 876,288 | 920,103 | 966,108 | 1,014,413 | 1,065,134 | 1,118,391 | 1,174,310 | 1,233,026 | 1,294,677 |
| | 8 | -5,100,000 | 876,288 | 920,103 | 966,108 | 1,014,413 | 1,065,134 | 1,118,391 | 1,174,310 | 1,233,026 | 1,294,677 |
| **Project IRR** | | **-1.65%** | | | | | | | | | |
| | 9 | Depreciation | 147,900 | 143,611 | 139,446 | 135,402 | 131,476 | 127,663 | 123,961 | 120,366 | 116,875 |
| | | - buildings and generation unit | 147,900 | 143,611 | 139,446 | 135,402 | 131,476 | 127,663 | 123,961 | 120,366 | 116,875 |
| | | - transmission and distribution | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 10 | Interest on loans | 326,400 | 293,760 | 261,120 | 228,480 | 195,840 | 163,200 | 130,560 | 97,920 | 65,280 |
| | 11 | Profit Before Tax | 401,988 | 482,732 | 565,542 | 650,531 | 737,818 | 827,528 | 919,790 | 1,014,740 | 1,112,522 |
| | 12 | Taxation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 13 | Profit After Tax | 401,988 | 482,732 | 565,542 | 650,531 | 737,818 | 827,528 | 919,790 | 1,014,740 | 1,112,522 |
| | 14 | Net Cash Accrual | 549,888 | 626,343 | 704,988 | 785,933 | 869,294 | 955,191 | 1,043,750 | 1,135,106 | 1,229,397 |
| | 15 | Principal Payments | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 |
| | | -1,020,000 | 141,888 | 218,343 | 296,988 | 377,933 | 461,294 | 547,191 | 635,750 | 727,106 | 821,397 |
| **Equity IRR** | | **31.5%** | | | | | | | | | |
| | 14 | Debt Service Coverage Ratio | | 1.31 | 1.44 | 1.59 | 1.76 | 1.96 | 2.18 | 2.44 | 2.74 |
| | | Average D/S Coverage | 1.59 | | | | | | | | |

**SECTION III. LOAN REPAYMENT SCHEDULE:**

| Description/ Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| OPENING BALANCE | 4,080,000 | 3,672,000 | 3,264,000 | 2,856,000 | 2,448,000 | 2,040,000 | 1,632,000 | 1,224,000 | 816,000 |
| PRINCIPAL REPAYMENT | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 | 408,000 |
| CLOSING BALANCE | 3,672,000 | 3,264,000 | 2,856,000 | 2,448,000 | 2,040,000 | 1,632,000 | 1,224,000 | 816,000 | 408,000 |
| INTEREST RATE | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% |
| **INTEREST** | 326,400 | 293,760 | 261,120 | 228,480 | 195,840 | 163,200 | 130,560 | 97,920 | 65,280 |

**Project name: Fresh Eggs Ltd. Poultry Litter to Energy Project**

**Technology from India**

| 7 kW POULTRY LITTER TO ENERGY PROJECT | | | |
|---|---|---|---|
| **IPP Model** | **18-Mar-04** | | |

| SECTION I. ASSUMPTIONS | | | all figures in US$ |
|---|---|---|---|
| | | | |
| **A. CAPITAL STRUCTURE** | | | |
| Total Project Assets (land not included) | | $ | **10,500** |
| Equipment & Civil Costs | | $ | **10,500** |
| Transformer Cost | | $ | - |
| Transmission Cost | | $ | - |
| Equity Capital | 20% | $ | **2,100** |
| Loan | 80% | $ | **8,400** |
| | | | |
| **B. LOAN DETAILS** | | | |
| Loan amount | | $ | **8,400** |
| Interest | Annual Rate | | 8.00% |
| Repayment Period (years) | | | 10 |
| Annual repayment amount | | $ | **840** |
| | | | |
| **C. GENERATION DETAILS** | | | |
| Installed Capacity | kW | | 7 |
| Days Generating | days | | 365 |
| Hours Generating Per Day | hours | | 10 |
| kWh per year | | | **20,440** |
| Rate per kWh (current price paid to LUCELEC) | $/Unit | | 0.22 |
| Gross annual revenue for generation | | $ | **4,497** |
| Capacity Factor | % of installed capacity | | 80.00% |
| | | | |
| **D. OTHER ASSUMPTIONS** | | | |
| Management Costs | % of total proj cost | | 2.00% |
| Equipment + Civil Cost | per KW installed | $ | 1,500 |
| Transmission costs | per meter | $ | - |
| Transmission line required | meters required | | 0.00 |
| O&M | % of total proj cost | | 4.00% |
| Land Expenditure | | $ | - |
| Income Tax Rate | % per year | | 0.00% |
| Insurance Expense (construction) | % of total proj cost | | 2.00% |
| Insurance Expense (T&D) | % of total proj cost | | |
| Inflation Factor | 5% per year | | 105.00% |
| VERs Generated (.9 kg $CO_2$/kWh) | metric tonnes per year | | **18.40** |
| VER rate (US$ per metric ton) | per VER | $ | 3.00 |
| Depreciation Rates: | | | |
| - buildings and generation unit | % per year | | 2.90% |
| - transmission and distribution | % per year | | 7.00% |

**All changes in assumptions to be made above this line. Section below is linked to the above assumptions.**

| | | YEARS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | Expected revenue (KWh sales) | 4,497 | 4,722 | 4,958 | 5,206 | 5,466 | 5,739 | 6,026 | 6,327 | 6,644 | 6,976 |
| 2 | Expected revenue (CC-related) | 50 | 52 | 55 | 57 | 60 | 63 | 67 | 70 | 73 | 77 |
| 3 | Management Costs | 210 | 221 | 232 | 243 | 255 | 268 | 281 | 295 | 310 | 326 |
| 4 | O&M Costs | 420 | 441 | 463 | 486 | 511 | 536 | 563 | 591 | 621 | 652 |
| 5 | Land Expense | 0 | | | | | | | | | |
| 6 | Insurance | 221 | 232 | 243 | 255 | 268 | 281 | 295 | 310 | 326 | 342 |
| 7 | Transmission Line | 0 | | | | | | | | | |
| | Project Revenues | 3,696 | 3,881 | 4,075 | 4,279 | 4,492 | 4,717 | 4,953 | 5,201 | 5,461 | 5,734 |
| 8 | -10,500 | 3,696 | 3,881 | 4,075 | 4,279 | 4,492 | 4,717 | 4,953 | 5,201 | 5,461 | 5,734 |
| Project IRR | 26.12% | | | | | | | | | | |
| 9 | Depreciation | 305 | 296 | 287 | 279 | 271 | 263 | 255 | 248 | 241 | 234 |
| | - buildings and generation unit | 305 | 296 | 287 | 279 | 271 | 263 | 255 | 248 | 241 | 234 |
| | - transmission and distribution | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Interest on loans | 672 | 605 | 538 | 470 | 403 | 336 | 269 | 202 | 134 | 67 |
| 11 | Profit Before Tax | 2,719 | 2,980 | 3,250 | 3,529 | 3,819 | 4,118 | 4,429 | 4,751 | 5,086 | 5,433 |
| 12 | Taxation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | Profit After Tax | 2,719 | 2,980 | 3,250 | 3,529 | 3,819 | 4,118 | 4,429 | 4,751 | 5,086 | 5,433 |
| 14 | Net Cash Accrual | 3,024 | 3,276 | 3,537 | 3,808 | 4,089 | 4,381 | 4,684 | 4,999 | 5,326 | 5,666 |
| 15 | Principal Payments | 840 | 840 | 840 | 840 | 840 | 840 | 840 | 840 | 840 | 840 |
| | -2,100 | 2,184 | 2,436 | 2,697 | 2,968 | 3,249 | 3,541 | 3,844 | 4,159 | 4,486 | 4,826 |
| Equity IRR | 114.7% | | | | | | | | | | |
| 14 | Debt Service Coverage Ratio | | 2.69 | 2.96 | 3.27 | 3.61 | 4.01 | 4.47 | 4.99 | 5.60 | 6.32 |
| | Average D/S Coverage | 3.25 | | | | | | | | | |

**SECTION III. LOAN REPAYMENT SCHEDULE:**

| Description/ Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| OPENING BALANCE | 8,400 | 7,560 | 6,720 | 5,880 | 5,040 | 4,200 | 3,360 | 2,520 | 1,680 | 840 |
| PRINCIPAL REPAYMENT | 840 | 840 | 840 | 840 | 840 | 840 | 840 | 840 | 840 | 840 |
| CLOSING BALANCE | 7,560 | 6,720 | 5,880 | 5,040 | 4,200 | 3,360 | 2,520 | 1,680 | 840 | 0 |
| INTEREST RATE | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% |
| **INTEREST** | 672 | 605 | 538 | 470 | 403 | 336 | 269 | 202 | 134 | 67 |

**Technology from OECD Countries**

| 7 kW POULTRY LITTER TO ENERGY PROJECT | |
|---|---|
| IPP Model | 18-Mar-04 |

| SECTION I. ASSUMPTIONS | | all figures in US$ | |
|---|---|---|---|
| | | | |
| A. CAPITAL STRUCTURE | | | |
| Total Project Assets (land not included) | | $ | 70,000 |
| Equipment & Civil Costs | | $ | 70,000 |
| Transformer Cost | | $ | - |
| Transmission Cost | | $ | - |
| Equity Capital | 20% | $ | 14,000 |
| Loan | 80% | $ | 56,000 |
| | | | |
| B. LOAN DETAILS | | | |
| Loan amount | | $ | 56,000 |
| Interest | Annual Rate | | 8.00% |
| Repayment Period (years) | | | 10 |
| Annual repayment amount | | $ | 5,600 |
| | | | |
| C. GENERATION DETAILS | | | |
| Installed Capacity | kW | | 7 |
| Days Generating | days | | 365 |
| Hours Generating Per Day | hours | | 10 |
| kWh per year | | | 20,440 |
| Rate per kWh (current price paid to LUCELEC) | $/Unit | | 0.22 |
| Gross annual revenue for generation | | $ | 4,497 |
| Capacity Factor | % of installed capacity | | 80.00% |
| | | | |
| D. OTHER ASSUMPTIONS | | | |
| Management Costs | % of total proj cost | | 2.00% |
| Equipment + Civil Cost | per KW installed | $ | 10,000 |
| Transmission costs | per meter | $ | - |
| Transmission line required | meters required | | 0.00 |
| O&M | % of total proj cost | | 4.00% |
| Land Expenditure | | $ | - |
| Income Tax Rate | % per year | | 0.00% |
| Insurance Expense (construction) | % of total proj cost | | 2.00% |
| Insurance Expense (T&D) | % of total proj cost | | 33.00% |
| Inflation Factor | 5% per year | | 105.00% |
| VERs Generated (.9 kg CO2/kWh) | metric tonnes per year | | 18.40 |
| VER rate (US$ per metric ton) | per VER | $ | 3.00 |
| Depreciation Rates: | | | |
| - buildings and generation unit | % per year | | 2.90% |
| - transmission and distribution | % per year | | 7.00% |

**All changes in assumptions to be made above this line. Section below is linked to the above assumptions.**

| Sl. No. | Description | | YEARS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Expected revenue (KWh sales) | | 4,497 | 4,722 | 4,958 | 5,206 | 5,466 | 5,739 | 6,026 | 6,327 | 6,644 | 6,976 |
| 2 | Expected revenue (CC-related) | | 50 | 52 | 55 | 57 | 60 | 63 | 67 | 70 | 73 | 77 |
| 3 | Management Costs | | 1,400 | 1,470 | 1,544 | 1,621 | 1,702 | 1,787 | 1,876 | 1,970 | 2,068 | 2,172 |
| 4 | O&M Costs | | 2,800 | 2,940 | 3,087 | 3,241 | 3,403 | 3,574 | 3,752 | 3,940 | 4,137 | 4,344 |
| 5 | Land Expense | | 0 | | | | | | | | | |
| 6 | Insurance | | 1,470 | 1,544 | 1,621 | 1,702 | 1,787 | 1,876 | 1,970 | 2,068 | 2,172 | 2,280 |
| 7 | Transmission Line | | 0 | | | | | | | | | |
| | Project Revenues | | -1,124 | -1,180 | -1,239 | -1,301 | -1,366 | -1,434 | -1,506 | -1,581 | -1,660 | -1,743 |
| 8 | | -70,000 | -1,124 | -1,180 | -1,239 | -1,301 | -1,366 | -1,434 | -1,506 | -1,581 | -1,660 | -1,743 |
| Project IRR | **negative** | | | | | | | | | | | |
| 9 | Depreciation | | 2,030 | 1,971 | 1,914 | 1,858 | 1,805 | 1,752 | 1,701 | 1,652 | 1,604 | 1,558 |
| | - buildings and generation unit | | 2,030 | 1,971 | 1,914 | 1,858 | 1,805 | 1,752 | 1,701 | 1,652 | 1,604 | 1,558 |
| | - transmission and distribution | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Interest on loans | | 4,480 | 4,032 | 3,584 | 3,136 | 2,688 | 2,240 | 1,792 | 1,344 | 896 | 448 |
| 11 | Profit Before Tax | | -7,634 | -7,183 | -6,737 | -6,295 | -5,858 | -5,426 | -4,999 | -4,577 | -4,160 | -3,749 |
| 12 | Taxation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | Profit After Tax | | -7,634 | -7,183 | -6,737 | -6,295 | -5,858 | -5,426 | -4,999 | -4,577 | -4,160 | -3,749 |
| 14 | Net Cash Accrual | | -5,604 | -5,212 | -4,823 | -4,437 | -4,054 | -3,674 | -3,298 | -2,925 | -2,556 | -2,191 |
| 15 | Principal Payments | | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 |
| | | -14,000 | -11,204 | -10,812 | -10,423 | -10,037 | -9,654 | -9,274 | -8,898 | -8,525 | -8,156 | -7,791 |
| Equity IRR | **negative** | | | | | | | | | | | |
| 14 | Debt Service Coverage Ratio | | | -0.12 | -0.13 | -0.15 | -0.16 | -0.18 | -0.20 | -0.23 | -0.26 | -0.29 |
| | Average D/S Coverage | | -0.15 | | | | | | | | | |

**SECTION III. LOAN REPAYMENT SCHEDULE:**

| Description/ Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| OPENING BALANCE | 56,000 | 50,400 | 44,800 | 39,200 | 33,600 | 28,000 | 22,400 | 16,800 | 11,200 | 5,600 |
| PRINCIPAL REPAYMENT | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 |
| CLOSING BALANCE | 50,400 | 44,800 | 39,200 | 33,600 | 28,000 | 22,400 | 16,800 | 11,200 | 5,600 | 0 |
| INTEREST RATE | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% |
| **INTEREST** | 4,480 | 4,032 | 3,584 | 3,136 | 2,688 | 2,240 | 1,792 | 1,344 | 896 | 448 |

ANNEX-E

# Project Proposal for UNF/UNFIP

| | |
|---|---|
| **Project Name:** | Global Sustainable Energy Island Initiative |
| **Project number:** | |
| **UNFIP/UNF project number:** | IDA-RLA-03-298 |
| **Programme Framework:** | |
| **Duration:** | 3 years |
| **Start date:** | May 2003 |
| **Docket number:** | (to be inserted by UNFIP/UNF) |
| **Location:** | Dominica, Grenada, St. Lucia, the Caribbean and the Pacific |
| **Responsible UN organization:** | UNIDO's Energy and Cleaner Production Branch |
| **Executing Agency:** | UNIDO, Organization of American States, Climate Institute and Energy and Security Group |
| **UNF project budget:** | $ 750,000 |
| | UNF core funding: $ 500,000 |
| | Third party matching fund: $ 250,000 |
| **Parallel funding:** | $ 300,000 |
| **Total overall budget:** | $ 1,050,000 |


SUMMARY

The overall objective of the project is to promote and support Small Island Developing States (SIDS) efforts in transitioning away from energy consumption and supply patterns based on conventional fossil fuels towards more sustainable energy development based on environmentally sound renewable energy technologies and more efficient use of energy.

SIDS face unique challenges associated with the generation and use of energy as most of them depend almost exclusively on imported petroleum for their energy needs. This high level of dependence leaves these countries vulnerable to the volatility of international oil prices and results in tremendous drain on capital for imports. In addition to that, while SIDS produce only a tiny fraction of global greenhouse gas emissions, many are among the most vulnerable to the effects of climate change such as sea level rise and extreme weather conditions.

In the Caribbean island nations of Dominica, Grenada and St. Lucia first and then in other SIDS, the project will address key barriers that constrain the use of renewable energy technologies for power generation on these islands despite their abundant renewable energy resources and will assist governments in developing and enforcing National Sustainable Energy Plans. The project will also support the development and implementation of clean energy projects encouraging private investments and promoting sustainable business models.

| Signed on behalf of: | Name and Title | Date | Signature |
|---|---|---|---|
| UNIDO | Abel J.J. Rwendeire<br>Managing Director<br>Programme Development and Technical Cooperation Division | 2004 | |

| Signed on behalf of: | Name and Title | Date | Signature |
|---|---|---|---|
| UNFIP | Amir A. Dossal<br>Executive Director<br>UNFIP | 2004 | |

# List of Acronyms/Abbreviations

| | |
|---|---|
| AOSIS | Association Of Small Island States |
| BIA | Basic Implementation Agreement |
| CARICOM | Caribbean Community |
| CARILEC | Caribbean Electric Utility Services Corporation |
| CDC | Commonwealth Development Corporation |
| CDM | Clean Development Mechanism |
| CDB | Caribbean Development Bank |
| CEIS | Caribbean Energy Information Service |
| CERMES | University of the West Indies Centre for Resource Management and Environmental Studies |
| CHP | Combined Heat and Power |
| COP | Conference of the Parties |
| CREDP | Caribbean Renewable Energy Development Programme |
| DSEC | Dominica Sustainable Energy Corporation |
| DOMLEC | Dominica Electricity Services Limited |
| EC$ | Eastern Caribbean Dollar (1 US$ = 2.7 EC$) |
| EDF | Electricité de France |
| EE | Energy Efficiency |
| EET | Energy Efficient Technology |
| FAO | Food and Agriculture Organization |
| GDP | Gross Domestic Product |
| GEF | Global Environment Facility |
| GRENLEC | Grenada Electricity Services Limited |
| GSEII | Global Sustainable Energy Island Initiative |
| INSULA | International Scientific Council for Island Development |
| kWh | kilowatthour |
| LUCELEC | St. Lucia Electricity Services Limited |
| MJ | Mega Joule |
| MOU | Memorandum Of Understanding |
| MW | Megawatt |
| NGO | Non-Governmental Organization |
| NWG | National Working Group |
| OAS | Organization of American States |
| OECS | Organization of Eastern Caribbean States |
| OLADE | Organisation Latino-americano de Energìa (Latin American Energy Organization) |
| PEU | Project Executing Unit |
| PRC | Project Review Committee |
| RBF | Rockefeller Brothers Fund |
| RE | Renewable Energy |

| | |
|---|---|
| REEEP | Renewable Energy and Energy Efficiency Partnership |
| RET | Renewable Energy Technology |
| SEP | Sustainable Energy Plan |
| SIDS | Small Island Developing States |
| USAID | United States Agency for International Development |
| USDOE | United States Department of Energy |
| UNFCCC | United Nations Framework Convention On Climate Change |
| UWICED | University of the West Indies Centre for Environment and Development |
| VER | Verified Emission Reduction |
| WRB | WRB Enterprises |

# Table of Contents

# 1 BACKGROUND AND CONTEXT

## 1.1 Global Sustainable Energy Island Initiative

The provision of energy represents a major hurdle to the sustainable development of small island developing States (SIDS). Most small island States depends almost exclusively on imported petroleum for their energy needs, largely electricity generation and transportation. This high level of dependence leaves these countries vulnerable to the volatility of international oil prices and results in significant drain on capital, which poses serious constraints on government spending for socio-economic development. In addition to that, while small island States produce only a tiny fraction of global greenhouse gas emissions, many, because of their location barely above sea level, are among the most vulnerable to the effects of climate change such as sea level rise and extreme weather conditions.

However, these nations have significant renewable energy resources and show good potential for energy efficiency improvements given their present energy consumption patterns. This makes small island States particularly suited to utilize combinations of modern renewable energy and energy efficient technologies to reduce their fossil fuel imports and reap all the benefits of such an achievement.

Several small island States, aware of the fundamental role that energy plays in sustaining economic growth and improving the welfare of people and recognizing the potential of renewable energy technologies, have taken steps, primarily through international assistance programmes, to promote the use of renewable technologies and the adoption of more efficient energy consumption patterns. But in order to substantially increase the role of renewable energy in the commercial energy mix, small island States still need enhanced technical, managerial, financial and particularly external assistance to make the necessary investments.

> "The Small Island States can by promoting a clean energy environment set an example for the rest of the world. Too much of our national budgets (up to 12%) are spent on fossil fuels for diesel generation of electricity. This is a drain on our national budgets and does not work towards a solution to the problems of climate change. When the tanker comes in the foreign reserves go out.
>
> Far too little attention has been given - amongst the Small Island States leadership and by the donor countries - to the development of alternative means of energy"
>
> T. Neroni Slade
> Chairman of Alliance of Small Island States (AOSIS)
> Ambassador of Samoa to the UN

The Global Sustainable Energy Islands Initiative (GSEII) was launched in November 2000 at COP6 (the Hague, the Netherlands), by a consortium of 5 international NGOs and multi-lateral institutions, namely Climate Institute, Winrock International, Counterpart International, Forum for Energy and Development and the Organization of American States. The GSEII has two objectives: (i) to support the interest of all small island states and potential donors by bringing renewable energy and energy efficiency projects, models, and concepts together in a sustainable plan for small island nations; (ii) to showcase small island States national efforts to significantly reduce greenhouse gas emissions.

Since its launch, the GSEII have focused its efforts on the island nations of St. Lucia, Grenada, and Dominica. Following a collaborative process with government senior policy makers and a wide range of energy stakeholders these three islands have ratified, or are in the process of ratifying it, a strategy paper (National Sustainable Energy Plan) establishing aggressive targets for renewables and energy efficiency, and setting the stage for significant changes in the energy sector.

Working in partnership with the GSEII consortium in order to benefit the most from activities already carried out in the islands, UNIDO project aims to provide Dominica, Grenada and St. Lucia with technical, managerial and financial assistance required to advance the reshaping process of energy supply and consumption patterns towards more sustainable development. The project will address key barriers that constrain the deployment of renewable energy and energy efficient technologies on these islands despite their abundant renewable energy resources and will support the development and implementation of clean energy projects encouraging private investments and promoting sustainable business models. The project also plans to expand to 4 additional AOSIS member nations the policy and technical consultative work on sustainable energy planning and implementation carried out in Dominica, Grenada and St. Lucia and provides outreach and training to up to 20 additional member nations.

## 1.2 Country context and energy scenario

Dominica, Grenada and St. Lucia are low-medium income countries. They are full members of the Organization of the Eastern Caribbean States (OECS) and members of the Caribbean Community (CARICOM).

### 1.2.1 Commonwealth of Dominica

With an area of 750 sq. km and a coastline of 148 km the Commonwealth of Dominica (from now on simply Dominica) is the biggest island country of the OECS. The terrain consists of rugged mountains mostly, with very little flat and rolling lands. It has a population of about 71,200. The economic growth has been sluggish as result of declining banana production and the weak development of stopover tourism. Poor air transport connections, high rainfall and the small number of good beaches have prevented the development of mainstream tourism. The government is encouraging growth in the small offshore financial sector and the development of telemarketing and informatics. The GDP per head in 2001 was 3,695 US$[1].

Currently, diesel generators fuelled by imported oil and hydropower plants generate Dominica's electric power. Total generating installed capacity amounts to 20.44 MW: 7.6 MW hydro and 12.84 MW diesel. Firm capacity is 3.2 MW for hydro and 10 MW for diesel. In 2002 gross generation reached 80,132 MWh (44.8% hydro; 55.2% diesel)[2] while sales amounted to 63,981 MWh. There have been no new investments in hydropower generation in over 10 years, while thermal generation has grown modestly.

Electricity rates in Dominica have risen significantly in recent years. At present, residential customers are paying EC$0.57 per kWh (US$0.21) for the first 50kWh and EC$0.662 (US$0.244) per additional kWh. Additionally, fuel surcharge is calculated monthly and added the total consumption. The fuel surcharge in May 2002 was EC$0.0516 (US$0.0189) per kWh. Overall electricity price in May 2002 reached EC$0.7138 per kWh (US$0.264). This is among the highest tariffs in the Eastern Caribbean and is currently the source of concern and protest among many residents.

The customer base for electricity services comprises domestic, commercial and hotels, industrial and street lighting (Fig.1). Nationwide, electricity is provided exclusively by the Dominica Electricity Services Ltd. (DOMLEC), which is owned by the Commonwealth Development Corporation (CDC).

[1] Jamaica, Belize, Organization of Eastern Caribbean States (Windward and Leeward Islands) – Country Profile 2003, The Economist Intelligent Unit Limited 2003

[2] 2002 DOMLEC Annual Report.

According to the Electricity Supply Act of 1996, DOMLEC holds the sole and exclusive license for electricity generation, transmission, distribution, and sale.

The transportation sector is a serious concern for Dominica in terms of sustainable energy use. Currently, very limited statistics are available. However, in the 2001 initial national communication to the UNFCCC, the transport sector (road and marine) was indicated to account for 50% of 1994 annual Dominica CO2 emissions (Fig.2). Concern has been recently raised regarding unregulated bus routes and a proliferation of low-efficiency used car imports.

**Sales of electricity by sectors - 2001**

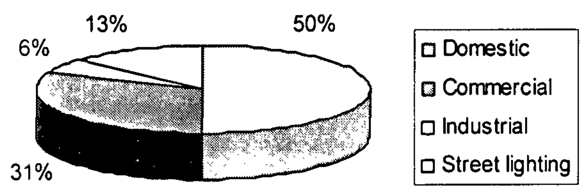



Fig.1 Sales of electricity by sectors in 2001

**CO2 Emissions by sectors - 1994**

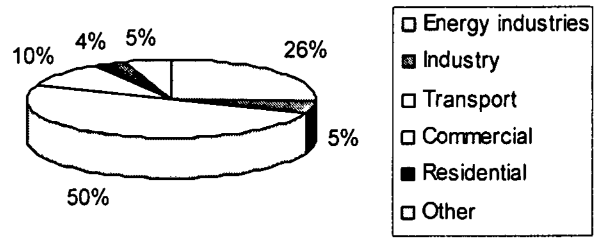



Fig.2 $CO_2$ Emissions by sectors in 1994

### 1.2.2 Grenada

The state of Grenada consists of the islands of Grenada, Carriacou and Petit Martinique. The island of Grenada is 34 km long and 18 km wide and the three islands taken together have an area of 345 sq. km and a coastline of 121 km. The terrain presents mountains in the center of the main island and flat and rolling lands along the coastline. It has a population of about 102,600. In 2001 GDP per head reached 3,881 US$. Fine scenery, marine life and some good beaches have encouraged a tourism industry that is now the main source of foreign-exchange earnings. Agriculture accounted for 7.8% of GDP in 2001. Small farmers produce a wide variety of fruit and vegetable crops. Nutmeg and mace are major exports as well as cocoa. There is a small manufacturing sector comprising food processing, beverages, garments and electronics assembly industries. Telemarketing is a rapidly growing economic activity[3].

Electricity generation and transportation accounts for 80% of Grenada fossil fuel consumption and CO2 emissions (Fig.3)[4]. Grenada present electricity generation is 100% fossil fuel based. Grenada Electricity Services Ltd. (GRENLEC) is the national electricity utility. GRENLEC is a private company whose bulk of shares is held by WRB Enterprise, a Florida based power company. The government is also a major shareholder of GRENLEC. GRENLEC supplies electricity for over 90% of the population in Grenada and is the sole provider of electricity in Carriacou and Petit Martinique. Ordinance No. 25 in 1960 granted GRENLEC the exclusive right to generate, transmit, distribute, and sell electricity in the country for a period of 80 years effect as from January 1, 1961. Total diesel-based generating capacity amounts to 38 MW. In 2001 gross generation reached 146,352 MWh while total sales amounted to 123,918 MWh[5]. Fig.4 shows the sales of electricity by sectors in 2001.

[3] Jamaica, Belize, Organization of Eastern Caribbean States (Windward and Leeward Islands) – Country Profile 2003, The Economist Intelligent Unit Limited 2003

[4] Grenada's Initial Communication to the UNFCCC, submitted November 2000.

[5] Grenada Sustainable Energy Plan

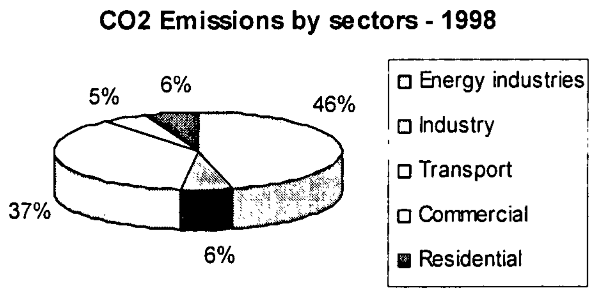



Fig.3 $CO_2$ Emissions by sectors in 1998.

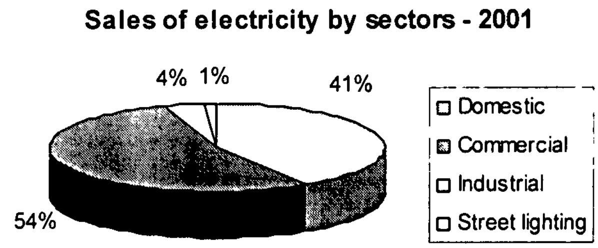



Fig.4 Sales of electricity by sectors in 2001.

Likewise to Dominica, electricity rates in Grenada are significantly high. At present, residential and commercial customers are respectively paying EC$ 0.386 per kWh and EC $0.416 per kWh. Additionally, a fuel surcharge is calculated monthly and added to the unit cost. The fuel surcharge in January 2004 was EC$ 0.222 per kWh. Overall, in January 2004, electricity price for residential and commercial customers amounted respectively to EC$ 0.608 (US$ 0.225) and EC$ 0.638 (US$ 0.236) per kWh.

The transport sector is the second largest consumer of fossil fuel imports. The expanded market for imported, used, vehicles, together with the relative ease access to credit for motor vehicles from the established financial institutions have been major factors in the recent increase in the island vehicles fleet.

### 1.2.3 Saint Lucia

St. Lucia has an area of 616 sq. km and a coastline of 158 km. The interior of the island is mountainous but there is more flat land than on Dominica and Grenada. It has a population of about 157,800. In 2001 GDP per head reached 4,184 US$. Tourism sector is the main source of foreign-exchange earnings. Agriculture accounted for 7.8% of GDP in 2001 with bananas being by far the most export crop. The manufacturing sector is the most diverse in the OECS. However, its contribution to the economy has declined from 8.2% of GDP in 1990 to 4.4% in 2001. It includes paper products, food processing and beverages. There is also a small offshore financing sector. The government is also encouraging the development of telemarketing and informatics[6].

In 2000 99% of St. Lucia's energy needs ware met from imported fossil fuel. Electricity generation and transport are the major consumers of fossil fuel and subsequently $CO_2$ emitter (Fig.5). St. Lucia Electricity Services Ltd. (LUCELEC) is the national electricity company. It is a private company owned by CDC, majority shareholder, the Castries City Council, the National Insurance Corporation, the government and some privates. According to the Electricity Supply Act passed in 1994, LUCELEC is granted an exclusive license for the production, transmission and sale of electricity in St. Lucia.

LUCELEC provides electricity to more than 97% of the population. It has an installed generating capacity of 66.4 MW concentrated at Cul de Sac power plant. In 2001 gross generation amounted to 286,539 MWh while sales reached 243,417 MWh. Fig.6 shows the sales distribution between LUCELEC customer base[7].

---

[6] Jamaica, Belize, Organization of Eastern Caribbean States (Windward and Leeward Islands) – Country Profile 2003, The Economist Intelligent Unit Limited 2003

[7] LUCELEC 2002 Annual Report

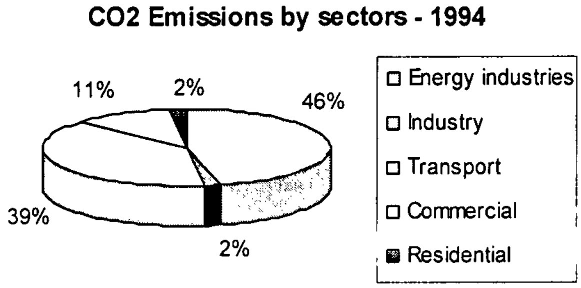



Fig.5 $CO_2$ Emissions by sectors in 1994.

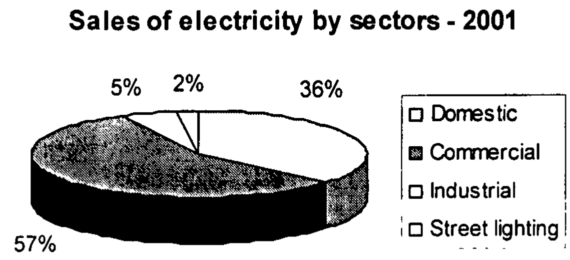



Fig.6 Sales of electricity by sectors in 2001.

LUCELEC tariff structure is similar to DOMLEC and GRENLEC structures, with a base per unit cost plus an additional fuel surcharge that is calculated monthly. In 2003 the average electricity cost for residential customers was EC$ 0.60 (US$ 0.222) per kWh, fuel surcharge included.

The transportation sector is also a major contributor to local air pollution. As in Dominica and Grenada vehicles fleet has grown steadily in the last years. As vehicle fuel economy has a large impact on the volume of emissions, the government has introduced some fiscal disincentives for the purchase of used vehicles. However, there is no yet regulation in place which sets precise emission limits.

## 1.3 Problem statement

The provision of modern energy services in small island developing States plays a critical role in fostering their economic growth and improving the welfare of people. Most small island developing States, like Dominica, Grenada and St. Lucia, face unique challenges associated with the generation and use of energy due to their heavy reliance on imported fossil fuels. Table I shows how much these three islands spent, of their export earnings, for primary energy imports in 1999 and 2000.

Table I

| Mineral fuels, lubricants and related materials. Value (US$ 000)[8] and percentage of country's total exports to all destinations[9] | | | | |
|---|---|---|---|---|
| **Country** | **1999** | | **2000** | |
| Dominica | 8,411 | 15.4 % | 14,194 | 28.2 % |
| Grenada | 18,320 | 24.6 % | 20,928 | 23.0 % |
| Saint Lucia | 24,103 | 39.6 % | 29,393 | 53.6 % |

This dependency brings about more than one negative effect. It makes small island developing States vulnerable to the volatility of international oil price and uncertain supplies. It entails heavy drain on foreign exchange earnings, with subsequent constraints on national investment plans. The high cost of imported fossil fuel, due to the remoteness of SIDS, contributes to create very high electricity prices.

[8] CARICOM's Intra-Regional Trade 1990-2000, Volume 1

[9] "Jamaica, Belize, Organization of Eastern Caribbean States (Windward and Leeward Islands) – Country Profile 2002," The Economist Intelligent Unit Limited 2002

All this slows down the pace of economic and social development and threatens its long-term sustainability.

Most small island developing States have significant renewable energy resources that can be utilized on a cost competitive basis for power, heat and cooling applications. Data available on resource assessments and explorations in Dominica, Grenada and St. Lucia have shown good potential for a range of applications based on solar, wind, geothermal, hydro and biomass resources.

Several studies conducted on different scales (sector, national and sub-regional) have shown that the estimated economic potential for energy use reduction in small island developing States varies between 10% and 30%. A recent study[10] commissioned by the OECS has shown that estimated economic potential for Dominica, Grenada and St. Lucia ranges between 10 and 20 percent. Energy efficiency improvement would represent the most practical measure to take in the short term, since most small island developing States are unable to make radical shifts in their energy mix over the medium term.

The opportunity that renewable energy sources offer in displacing expensive imported fossil fuel for the provision of modern energy services, in particular electricity, and the importance of energy efficiency improvement and the benefits that would stem from that, have been acknowledged by small island developing States and many have demonstrated positive and progressive political attitudes. Nonetheless, the utilization and development of renewable and sustainable energy technologies in small island developing States has been limited to date and basically restricted to international assistance programmes. This has been due to a number of barriers including: lack of understanding of the costs, benefits and applications of these technologies; lack of adequate expertise to assess and validate technology options; policy and regulatory climates that favor environmentally damaging fossil fuels and hinder development of clean options; lack of in-country institutions able to coordinate and monitor all aspects of clean energy project design, development, implementation and operation; a power utility structure resistance to transitioning away from conventional fossil fuel generation to cleaner energy options; lack of available, affordable financing for clean energy projects; limited project identification and development expertise.

The conditions for the creation of a small island developing States-driven development of renewable and energy efficiency technologies are not in place yet. External support from donors and international development agencies is still required, now more than ever in the light of the efforts that many small island States have been recently making to orient their future energy development towards renewable resources and sustainability.

## 1.4 National energy policy

Dominica, Grenada and St. Lucia do not currently have a consistent energy policy integrated with the country development strategies. However, with the support of several partners, governments of these three islands have started to develop national sustainable energy plans that orient, through renewable energy resources utilization and more energy efficient consumption patterns, country's energy development policy towards sustainability. These plans set firm targets, timetables and actions for a sustainable development of the electricity generation as well as transportation sectors. The preparation of these national sustainable energy plans is in different stages of implementation for the three islands.

In Saint Lucia the sustainable energy plan has already been ratified by Cabinet and the government is now working on specific strategies to achieve the targets and expectations described in the Plan.

[10] "I dentification of Policy framework options and elements for enhanced efficiency of energy use in the OECS states," Lewis Engineering Inc. & Marbek Resource Consultants Ltd., January 2001

However, Saint Lucia took important steps before that to encourage renewable-energy development. In May 1999, government adopted a policy to eliminate all import duties and consumption taxes on renewable energy equipment and materials, and in April 2001 decided to allow the purchase of solar water heaters as an allowance against taxable income. St. Lucia has established an annual Energy Week, which took place for the first time in January 2003, scheduled to coincide with households receiving high electricity bills following their use of Christmas lights and other decorations. The purpose of this event is to inform the public about energy efficiency and renewable energy options. In 2003 government has also waived import duties on some energy efficient technologies and started working on the introduction of energy efficiency standards.

In Dominica the sustainable energy plan is in the ratification process after being modified according to the outcomes of two stakeholder consultations organized by the Ministry of Communications, Works, and Housing in collaboration with GSEII partners in July 2002 and January 2003. In the last consultation Minister Reginald Austrie confirmed government commitment to take necessary policy decisions to achieve higher levels of efficiency in the use of energy and in the utilization of Dominica's renewable energy resources.

In Grenada the Ministry of Works, Communications, and Public Utilities prepared, with input from key stakeholders from all sectors of society, a draft of the sustainable energy plan and stakeholder consultations have been planned to take place throughout the country for reviewing and finalizing the document.

Last but not least, at the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa, in August 2002, the Prime Minister of Dominica, and Ministers from St. Lucia and Grenada, publicly stated their strong commitment to adopt those measures needed to achieve energy self-reliance along with economic growth, poverty reduction and improved environmental protection. They invited developed nations, international agencies, NGOs and the private sector to join the process and assist in the provision of technical assistance, technology, soft financing, policy support and business partnering.

## 1.5 Experience in renewable energy and energy efficient technologies

*Dominica*

There are three mini hydro plants with a total installed generating capacity of 7.6 MW and a firm capacity, during dry season, of 3.2 MW. In 2002 hydro generation accounted for electricity 44.8% of total electricity generation.

Between 1983 and 1988 a technical cooperation program for biogas technology transfer was executed. Within the program, supported by the Government of the Federal Republic of Germany and the Caribbean Development Bank (CDB), 14 units were constructed but after the end of the program there was no further dissemination.

There is a local manufacturer of solar water heathers. Potential for solar energy applications is substantial with the sun providing about 6 kWh of energy per day per square meter.

Several geological surveys have assessed Dominica geothermal resources and concluded that the chances for finding economic quantities of natural steam for power generation are excellent[11], with an estimated capacity of 50-100 MW. However, no deep exploratory wells have been drilled so far.

Wind resource assessments have been carried out and several site with good potential for commercial exploitation have been identified. With support from the OAS, the Dominica Sustainable Energy

[11] "Renewable Energy on Small Islands - 2nd Edition," Forum for Energy and Development, August 2000

Corporation installed in August 2002 two 1 kW pilot wind turbines to provide electricity to an estate house in Dominica's southeast. In Fall 2002, the OAS granted DSEC additional support to continue wind studies and install a 10 kW wind turbine.

*Grenada*

There is very little experience on renewable energy and energy efficient technologies. Many hotels and some households use solar water heaters, but they are imported from Dominica and St. Lucia.

Studies commissioned in the past to assess hydro and wind resources have indicated that micro hydro and wind energy systems are both viable.

*St. Lucia*

There is a local manufacturer of solar water heaters producing for the internal and the regional market. Although many hotels and houses have already installed solar water heaters, there is still a significant potential to tap, due to the high price of electricity.

Drilling explorations programs, funded by U.S. and European companies as well as the UN, have confirmed the presence of geothermal resource capable of supplying electricity to the national grid. However, no adequate determination of feasibility is currently available.

There is limited experience in PV applications. In 1999 the UN Trust Fund on New and Renewable Sources of Energy completed a demonstration project in which PV systems were used to provide electricity to the school of a remote not-grid connected village and provide emergency lighting to hurricane shelters.

Several wind resource studies and assessment have been carried out and few sites with moderately high wind speed have been identified. But to date, no initiative has gone further the pre-feasibility study.

With regard to energy efficiency, LUCELEC has made some efforts to improve consumers' awareness about efficient use of electricity. A demonstrative energy conservation program carried out in a government office building was able to reduce annual electricity consumption by close 15%.

## 1.6 Related past and current activities

The GSEII consortium has started in 2001 to provide assistance to Dominica, Grenada and St. Lucia in the development and execution of National Sustainable Energy Plans. GSEII has helped to identify critical policy and regulatory reforms favoring energy sector diversification, as well as detailing the key capacity building, technical, and financial mechanisms required. In parallel to these national plans, GSEII has been working with the private sector to develop industry capability and partners for project design and implementation; and assist in securing financing and investment sources.

UNIDO is committed to supporting SIDS in the delivery of reliable and affordable sustainable energy. Within this scope UNIDO has recently completed in Cuba the PDF-B phase activities for a GEF project entitled "Generation and Delivery of Renewable Energy Based Modern Energy Services in Cuba: the Case of Isla de la Juventud". The project main objective is to establish commercial business models for renewable technologies providing modern energy services on the island and their replication. Project activities include, between others, the establishment of a policy and regulatory framework to provide enabling environment to the development of renewable energy, building local and national capacity to utilize the commercial potential of renewable energy technologies and setting up appropriate financial and institutional mechanisms to encourage private sector investment in renewable energy projects.

With specific reference to Dominica, Grenada and St. Lucia, through a recent planning grant provided by UNF and in partnership with the GSEII consortium, UNIDO has undertaken a mission in the islands to meet counterparts, key stakeholders and potential project developers as well as to collect information. This initial mission has resulted in identification and screening of a pipeline of clean energy projects in the three island nations of Dominica, Grenada and St. Lucia. Table II lists the projects identified and screened during the mission, for which a project profile is provided in Annex A, as well as potential projects that will be further considered in the light of the present proposal primary focus on achieving synergies with other on-going programme/projects and responding effectively to government and community priorities.

Table II Identified potential projects in Dominica, Grenada and St. Lucia

| | |
|---|---|
| **Dominica** | ▪ DOMLEC Micro Hydro Project<br>▪ Energy efficiency improvements of DOMLEC distribution system<br>▪ Dominica Cooperatives League and Credit Unions Solar Hot Water Heating Financing Programme<br>▪ Large Scale Geothermal Project Pre-feasibility Development |
| **Grenada** | ▪ 225 kW Wind Turbine on Carriacou island<br>▪ Grenada Nutmeg Biomass Combustion and Solar Drying Project<br>▪ Grenada Cooperatives League and Credit Unions Solar Hot Water Heating Financing Programme<br>▪ PV system for Grenada Chocolate Company energy supply |
| **St. Lucia** | ▪ 400kW Methane-to Energy Project<br>▪ Poultry Litter-to Energy Project<br>▪ LUCELEC 1.4 MW Wind Farm<br>▪ St. Lucia Cooperatives League and Credit Unions Solar Hot Water Heating Financing Programme<br>▪ Sulphur Springs Geothermal Project<br>▪ Water Utility Energy Efficiency Retrofit |

# 2 PROJECT OBJECTIVES AND RATIONALE

## 2.1 Goals and objectives

The goal of this project proposal is to promote and support the transition of AOSIS nations toward cleaner, more sustainable energy use. A principal focus of the project will be to support the consolidation of Dominica, Grenada and St. Lucia efforts in orienting their national energy policy and development towards renewable energy and energy efficient technologies. In line with the national priorities, the project will help these islands to lay the foundations of improved energy security, reduced electricity tariffs and improved allocation of resources. In addition, the project plans to expand its sustainable energy planning/implementation efforts to an additional 4 AOSIS member nations and to provide outreach and training to up to 20 additional member nations.

The main objectives of this project are the following:

1. Work with partner countries on the development and implementation of Sustainable Energy Plans that identify policy, financing, technical and institutional barriers hindering project development and outline solutions to mitigate these barriers
2. Build and strengthen local capacity at national and regional levels to continue to develop and implement sustainable energy options and approaches
3. Catalyze private investment in renewable energy (biomass, geothermal, hydropower, photovoltaic, solar thermal and wind technologies) and energy efficiency projects
4. Demonstrate that energy can be used as a tool for sustainable development and poverty reduction, thereby contributing to attainment of the Millennium Development Goals (MDGs).

In each of the countries involved, the project will promote the development of sustainable, market-based approaches to the delivery of energy services through public-private partnerships.

## 2.2 Project rationale

**Reduce Fossil Fuel Imports**. In most small island developing states fossil fuels are the chief source of energy and in many cases are 100% imported. Energy dependence represents a major threat to these economies from the perspective of foreign exchange. Since most small island States are dependent on commodities and/or services (i.e. tourism, raw materials) whose prices are set external to their economies, a marginal increase in oil prices could have a harmful impact as more foreign exchange will be required to purchase the same amount of oil. This in turn could have more serious social and economic implications, which could further hinder sustainable development efforts.

**Demonstrate Leadership in Reducing Greenhouse Gas Emissions**. Although small island nations produce a tiny fraction of global greenhouse gas emissions, they are among the most vulnerable to the effects of climate change, such as the increased strength and frequency of hurricanes and the rise in sea level. It is in their best interest to mitigate greenhouse gases thereby setting an example for other countries in making similar commitments. St. Lucia, Dominica and Grenada have made these public commitments and are interested in moving forward to demonstrate this with a favorable policy environment and investments in clean energy projects.

**Barbados+10 Conference**. At the Global Conference on the Sustainable Development of Small Island Developing States held in 1994 in Barbados, more than 100 countries adopted a Programme of Action to assist small island developing States in pursuing sustainable development. Five years later, the UN General Assembly convened a special session to assess the results of those commitments and in 2000, at the United Nations Millennium Summit, world leaders resolved to address the vulnerabilities faced by small island developing States, rapidly and in full by 2015. While small islands have been gaining global attention and international support, the results to date have not kept pace with the problems. The 10 Year Review of the Barbados Programme of Actions Conference, to be held in Mauritius in August/September 2004, will be a critical opportunity to track developments and inspire international action. This forum provides an excellent opportunity to highlight the progress of UNIDO-GSEII project as a model for enhancing sustainable energy development in the small island States.

**Link to World Summit on Sustainable Development.** At the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa in August 2002, the Prime Minister of Dominica, and Ministers from St. Lucia and Grenada, reaffirmed their strong commitment to adopt those measures needed to achieve energy independence along with economic growth, poverty reduction and improved environmental protection. They also invited developed nations, international agencies, NGOs and the private sector to join the process and assist in the provision of technical assistance, technology, soft financing, policy support, business-partnering, etc. These nations also expressed their commitment to the Millennium Development Goals, and the important contribution of energy in enhancing quality of life and reducing poverty.

## 2.3 Relationship to UNF/UNFIP Program Framework

The "Interim" Program Framework for Sustainable Energy/Climate Change proposed by UNF in close consultation with UNFIP has identified three Program Focal Areas as having overriding importance for grant making:

- Program Focal Area 1 – Develop and Demonstrate Sustainable and Commercial Approaches to Deliver Community-Based Renewable Energy Services.
- Program Focal Area 2 – Improve Energy Efficiency in the Industrial, Residential and Commercial Sectors through Market-Oriented Policies and Programs.
- Program Focal Area 3 – Promote the Clean Development Mechanism as a means to engage the Private Sector in the Areas of Renewable Energy and Energy Efficiency.

This project proposal has cross-relevance to all three program focal areas. It is relevant to Area 1 as the project aims to support the development of market-based renewable energy services and to advance the institutional capacity and financing infrastructure needed to address some of the key barriers to the market commercialization of technically proven renewable energy applications. The project will also pursue the establishment of effective private-public partnerships.

The proposal addresses Area 2 as it provides technical assistance in the design of government policies and programs that encourage energy efficiency as well as training and information to consumers and operators about energy efficiency. Likewise to Area 1, market-based delivery models will be pursued in the development and implementation of any identified energy efficiency project.

For Program Area 3, the project will provide the capability to quantify the costs of reducing GHG emissions and will explore, in the light of the recently approved simplified modalities and procedures for small-scale CDM project activities, the potential of the candidate projects to benefit by the CDM, as an additional asset for engaging private sector attention with renewable energy and energy efficiency investments.

Finally, at WSSD, UNF supported a GSEII consortium side event which brought together the Prime Minister of Dominica, and Ministers from Grenada and St. Lucia, to express their commitments to a sustainable energy future and to layout steps to facilitate this transition. This project proposal supports the implementation of those WSSD commitments and ensures effective leveraging and results from prior UNF support.

## 2.4 Charitable Purposes Justification for UNF

Accessibility of energy varies widely within and between small island States regions. In Pacific island countries approximately 70% of the people do not have access to modern energy services, with many of these people living on remote islands or in isolated rural areas. In the Caribbean as well as in the Indian Ocean there is less a problem of access[12] but rather of affordability.

Addressing the problem of small island States heavy dependency on imported petroleum oil through the utilization of the renewable energy resources that most small island States are plenty of and the improvement of energy generation, transmission and consumption, the project will contribute to: (i) directly or indirectly lessen the burdens of government; (ii) promote environmental protection by generating investment in the provision of sustainable energy services; (iii) free resources for more economically and socially productive uses and (iv) provide electricity to remote areas households and at more affordable prices[13]. These outcomes will positively impact the poverty alleviation efforts of small island developing States. Therefore, this project can be deemed an exclusive charitable project.

[12] In Caribbean island countries average grid coverage is over 80%. In Dominica, Grenada and St. Lucia average grid coverage is over 94 %.

[13] Poor households will be mostly benefit from a reduction in electricity price as a consequence of their higher marginal utility of income with respect to income.

# 3 PROJECT DESIGN

## 3.1 Process followed in project formulation

The development of Dominica, Grenada and St. Lucia sustainable energy plans has been the result of governments and stakeholders dialogue with the provision of technical assistance by the GSEII consortium, supported by UNF and the Rockefellers Brothers Fund. During this formulation process the GSEII consortium helped identify critical policy and regulatory reforms favoring energy sector diversification as well as detailing the key capacity building, technical, and financial mechanisms required. In parallel the GSEII consortium has also started to work with the private sector to assess and develop industry capability for project design and implementation.

Through the provision of a planning grant by UNF and in partnership with the GSEII consortium, UNIDO has worked to support and advance the sustainable energy plan implementation efforts made. A mission by UNIDO representative and international experts in renewable and energy efficiency technologies and clean energy project financing was undertaken to Dominica, Grenada and St. Lucia. These initial activities have resulted in identification and screening of a pipeline of clean energy projects (Table II). Criteria used for the identification and selection of renewable energy and energy efficiency project included potential of renewable energy resource, specific demand for energy services, technical and commercial feasibility, interested project developers, utilization of sustainable business models, potential in overcoming existing market, policy, financial, technical barriers and potential for replication in other AOSIS member nations. Profiles of selected pipeline projects are included in Annex A.

The current project proposal reflects the work done by the GSEII consortium on the sustainable energy plan development in Dominica, Grenada and St. Lucia, the preliminary findings of the undertaken mission and the results of discussions held with representatives of the three island governments and representatives of UNF.

## 3.2 Project strategy

The project has been developed along two lines drawn by the intended global-reaching scope of the Global Sustainable Energy Island Initiative and by recognizing the importance of advancing Dominica, Grenada and St. Lucia sustainable energy plan implementation in achieving such scope.

Building on the activities carried out and the potential clean energy investments identified in the three islands the UNIDO-GSEII Team will focus on advancing the development of selected clean energy projects and bringing them to financial closure. This will entail to identify all project-specific barriers and, working with governments, utilities and local stakeholders, to devise appropriate mitigation measures.

In order to expand the scope of the GSEII, it is anticipated that sustainable planning activities will occur in four additional countries, with training and outreach provided to an additional 20 island nations. Selection of these countries will be based on a set of criteria which includes: government commitment to becoming sustainable energy islands; available renewable energy resource base; willingness to support the development and implementation of sustainable energy planning efforts; support for favorable policy and regulatory frameworks; local industry and utility capabilities; willingness to work with international investors and the private sector; and geographic diversity across the Caribbean, Indian Ocean, and Pacific Island nations.

Locally or regionally where appropriate, the project proposes to implement technical assistance activities for capacity building, technology transfer, financial packaging and strengthening of institutional and policy mechanisms, and setting up initial investments as business models to demonstrate commercial viability of renewable energy technologies to provide modern energy services and energy efficiency.

### 3.3 Activities and anticipated outputs

To achieve the project goals and objectives, the proposed project would involve conduct and achievement of the following activities and outputs.

**Objective 1: Work with partner countries on the development and implementation of Sustainable Energy Plans that identify policy, financing and institutional barriers hindering project development and outline solutions to mitigate these barriers**

Task 1.1: Continue working with the St. Lucia, Grenada and Dominica on the implementation of their sustainable energy plans

**Activity 1.1.1** Advance a set of clean investment opportunities developed under planning grant activities supported by UNF and the Rockefeller Brothers Fund

In particular, efforts will focus on helping enterprises and project developers to mitigate barriers to commercial scale investment, conduct pre-feasibility and feasibility studies, secure needed business development and planning support, obtain project financing and develop and expand local markets for clean energy projects and programs.

**Activity 1.1.2** Support policy and regulatory measures to enable and advance clean energy projects.

**Activity 1.1.3** Public education campaigns

**Activity 1.1.4** Leverage investment by public and private sector sources

Financing sources will include World Bank, International Finance Corporation, Global Environment Facility, regional development banks, local banks and others. The project will also work with local governments and project developers on the development and packaging of projects for carbon financing through the Clean Development Mechanism, Prototype Carbon Fund and other sources.

**Output 1.1.1** Approved national sustainable energy plans in Dominica, Grenada and St. Lucia

**Output 1.1.2** Initiation of at least 3 new sustainable energy projects, one in each island, and plans for at least 10 MW of clean energy projects (new renewable or equivalent savings through efficiency measures) facilitated with corresponding GHG emissions reductions

*This task is a priority area for UNF, with approximately $300,000 of proposed UNF funds to support project development and investment opportunities in the three island nations of St. Lucia, Grenada and Dominica. In particular UNF funds will build upon the planning grant activities to advance the base of projects identified in Table II and bring these to financial closure. A key source of financing would be the Caribbean Sustainable Energy Fund in development in Task 5 below.*

Task 1.2: Identify, select and support additional Sustainable Energy Island Nations

**Activity 1.2.1** Outreach to other nations within the AOSIS membership to explore their interest in becoming sustainable island nations

A number of these nations have already expressed their interest in participating, if provided with technical and financial assistance. These include Barbados, St. Kitts and Jamaica in the Caribbean; the Maldives in the Indian Ocean; Vanuatu, Tuvalu, Niue, Samoa, Nauru, Marshall Islands and Fiji in the Pacific. Following a preliminary visit undertaken in November 2003 by a GSEII consortium partner, St. Kitts and Nevis is envisaged to likely be the first island State in the Caribbean to which extend the sustainable energy planning and implementation activities.

**Activity 1.2.2** Selection of 4 new sustainable island nations and development of sustainable national energy plans

It is anticipated that 4 new countries will be added over the 3-year duration of the program. These countries will be selected according to the criteria discussed in the Project strategy section above. In each selected country the following sub-activities will be carried out:

- Facilitate a national level consultation to bring together key stakeholders in the island to identify energy needs, opportunities, barriers, approaches and players
- Work with the key stakeholders to develop a Sustainable Energy Plan (SEP) that transitions the economy from fossil fuels to a cleaner energy resource base (renewable energy and energy efficiency). The plan will include recommended policy reforms, establish national targets and timetables for a 5-10 year transformation, and identify candidate projects and programs
- Support renewable energy resource assessments
- Conduct end-use energy consumption studies and identify energy efficiency opportunities and projects
- Support project development, including pre-feasibility and feasibility studies, and packaging for investors
- Coordinate with local utilities on project development
- Leverage funding for project support
- Identify project partners/developers
- Provide technical assistance, training and capacity building
- Link with related national and regional activities

**Output 1.2.1** Approved national sustainable energy plans for 4 countries

**Output 1.2.2** Initiation of 2-4 energy efficiency projects in Government facilities, commercial, residential and industrial sectors, especially in the hotels and tourism industry

**Output 1.2.3** Initiation of at least 4 new sustainable energy projects, and plans for at least 20 MW of clean energy projects (new renewable or equivalent savings through efficiency measures) facilitated with corresponding GHG emissions reductions

*It is anticipated that approximately $100,000 of the proposed UNF funding would support Sustainable Energy Planning and project development activities in up to 3 of the 4 target countries*

**Objective 2: Build and strengthen local capacity at national and regional levels to continue to develop and implement sustainable energy options and approaches**

Task 2.1: Regional level activities for capacity building and awareness

In addition to national level support to a select number of island states, the project will extend its reach to at least 20 additional member nations through broader regional-level capacity building and awareness activities. These will be aimed at strengthening local capabilities in all aspects of design, development, financing, implementation, maintenance and operation of sustainable energy projects and programs.

**Activity 2.1.1** Training seminars and workshops for policy makers, engineers and utility staff in the selected island states, as well as for local firms, entrepreneurs, financial institutions, trade groups and research organizations

**Activity 2.1.2** Dissemination of information on successful sustainable energy planning and project activities

The project will coordinate these efforts by closely working with the existing regional organizations and multilateral initiatives, including OECS, UNDP, the GEF and other recently launched initiatives in the energy sector, such as the European Union initiative.

**Output 2.1.1** Financial institution training seminars in the Caribbean and the Pacific

**Output 2.1.2** Policy maker seminars in the Caribbean and the Pacific

**Output 2.1.3** Business planning seminars in the Caribbean and the Pacific

**Output 2.1.4** Technology and energy management seminars in the Caribbean and the Pacific

The outcome of delivered outputs will be the enhancement of capacity for renewable energy and energy efficiency development at regional level and among at least 20 members of the AOSIS, including over 50 trained policy makers, financial institutions and private firms/entrepreneurs who are effectively designing, developing and implementing renewable energy and energy efficiency projects.

*No UNF funding anticipated for this Task; this funding will come from other donors.*

<u>Task 2.2:</u> Establishment of Regional Offices in the Caribbean and the Pacific

To effectively mount a large-scale, multi-island, multi-year initiative, it will be necessary to set up local offices in the Caribbean and the Pacific Islands. These offices would be responsible for coordinating activities in these regions, tracking and monitoring local activities, working with island nation governments and stakeholder organizations, facilitating linkages with the international financial communities and private sector and coordinating activities with the broader partner base. It is anticipated that offices would be set up in conjunction with a regional institution or initiative already working in this field (e.g. CREDP, UWICED, CEIS), and in Fiji at the offices of GSEII partner, Counterpart International. The purpose of this type of arrangement would be to build on and enhance capacity already available in the region. These offices would each include 1-2 people with some support staff capability.

**Activity 2.2.1** Establishment of regional offices in the Caribbean and the Pacific

**Output 2.2.1** Establishment of regional offices in the Caribbean and the Pacific

*No UNF funding anticipated for this Task; this funding will come from other donors.*

**Objective 3: Catalyze private investment in renewable energy (biomass, geothermal, hydropower, photovoltaic, solar thermal and wind technologies) and energy efficiency opportunities**

<u>Task 3.1</u>: Caribbean Sustainable Energy Fund Development

Currently in the Caribbean, the GEF-Caribbean Renewable Energy Development Program (CREDP) is seeking to establish a renewable energy fund to support project development in the region. However, to date the management team has been unable to secure the funding partners for this effort. The UNIDO-GSEII Team will work with CREDP, the Caribbean Development Bank, the GEF, the local and regional cooperative associations and others to develop either a dedicated fund for the selected projects or project specific investments. In this case the UNIDO-GSEII team will build on previous and ongoing efforts and discussions, and project pipeline already in progress.

**Activity 3.1.1** Work with local and regional credit institutions to establish a micro-credit lending program for renewable energy and energy efficient technologies' application

**Activity 3.1.2** Work with CREDP and other entities active in the region to establish a renewable energy funding facility in the Caribbean

**Output 3.1.1** Micro credit lending program with the Caribbean Conference of Credit Unions

**Output 3.1.2** Operational renewable energy funding facility in the Caribbean, either with CREDP or other entities

The overall outcome of the outputs delivered under this task will be the commitment and/or leverage of at least $20 million in investment in RE/EE projects and enterprises

*It is anticipated that approximately $50,000 of the proposed UNF funding would support project funding and possible fund development activities.*

**Objective 4: Demonstrate that energy can be used as a tool for sustainable development and poverty reduction, thereby contributing to attainment of the Millennium Development Goals**

Task 4.1: International Outreach/Barbados+10 Conference Participation

This task will involve developing and implementing an on-going outreach and promotion campaign to advertise the commitment, activities and progress of AOSIS member nations as national sustainable energy leaders. This campaign will seek to encourage larger nations to follow their examples and to influence international policy on climate change. International outreach activities will demonstrate that with the necessary technology and political will, nations can achieve energy self-sufficiency, leapfrogging the current fossil fuel technologies, and that sustainable energy can be used as a tool for sustainable development. This task will also build support among the international community, donors and foundations for the sustainable energy initiatives undertaken by the SIDS. A key component of this task will be to participate in the Barbados+10 Conference and advance preparatory meetings to highlight the GSEII work program and to identify ways to replicate this program this throughout AOSIS.

**Activity 4.1.1** Development of marketing and promotional materials (brochures, newsletters, CD Roms and reports)

**Activity 4.1.2** Development of a GSEII website

**Activity 4.1.3** Facilitate AOSIS member participation in international fora and support international policy making events (Conference of the Parties, WSSD, etc)

**Activity 4.1.4** Participate in the Barbados+10 Conference and its preparatory meetings

**Output 4.1.1** Brochure on UNIDO-GSEII project for Barbados+10 Conference

**Output 4.1.2** Participation in Barbados+10 Conference preparatory meeting

**Output 4.1.3** UNIDO-GSEII side event/presentation at Barbados+10 Conference, to include senior level representatives from AOSIS countries participating in the program

**Output 4.1.4** Report documenting UNIDO-GSEII project case study examples of energy linkages to the MDGs

**Output 4.1.5** Develop personal impact narratives detailing the quotidian effect of this grant on beneficiaries

**Output 4.1.6** Catalyzed interest of at least 2 larger nations to follow the SIDS example.

*It is anticipated that approximately $50,000 of the proposed UNF funding would support international outreach efforts, particularly participation in the Barbados + 10 conference and preparatory sessions.*

## 3.4 Proposed project restructuring in the event full matching funds are not achieved

The implementation of all activities indicated in section 3.3 is subordinated to the UNIDO-GSEII team success in mobilizing the third party funds required by UNF to provide its maximum support to the project (see section 5.1). In the event that full matching funds are not achieved the project will be restructured as follows:

1) The existing focus on advancing activities in the existing island nations of St. Lucia, Grenada and Dominica will continue as priority. There will be no reduction of activities in these three nations.

2) The primary reduction in activity to reflect a decreased funding base would occur in Task 1.2, which involves expansion of activity to other countries. In the unlikely case that matching funds were not secured, UNIDO-GSEII would limit expansion to other countries from current plans of 4 additional countries, to a lesser number contingent on funding availability.

3) Other adjustments that would occur as required are: (i) reduction in support for the regional offices, in particular, no regional office would be established in the Pacific, and (ii) reduced funding would be available for participation in Barbados+10 Conference and its preparatory meetings.

## 3.5 Linkage to ongoing projects and programmes

Currently, there is a number of renewable energy based projects and activities funded by international organizations and agencies which are ongoing in Dominica, Grenada and St. Lucia as well as in the Caribbean region. A brief description of some important energy projects that have relevance to the proposed GSEII project is as follows:

**Caribbean Renewable Energy Development project (CREDP), UNDP-CARICOM:** This PDF project aims at developing a regional project to remove barriers to renewable energy utilisation in the Caribbean region. Through specific actions related to policy, finance, capacity and awareness barriers, it is estimated that the contribution of renewable energy sources to the region's energy balances will be significantly increased. A wide- range of renewable energy activities have been proposed by the many countries involved in this project.

**Development of Energy Efficiency in the Caribbean, UNDP/GEF/OLADE:** The overall project objective is to dismantle the barriers to application, implementation, and dissemination of least-cost energy efficiency technologies and to promote the efficient distribution and use of electrical energy in the countries of the Caribbean. The project is under the responsibility of the following institutions: Organizacion Latino-americano de Energia (OLADE) as the principal Executing Agency, Caribbean Energy Information System (CEIS), University of the West Indies Centre for Environment and Development (UWICED), Caribbean Electric Utility Services Corporation (CARILEC), and the Organization of the American States (OAS).

**Forum for Co-operation in Renewable Energy (Europe-Caribbean), INSULA – UNESCO:** The forum aims at the development of commercial technological solutions for the use of renewable energies and to improve the energy efficiency to mitigate global climate change not only in island states, but also in isolated regions of the developing world.

**Alliance of Small Island States (AOSIS):** The Alliance of Small Island States is a coalition of small islands that share similar development challenges and concerns about the environment, especially their vulnerability to the adverse effects of global climate change. It functions primarily as an ad hoc lobby and negotiating voice for Small Island Developing States (SIDS) within the United Nations system. AOSIS has a membership of 43 States and observers, drawn from all oceans and regions of the world.

The proposed project will strive to achieve synergies with these and other ongoing programmes/projects by exchanging information. Lessons learned from other important climate change projects will be taken into account while implementing the project activities to avoid duplication, and also to establish close linkages with the ongoing initiatives to make full use of their results, complement their activities and to develop synergies to maximize the impact.

The project will also strive to achieve synergies and coordination with regional organizations in each of these countries. These include regional entities such as the OAS, South Pacific Regional Environment Program (SPREP), South Pacific Applied Geoscience Commission (SOPAC), Caribbean Community (CARICOM), Organization of Eastern Caribbean States (OECS), the Organization for Economic Cooperation and Development (OECD) and utility associations like CARILEC and the Pacific Power Association (PPA). The UNIDO-GSEII Team already has an established working relationship with many of these organizations.

# 4 STAKEHOLDER PARTICIPATION AND IMPLEMENTATION ARRANGEMENTS

## 4.1 Beneficiaries

Government ministries and departments, national utilities, national and regional institutions, public and private sector companies and private entrepreneurs will benefit directly from UNIDO project activities in terms of: better understanding of renewable technologies and energy efficiency market potential, costs and benefits, actions required to facilitate their deployment, and support to project development and implementation.

However, in the mid-term the population of these islands will be also a major beneficiary of these project activities. The efficiency improvement in the use of energy and the adoption of renewable technologies to produce electrical and thermal energy will reduce the imports of fossil fuels. This will bring about two effects: a reduction of the electricity price that will benefit the most low-income households; a substantial amount of national exports earnings will be freed for more socially and economically productive use than buying highly expensive fossil fuels.

## 4.2 Project management and implementation arrangement

For UNF, UNIDO is the implementing agency that will oversee the successful achievement of the project objectives, while the GSEII consortium, as executing agency, will execute most of the project activities.

UNIDO will set up a Project Executing Unit (PEU) in charge of project activities execution and monitoring. A unit coordinator will be appointed by UNIDO to coordinate and ensure timely implementation of the project activities.

National Working Groups (NWG) comprising of key stakeholders including representatives of government ministries, electricity utilities, industrial and commercial organizations, educational institutions and the civil society will be formed in each additional AOSIS member nations in which the policy and technical consultative work on sustainable energy planning and implementation carried out in Dominica, Grenada and St. Lucia will be replicated. The NWG will facilitate stakeholders and public participation in the development and implementation phases of the national sustainable energy plans, and would ensure local ownership of the project through information dissemination on regular basis. In Dominica, Grenada and St. Lucia NWGs have been formed during the national sustainable energy plans development.

A Project Review Committee (PRC) comprising leadership of the AOSIS, representatives from each of the partner organizations, regional organizations and donors will be formed. The PRC will meet twice every year and will oversee the progress and provide direction and guidance.

The national counterpart agency in Dominica will be:

> Ministry for Communications, Works and Housing – The Ministry for Communications, Works and Housing has a key role in the national planning and control of the energy resources and elaborates the main development policy and strategy of the energy sector. It is also CREDP focal point.

The national counterpart agency in Grenada will be:

> Ministry of Works, Communications and Public Utilities – The Ministry of Works, Communications and Public Utilities play a key role in developing policy and strategy for the energy sector and setting the regulatory framework for public utilities. It is CREDP focal point. Following recent political elections in November 2004 the mandate for public utilities might be transferred to other ministry. In this case appropriate actions will be taken.

The national counterpart agencies in St. Lucia will be:

Ministry of Physical Development, Housing and Environment – The Ministry of Physical Development, Housing and Environment with its Sustainable Development and Environment unit elaborates policies and strategies for the energy sector development as well as environment preservation. It is CREDP and GEF focal point.

Ministry of Communications, Works, Transport and Public Utilities – The Ministry of Communications, Works, Transport and Public Utilities is responsible for setting the regulatory framework for national public utilities operations and service tariffs, including the electrical power company.

During implementation the UNIDO-GSEII team will work in close cooperation with the AOSIS national counterpart and regional and international organizations to ensure coordination and complementary efforts with other developmental and renewable energy programmes being implemented in the AOSIS member states.

**IMPLEMENTATION ARRANGEMENT**

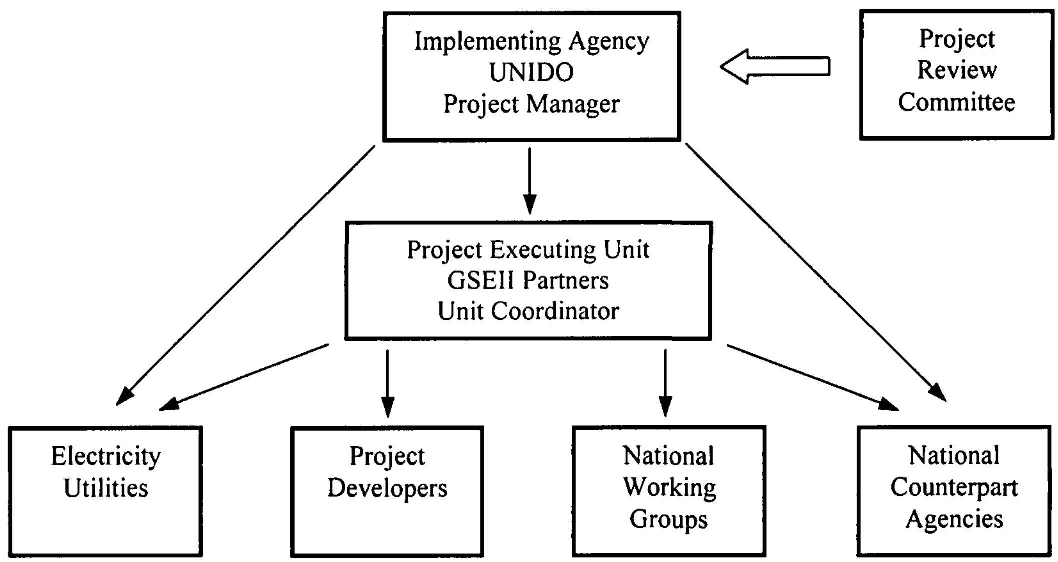



Fig.7 Scheme of proposed project implementation arrangement

A tentative workplan for the first 18 months of the project is provided in Annex C. The working plan is based on the assumption that full matching funds will be achieved within a 6-month period from the initiation of project activities.

# 5 PROJECT FINANCING

## 5.1 Project financing

The present total budget amounts to US$ 1.050 million with a source breakdown as follows:

| | |
|---|---|
| Total proposed UNF budget | US$ 750,000 |
| Parallel funding sources | US$ 300,000 |
| Total | US$ 1,050,000 |

**UNF core funding** amounts to US$500,000 that includes $250,000 grant plus up to $250,000 in additional grant funding to match each dollar contribution made by public and private third party donors to the UNF in support of this project. This additional grant funding is expressly contingent upon and proportionate to the UNF receipt of contributions from the public and private third party donors. UNF shall encourage private and public third party donors to support the project up to and until total funding, inclusive of the grant and additional grant for the project, equals $750,000.

In order to achieve the maximum amount of US$ 250,000 third party matching funds UNIDO-GSEII team have undertaken consultations with several public and private third party donors. Present situation is as follows:

UK Renewable Energy and Efficiency Partnership (REEEP) -*funding confirmed*

US Department of Energy (USDOE) -*funding confirmed*

US Agency for International Development (USAID)-*funding confirmed*

Government of Austria, Government of Italy, Blue Moon Fund, Rockefeller Brothers Fund – *ongoing discussions*

Approximately, US$ 150,000 in funding for match through UNF has been confirmed from USAID, REEEP and USDOE. At least $100,000 in match through UNF is being sought from other sources including: RBF; Blue Moon Fund; the Governments of Austria, and Italy; the European Union; and others.

**Parallel Funding sources** identified include GEF, OAS, EDF, the Government of Austria. Currently, at least $300,000 has been identified as parallel funding from GEF, OAS, and EDF. This figure could be significantly higher pending the approval by GEF of a $1.5 million Eastern Islands Geothermal Project Preparation Facility.

## 5.2 Budget by activity

Table III shows present tentative budget by activity. Table IV shows a scheme of proposed funding by donors. A breakdown by personnel and ACC costs of the UNF budget is provided in Annex B.

Table III Proposed budget by activity – US$ ,000.

| ACTIVITIES | Year 1 | Year 2 | Year 3 | Total |
|---|---|---|---|---|
| 1. Continue work with Grenada, St. Lucia and Dominica | 300 | 100 | 25 | 425 |
| 2. Work on Sustainable Energy Plans with 4 additional SIDS | 50 | 50 | 50 | 150 |
| 3. Support activities in on-going countries | 25 | 65 | 65 | 155 |
| 4. Regional Office Support (Caribbean and Pacific) | 50 | 60 | 55 | 165 |
| 5. Caribbean Sustainable Energy Fund | 60 | 20 | | 80 |
| 6. Regional Training, International Outreach and Barbados +10 Conference Support | 25 | 25 | 25 | 75 |
| **TOTAL** | **510** | **320** | **220** | **1,050** |

Table IV Proposed activity funding by donors – US$ ,000.

| ACTIVITIES | UNF | RBF [14] | REEEP/ USAID[15] | GEF [16] | USDOE [17] | Other Donors[18] | Total |
|---|---|---|---|---|---|---|---|
| 1. Continue work w/Grenada, St. Lucia, Dominica | 300 | 20 | 80 | 25 | | | 425 |
| 2. Work on Sustainable Energy Plans with 4 additional SIDS. | 100 | 90 | 20 | | | 45 | 255 |
| 3. Support activities in on-going countries | | 25 | | | 50 | 10 | 85 |
| 4. Regional Office Support (Caribbean and Pacific) | | 35 | | | | 70 | 105 |
| 5. Caribbean Sustainable Energy Fund | 50 | 10 | | | | 20 | 80 |
| 6. Regional Training, International Outreach and Barbados +10 Conference Support | 50 | 20 | | | | 30 | 100 |
| **TOTAL** | **500** | **200** | **100** | **25** | **50** | **175** | **1,050** |

[14] GSEII has received a grant in the amount of $200,000 from RBF for support of activities outlined in the proposal; a portion of this could potentially serve as match through UNF.

[15] REEEP and USAID have confirmed their commitments at a level of respectively GB£ 30,000 and US$ 50,000 for a total of about $ 104,000 grants to be provided through UNF.

[16] OAS has received $25,000 in support for a concept note on the geothermal drilling fund for Dominica and St. Lucia.

[17] USDOE has made a commitment of $50,000 pending funds availability. This may occur in 4th quarter 2004.

[18] GSEII has held preliminary discussions with a number of donors that are potentially interested in supporting this initiative including Blue Moon Fund, the Governments of Austria and Italy, the EU, Rabobank, Sainsbury Foundation, Shell Foundation, etc. These discussions are on going.

## 5.3 Project restructuring in the event full matching funds are not achieved

It is stipulated in this document that the level of UNF funding support is dependent on the project partners' success in mobilizing matching funds. As already indicated in section 3.4, in the event that full matching funds are not achieved the project will be restructured as follows:

1) The existing focus on advancing activities in the existing island nations of St. Lucia, Grenada and Dominica will continue as priority. There will be no reduction of activities in these three nations.
2) The primary reduction in activity to reflect a decreased funding base would occur in Task 2, which involves expansion of activity to other countries. In the unlikely case that matching funds were not secured, UNIDO-GSEII would limit expansion to other countries from current plans of 4 additional countries, to a lesser number contingent on funding availability.
3) Other adjustments that would occur as required are: (i) reduction in support for the regional offices, in particular, no regional office would be established in the Pacific, and (ii) reduced funding would be available for participation in Barbados+10 Conference and its preparatory meetings.

## 5.4 Follow-on UNF funding support

It is recognized that follow-on funding for implementation is not implied or guaranteed by the award of this program planning and partnership development grant. Follow-on funding decisions will be based on quality of proposed program, available resources, UNF project strategies and priorities, and identification and commitment of additional funding parties.

# 6 MONITORING AND EVALUATION

## 6.1 Reporting

Semi-annual un-audited financial utilization reports, annual progress reports, annual certified or audited financial statements and final project reports and audited financial statements will be provided in accordance with existing memorandum of understanding (MOU) or Basic Implementation Agreement (BIA) as applicable with UNFIP, UNIDO and other UN rules and regulations.

## 6.2 Monitoring and evaluation

The project steering committee will be responsible for the general monitoring and supervision of the project implementation. The PSC will meet twice a year and on the basis of the reports prepared by the PEU coordinator and UNIDO project manager will provide an assessment of the progress of the project and will make recommendations for adjustments whenever appropriate.

The UNIDO project manager will be responsible for tracking milestones, which will include ending activities and report submission.

The PEU coordinator will have direct responsibility for continuous ongoing monitoring of implementation activities and the preparation of periodic activity and deliverable reports.

Annual progress will be evaluated by the PSC against work plans and reports that the PEU coordinator and UNIDO project manager will develop at the start of the project as well as at regulate intervals. At the inception of each activity, a work plan will be established, whereby the sub activities will further be monitored on time-bound milestones or indicators.

An independent Mid-Term Review will be made not more than 18 months into grant implementation. The anticipated outcome of this midcourse review will be also an agreement among national stakeholders, as possible, on the indicators of success and methods for country level learning dissemination.

A final evaluation of the project will be made after operational completion of the project. The final evaluation will make also use of agreed indicators to assess the project's success in achieving its outcomes.