**MINISTERIO DE CIENCIA, TECNOLOGIA Y MEDIO AMBIENTE**
**Dirección de Colaboración Internacional**

CITMA

La Habana, 3 de septiembre del 2003

DCI / 1955

Sr. Ali Cahit Gurkok.
Director
Sector para la Eficiencia Energética Industrial
ONUDI, Viena
Austria

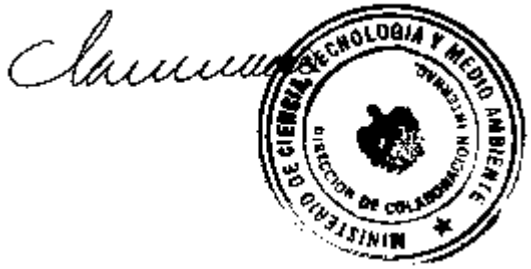
Estimado Sr. Gurkok:

Tengo el placer de comunicarle la aprobación del Gobierno de Cuba, para que el proyecto **"Generation and Delivery of Renewable Energy Based Modern Energy Services in Cuba; the Case of Isla de la Juventud",** sea presentado al Fondo para el Medio Ambiente Mundial para su correspondiente aprobación.

Teniendo en cuenta los procedimientos aprobados por el Consejo del GEF, le agradecería tramitar esta solicitud a través del Programa de las Naciones Unidas para el Medio Ambiente (PNUMA), atendiendo a sus funciones como Agencia de implementación del Fondo para el Medio Ambiente Mundial.

Estamos seguros que este proyecto, - de gran utilidad para nuestro país dada la prioridad otorgada por el Gobierno al desarrollo de las fuentes renovables de energía-, constituirá para el GEF, un excelente ejemplo de cooperación entre las Agencias de Implementación y Ejecución, con importantes resultados a compartir con otros países.

Atentamente,




Jorge L. Fernández Chamero
Director de Colaboración Internacional,
Punto Focal Operacional del GEF en Cuba

**Capitolio Nacional, La Habana 10200, CUBA, Tel: (537) 867 0606, Fax: (537) 33 8054,**
**Email: chamero@citma.cu**

CITMA

cc. Sr. Ahmed Djoghlaf, Assistant Executive Director
Director, Division of GEF Coordination
United Nations Environment Programme (UNEP), Nairobi

Sr. Florentino Chacón, Oficial de Programa,
ONUDI, La Habana

Sr. Pedro Morales, Director
Dirección Organismos Económicos Internacionales,
Ministerio para la Inversión Extranjera y la Colaboración Económica,
Cuba

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MINVEC
Ministerio para la Inversión Extranjera y la Colaboración Económica

**DIRECCION DE ORGANISMOS ECONOMICOS INTERNACIONALES**
Calle Primera No. 1803 esq.18, Miramar, Playa, La Habana.
Telf: (537) 202-4218; FAX: (537) 204-3183.

***El Director***

DOEI: 2598

Ciudad de La Habana
26 de mayo de 2004

Sr. A.J.J. Rwendeire
Managing Director
Programme Development and
Technical Cooperation Division
Organización de las Naciones Unidas
para el Desarrollo Industrial (ONUDI)
Viena.

Estimado señor Rwendeire:

Asunto: Proyecto ONUDI/GEF. "Producción y comercialización de servicios modernos de energía basados en las energías renovables en la Isla de la Juventud".

Permítame expresar nuestro agradecimiento por el trabajo desarrollado por la ONUDI para llevar a vías de aprobación el proyecto de la referencia.

En ese sentido, tengo el agrado de referirme a su nota de marzo pasado, adjuntado un ejemplar del documento de proyecto en formato PNUMA, el cual debe ser sometido a la Secretaría del GEF para su endoso final y financiamiento.

El equipo técnico de GEPROP ha revisado el documento de proyecto y solicita se consideren las propuestas de enmienda que le adjunto a algunos párrafos del documento, antes de la presentación del mismo al GEF.

Para iniciar las actividades del proyecto proponemos tener con ONUDI sesiones de trabajo detalladas para definir el papel de las distintas instituciones cubanas y los montos de los servicios que ellos van a requerir para garantizar la transparencia y la óptima utilización de los recursos. Por ello, solicito a usted autorice viajar a Cuba, en la primera quincena de julio del presente año, una delegación de ONUDI que permita analizar entre otros aspectos, la ejecución del presupuesto del proyecto.

Aprovecho la oportunidad para saludar a usted muy atentamente.

Pedro Morales Carballo

**ADEME**

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To

Dr. Cahit Gurkok
Director, Energy and Cleaner
Production Branch,
PTC Division, UNIDO,
A 1400, Vienna, Austria

Valbonne, 26 January 2004

**Subject : Collaboration between ADEME and UNEP/UNIDO GEF Project in Cuba**

Dear Sir,

Further to our discussions on the subject, we are pleased to confirm that ADEME is willing to participate in the UNEP/UNIDO GEF project in Cuba - **"Generation and delivery of renewable energy based modern energy services in Cuba; the case of Isla de la Juventud".**

ADEME undertakes to co-finance the mutually agreed project activities (i.e. project financing mechanism) up to 200 000 euros, based on the funding to the tune of 270 000 euros made available from the project for the same activities (40 % ADEME financing, 60 % Project financing).

In case this proposal is accepted, we confirm that ADEME undertakes to follow the objectives and activities of the proposed GEF project in Cuba.

Yours sincerely,

Jean-Louis BAL
Director of Renewable Energies, Energy Networks and Markets

ADEME

**Contact person in ADEME :**

Mr Stephane POUFFARY,
Coordinator – International Projects
Directorate of Renewable Energies, Energy Networks and Markets

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# MINISTERIO DE CIENCIA, TECNOLOGÍA Y MEDIO AMBIENTE
## Dirección de Colaboración Internacional

CITMA

Havana, Cuba, January 14th, 2005

DCI / 96

**Mr. Ahmed Djoghlaf, Assistant Executive Director**
**Director, Division of GEF Coordination**
**United Nations Environment Programme (UNEP), Nairobi**
**Fax : (254 20) 62 4041/42**

Dear Mr. Djoghlaf:

It is a pleasure for us to communicate you that the Cuban Government is committed to co-finance the project "Generation and Delivery of Renewable Energy Based Modern Energy Service in Cuba: the case of Isla de la Juventud" with the amount of 1,624 millions USD (in cash / in kind) for the successful completion of the project activities.

Sincerely yours,


Mr. Jorge L. Fernández Chamero
GEF Operational Focal Point
Director
International Co-operation Department
Ministry of Science, Technology and Environment
Cuba

**Capitolio Nacional, La Habana 10200, CUBA**
**Tel: (537) 867 06 06, Fax: (537) 8668054**
**e- mail: chamero@citma.cu**

**GAA**

**ANNEX E:**

# TECHNICAL AND FINANCIAL DETAILS ABOUT FOUR BUSINESS MODELS

**Table E-1: Biomass Fuel Production and Supply Model**

| | Project Details | Financing Structure | Range of viable Indicators |
|---|---|---|---|
| **Biomass production for fuel supply** | Technical assumptions:<br>Total biomass produced 36,423 tonnes per year<br>Humidity of the biomass delivered: 30%<br><br>Financial Assumptions:<br>Loan period (years)[1] 5 years<br>Grace Period (years)[2] 1 year<br>Interest rate 7%<br>Discount rate: 14%<br><br>Costs:<br>Total Project cost: US $ 0.792 M<br>[3]RRM Fund Contribution: US $ 0.158 M<br><br>Price/cost of biomass<br>Cost of biomass crop and delivery 15.0 US $/tonne<br>Price of biomass 19.0 US $/tonne | Investment conditions<br>Private investment needed US$0.792 M<br>RRM Fund contributions 20%<br>Loan component 30%<br>Investment component 50% | Indicators Values<br><br>Pay back period 7<br>NPV[4] 493,750<br>RNPV[5] 0.80<br>IRR[6] 20.36% |

[1]Loan period - Length of time to repay the loan taken from a Bank or a Financial Institution on normal terms and conditions.
[2] Grace Period - Initial period of time with no repayment due as agreed by the concerned Bank or the Financial Institution on the normal loan.
[3] RRM Fund - Risk and Replication Management Fund to be created under the project through GEF funds with the Compañía Fiduciaria to encourage investments by providing interest free loan. Terms and conditions including pay back schedule, grace period and penal clauses will be worked as a start up activity in the first year of the implementation.
[4] NPV - Net Present Value.
[5] RNPV - Ratio of Net Present Value to Investment.
[6] IRR - Internal Rate of Return.

**Table E-2: Biomass Gasifier Business Model for Power Generation**

**A. Biomass Gasifier Specifications:**

| | **Project Details** | **Financing Structure** | **Range of viable Indicators** |
|---|---|---|---|
| **Biomass gasification plant for electricity production** **(Will replace 80% of the fuel oil currently used)** | Technical assumptions:<br>Power to be installed: 10.6 MWth, Power Plant annual operating time: 8,000 hrs, Humidity of the biomass delivered: 30%, Humidity of the biomass use at site: 10%, Power plant life time: 15 years, Biomass consumption: 0.75 kg/kWh, Biomass hourly consumption: 2.7 tonne/hr @10%<br>Financial Assumptions:<br>Loan Period (years) 8 years<br>Grace Period (years) 1 year<br>Interest rate 10%<br>Discount rate 14%<br>Costs:<br>Total Project cost: US$ 2.835 M (only gasifier)<br>RRM Fund Contribution: US $ 0.567 M<br>Biomass wood price: 19 US$/tonne<br>Fuel oil price: US$ 197/tonne<br>Price/cost of gas<br>Cost of gas production (biomass and O&M) 6.29 US $/MWth<br>Price of gas 13.0 US $/MWth<br>Production of gas<br>Energy Produced 90,222 MWhth per year | Investment conditions<br>Private investment needed US$2,835 M<br>RRM Fund contributions 20%<br>Loan component 30%<br>Investment component 50% | Indicators Values<br>Pay back period 6 years<br>NPV 1,458,477<br>RNPV 0.97<br>IRR 26.91% |

**Table E-2: Biomass Gasifier Business Model for Power Generation**

**B. Specifications for the Electricity Generation Unit:**

| | **Project Details** | **Financing Structure** | **Range of viable Indicators** |
|---|---|---|---|
| **Electricity generation unit.**<br>**(Will work with 20% fuel oil and 80% producer gas from the biomass gasification unit)** | Technical assumptions:<br>Power to be installed: 3.5 MW, Power Plant annual operating time: 8,000 hrs, Power plant life time: 15 years, Net Power efficiency: 32-34%<br>Financial Assumptions:<br>Loan Period (years) 5 years<br>Grace Period (years) 1 year<br>Interest rate 10%<br>Discount rate 14%<br>Costs:<br>Total Project cost: US$ 3.465 M (generator plus dual system)<br>RRM Fund Contribution: US $ 0.693 M<br>Fuel oil price: US$ 197/tonne,<br>Price of gas 13.0 US $/MWth<br>Electricity from dual generator<br>Cost of electricity produced by a dual generator (20% fuel oil and 80% electricity) 0.065 US$/kWh<br>Production of electricity<br>Energy Produced 28,000 MWh per year | Investment conditions<br>Private investment needed US$3,465 M<br>RRM Fund contributions 20%<br>Loan component 30%<br>Investment component 50% | Indicators Values<br>Pay back period 6 years<br>NPV 3,380,788<br>RNPV 0.51<br>IRR 25.51% |

**Table E-3: Biomass Gasifier Business Model for Process Heat**

| | Project Details | Financing Structure | Range of viable Indicators |
|---|---|---|---|
| **Biomass gasification plant for heat production.** | Technical assumptions:<br>Meat company 2.4 MWth at 3,180 hrs per year<br>Milk Company 1.4 MWth at 6,000 hrs per year<br>Fishing Company 1.4 MWth at 3,000 hrs per year<br>Ceramics Company 0.5 MWth at 6,000 hrs per year<br>Humidity of the biomass delivered: 30%, Humidity of the biomass use at site: 10%, Power plant life time: 15 years, Net Power efficiency 80%, Biomass consumption: 0.75 kg/kWh, Biomass hourly consumption: 0.15-0.75 tonne/hr @30%<br>Financial Assumptions:<br>Loan Period (years) 5 years<br>Grace Period (years) 1 year<br>Interest rate 10%<br>discount rate 14%<br>Costs:<br>Total Project cost: US $ 0.865 M (only gasifier)<br>RRM Fund Contribution: US $ 0.173 M<br>Biomass wood price: 19 US$/tonne<br>Fuel oil price: US$ 197/tonne,<br>Price/cost of gas<br>Cost of gas production (biomass and O&M) 6.29 US $/MWth<br>Price of gas 13.0 US $/MWth<br>Production of gas<br>Energy Produced 25,783 MWhth | Investment conditions<br>Private investment needed US$0.865 M<br>RRM Fund contributions 20%<br>Loan component 30%<br>Investment component 50% | Indicators Values<br>Pay back period 9<br>NPV 375,220<br>RNPV 1,15<br>IRR 23.92% |

**Table E-4: Wind Farm Business Model Park at Playa de la Bibijagua**

| | Project Details | | Financing Structure | | Range of viable Indicators | |
|---|---|---|---|---|---|---|
| **Wind Farm at Playa de la Bibijagua** | Technical assumptions: | | Investment conditions | | Indicators | Values |
| | Capacity installed | 1.5 MW | Private investment needed | US$1.665 M | | |
| | Capacity Factor | 25% | RRM Fund contributions | 20% | Pay back period | 9 |
| | Financial Assumptions: | | Loan component | 30% | NPV | 1,470,845 |
| | Loan Period (years) | 8 years | Investment component | 50% | RNPV | 0.57 |
| | Grace Period (years) | 1 year | | | IRR | 17,71% |
| | Interest rate | 8% | | | | |
| | discount rate | 14% | | | | |
| | Costs: | | | | | |
| | Total Project cost: US $ 1.665 M | | | | | |
| | RRM Fund Contribution: US $ 0.333 M | | | | | |
| | Price/cost of electricity | | | | | |
| | Cost of kWh (O&M) (US $/MWh) | 24.32 | | | | |
| | Price of electricity (US $/kWh) | 0.09 | | | | |
| | Production of gas | | | | | |
| | Energy Produced 3,700 MWh per year | | | | | |

## Annex E 1

## Report on the Cuban Banking System and Compañía Fiduciaria to Support Risk and Replication Fund

**GEF Project - Generation and Delivery of Renewable Energy based Modern Energy Services in Cuba: the case of Isla de la Juventud**

**CUBAN BANKING SYSTEM**

**Central Bank**

Banco Central de Cuba is the main organization to the Cuban State's monetary and credit policy, and has obligation for all the companies and natural people that operate in the Cuban territory. This institution was created by means of the Decree-Law. 172 of May 28th, 1997. It's most important functions among others include: to propose and implement the monetary policy of the State; to regulate currency and guarantee its stability; to be bank of banks; to be the government's banker and his fiscal agent, and to be the receiver of the country's monetary reserve.

Other Cuban banking institutions are:

- Banco Nacional de Cuba
- Banco Financiero Internacional S.A.
- Grupo Corporativo Nueva Banca
- Banco Popular de Ahorro
- Banco de Crédito y Comercio
- Havana International Bank Ltd.

Grupo Corporativo Nueva Banca: It was formed by integrating three banks and three non banking institutions namely:

- Banco Internacional de Comercio S.A.
- Banco Metropolitano S.A.
- Banco de Inversiones S.A.
- Financiera nacional S.A.
- Casas de Cambio S.A.
- Compañía Fiduciaria S.A.

**Compañía Fiduciaria**

In Cuba the biggest volume of fiduciary activities is concentrated in two institutions mainly:

- Banco de Inversiones S.A.
- Compañía Fiduciaria S.A.

Their financial activities are governed and regulated by a well-defined normative and legal framework. It is necessary to highlight the following dispositions:

- Law No. 59 of the Civil Code
- Decree Law No. 172 of the Council of State

- Decree Law No. 173 of the Council of State
- Resolution No. 5/ 1997 of the Central Bank of Cuba

Compañía Fiduciaria S.A., has eight years of experience dealing with fiduciary activities, and has 171 clients with effective contracts, of which more than half are foreign clients. It carries out a great volume of financial operations annually. It provides professional service through highly skilled staff, known for excellence in their services. These factors along with rich experience in dealing with similar funds make Compañía Fiduciaria S.A. a promising partner to implement and manage Replication and Risk Fund being proposed under the project.

**Compañía Fiduciaria, S.A: Background and Functions**

Fiduciary company, as a member of Group New Banking, was approved on 1 August 1996 by the Executive Committee of the Council of Ministers, and registered at the Special Notary Office at the Ministry of Justice as a lawfully private Cuban Stockholding Company, incorporated by Public Deed No. 1623, dated August 30th, 1996 and modified by Public Deed No. 1821 dated November 1st, 2001.

Since its foundation, the Company has developed financial services that have contributed to obtain their costumer's confidence and to meet the demands and find solutions to the problems being faced in the field of financial intermediation, and the request for specialized advising and consultancy services from Cuban and foreign entities, for which the following main activities are carried out:

- Trustee Business
- Trustee Management

Trustee services provide the clients with advice and handling of their business operations, which are not possible or covered by the so-called standardized banking institutions. By means of this kind of services, the client deposits his trust in the trustee company and transfers him goods and rights to achieve a specific aim.

**Management of the Trustee Activity**

The year 2003 was characterized by a strong increment in the Company activity level, evidenced by the number of concerted contracts and major rise in the processed operations.

As on 31 December 2003, the Company services and concerted contracts touched a total figure of 171; while 64 of these contacts were signed with foreign companies. The value of these contracts is estimated at $ 1,206.2 M, while the assets deposited in trust to the company rose to $ 12.5 M.

The evolution of signed contacts by the Company shows the following tendency:

**Number of contracts by Compañía Fiduciaria – year wise**

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|
| Management and Investment Trustee | 16 | 15 | 20 | 51 | 59 | 79 | 168 |
| Other Trustee Commitments | 0 | 0 | 0 | 1 | 1 | 1 | 2 |
| Mandates | 3 | 3 | 7 | 3 | 1 | 3 | 1 |
| Collections | 1 | 1 | 4 | 4 | 1 | 0 | 0 |
| Total | 20 | 19 | 31 | 59 | 62 | 83 | 171 |

**Accounting Management and Economic-financial Results**

El desarrollo alcanzado ha determinado un incremento en el nivel de actividad en un 2.8% con respecto al año 2002. Las utilidades alcanzaron los 345.7 MUSD, que representan un incremento del 169.2% respecto al año anterior; el total de ingresos ascendió a 631.8 MUSD, que representa el 128.2% respecto al 2002, constituyéndose ambas en la cifra histórica más alta alcanzada por la empresa desde su constitución.

The development reached by the company has determined an increment in its activity in 2.8% with regard to 2002 year. The profits reached $345.7M that represents an increment of 169.2% as compared to the previous year; the total of revenues rose to $631.8M that represents 128.2% regarding the 2002, being constituted both figures the highest historical ones reached by the company from its constitution.

**Management of the Fund**

One of the viable options for the implementation of this fund is that the financing that will be dedicated to this fund would be deposited in an account at Compañía Fiduciaria S.A. whose owner will be one of the United Nations Agencies participants in the project. This Agency will sign a Fund Management Contract with Compañía Fiduciaria S.A. in which a reference will be made to an Authorization Contract.

This Authorization Contract would be signed between the United Nations Agency mentioned above and the Cuban institution that would manage this Fund. By virtue of this Contract, the International Agency would delegate to the Cuban institution, the authority to execute the administration of this Fund, maintaining a systematic supervision of its operations. This Cuban institution would carry out the management of the Fund according to the instructions that it would receive from the Administration Board that would be settled down with this end. It will also manage disbursement and recovery of loans as per the guidelines issued by the project steering committee, and frame rules for the same.

**Annex E 2**

## A Brief Note on Economic Profitability and the Innovative Profitability Index Method to be used as a part of capacity building initiatives at national level under Isla de la Juventud GEF Project

ADEME (French Agency for the Environment and Energy Management) has confirmed to collaborate and co-finance the project activities in Cuba to the tune of about $ 200,000, especially concerning feasibility studies and operationalization of the financial mechanisms proposed in the project. ADEME will also coordinate activities relating to capacity building at the national level in terms of financial sustainability of pilot demonstration projects on Economic Profitability and the Innovative Profitability Index Method.

The "Profitability Index" (PI) is simply the ratio between the net present value (NPV, the sum of the discounted cash flows of a project over its lifetime, including the initial investment period) and its initial investment cost (I). It is already used in industry and business as an indicator of the profitability of a project, but a recent simple and innovative analysis has shown that its advanced use gives access to a comprehensive, reliable and simple way to analyse the profitability of all kinds of investment projects, and moreover to the definition and then to the use of optimal market regulation and economic incentives systems designed to favour investments that support sustainable development. Such systems may include soft loans, subsidies on initial investment and/or on operating expenses, guaranteed tariffs of marketed products and services, sales on a derivative market of environmental advantages (e. g. "green certificates" or "carbon credits"), or a combination of such incentives.

For an energy service company (ESCO) active on global dynamic markets with various technologies and applications requiring different operating periods, the profitability index method (PIM) is an adequate tool which can give a competitive advantage to assess at a very preliminary stage the profitability of a simple project, to choose on a sound basis between various options of investments and last but not least to define an investments portfolio in a context of capital rationing which is very near to the theoretically possible optimum.

**Summary of the content of the Profitability Index Method (PIM) and of its basic tools:**

Linear Model "Profitability Index (PI) versus average selling price (tariff)" allowing:

- To describe a simple project economic profitability from its costs and performance ratios and to give access to the simple and powerful related "PI - Tariff" linear graph.
- To determine directly the value of the Overall Discounted Cost (ODC, the "manufacturing cost") of a product or a service delivered from the investment and to assess its structure (variable cost part, O&M cost part, investment cost part).
- To determine the relevant selling price (the tariff) and the related profit margin to apply on this cost (the margin on cost MOC) to get a targeted profitability of the project expressed in PI value.
- To clarify the linear link between the PI of a project and its margin on cost (MOC). In the case of power production, this link allows to demonstrate the "Free fuel cost energy sources paradox", which should be at the basis of the definition of a sound market regulation in order to favour renewable energy sources versus fossil based ones.
- To determine from a dynamic "Markets / Technologies Matrix" the minimal weighted mean value of the profitability indexes for the investments of a company active on global expanding markets and using advanced technologies, in order to ensure a stable and strong long term development of this company.
- To establish the links between the PI and the other profitability parameters (direct pay back time, discounted pay back time, internal rate of return (IRR), benefit-cost ratio), in order to assess their minimum or maximum required values from the above rational minimum values of profitability index.
- To easily integrate the valuable inputs from advanced profitability methods such as CAPM (capital asset pricing model) or ROV (real options valuation).

- Standard method to describe a complex project with variable cash-flows as a simple equivalent constant cash-flow project, this simple project being described by the above linear model with its relevant advantages as described above.

- Method and graphic tool to optimise an investment portfolio in a context of capital rationing which does not allow to finance all the potential possible projects.

- Simple electronic spreadsheets (on Microsoft Excel) to apply the PIM either to general projects or to standard types of projects using specific technologies and applications. Those electronic spreadsheets are based on explicit formulas, and sensibility studies can be carried out easily.

**Types of applications for which the method has already been validated:**

- Power production from conventional or renewable energy based power plants.
- Heat production from conventional or renewable energy based systems.
- Combined heat and power production systems using conventional and/or renewable fuels.
- Energy saving, energy efficiency, demand side management and rational use of energy projects.
- Energy production from hybrid systems.
- Simple production process delivering products or services.
- Profitability resulting in investing in a "clean and efficient process" in place of investing in a conventional one ("mutually exclusive investments" or "differential profitability"), such as for example:
    - Case of a high quality and high efficiency building (such as a passive solar building) versus a conventional one.
    - Case of an advanced innovative industrial process in place of an existing one (profitability resulting from an R&D programme).
    - Case of a "clean and efficient" industrial process in place of a conventional one (profitability of an "industrial ecology" programme).

**Advantages for a market regulation by prices:**

- Direct and reliable design of "advanced tariffs systems" in order to develop a large-scale market deployment of the technologies favourable to a "sustainable development".

- Used with success to design the French wind tariff system in 2000 (up to 10 b€ of related investments up to 2010).

**Advantages for a market regulation by subsidies:**

- Direct calculation of the subsidy on initial investment required to get a targeted value of profitability, taking into account the too low profitability level before subsidy. Direct graphic sensibility analysis diagrams.

- Rational assessment of the impact of subsidies on the level and on the speed of market deployment of products and services favourable to a "sustainable development".

- Rational assessment of a mix of subsidies on initial investment, and/on O&M expenses and/on variable costs in the case where the final customer (typically a family in a rural area of a developing country) has not a sufficient financial capability to purchase a decentralised energy service such as rural electrification, potable water delivering, etc.

1) **Advantages for a market regulation by taxes:**

- Direct assessment of the impact of an "energy tax" or a "carbon tax" on the profitability of a simple investment project. Direct graphic sensibility analysis diagrams.

- Direct assessment of the profitability increase due to the energy or the carbon taxes, in favour of the projects using "clean and efficient technologies" in place of conventional ones (increase of the "differential profitability").

- Direct assessment of the impact of potential energy or carbon taxes on the level of the selling price or the profit margin of products or services from a potential investment project taking into account the acceptable profitability level for the project developer.

2) **Advantages for a market regulation by quantities** (e. g. mandatory production regulation systems with targeted levels of production or quotas to be justified by companies active on the market by providing relevant amounts of "green certificates" or "carbon credits") :

- Method to assess the potential additional equivalent constant annual revenue from an hypothetical profile of the value of the relevant "green certificates" or "carbon credits".

- Direct assessment of the impact of this potential additional revenue on the profitability of a project. Direct graphic sensibility analysis diagrams.

- Assessment of the impact of the hypothesis made on the "baseline" (reference case) on the quantities of carbon credits and direct assessment of the impact of those hypothesis on the profitability of the project. . Direct graphic sensibility analysis diagrams.

3) **Advantages for a market regulation by a mix of solutions** :

- Explicit formulas to assess the increase or the decrease of profitability of a project from a mix of regulatory economic measures (soft loans, incentives, taxes, guaranteed tariffs, environmental based derivative markets).

- Direct sensibility studies from explicit formulas and related graphs.

- From the relevant PI values of the project, direct calculation of the corresponding values of the other conventional profitability parameters (IRR, pay-back times, benefit/cost ratio, margin on cost or margin on selling price of the related product or the service).

4) **Conclusion**

The profitability index method and its associated tools can clearly contribute to the economic analysis of sustainable energy projects by providing a sound, simple and reliable view:

- For market regulators, on what are the best measures or what is the best mix of measures for the regulation of energy and environmental markets in order to give clear advantages to the technologies and to the applications, which are in favour of sustainable development, so that the relevant markets can reach specific targeted levels within a specific time frame.
- For projects developers, on what is the impact of a specific set of incentives or market regulation mechanisms (soft loans, subsidies, energy or carbon based taxes, green certificates or carbon credits to be sold on an environmental derivative market…) on the selling price of the product or the service delivered by a kind of energy project, and what are at the end the profitability and the prospects for market deployment of this kind of projects.
- For energy services companies, operating under various global specific market regulation conditions, on what are the corresponding economic profitability levels of sustainable energy projects versus the costs and performance ratios of related technologies and applications (renewable energy based projects, energy efficiency projects…), and what is the best potential investment portfolio in order to maximise the economic profitability of the company in a context of capital rationing.

Of course, the preliminary results from the Profitability Index method must be completed by a financial profitability analysis before the final decision to set up a new regulation measure of before to invest in a

project, but the advantages of such a comprehensive, simple and reliable preliminary analysis are evident in order to save time and money and in order to reduce the related economic risks.

## Training session content and schedule for decision makers and projects managers

### 1) SCOPE :

- Step by step presentation and assimilation of the innovative "Profitability Index Method" (PIM) designed specifically to assess the economic profitability of sustainable energy projects and programmes (renewables, energy efficiency, CHP, decentralised energy services…) at their early phase (feasibility studies, preliminary design of dissemination programmes).
- Learning process based on successive phases, from the explanation of the basic economic concepts, establishing basic formulas, to their application on simple examples.
- Use of the concepts, the method and its related tools to assess economic profitability of sustainable energy technologies and applications from simple but representative case studies e. g. renewables for heat and power, CHP, energy savings, energy efficiency…
- Presentation and use by trainees of the simple software based on the PIM, both for specific technologies/applications and for general cases, for simple calculation or for sensibility studies. Links between economic framework and market dissemination of sustainable energy technologies.
- Adapted to the needs and capabilities of sustainable energy projects managers, dissemination programmes designers and managers, including engineers with no preliminary training in economics.

### 2) CONTENT :

A training session is composed of four general modules (M1, M2, M3, M5, M8, M9) and " application modules" such as M4, M6 and M7). Specific application modules for energy saving, energy efficiency, demand side management, etc. can be added if necessary.

**M1 : Micro-economic analysis basis:**

**M1.1** : The context for a simplified economic analysis, discounting and how to select discount rate, how to take into account the inflation rate.

**M1.2** : Application : present value calculation, sum of discounted fixed cash flows, loans.

**M2 : The "overall discounted cost" (odc) of a kWh or of an energy service:**

**M2.1** : Definition, examples (kWh, energy services), orders of magnitude.

**M2.2** : Simplified formulas using ratios.

**M2.3** : Application : ODC from conventional or renewable energy based power plants

**M3 : assessing the economic profitability of projects from the profitability index method:**

**M3.1** : Creating value: the NPV (Net Present Value) concept, its use, its limitations.

**M3.2** : The classical profitability parameters derived from the condition NPV = 0: Simple Pay-Back Time (SPBT), Discounted Pay-Back Time (DPBT), Internal Rate of Return (IRR) : their advantages, their limits and how they are often misused.

**M3.3** : **The Profitability Index parameter PI = NPV per $ (or €) invested :**

- Interest, how to use it
- Calculation and formula in the case of a constant Cash flow: the universal linear model PI = f(Selling Price) and its use for the price and the cost structure of a kWh or an energy service.
- Its links with the Margin on Cost (MOC) ratio ; consequences on the minimum PI value and on the different MOC values between renewables and fossil fuel-based power plants.
- Specific and universal graphic tools.
- Links between PI and IRR, DPBT, SPBT, Benefit/Cost ratio.
- Universal formula for cost and selling price values calculation.
- Taking into account subsidies on initial investment, on O&M costs, on variable costs. How to define a rational subsidy policy.
- From simple to complex cases: how to replace an actual project by an equivalent simple project with an overnight investment and a constant cash flow during operation.

**M4: Case study : zero fuel cost power plants: the case of Wind Power**

- kWh cost and price calculation ; sensibility studies ; long-term prospects (2005-2030) for onshore projects.
- Calculation of an "efficient tariff" ; design of an "advanced tariff system": the French case study and its potential use in other contexts.
- Complete economic analysis of a wind power plant.
- Presentation and use of the "**TECEOL"** software.
- Links between incentives systems and wind power development: world, EU15, Germany, France, developing countries.
- Long-term development scenarios for wind power: world, EU15, France, developing countries.

**M5: Using the PIM to assess the profitability of clean and efficient energy services:**

- The differential profitability resulting from using a clean and efficient energy technology in place of a conventional one : the differential NPV concept, the differential profitability index, the apparent profitability index: definition, formulas, why and how use them.
- Profitability criteria. Impacts of subsidies on initial investment. Definition and calculation of the differential IRR and the differential SPBT and their target values.
- The global approach to assess and optimise the use of a clean and efficient technology in place of a conventional one.
- Presentation and use of the universal **TECDIF** software.

**M6: Case studies: biomass-based clean and efficient energy services:**

- Simple biomass based energy systems and hybrid biomass-fossil fuels based systems.
- Combined heat and power production (CHP) using biomass resources : direct calculation of electrical kWh cost and price. Direct assessment of profitability of a CHP project. Impact of subsidies on initial investment.
- Comparisons of primary energy consumption and CO2 emissions between a CHP biomass-based system and the equivalent two separate fossil fuel-based thermal and power systems.

**M7: Case study : decentralised rural electrification and energy services in remote areas:**

- Case study : village power from a small hydropower plant or a small diesel based power plant.
- Case study : domestic rural electrification from photovoltaic solar home systems: defining an efficient monthly fee for service and related incentives in order to be compatible with the end users financial capacities.
- Case study : photovoltaic pumping systems : defining efficient tariffs for delivered water and related incentives.

**M8 : The PIM advantage for the profitability analysis of projects with "carbon credits":**

- The derivative markets for "carbon credits" valuation: Europe (ETS), Kyoto Protocol (Joint Implementation, clean development mechanism), prototype carbon funds (World Bank, NL…)
- Method, formulas and tools to calculate primary energy savings and greenhouse gas emission reductions.
- Using the PIM to assess the supplementary profitability of a project resulting from the valuation of "carbon credits" : the "Supplementary PI" way. Advantages compared on methods based on IRR changes.

**M9: Synthesis:**

- Global optimisation of incentives to promote sustainable energy based projects: advanced tariffs, subsidies, and environmental derivative markets (green certificates, white certificates, carbon credits…).
- Optimising a portfolio of sustainable energy projects for an energy service company (ESCO) in a context of capital rationing and carbon based policies.

**Annex E 3**

## A Brief Note on the Foreign Investments Policy Framework in Cuba

The foreign investment process in Cuba is ruled, since 1995, by the Foreign Investment Law No. 77, which is also supported by recently published resolutions which complement the mentioned above opening new ways to invest in Cuba.

The Foreign Investment Law states in its first article: "…This law bears as its main objective the promotion and incentive of foreign investment in Cuba, for carrying out lucrative activities capable of contributing to strengthening the economics and sustainable development of the country on national freedom and Cuba's sovereignty basis as well as to protecting national resources and its efficient use…"

Among its regulations the law states:

• The foreign investment can adopt any of the following approaches: Joint Venture Company, international economic association contract and foreign capital enterprise.

• The law only includes two main taxes: taxes on investment profits and salary, amounting to 30% and 25% respectively.

• Exemption from taxes on repatriation of capital investment proceeds when returning them to home country.

• Approval of investment is carried out only by Executive Committee of the Ministry Council or any other Commission assigned.

Direct foreign investment in Cuba is envisaged as a complementary activity at a nation-wide level, oriented at seeking new markets abroad, leading technologies and funding (mainly long term funding.)

In 2003 out of the total number of international economic associations settled under the foreign investment law, it was evident that certain economic branches of the country such as: mining, oil drilling, tourism, building and process industries (food, metallurgy, software and communication) took the major initiatives.

Capital invested on associations mentioned above has come mainly from 46 countries among which Spain, Canada and Italy bear the highest participation in business deals with Cuba. EU countries exhibit over 50% participation on international economic associations with Cuba. The structure of economic associations settled by region is as follow: Latin America and the Caribbean 55%, Europe 27%, Asia 11% and Africa 7%.

Besides the Cuban investment law and as a result of the dynamic which has characterized this process in Cuba in latest years, new instruments for foreign investments have been developed resulting in more flexible and easier way of doing business. Among these forms of new business deals can be said the following: Joint Goods Production and Service Contracts and Management Production Contract.

The Joint Goods Production and Service Contracts feature the following:

- Cuban and foreign parties are involved in the business deal.
- Cuban and foreign parties jointly develop the production activities and/or services.

- The foreign party should provide resources, funding, technology or market for ensuring the production of goods and services that contract has set out and also defining the repayment for each concept.
- Autonomy on execution and participation in products and services marketing (at national and world wide levels)

Taxes, rates and fiscal contributions resulting from the execution of these new business deals on foreign investment will be independently charged to each party according to their business obligations. Necessary imports for developing activities included in these business contracts, as well as customs taxes, will be charged to Cuban party involved in the contract.

In 2003 Joint Cooperation Contracts were mainly settled by the process industry linked to metallurgy and light industry. The industrial branch starts getting experience with some Production Management Contracts and in tourism sector Hotel Management Contracts are usual forms of setting business deals with Cuba. Once again Spain, Canada and Italy are countries exhibiting major shares in hotel business participation.

In the power industry major foreign investments are ENERGAS enterprise, involved in generating power from accompanied gas exiting from oil wells, based on Varadero and GENPOWER enterprise, which provides power to Isla de la Juventud.

When implementing Isla de la Juventud project it is likely that some of the businesses mentioned above, will consider investing in the project, taking into account featuring of each project's business unit.

Likely business deals that could be included are:

- Foreign enterprise setting out BOT contract or Joint Venture Company for the biomass power generation unit envisaged in the project.
- Joint Production Contract is likely to be settled in the wood chip producing unit and also to gas producing unit for provision of heating needs to process industry.
- Technology Provision Contract and Technical Assistance to Cuban enterprise in charge of the Isla de la Juventud wind farm.

Nevertheless the ultimate business deal option, to be settled when dealing with Cuban party, should always be an outcome obtained from negotiating steps among foreign enterprise interested in participating in the business proposal, taking always into consideration the interest and conditions of parties involved and the national Cuban ones.

**ANNEX F**

## COSTING OF FUELS IN TERMS OF HEAT VALUE

### Biomass

Cost of biomass is taken at US $ 19 per tonne

Calorific value of biomass is 14.5 MJ/kg;

This amounts to about 1.9 cents per kg of biomass, which has a calorific value of 14.5 MJ.

Cost of bio-fuel based on the energy works out to be 0.13 US c per MJ

### Diesel

Cost of diesel is taken at US $ 247 per tonne

Calorific value of diesel is 42.0 MJ/kg;

This amounts to 24.7 cents per kg of diesel, which has a calorific value of 42 MJ

Cost of fuel based on the energy works out to be 0.58 US c per MJ

### Fuel oil

Cost of fuel oil is taken at US $ 197 per tonne

Calorific value of fuel oil is 42.0 MJ/kg;

This amounts to 19.7 cents per kg of fuel, which has a calorific value of 42 MJ

Cost of fuel based on the energy works out to be 0.47 US c per MJ

### LPG

Cost of LPG is taken at US $ 200 per tonne

Calorific value of LPG is 42.0 MJ/kg;

This amounts to 20.0 cents per kg of fuel, which has a calorific value of 42 MJ

Cost of fuel based on the energy works out to be 0.47 US c per MJ

**ANNEX G:**

# BIOMASS FUELS ASSESSMENT

During the PDF phase, a comprehensive resource mapping undertaken on the Isla de la Juventud led to the conclusion that forests and fellow areas with woody growth can provide woody biomass on sustainable basis to meet the requirements of business models for power generation and process heat provided sustainable forest harvesting is undertaken. Further, since biomass harvesting has to be undertaken strictly in conformity with the existing approved forestry working plans, new wood extraction and chipping technologies will be needed to meet the demand for the biomass gasifier systems, and to minimize the waste. Also main provisions of national forestry laws would have to be taken into consideration while planning for sustainable forest harvesting activities under the proposed RE IJ project.

The Cuban forestry laws closely monitor forestry exploitation and at the same time guarantee decreasing environmental impact. Among those laws, which are aimed at forest harvesting issues, most important is the Law No 85: Cuban Forest Laws, approved by the People National Assembly on 21st July 1998 which clearly states the objectives regarding Cuban forest management and exploitation.

In its first article, Law No. 85 states:

- Setting up the principles and general rules for protecting, increasing and developing, on sustainable manner, the national forest patrimony.
- Controlling the national forest patrimony resources using established regulations through competent national organizations.
- Encourage reforesting activities aimed to achieve economical and social benefits as well as protecting the forest itself. It is also important to consider appropriate producer unit management on plantations and natural forest.
- Saving biological diversity resources related to the forest ecosystem.
- Protecting the forest from woody dismantle, unmanaged cutting down, fire, free herding, plagues and disease as well as any other activity which could affect the forest.
- Regulate multiple and sustainable usage of the forest patrimony and encourage rational management and utilization of forest's products.

Taking into account all mentioned above statements coming from the law, there are three general criteria, given by the Cuban forestry experts, which were used for choosing the forest areas to be exploited under the project, and to prevent any negative impacts on environment. These criteria were:

1. The status of the forest aimed to provide biomass must solely be a Producer one,
2. Any forest chosen must not be in any protected area on which any biologically significant flora or fauna is present, and must not be disturbed by the extraction of biomass.
3. Only those producer areas exhibiting the best condition for forest development should be selected and degraded lands to be regenerated.

1. **The status of the forest aimed to provide biomass must be solely a Producer one.**

This means that there must be excluded all of the core natural forest areas existing on the island territory. According to figure 1, estimates were made for earmarking the areas occupied by each woody category.

**Table 1. Area distribution by forest categories on the Isla de la Juventud**

| Forestry category | Area (ha) |
|---|---|
| Productive Forests | 28409.90 |
| Soil and Water protection | 3966.82 |
| Coastal Zone protection | 21024.67 |
| Flora and Fauna Conservation Forests | 66187.74 |
| Recreation Forests | 1075.11 |

Species planted on productive areas do not posses any endemic value. Only the following species are present:

- Pinus caribaea (Pc)
- Pinus tropicalis (Pt)
- Casuarina sp. (csp)
- Calophyllum antillanum (Ca)
- Tabebuia angustata (Ta)
- Hibiscus sp. (Hbsp)

2. **Any forest chosen must not be in any protected area on which any biologically significant flora or fauna is present, and must not be disturbed by the extraction of biomass.**

At Isla de la Juventud there are several forests regions having special managing and protecting status, which are officially recognized and protected by the Cuban Government. Figure 2 shows their distribution and table 2 expose brief data on them. Those areas of Producer forest, which are based at the nearby of protected regions and could have any impact on these ones, are specially managed and restricted, and would not be sued for biomass extraction, as stated in Law 85.

It was determined during the field survey and GIS mapping that on the northern region of the island, appropriately planned forest exploitation as per the forest working plan in Producer areas would not have any negative environmental impact due to the application of methods related to sustainable forest management, which will continue to be used during the biomass extraction process including biofuel to be used as energy source under the project.

**3. Only those producer areas exhibiting the best condition for forest development should be selected and degraded lands to be regenerated**

Northern region was chosen, as the soil of this region is capable of producing species having high capacity of providing biomass. The soil is generally characterized by having quartzical sand and exhibiting red ferralitic quartzical grounds. They are not erosion sensitive and also not very deep.

Figure 3 shows producer No.1 unit space distribution and figure No. 4 shows soil distribution on the region.

For choosing optimal areas for biomass extraction in producer areas, Geographical Information System was used, obtaining the mapping of the optimal distribution area for biomass extraction aimed to energy usage (fig. 5). It was concluded that no negative environmental impact would exist because of the biomass need to be extracted falls within permissible limits.

Selection of the existing producer areas for wood extraction with energy propose also means that no new road network will be required for biomass extraction. The existing road network will be utilized, which is currently used for collecting and transporting wood.

**Table 2. General data of protected areas in Isla de la Juventud.**

| Name | Category | Signification |
|---|---|---|
| La Cañada | Managed resource | Local |
| Sierra de Caballos | Protected Landscape | Local |
| La Daguilla | Without category | Local |
| Cerros de la Ceiba - La Jía | Without category | Local |
| Cerros del Monte | Without category | Local |
| Cerros el Descanso - Mal País | Without category | Local |
| Cerro Cristal | Without category | Local |
| Cerros de San Juan | Without category | Local |
| Cerros La Guanabana | Without category | Local |
| Río del Medio - Las Nuevas | Without category | Local |
| Ciénaga de Lanier | Ecological Reserve | National |
| El Sur | Managed resource | National |
| Sierra de Casas | Sin Categorizar | Local |
| Punta del Este | Ecological Reserve | National |
| Cayo Los Indios | Wilderness | Local |
| Siguanea | Sin Categorizar | Local |
| Los Indios | Ecological Reserve | National |
| Punta Francés | National Park | National |
| Cayo Rosario | Wilderness | National |
| Cayo Campo | Managed resource | Local |
| Cayo Cantiles | Managed resource | Local |
| Cayo Largo | Ecological Reserve | National |

In brief, biomass will be extracted from only 3 % of total forest areas through a sustainable harvesting scheme, which is as follows:

**Producer Forests:** Conforming to the forestry management plan, 27 ha of producer forests will be used for the production of 1,700 tonnes every year (at a yield of 63 tonnes per ha). The possible impact due to this activity was evaluated under the Environmental Impact Assessment carried out during the PDF phase, and no significant change or adverse impact in the environmental state of the affected forests[1] is anticipated.

[1] Forest area to be harvested - 27 ha every year under the proposed project is much less than the forests area already being covered under ongoing forestry operations to meet local needs on the island.

**Thinning Operations:** Conforming to the forestry management plan, 1725 ha of plantation forests per year will be thinned yielding 24,150 tonnes per year (yield assumed 14 tonnes per ha). This activity will contribute significantly to improve the environmental situation of the plantation forests. At the end of this project, plantation forests will be managed scientifically, and consequently, would witness an increased value in their biodiversity and commercial products.

**Forests regeneration:** 190 ha of degraded forests will be planted and added every year yielding 10,640 tonnes (at a yield of 56 tonnes per ha). This would facilitate in regenerating 1140 ha of degraded forest area during the project life of 6 years, and improve local ecosystem for the conservation of the flora and fauna by using appropriate species. **Only indigenous fast growing species will be used to grow new forests on degraded lands.**

The end product of the forest harvesting will be woodchips to be fed to biomass gasifiers. Cutting activities, by means of internal combustion chain saws, will be established in the forest itself. The chipping activity will be located at a distance of up to 25 km, from the electricity generation plant.

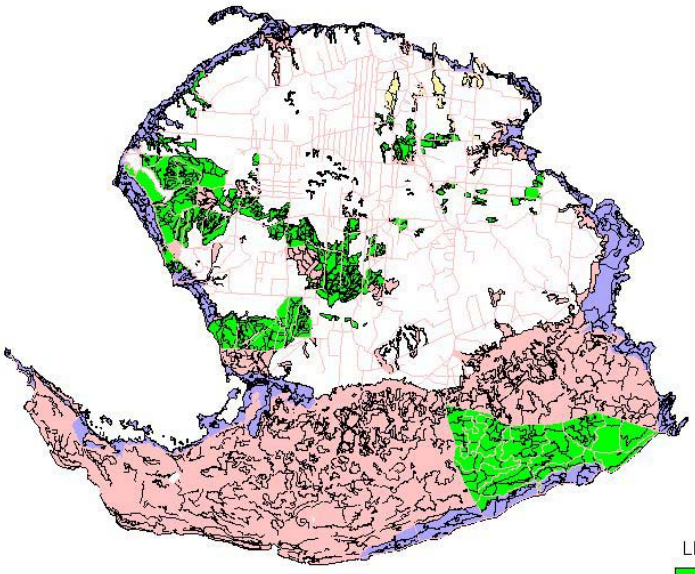
In addition, the environmental experts carried out the Environment Impact Assessment of the extracting biomass needed every year to meet the biomass demand under the proposed project, and found no negative impact as quantity of the wood chips (36,400 tonnes per year) required under the project are much less than the quantity (48,200 tonnes) of wood already available every year through sustainable forests harvesting practices. Further, the biomass availability does not take into account the huge potential of woody weed Marabu (Dichrostachys Cynerea) present on the Island. During the PDF phase, wood likely to be available form this weed was tested and found have Since it has calorific value of about 10 MJ/kg; its potential use in the biomass gasification technology will be explored seriously during the main phase in addition to the amounts obtained from forestry operations described above.

The Empresa Forestal Integral (EFI) - local forestry company on the Isla de la Juventud, a partner of the Grupo Empresarial de Agricultura de Montaña (GEAM), will be the Cuban institution in charge of the production, supply and sale of wood chips (with maximum humidity 30 %), as well as the forestry management needed to ensure sustainability. The project envisages purchasing agreements between the local forestry company (EFI) and the biomass gasifier plant owners for the production of gas for electricity, and between the EFI and Alastor for the production of heat.

The Empresa Forestal Integral (EFI) on the Isla de la Juventud is ready to set up an agreement with foreign companies in order to establish the business model. This company would be a supplier of technology and a co-financer of the project, and will transfer its own experience on modern forestry management that could be replicated elsewhere.

**Keeping in view the environment practice standards of the GEF, as a start up activity, an external reviewer will be asked to review the biomass production plan, EIA study and facilitate certification under a universally accepted schemes such as FSC or national forestry guidelines. EIA recommendations will be adhered to strictly and monitored on regular basis by the project team.**

# Figure 1. Forest Use in Isla de la Juventud



N

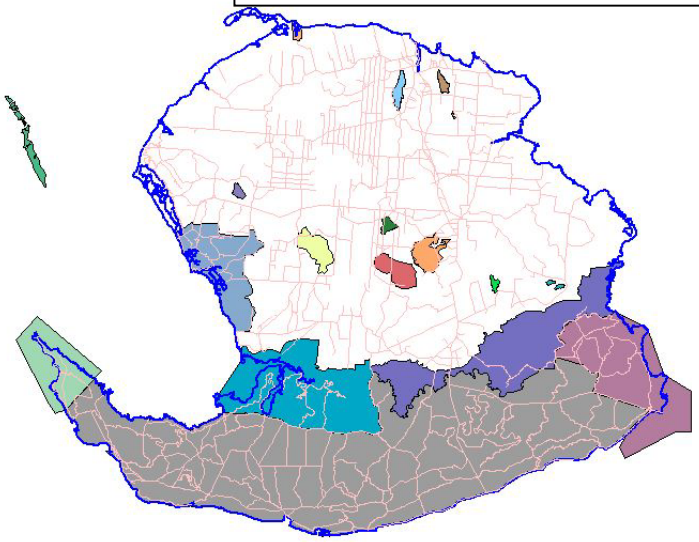
6000 0 6000 12000 Meters

**LEGEND**

LEYENDA

- Productive.
- Soil and Water Protection.
- Costal Zone Protection
- Costal Zone Protection.
- Fauna Conservation.
- Recreation

# Figure 2. Protected areas in Isla de la Juventud



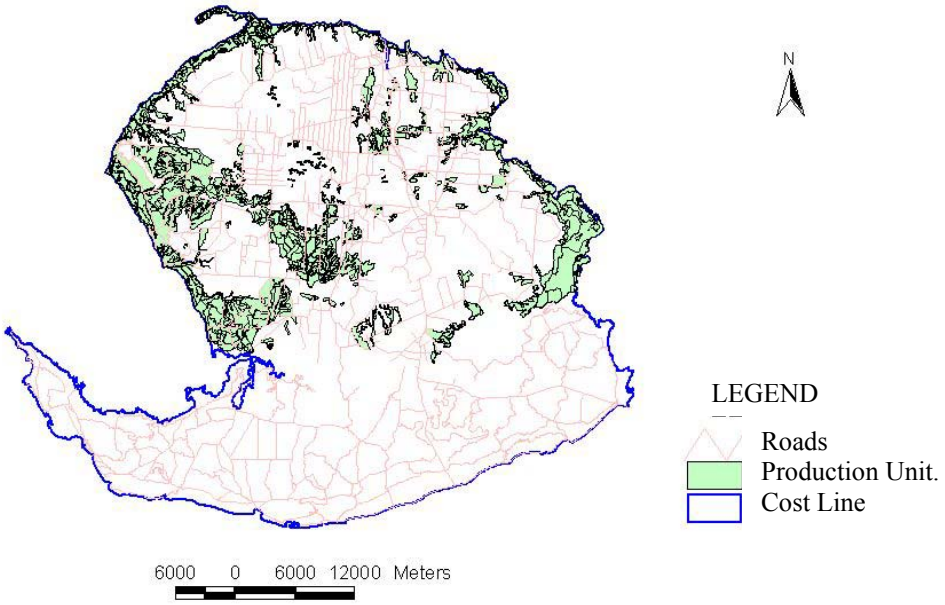
N

10000 0 10000 20000 Meters

LEYENDA

- Cayo Campo
- Cayo Cantiles
- Cayo Largo
- Cayo Los Indios
- Cayo Rosario
- Cerro Cristal
- Cerros de la Ceiba - La Jía
- Cerros de San Juán
- Cerros del Monte
- Cerros el Descanso - Mal País
- Cerros La Guanábana
- Ciénaga de Lanier
- El Sur
- La Cañada
- La Daguilla
- Los Indios
- Punta del Este
- Punta Francés
- Río del Medio - Las Nuevas
- Sierra de Caballos
- Sierra de Casas
- Siguanea

## Figure 3. Production Unit No. 1 Spatial Distribution Isla de la Juventud




## Figure 4. Soils in Isla de la Juventud

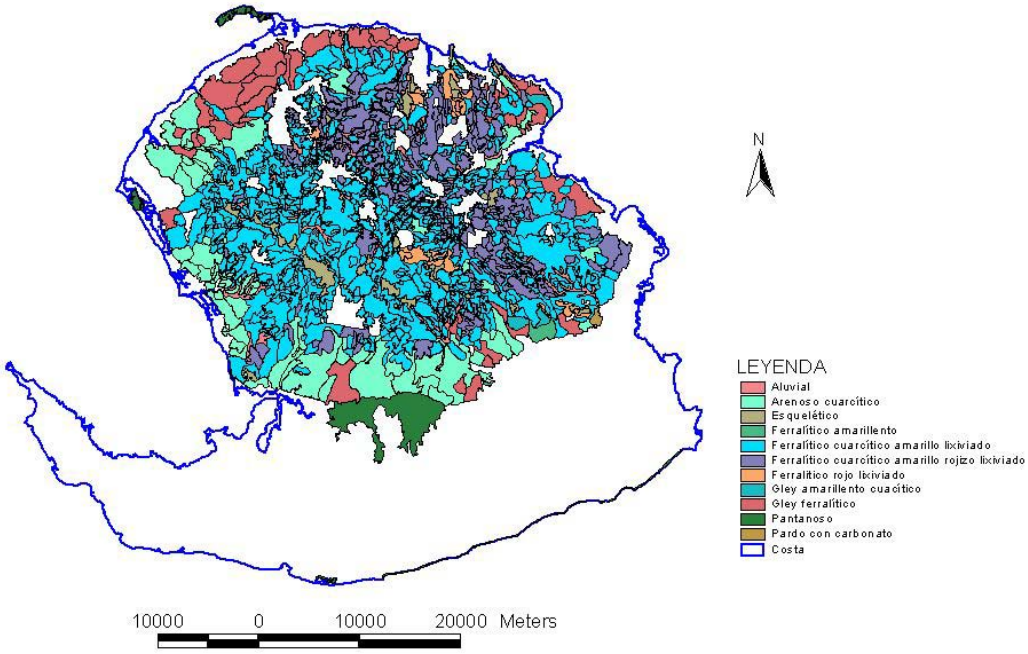
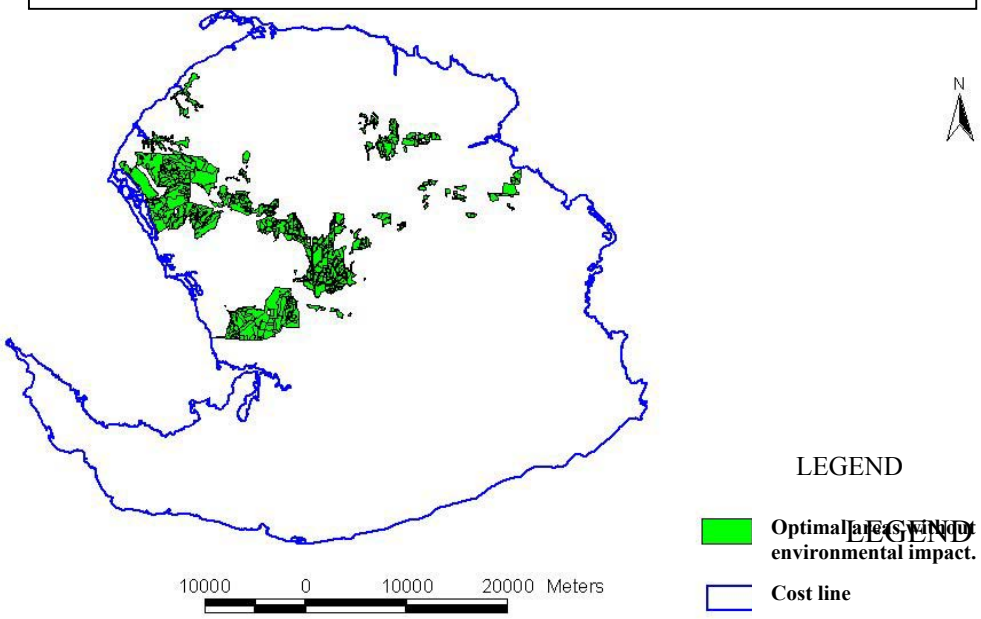


**Figure 5. Optimal areas distribution for woody biomass extraction used as energy source**



**Annex G1**

## REPORT BY AN INDEPENDENT FORESTRY REVIEWER

### GEF PROJECT - GENERATION AND DELIVERY OF RENEWABLE ENERGY BASED MODERN ENERGY SERVICES IN CUBA: THE CASE OF ISLA DE LA JUVENTUD


**Summary**

1. This report covers the activities and reporting of Mr. Hector A Martinez, Forestry Expert during 9 to 18 November 2004 both in Havana and Isla de la Juventud.

2. According the Project Document (PD), the main project objective is to reduce the Greenhouse Gas Emissions (GHGs) in Cuba by promoting environmentally sound renewable energy technologies for power generation as well as for providing modern energy services on a commercial basis at the Isla de la Juventud.

3. The forestry expert was requested to undertake an independent review of the technical information generated during the PD formulation and other data and documents developed in the Isla de la Juventud of biomass production made by the Cuban forestry institutions based in detailed field surveys and consultation made during the PD formulation process; provide comments on quantifications of biomass; outline a self certification programme for the Cuban situation, that will be recognized internationally; provide comments on the potential use of marabu (*Dichrostachys cinerea*[1]) for biomass production; outlined the potential for raising forestry plantations for energy production and provide comment on opportunities for woody biomass use in the Central American and Caribbean areas.

4. According to the technical information reviewed, the project has a strong data basis for energy production based on biomass energy based generators, both gasifiers and boilers. Additionally marabu natural vegetation shows a high potential for biomass production reinforced by invasion of agricultural and cattle raising fields, nevertheless this is considered as high risk problem for agricultural activities in the Isla (an option to control this problem will be the establishment of other forestry species with more biomass production potential like *Leucaena leucocephala* or some *Eucalyptus* species adapted to the island conditions). In the other hand actual plantation areas (covered with pines, eucalyptus and casuarinas species) shows a reliable resource basis for biomass production. Some plantation areas are requiring thinning to improve its biomass production, but wood produced has not at this moment an adequate biomass consuming plant to use it.

5. Related to a national forest certification programme the Forest Stewardship Council based in Bonn, statement Germany (www.fsc.org) provides the basis for these activities in this context it is necessary organize the National Initiative for Voluntary Forest Certification (FSC provides the information and support necessary for such activities).

6. Forest biomass production has an enormous potential both in Central America and the Caribbean where forest information exists, developed by the Centro Agronomico Tropical de Investigacion y Enseñanza (Tropical Agricultural and Training Center), based in Turrialba, Costa Rica during the last 40 years.

7. Additionally to above considerations, the Isla has remarkable advantages for project implementation: a high density road network in good conditions; a network of forest institutions well developed and integrated for forest management practices; a well trained group of technicians which show to be enthusiastic and dedicated. In the other hand, the Isla has a well-developed electrical grid.


1 Marabu is considered as a weed in Cuba as well as other tropical countries for his potential for colonizes open lands like agricultural o cattle raising lands. This capacity is provided by its mechanisms of dissemination: seeds and suckers.

8. In general terms the risk of the project is low especially in terms of environmentally negative impacts, availability of hand labor (the potential for employment is high) and negative impacts over all stakeholders involved are predicted as very low.

## A. Background

1. Cuba is an island country with an area of 110,860 sq. km and a long coastline of 3735 km. It has a population of about 11 million with terrain mostly flat to rolling plains, with rugged hills and mountains in the southeast on the main island. The country is composed of several islands, Isla de la Juventud being the second largest island outside the main island, with tourism potential as well as agricultural prospects.

2. Provision of reliable electricity at affordable prices to all households, services and industries is an integral component of the national development plan of the Government of Cuba. In 2001, over 90 percent of Cuba's electricity generation capacity was oil-fired (table 1 from CITMA, 2002). Currently, Cuba produces 50 percent of oil for its domestic consumption while rest is imported. The national grid has covered about 95% of total population at present while 5% of the population located in far and remote places, mainly in the eastern province, is yet to be provided with reliable electricity services. Electricity tariff for the household sector and agriculture is highly subsidized by the Government while export earning industries face full cost tariffs.

**Table 1**

**Installed Capacity and Generation in the National Electric System (NES) of Cuba, 2001**

| Source | Installed capacity, MW | Generation, GWh | Percentage of Total Generation |
|---|---|---|---|
| Fuel-oil | 3,505 | 14,372 | 85.5% |
| Hydroelectric | 57 | 75 | 0.5% |
| Natural Gas | 145 | 1,258 | 8% |
| Biomass | 704 | 929 | 6% |
| TOTAL | 4,411 | 16,634 | 100% |

Source: CITMA, Ministerio de Ciencia, Tecnologia y Medio Ambiente, 2002.

3. The National Program for Development of Local Energy Sources in Cuba places a high priority on the development of indigenous and environmentally benign renewable resources/options for rural/urban areas. These options, among others, include biomass, wind, solar, and small hydro technologies in order to meet growing demand for electricity, reducing oil imports and preserving the environment.

4. The total forest cover is 2.348.000 ha (FAO, 2000) with 1.867.000 ha of natural forest and 482.000 ha of plantations which represent that Cuba has nearly 21% of its land covered with forests representing an important biomass resource (table 2 from FAO 2000 present the distribution of principal forests resources for the Isla of Cuba, showing that at present, no forests have been certified by the Forest Stewardship Council system).

5. The overall objective of the project is to reduce the Greenhouse Gas Emissions (GHGs) in Cuba by promoting environmentally sound renewable energy technologies for power generation as well as for providing modern energy services on a commercial basis at the Isla de la Juventud, the second island of Cuba with 2.436 sq. km. The project addresses key barriers that constrain the use of renewable energy technologies (biomass and wind) for power generation on the Isla de la Juventud, and promotes business models for sustainable harnessing of renewable energy resources in Cuba.

Given the high cost of generating electricity on the island and the demonstrated engagement of private sector investments in fossil fuel based power generation, Isla de la Juventud presents a priority opportunity for a GEF intervention to support renewable energy technologies.

**Table 2. Forest Resources of Cuba (from FAO, 2000)**

| Forest Area and Change | Cuba | Central America & Caribbean | World |
|---|---|---|---|
| Total forest area, 2000 (000 ha) | 2,348 | 78,737 | 3,869,455 |
| Natural forest area, 2000 (000 ha) | 1,867 | 76,556 | 3,682,722 |
| Plantations area, 2000 (000 ha) | 482 | 1,295 | 186,733 |
| Total dryland area, 1950-1981 (000 ha) [a] | 1,211 | 138,063 | 5,059,984 |
| Change in forest area: | | | |
| Total, 1990-2000 | 13% | -11% | -2% |
| Natural, 1990-2000 | 1% | -11% | -4% |
| Plantations, 1990-2000 | 8% | 0% | 3% |
| Original forest [b] as a percent of total land area [c] | 90% | 67% | 48% |
| Forest area in 2000 as a percent of total land area [c] | 21% | 29% | 29% |
| **Forest Area by Crown Cover (000 ha), 2000** | | | |
| *Note: Crown cover data are gathered using different methodologies than the forest area calculated above. The two estimates may differ substantially.* | | | |
| Area of forest with crown cover: | | | |
| Greater than 10% | 9,916 | 175,478 | 6,537,209 |
| Greater than 25% | 6,598 | 134,045 | 4,842,071 |
| Greater than 50% | 3,174 | 72,537 | 3,143,720 |
| Greater than 75% | 1,730 | 38,012 | 1,945,916 |
| **Ecosystem Areas by Type** | | | |
| Total land area | 11,086 | 271,325 | 13,328,979 |
| Percent of total land area covered by: | | | |
| Forests | 23% | 34% | 24% |
| Shrublands, savanna, and grasslands | 24% | 41% | 37% |
| Cropland and crop/natural vegetation mosaic | 44% | 22% | 20% |
| Urban and built-up areas | 0.4% | 0.1% | 0.2% |
| Sparse or barren vegetation; snow and ice | 0% | 1% | 16% |
| Wetlands and water bodies | 9% | 3% | 3% |
| **Forests certified through the Forest Stewardship Council** | | | |
| Natural forests, 2002 (hectares) | 0 | 860,225 | 11,457,393 |
| Plantations, 2002 (hectares) | 0 | 47,335 | 3,324,996 |
| Mixed forests, 2002 (hectares) | 0 | 125,342 | 11,461,154 |

6. According the PD, the project would adopt a holistic approach for demonstrating the technical, economic and financial viability of sustainable renewable energy production through business models on the Isla de la Juventud, and help in creating an enabling environment – in terms of institutional, financial and policy mechanisms – for their replication through-out the country and the region. Both, the national counterpart agency – the Centre for Management of Priority Programmes and Projects (GEPROP) and Compañía Fiduciaria – a national level trust fund financial and banking company - are designated agencies for the introduction of business models to support The project would adopt a holistic approach for demonstrating the technical, economic and financial viability of sustainable renewable energy production through business models on the Isla de la Juventud, and help in creating an enabling environment – in terms of institutional, financial and policy mechanisms – for their replication through-out the country and the region. Both, the national counterpart agency – the Centre for Management of Priority Programmes and Projects (GEPROP) and Compañía Fiduciaria – a national level trust fund

financial and banking company - are designated agencies for the introduction of business models to support sustainable development in Cuba.

7. Other project objective is to introduce new and innovative financial and institutional structures to encourage private investments, support economically viable, environmentally sustainable markets, and enhance local manufacturing capacity for renewable energy technologies in Cuba. As a result, a robust market and strong institutional and financial capacity at the national level for supporting renewable energy investment projects will emerge that would make Cuba's economy less reliant on imported fossil fuels to meet its growing energy needs, and in the process, also help in reducing overall GHGs emissions through wide-spread use of renewable energy technologies in the country as well as in the Caribbean region. Additionally the project propend the creation of employment for local people.

## B. Objectives and Methodology

8. According the TORs, the objective of the consultant work was to undertake a desk review of technical information generated during the PD formulation and other data and documents developed in the Isla de la Juventud of biomass production made by the Cuban forestry institutions based in detailed field surveys and consultation made during the PD formulation process; provide comments on quantifications of biomass; outline a self certification programme for the Cuban situation, that will be recognized internationally; provide comments on the potential use of marabu (*Dichrostachys cinerea*) for biomass production; outlined the potential for raising forestry plantations for energy production and provide comment on opportunities for woody biomass use in the Central American and Caribbean areas.

9. To achieve the objectives the following activities were undertaken:

Review of Project Document and related documents; field visit to Isla de la Juventud and visual assessment of natural forest plots and plantations with local technicians; meetings with local technicians both in Nueva Gerona, Isla de la Juventud and Havana; and review of environmental and forest information available in several sites in Internet

## C. Results

10. According to the experience gained during the field visit, the interviews conducted with the Cuban technicians and review of literature, the following results were obtained:

a) Related data presented in the Project Document (Table 1, annex G) and the management plan figures for producer forest: conforming to the forestry management plan, 27 ha of producer forests will be used for the production of 1,700 metric-tonnes every year (at a yield of 63 tonnes per ha).

**Table 1. Area distribution by forest categories on the Isla de la Juventud**

| Forestry category | Area (ha) |
|---|---|
| Productive Forests | 28409.90 |
| Soil and Water protection | 3966.82 |
| Coastal Zone protection | 21024.67 |
| Flora and Fauna Conservation Forests | 66187.74 |
| Recreation Forests | 1075.11 |

Species planted on productive areas do not posses any endemic value. Only the following species are present:

- Pinus caribaea (Pc)
- Pinus tropicalis (Pt)
- Casuarina sp. (csp)
- Calophyllum antillanum (Ca)
- Tabebuia angustata (Ta)
- Hibiscus sp. (Hbsp)

b) **RESULT 1:** *The forestry expert agrees with the figures about forest cover and the management plan figures to produce the planned annual biomass (1.700 metric-tonnes per year) and considered that the volume will be incremented in the future according the needs of the project for produce the biomass combustible for gasifiers machines or steam moved turbine to generate electricity.*

*The aggressive behavior of marabu will permit increment the productive area and biomass production in the near future. It is possible that this species behavior produce a diminution of agricultural and cattle raising areas. Appropriated environment measures should be determined in the future.*

*Some species like Leucaena leucoephala, Acacia mangiun or eucalyptus genus species with ample experimental data in the Caribbean and Central America will be used in the future specially to stop the marabu expansion.*

Related comments on biomass figures the forestry expert considered after discussion with forest technicians that the same were adequate.

c) **RESULT 2:** *The forestry expert suggests the establishment of Permanent Sample plots to evaluate in an accurate manner the yields of the natural forests, the marabou forests and plantation plots.*

Related the establishment of a forest certification program in Cuba the forestry expert suggests that the forest producers, the environmental institutions and other related organizations obtain the support from the Forest Stewardship Council (FSC) from Bonn, Germany, to organize the National Initiative to Voluntary Certification of Cuba.

d) **RESULT 3**: *The forestry expert considered that the creation of a certification program requires specialized assessment, from a certification body or directly from the FSC and can be put in place as a start up activity during the main phase.*

Related with use of marabou, the forestry expert considered that the species has a high potential for biomass production and will be managed as natural forests.

e) **RESULT 4**: *Marabou management requires some special measures related with harvesting and security for people working inside the stands. Some considerations will be made to replace this species for some leucaena species, and to establish permanent sample plots to know production and yield,*

The forest plantation management is urgent to increment their annual production and concentrate the biomass in the bole instead branches and twigs.

f) **RESULT 5**: *It is necessary to define and implement the forest management plan for plantations, including the establishment of permanent sample plots to measure yields and management practices.*

g) **RESULT 6:** *This Project has a high replication potential in the Caribbean countries and some Central America countries like Guatemala, El Salvador and Nicaragua. In this countries exist plantations and natural forest management data generated and collected by CATIE from Turrialba, Costa Rica.*

D. Conclusions

11. The evaluated project was well documented and based both in field and desk data. It has high importance for the Cuban economy and the Isla de la Juventud biomass management and stakeholder development. Some aspects that increase the sustainability and replicability aspects of the project are:

- Additionally to above considerations, the Isla has remarkable advantages for project implementation: a high density road network in good conditions; a network of forest institutions well developed and integrated for forest management practices; a well trained group of technicians which show to be enthusiastic and dedicated. In the other hand, the Isla has a well-developed electrical grid.
- In general terms the risk of the project is low especially in terms of environmentally negative impacts, availability of hand labor (the potential for employment opportunities is high) and negative impacts over all stakeholders involved are predicted as very low.

**ANNEX: G 2**

## SUSTAINABLE BIOMASS PRODUCTION AND HARVESTING ON ISLA DE LA JUVENTUD

### I. Background:

During the PDF phase, a comprehensive biomass resource mapping exercise was undertaken on the Isla de la Juventud which led to the conclusion that forests and fallow areas with woody growth can provide requisite biomass on sustainable basis to meet the requirements of business models for power generation and process heat provided sustainable forest harvesting practices are undertaken. Further, since biomass harvesting has to be undertaken strictly in conformity with the approved forestry working plans, new wood extraction and chipping technologies will be needed to minimize the waste in order to meet the demand for the biomass gasifier systems. Also main provisions of national forestry laws were taken into consideration while planning for sustainable forest harvesting activities under the proposed RE IJ project.

Taking into account all parameters, three specific criteria were used for choosing the forest areas to be harvested under the project, and to prevent any negative impacts on environment. These criteria were as follows:

- Present status and condition of the forests;
- Presence of any biologically significant endemic flora or fauna; and
- Use of suitable and degraded lands for raising new plantations
- Use of invasive alien species to control their presence.

**a) Present status and condition of the forests**

The Isla de la Juventud has more than 100,000 ha. of forests, and the local forestry company accounts for ownership of 32,500 ha of forests on the island. In addition, 2,300 ha of degraded lands can be included that are covered with medium and heavy growth of Marabú woody weed and other shrubs.

**Table 1. Area distribution by forest categories on the Isla de la Juventud**

| Forestry category | Area (ha) |
|---|---|
| Productive Forests | 28409.90 |
| Soil and Water protection | 3966.82 |
| Coastal Zone protection | 21024.67 |
| Flora and Fauna Conservation Forests | 66187.74 |
| Recreation Forests | 1075.11 |

Species present as well as planted on the productive forest areas:
- Pinus caribaea (Pc)
- Pinus tropicalis (Pt)
- Casuarina sp. (csp)
- Calophyllum antillanum (Ca)

- Tabebuia angustata (Ta)
- Hibiscus sp. (Hb sp)

**b) Presence of any biologically significant endemic flora or fauna**

On Isla de la Juventud, there are several forests regions having special managing and protecting status, which are officially recognized and protected by the Cuban Government. Figure 2 shows distribution of forest regions. Those areas of Producer forests, which are based at the nearby of protected regions, are specially managed and restricted, and would not be used for biomass extraction.

It was determined during the field survey and GIS mapping that on the northern region of the island, appropriately planned forest harvesting as per the forest working plan in Producer areas would not have any negative environmental impact due to the application of methods related to sustainable forest management, which will continue to be used during the period of the project implementation. There are no biologically significant endemic flora or fauna that would get affected by the proposed project, and this aspect was also reviewed and certified by the external forestry reviewer during his field visit to Isla de la Juventud.

**c) Use of suitable and degraded lands for raising new plantations**

Northern region was chosen for raising new plantations, as the soil of this region is capable of producing species having high capacity of providing biomass. The soil is generally characterized by having quartzical sand and exhibiting red ferralitic quartzical grounds. They are not erosion sensitive and also not very deep. Figure 3 shows land distribution and figure 4 shows soil distribution on the region.

For selecting optimal areas for biomass harvesting, Geographical Information System was used, obtaining the mapping of the optimal distribution area for biomass extraction aimed at energy usage (figure 5). Environment impact assessment exercise carried out during the PDF phase concluded that no negative environmental impact would exist due to the project, as no endemic species is involved in the area and the biomass need to be extracted will be relatively small and falls well within permissible limits (only 3 % of total forest areas will be used for biomass harvesting). To minimize impact of logistic support, the existing road network will be utilized, which is currently used for collecting and transporting wood.

## II. Sustainable Forests Harvesting Plan:

On supply side, keeping in view the total need for the woody biomass for power generation and process heat (about 36,400 tonnes per year) under the project, the following sustainable forests harvesting plan[1] has been envisaged:

**Producer Forests:** Conforming to the forests working plan, 27 ha of producer forests will be used for the production of 1,700 tonnes every year (at a yield of 63 tonnes per ha). The possible impact due to this activity was evaluated under the Environmental Impact Assessment carried

[1] Year wise yield has been worked out as per the forestry working plan and accepted principles of sound forestry practices.

out during the PDF phase, and no significant change or adverse impact in the environmental state of the affected forests[2] is anticipated.

**Thinning Operations:** Conforming to the forestry management plan, 1725 ha of plantation forests per year will be thinned yielding 24,150 tonnes per year (yield assumed 14 tonnes per ha). This activity will contribute significantly to improve the environmental situation of the plantation forests. At the end of this project, plantation forests will be managed scientifically, and consequently, would witness an increased value in their biodiversity and commercial products.

**Forests regeneration:** 190 ha of degraded forests will be planted and added every year yielding 10,640 tonnes (assuming yield of 56 tonnes per ha). This would facilitate in regenerating 1140 ha of degraded forest area during the project life of 6 years, and improve local ecosystem for the conservation of the flora and fauna by using appropriate species. Only indigenous fast growing species will be used to grow new forests on degraded lands.

A spreadsheet has been added (page 6) to show yearly and cumulative production of biomass from various earmarked areas including regenerated forests, which will start producing biomass only from 6$^{th}$ year onwards.

The end product of the forest harvesting will be woodchips to be fed to biomass gasifiers. Cutting activities, by means of internal combustion chain saws, will be established in the forest itself. The chipping activity will be located at a distance of up to 25 km, from the electricity generation plant.

In addition, a team of environmental experts carried out the Environment Impact Assessment of the extracting biomass needed every year to meet the biomass demand under the proposed project, and found no negative impact as quantity of the wood chips (36,400 tonnes per year) required under the project are much less than the quantity (48,200 tonnes) of wood already being harvested every year through sustainable forests harvesting practices.

Further, the biomass availability does not take into account the huge potential of woody weed Marabu (Dichrostachys Cynerea) present on the Island. Marabu is a woody weed on the Isla de la Juventud, and its utilization as biomass resource for power generation and process will have dual advantage of controlling spread of a weed besides using it as woody biomass in the project. However, biomass production from Marabu species has not been taken into account when making calculations for biomass supply. This option will be seriously explored during the implementation phase as a backup and it is likely to further reduce the cost of biomass production on the Isla de la Juventud.

During the PDF phase, wood likely to be available from Marabu weed was tested (it has calorific value of about 10 MJ/kg); and its potential use in the biomass gasification technology was explored. This has now been confirmed by the report of the independent forestry expert who has compared yield from Marabu in Caribbean region, and has recommended its increased use in the project.

[2] Forest area to be harvested - 27 ha every year under the proposed project is much less than the forests area already being covered under ongoing forestry operations to meet local needs on the island.

## III. National Forestry Partners

The Empresa Forestal Integral (EFI) - local forestry company on the Isla de la Juventud, a partner of the Grupo Empresarial de Agricultura de Montaña (GEAM), will be the Cuban institution in charge of the production, supply and sale of wood chips (with maximum humidity 30 %), as well as the forestry management needed to ensure sustainability. The project envisages purchasing agreements between the local forestry company (EFI) and the biomass gasifier plant owners for the production of gas for electricity, and between the EFI and Alastor for the production of heat.

The Empresa Forestal Integral (EFI) on the Isla de la Juventud has been in touch with potential foreign partners and companies through the project team in order to establish the business model. The private company would be a supplier of harvesting technology and a co-financer of the project, and will transfer its own experience on modern forestry management practices that could be replicated elsewhere in eth country for replication.

## IV. Report of Independent Forestry Expert

According to the technical information reviewed and field visit undertaken to the Isla de la Juventud, independent forestry expert confirmed that the project has a strong data basis for energy production based on biomass based generators, both gasifiers and boilers. Additionally Marabu natural vegetation shows a high potential for biomass production reinforced by invasion of agricultural and cattle raising fields (an alternative option will be the establishment of forestry species with more biomass production potential like *Leucaena leucocephala* or some indigenous tree species adapted to the island conditions). Actual plantation areas (covered with pines, eucalyptus and casuarinas species) show a reliable resource basis for biomass production as envisaged under the project.

The forestry expert confirmed that some of the species selected under the proposed project on Isla de la Juventud for the Cuban reforestation program are widely planted in Central American and the Caribbean Islands for wood or firewood production.

For instance, Pinus tropicalis Morelet (Pino blanco; Pino hembra) is an endemic coniferous from Cuba naturally distributed in sandy soils, preferable in dry sites from Pinar del Río province (western part of Cuba) and the Isla de la Juventud (Southeast of main island of Cuba). Trees reach 20 meters of total height (Bisse, 1998). Ibáñez, Sosa y Manzanares (inedited) indicate that natural distribution includes from P. del Río, San Diego de los Baños to east limit of Guanahacabibes peninsula and the Isla de la Juventud, from North to Ciénaga de Lanier, in the South, with straight bole trees which may reach 30 m total height and 30 cm diameter. This figure indicates that it is possible to reach more than 380 m3/ha in a 18-20 years cycle. Pinus caribaea has also become one of the most important timber trees planted throughout the humid lowland tropics, because it can grow at sea level on poor sites. Firewood is easily obtained as byproduct.

Related to a national forest certification programme[3], the forestry expert has suggested a mechanism to put in place a National Initiative for Forest Certification on the Isla de la Juventud

[3] Forest management certification is the process by which forest management practices are evaluated against a set of standards. The term "certification" is now commonly understood to be "independent verification" (SAF 1999; Pinchot Institute 1999) of conformity to those standards, generally by a third party. It is a tool designed to document and reward specific forest management practices, and to assure consumers of forest products that their purchase comes from a forest whose management meets certain standards. A critical aspect of certification is the fact that it is a voluntary, non/regulatory approach to improving

by the Forest Stewardship Council based in Bonn, Germany. FSC[4] is known for its expertise in certification processes and mechanisms, and will provide the basis for these activities in this project.

Although a critical aspect of forestry certification is that it is a voluntary, non/regulatory approach to improving forest management practices, but as suggested by GEF, it is proposed to make it mandatory and put it in place in the first year of the project implementation itself, before steps are taken to set up business models for power generation and process heat based on sustainable harvesting of biomass on the Isla de la Juventud.

forest management practices. Certification is designed to allow products flowing from certified forests to gain favor in the marketplace.

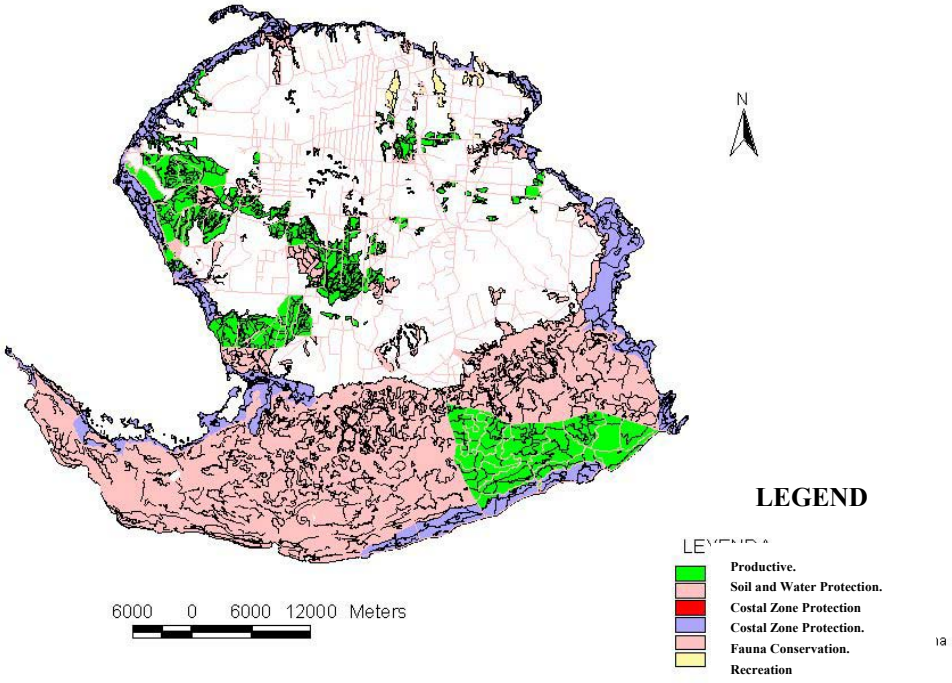
[4] The Forest Stewardship Council (FSC) is an independent, non-profit, non-governmental organization founded in 1993 by a diverse group of representatives from environmental and conservation groups, the timber industry, the forestry profession, indigenous peoples' organizations, community forestry groups and forest product certification organizations from 25 countries. The goal of the FSC is to promote environmentally responsible, socially beneficial, and economically viable management of the world's forests, by establishing a worldwide standard of recognized and respected Principles and Criteria of Forest Stewardship. FSC certification involves an on-the-ground assessment of a landowner's forestry practices by an independent interdisciplinary team of experts. The assessment evaluates the ecological, economic and social aspects of the operation in accordance with the FSC approved certification standards of the region. If the forest management meets the certification standards, then the operation may be certified. Forest products coming from forest operations certified using FSC-endorsed standards can carry the FSC label, provided their "chain of custody" is also independently certified.

## Biomass Production in Isla de la Juventud

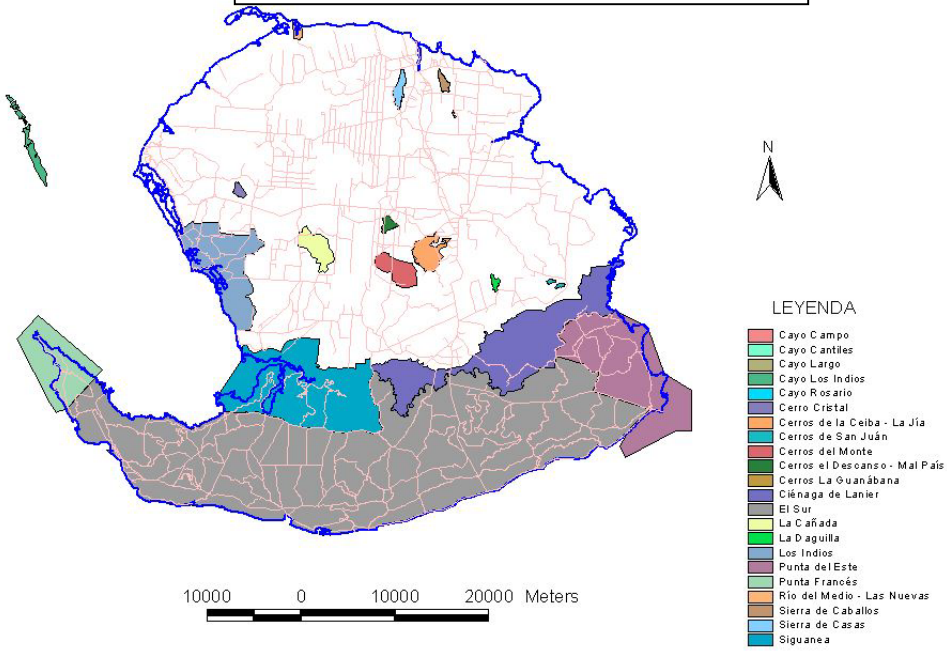
| | Forest area for biomass (ha) | Yield (tonnes) | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Producer Forests | 27 | 63 | 1,701 | 1,701 | 1,701 | 1,701 | 1701 | 1,701 | 1,701 | 1,701 | 1,701 | 1,701 |
| Thinning Operations | 1,725 | 14 | 24,150 | 24,150 | 24,150 | 24,150 | 24,150 | 24,150 | 24,150 | 24,150 | 24,150 | 24,150 |
| Forest Regeneration (1-6 years) | 190 | 56 | 0 | 0 | 0 | 0 | 0 | 10,640 | 10,640 | 10,640 | 10,640 | 10,640 |
| Total Biomass Production (yearly) | | | 25,851 | 25,851 | 25,851 | 25,851 | 25,851 | 36,491 | 36,491 | 36,491 | 36,491 | 36,491 |
| Cumulative Biomass Production | | | 25,851 | 51,702 | 77,553 | 103,404 | 129,255 | 165,746 | 202,237 | 238,728 | 275,219 | 311,710 |
| Cumulative Biomass Used | | | 0 | 0 | 36,400 | 72,800 | 109,200 | 145,600 | 182,000 | 218,400 | 254,800 | 291,200 |
| Biomass in Reserve (yearly) | | | 25,851 | 51,702 | 41,153 | 30,604 | 20,055 | 20,146 | 20,237 | 20,328 | 20,419 | 20,510 |

| | Forest area for biomass (ha) | Yield (tonnes) | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Producer Forests | 27 | 63 | 1,701 | 1,701 | 1,701 | 1,701 | 1,701 | 1,701 | 1,701 | 1,701 | 1,701 | 1,701 |
| Thinning Operations | 1,725 | 14 | 24,150 | 24,150 | 24,150 | 24,150 | 24,150 | 24,150 | 24,150 | 24,150 | 24,150 | 24,150 |
| Forest Regeneration | 190 | 56 | 10,640 | 10,640 | 10,640 | 10,640 | 10,640 | 10,640 | 10,640 | 10,640 | 10,640 | 10,640 |
| Total Biomass Production (yearly) | | | 36,491 | 36,491 | 36,491 | 36,491 | 36,491 | 36,491 | 36,491 | 36,491 | 36,491 | 36,491 |
| Cumulative Biomass Production | | | 348,201 | 384,692 | 421,183 | 457,674 | 494,165 | 530,656 | 567,147 | 603,638 | 640,129 | 676,620 |
| Cumulative Biomass Used | | | 327,600 | 364,000 | 400,400 | 436,800 | 473,200 | 509,600 | 546,000 | 582,400 | 618,800 | 655,200 |
| Biomass in Reserve (yearly) | | | 20,601 | 20,692 | 20,783 | 20,874 | 20,965 | 21,056 | 21,147 | 21,238 | 21,329 | 21,420 |

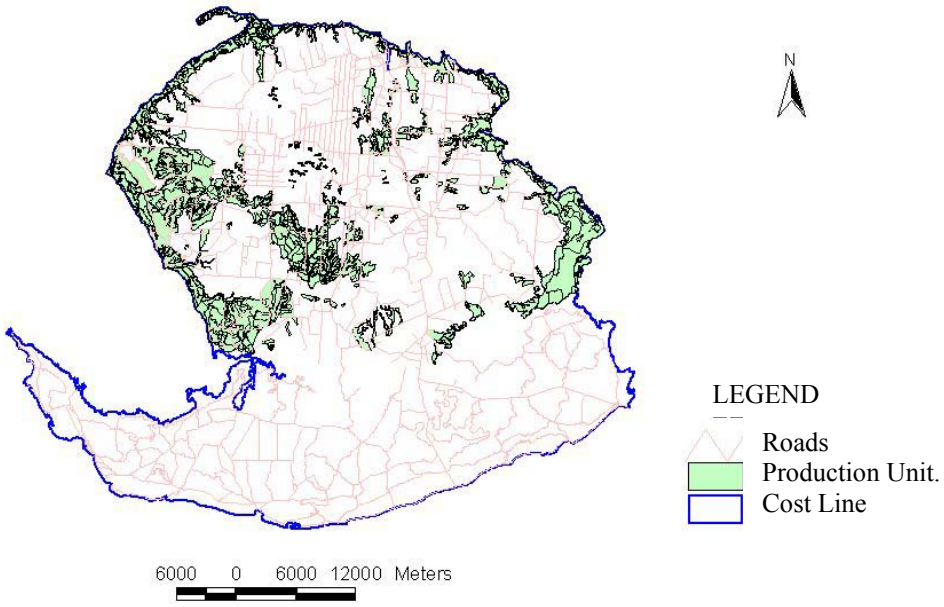
## Figure 1. Forest Use in Isla de la Juventud




## Figure 2. Protected areas in Isla de la Juventud



## Figure 3. Production Unit No. 1 Spatial Distribution Isla de la Juventud




## Figure 4. Soils in Isla de la Juventud

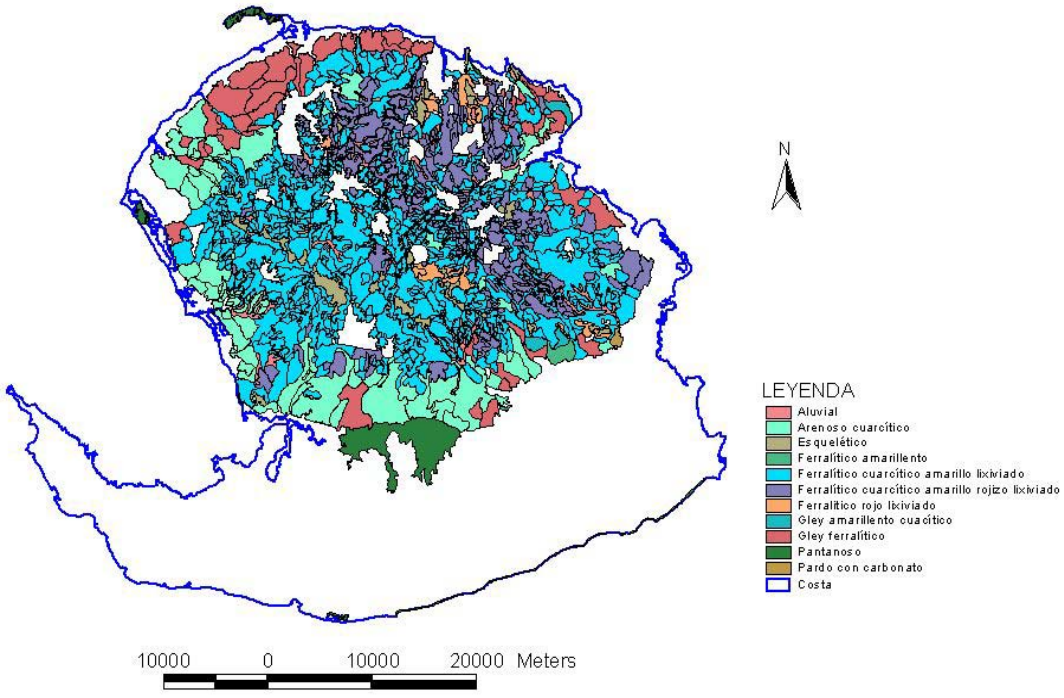
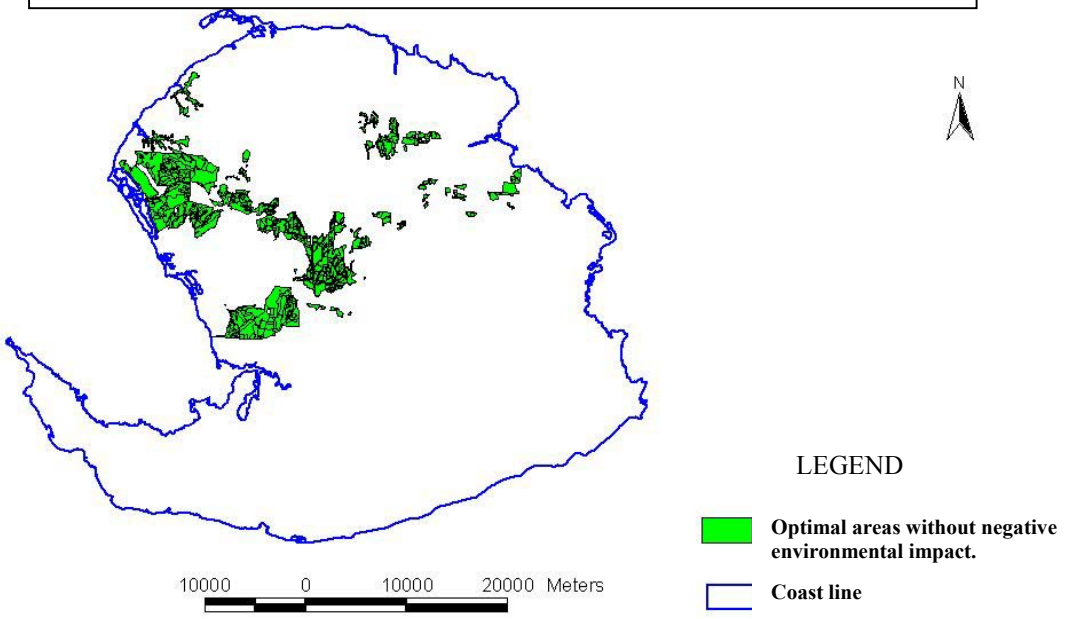


**Figure 5. Optimal areas distribution for woody biomass extraction used as energy source**



**ANNEX H:**

# COCODRILO DEMONSTRATION MINI GRID

## Objectives

The town Cocodrilo is located on the south coast of the Isla de la Juventud. This is the only settlement in the existing protected area in the south of the island municipality, which is not connected with grid. Currently, the electric service is provided through diesel engines for a period of 12 hours only every day. Since diesel is imported, there are no plans by the local administration to improve the electricity supply. This project presents a sustainable demonstration proposal as a part of capacity building activities to extend the electricity services based on renewable - biomass gasifier technology for meeting the energy needs of the local population for 24 hours, while at the same time providing valuable capacity building and training activities for renewable energy technologies based electricity sector stakeholders on the Isla de la Juventud. The project will also help in putting forestry management on a scientific footing by providing resources and training to the local forestry staff.

## Project rationale

The existing power generating station is composed of two recently acquired diesel generators of 37 kW, with no synchronization among them. This leads to interruptions of the service when generators are taken off or put back for maintenance or to increase the load capacity. This form of distribution brings high voltage falls and energy losses in the system, as the farthest consumer from the generating station is located at a distance of 665 meters. Since the Cocodrilo power station has inherent weaknesses, so from the point of view of assuming new loads, when a small motor of 1 kW is connected to the system, it causes load problems especially for distant customers.

From an environmental point of view, forests of the protected area on the south of the island are slowly deteriorating due to lack of funding for their scientific management and maintenance. Although the Empresa de Fauna y Flora is the organization in-charge of carrying out forestry maintenance, the lack of resources and skilled staff makes their task difficult. The pilot demonstration project will propose two basic solutions: a) provide reliable electricity supply based on renewable energy resources to the local community, and b) support scientific management of forests located in and around Cocodrilo.

To achieve uninterrupted 24-hour electricity supply to the Cocodrilo inhabitants, it is proposed to increase the generation capacity by means of a biomass gasifier plant 25 kV with a dual mode diesel generator. Also, it is proposed to modify the current grid and transform it into a mini-grid with all the necessary technical characteristics for a provision of electric service of quality, capable of being connected to the municipal grid in the future.

The proposed biomass gasifier plant will use forest residues coming from the pruning and dead woods that Empresa de Flora y Fauna will carry out in the protected forests from maintenance point of view only (creating a source of income for the forestry company). The OBE will be the operator of the whole system, and Empresa de Flora y Fauna will be the supplier of biomass fuel. Given the ground conditions and availability of resources in the south region of the island, the electricity generation option by means of renewable energy is the most environmentally friendly solution, and a biomass gasifier based power generation plant is the most appropriate technology

which is economically and environmentally feasible in that location to meet local energy needs for power and energy services.

The replacement of the distribution grid would consist of locating a distribution sub-station (two transformers, 3F, 100 Kva) at the exit of the current plant. It will also allow the assembly of distribution transformers (7620/120-240 Volt) that is required, and to build the secondary circuits necessary to give quality service to residential and governmental consumers. It will be necessary to prepare a qualified skilled team to run the biomass system that belongs to the community. This would also promote local employment.

The second component of this project proposes implementation of a scheme for the scientific maintenance of the forests for the supply of biomass for the operation of the biomass gasifier plant. This maintenance scheme will be coordinated by Empresa de Flora y Fauna that will assure that the whole operation is carried out according to the scientific management meeting the provisions of national forestry laws. The biomass plant would need around 500 Kg of dry biomass material per day.

**Sustainability**

The sustainability of this proposal is based on four basic principles: a) firstly, the additional electricity generation capacity will be provided by means of a biomass gasification plant. This is a technology that is not only relevant from low GHGs emissions point of view, but also from economic point of view as it would use a local resource - the forest residues, as fuel. Also, the utility that operates the existing diesel plant has some experience in older biomass technology; b) secondly, the proposed project will allow the Empresa de Flora y Fauna to obtain the necessary resources to carry out scientific management of the protected forests. The residue material of this operation will be provided to the operator of the biomass electricity plant as fuel; c) thirdly, electricity is a basic element necessary for the economic development and provision of reliable and assured quality electricity supply will support social and economic development of Cocodrilo area through productive activities; and d) fourth, although upfront costs of project design and procurement of the equipment for the proposed mini grid at Cocodrilo will be met through GEF and donor funds (consultations have revealed high degree of interest among some bilateral agencies to fund and support a large part of mini-grid activities at Cocodrilo), the project strategy would envisage generating enough revenue through sale of electricity for domestic and productive use activities to meet the operational and maintenance (O & M) costs, and in the process, make the proposed mini grid at Cocodrilo sustainable and self reliant.

Besides demonstration, the proposed mini grid at Cocodrilo would provide an excellent opportunity for replication in the mainland.

Environment Impact Assessment studies carried out confirmed the feasibility of setting up of a biomass gasifier plant based on local biomass resources available at Cocodrilo.

**Beneficiaries**

- Local community of Cocodrilo
- The Public Utility (Organización Básica Eléctrica Integral, OBE integral)
- The Local Forestry Company - Empresa de Flora y Fauna

***Community of Cocodrilo***

The local community has about 97 houses and 331 inhabitants that primarily depend on the fishing and forest resources. As mentioned previously, the expectations of this community is to get quality electricity service for 24 hours a day. This provision will not only improve the quality of life, but also would offer them the possibility to undertake productive use activities such as agro-processing of local agricultural produce.

***The Public Utility***

The Public Utility OBE would get direct and indirect benefits from this project. The direct benefit is that they will be in a position to meet the growing demand for electricity at Cocodrilo through renewable energy resources. The other benefit would be that they would get an opportunity to use a new technology, with expert advice and training, so that they will be able to put the plant into operation and do the maintenance.

***Empresa de Flora y Fauna***

The local forestry company will be able to obtain the economic resources and the equipment to maintain the surrounding forests on scientific basis, and to make the necessary pruning and maintenance. Also, they will obtain experience and training in the operation of fuel provision to a biomass plant. This experience could be replicated elsewhere in the island as well as on the mainland given the potential for use of biomass for power generation in Cuba.

**System Design**

The Gasifier System of 50 kg/hr biomass capacity with canopy for outdoor installation will be supplied to OBE. The gas generated shall be supplied to a suitably rated Diesel-Generator set to operate on dual-fuel mode: The table below shows the different components of the overall system.

**Table: Components of Cocodrilo gasifier electricity production system**

| **Sub system.** | **Scope of supply** | **Qty.** |
|---|---|---|
| Reactor with ash extraction unit | Ceramic lined reactor with top cover<br>Ash extraction system fitted to the reactor bottom<br>Instrumentation for pressure measurement at reactor exit. | 1 No. |
| Structural | Suitable support structure to facilitate gasifier operation with epoxy coat of paint.<br>A canopy to cover the gasifier system (excluding engine) | 1 No. |
| Gas cooling scrubbing & filtering system | Suitable cooling and cleaning system to maintain the temperature and quality of the gas<br>Water dump to collect wash water under the cooler<br>Suitable water pumps<br>Water plumbing from/to water sump<br>Fabric filter and paper filter | 1 set |
| Water cooling and treatment system | Flocculation, separation of the sludge from the cooling water and recycling and treatment | 1 Set |
| Blower | Mild steel blower with high quality epoxy paint and with shaft seal arrangement | 1 No. |
| Pilot burner | Stainless steel swirl burner along with flame arrestor | 1 No. |

| | | |
|---|---|---|
| Plumbing | Corrosion resistant gas and water piping with necessary valves and fittings | 1 set |
| Engine Generator | A suitable Diesel Engine Generator mounted on anti vibration mounting (AVM) with suitable modifications to generate 220/110V at 60 Hz along with 24 V battery, diesel tank and control panel | 1set |
| Biomass loading system | A winch based manual biomass loading system | 1 No |
| Automation | Not included | - |
| Miscellaneous | One oxygen measuring system for safety<br>Water manometers at various locations | 1 set |
| Spares | Essential gasifier and engine spares for one year maintenance | 1 set |
| Tools | Essential tools for gasifier and engine maintenance | 1 set |
| O & M manual | Comprehensive operation and maintenance manual for gasifier and engine published in English /Spanish | One copy each |

**Table: Auxiliaries for the preparation of the biomass fuel into the gasifier**

| | | |
|---|---|---|
| a. | Biomass chipper | A suitable biomass chipper to meet the requirement |
| b. | Wood chip drier | A suitable wood chip drier to control the biomass moisture level to the specified level. |

**Technical specification for the biomass gasifier**

The table below presents a technical data sheet with all the specification details of the gasifier unit.

**Table: Specification details for gasifier unit at Cocodrilo**

| **Parameter** | **Details** |
|---|---|
| Gasifier Type | Open top, twin air entry, down draft gasifier system capable of being placed outdoor (without a building) in an environment with ambient temperature being in excess of 15 $^0$C. |
| Gasifier Capacity | 20 kWe |
| Biomass Consumption rate | 50 kg/hr |
| Turndown ratio | 4:1 |
| Diesel Replacement | 80% |
| Tar and particulate level in gas after cooling, cleaning train | <100 ppm |
| Calorific value of gas generated from gasifier and its composition | Mean Cal value is 4.6 ± 0.2 MJ/Kg<br>Composition: CO: 20 + 1%; $CH_4$ : 2.0 + 0.5%, $H_2$ : 20 + 1%, $CO_2$: 12 + 1% and rest $N_2$. |
| Standard System elements | Reactor, cooling and cleaning system, DG set |
| Auxiliaries | Biomass cutter, Biomass drier |
| Feed stock | Any solid bio-residue of bulk density over 250 kg/m$^3$, ash content less than 5% and moisture content less than 15%. |
| Size of feed stock, mm | 60 x 25 x 25 and a mix in lower ranges |

| | |
|---|---|
| Allowable moisture content in biomass | < 15% |
| Biomass to gas conversion efficiency | 80 % |
| Site requirement | A cement concrete flooring for a carpet area of 5m X 6m, to place the gasifier<br>A separate room (with ventilation), measuring 4 x 3 x 2.5 m to house the engine-generator and control panel room<br>Biomass preparation and storage facility, measuring 5 x 5 x 3 m<br>Water sump of 5 cu m capacity for gas cooling |
| Water requirement, $m^3$/hr | 5.0 |
| Parasitic load, kWe | 3.5 |

Note: The scope of supply is limited to the electricity being made available at the control panel terminals at 110/220V.

**Site preparation needed by the Client Institutions**

The OBE and client institutes would take care of civil works like concrete flooring for housing the gasifier, water tank, biomass store and engine room, electrical, mechanical or any other works required at site. The OBE will provide facilities for loading and unloading, and the necessary material handling equipment as well as all consumables etc. required during the erection, installation and commissioning of the plant

**Supervision of Erection, Commissioning and Training of personnel**

The gasifier system will be assembled and installed at the site. The staff designated by the OBE and the local institutions will carry out actual erection. The total duration of erection and commissioning is anticipated to be 15 working days spread over 3 weeks. This includes ten days of hands-on training of the identified personnel/s of the client.

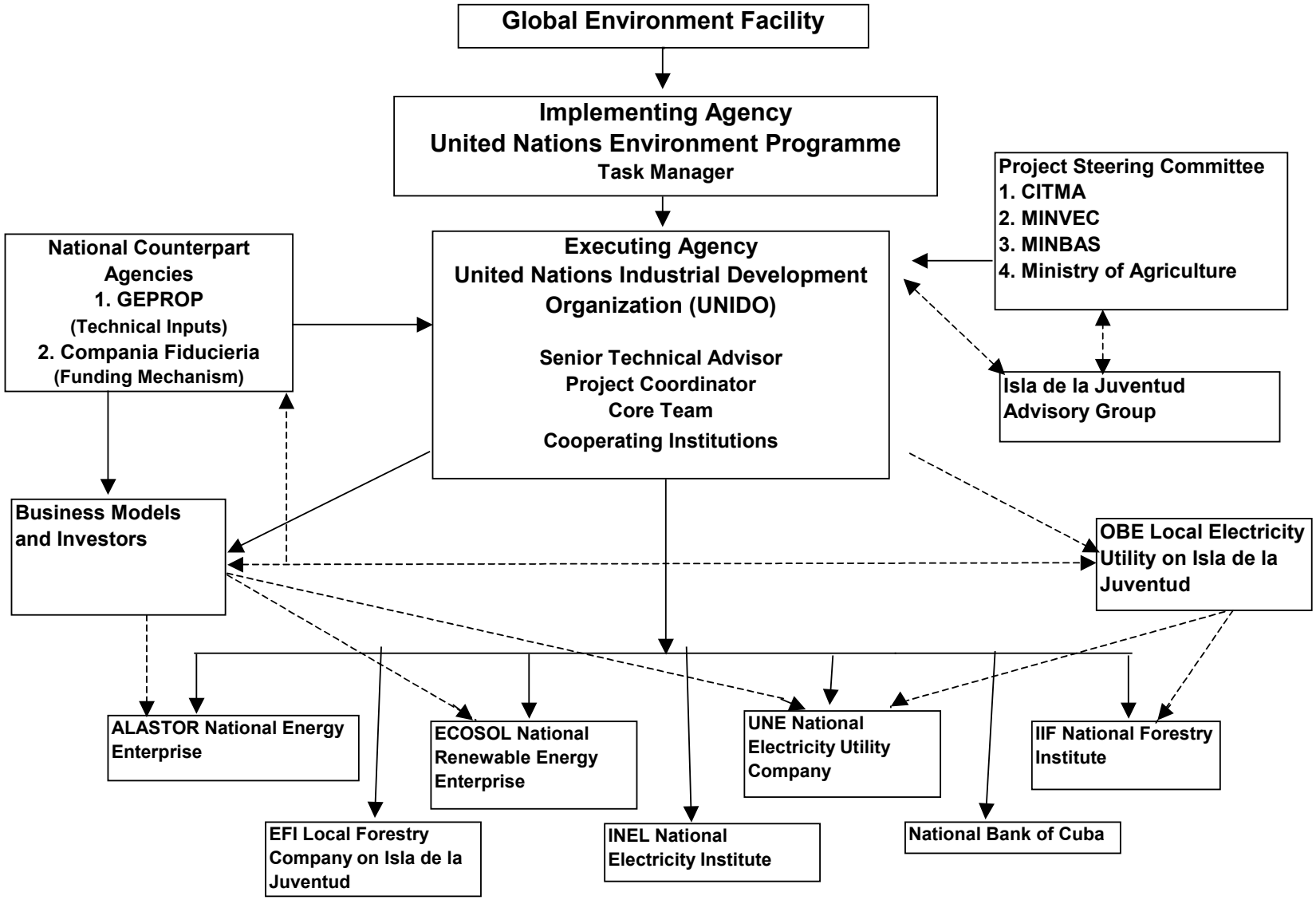
**Financial analysis**

Breakdown of costs for Renewable Energy based Power Plant at Cocodrilo (US $)

| | |
|---|---|
| 50 kW gasification biomass plant and related facilities | 45,000 |
| Training and capacity building | 5,000 |
| Extension and improvement of the local grid | 60,000 |
| Increase of the generation capacity. | 25,000 |
| Miscellaneous expenditure | 15,000 |
| Total | 150, 000 |

This mini-grid will essentially be a pilot demonstration plant as start-up activity, and besides meeting the local energy needs, would also act as a knowledge base for larger biomass gasifier plants to be set up as a part of main business models.

**ANNEX J: MONITORING AND EVALUATION STRUCTURE**



**H2 Monitoring, Evaluation and Reporting**

The objective of monitoring and evaluation plan will be to assist all project participants in assessing project performance and impact, with a view to maximizing both. Monitoring will be a continuous review and surveillance by PMU to ensure that all required actions are proceeding according to plan. Evaluation will help in determining systematically the relevance, efficiency, effectiveness and impact of various activities in light of their objectives.

The general and specific objectives of the project, and the planned outputs, have provided the basis for monitoring, evaluation and reporting.

The project will be evaluated on the basis of execution performance, output delivery, and project impact.

**Execution performance:**

Execution monitoring will assess whether the management and supervision of project activities is efficient and seek to improve efficiencies when needed so as to improve overall effectiveness of project implementation. It is a continuous process carried out by PMU, which will collect information about the execution of activities programmed in the activities time frame at Annex G (annual work plan will be firmed up at the start of project activities in consultations with PSC and LAC) advise on improvements in method and performance, and compare accomplished with programmed tasks. This activity will be the direct responsibility of the Project Management Unit (PMU), under the supervision of the project coordinator.

The UNIDO Senior Technical Adviser and the UNEP Task Manager will, in collaboration with the PMU, track milestones. Milestones will include ending activities in the TimeLine ANNEX G and fix dates for reports on indicators in ANNEX B Logical Framework.

**Output Delivery:**

Ongoing monitoring will assess the project's success in producing each of the programmed outputs, both in quantity and quality. Internal assessment will be continuously provided by the PMU, and mid-term and final evaluations of outputs will be carried out by UNIDO and UNEP. Please see section 4.2 (page 22 onwards) for the list of project activities and corresponding outputs and time frame at Annex G. The Executing Agency is primarily responsible for project outputs.

**Project impact:**

Evaluation of the project's success in achieving its outcomes will be monitored continuously throughout the project through semi-annual progress reports, annual summary progress reports, a mid-term and final evaluation all of which will use the project logical framework (Annex B) for indicators and means of verification. While indicators of outcomes in the marketplace will be monitored, no single project will be solely responsible for all change in the marketplace. Influence may be detectable.

**Global Goal:**

The project is consistent with the global objective expressed in Operational Program #6, focussing on biomass gasification and wind technologies for island states. The GEF alone cannot influence this goal but must carryout actions as financial instrument of the UNFCCC. In the absence of OP6 projects, fossil fuel emissions would certainly be greater and RETs would have much less chance of success. UNEP/UNIDO are not responsible for monitoring at this level, however some sources of information are referenced in any case.

**Responsibilities of the Project Management Entities**

The following table summarizes the responsibilities of the project management entities regarding monitoring and reporting.

| UNEP | UNIDO – Project Management Unit (PMU) | Isla de la Juventud Advisory Group | National Project Steering Committee |
|---|---|---|---|
| Monitor the agreed M&E plan in accordance with the terms of agreement with GEFSEC<br><br>Receive half-yearly progress and annual summary progress reports, and copies of all substantive reports from Project Management Unit.<br><br>Task manager to attend and participate fully in meetings of the project Steering Committee<br><br>Task Manager to conduct supervision missions with UNIDO Staff member/PMU to selected project sites and to identify implementation problems and suggest remedies to annual meeting of the Steering Committee.<br><br>Engage and prepare terms of reference for independent M&E consultants to conduct the mid-term and final evaluations | Establish responsibility and reporting guidelines for all partners in the project and ensure that they meet reporting dates and provide reports of suitable quality<br><br>Coordinate inputs from all investors, cooperating institutions and experts associated with the project.<br><br>Prepare half-yearly progress reports and annual summary progress reports for UNEP, and forward substantive financial reports, with supporting documentation as appropriate, in a timely manner.<br><br>Carry out a programme of regular visits to sites of business models to supervise activities, and pay special attention to those models with serious implementation problems | Receive half-yearly progress reports, annual summary progress reports and all substantive reports.<br><br>Advise Project Management Unit on implementation problems that emerge, and on desirable modifications to the work plan for the succeeding year.<br><br>Monitor progress in the capacity-building aspects of the project, and advise the Project Management Unit on steps to enhance this aspect of the project. | Receive yearly progress reports, annual summary progress reports, financial reports and all substantive reports, and provide policy guidance to the project on any matters arising from a reading of these reports<br><br>Assist the Project Management Unit in inter-ministerial coordination.<br><br>Assist the Project Management Unit in developing linkages with other projects, thus ensuring the wider impact of project work<br><br>Provide overall guidance for the project implementation. |

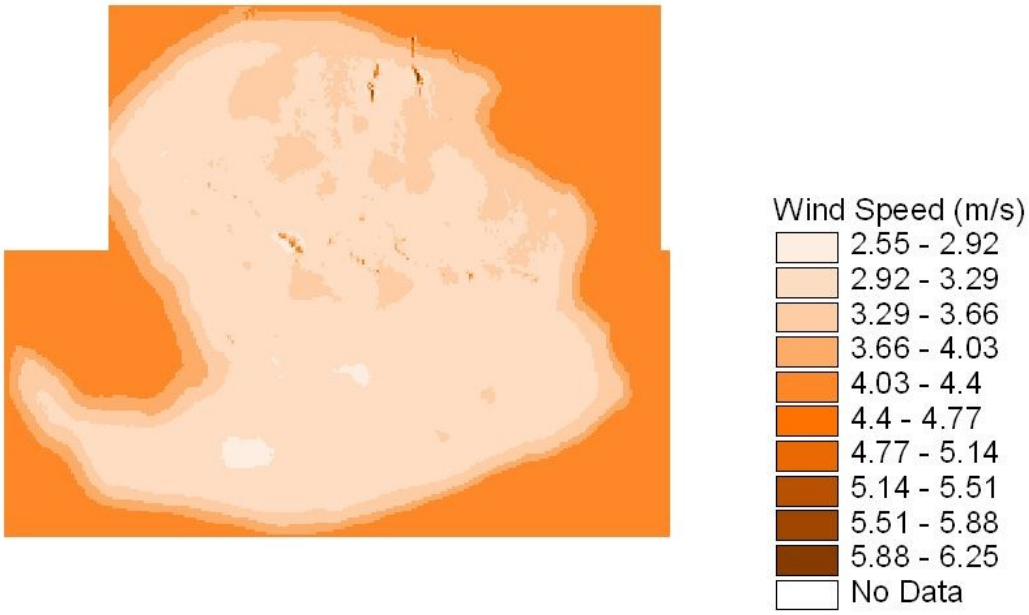
| Report | Format | Timing | Responsibility |
|---|---|---|---|
| Progress Report | Standard format | Quarterly | Project Coordinator (PC) |
| Financial Report | Standard format | Half-yearly | Project Coordinator |
| Project Implementation Review (PIR) report | Per GEF Sec format | Yearly (after project has been under implementation for one year) | Task Manager |
| Spot check | Once in 6 months (PC) Once in a year (TC) | During project implementation | PC/Task Manager |
| Mid-term Review | In-depth evaluation report | During project implementation | PC/Task Manager |
| Terminal Report | Standard format | End of project | Project Coordinator |
| Terminal Evaluation | In-depth evaluation report based on Terms of Reference (TOR) | End of project | Task Manager |
| Financial Audit Report | | Yearly and/or End of project | Project Coordinator |

**REPORTING**

- Project Coordinator will be appointed by UNIDO, while UNEP will appoint Task Manager.
- Every six months the executing agency will submit progress reports to the UNEP/GEF Division.
- The GEF Project Implementation Review report will be prepared in the second / third quarter of the year for submission to the GEF Secretariat.
- The executing agency will prepare terminal/final report of the project at the end of the project.

**ANNEX K** **MAPS**

WIND RESOURCE ON ISLA DE LA JUVENTUD




Biomass Cover on the Isla de la Juventud