UNDP Project Document

Government of Cuba
United Nations Development Program

PIMS No. 4899

Project Title: Clean Energy Technologies for the Rural Areas in Cuba (Clean Energy - Cuba).

UNDP Strategic Plan	*Outcome 1:* Growth and development are inclusive and sustainable, incorporating productive capacities that create employment and livelihoods for the poor and excluded.
UNDAF / UNDP CPD CUBA	*Outcome 5 / Outcome 28*: Communities and key sectors develop and increase energy efficiency and use of renewable energy.
UNDP CPD CUBA	*Output 28.1:* Strengthened institutional mechanisms for efficient and sustainable management of energy at local level including knowledge management, and a system of information on production and consumption of renewable energy for decision-making purposes.

Brief Description

The objective of the Project is to increase access to bioenergy technology in Cuba by promoting the use of biodiesel and biogas technologies by rural farmers. Specifically, the Project will (i) strengthen government policies in support of small-scale bioenergy technologies; (ii) address technology barriers presently limiting the widespread production and dissemination of cost-effective biodigesters and biodiesel conversion plants in Cuba; (iii) establish a comprehensive network of project design, maintenance, repair and extension services for small farmers to increment local food production, generate new jobs and income, promote community resilience and recover degraded lands. Bioenergy market development under the target beneficiary group will expectedly avoid greenhouse gas emission by conventional, fossil fuels to the amount of 207.1 ktons CO_{2eq}.

SIGNATURE PAGE

Country: Cuba

Government:	Ministry of Foreign Trade and Investment (MINCEX)
Executing Entity/ Implementing Partner:	Estación Experimental Indio Hatuey (EEIH) / Ministry of Higher Education (MES)

UNDP Strategic Plan Period:	2014-2017
Award ID:	00085068
Project ID:	00092839
PIMS #	4899
Project Duration:	5 years
Management Arrangements:	NIM

Total budget:	**US$ 22,686,631**
Total allocated resources:	
• **GEF**	**US$ 2,737,524**
• **Cofinancing**	**US$ 19,949,107**
○ *Estación Indio Hatuey (EEIH)*	*US$ 2,034,900*
○ *Cubaenergía*	*US$ 50,000*
○ *Local manufacturers (INPUD, INTEC,POLIGOM , Empresa Cubana de Acero,)*	*US$ 6,130,875*
○ *EEIH / Donor Programmes (SDC/Boimas Cuba, EU-OIKOS/Agroenergía)*	*US$ 11,683,332*
○ *UNDP*	*US$ 50,000*

	Name	Title	Signature	Date
Agreed by Government: MINCEX	William Díz Menéndez	Director		13/05/16
Agreed by Implementing Partner: Ministry of Higher Education	María Victoria Villavicencio	Directora DDI		13/5/16
Agreed by: UNDP	Claudio Tomasi	Rep Res. Adjunto.		16/5/16

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List of acronyms

ANAP	National Association of Small Farmers
APR	Annual Project Review
BCC	Banco Central de Cuba
BTOR	Back To Office Report
CAM	Consejo de la Administración Municipal
CCA	Common Country Analysis
CCF	Country Cooperation Framework
CC(M)	Climate Change (Mitigation)
CCP	Climate Change Program
CDM	Clean Development Mechanism
CDR	Combined Delivery Report
CH4	Methane
CITMA	Ministry of Science, Technology and Environment
CMEA	Council for Mutual Economic Assistance
CO	Country Office (UNDP)
COP	Conference of Parties (UNFCCC)
CO2	Carbon Dioxide
$CO2_{eq}$	Carbon Dioxide Equivalents
CUC	Convertible Currency (of Cuba)
CUP	Cuban Peso (local currency)
CTA	Chief Technical Advisor
DG	Distributed Generation
DPNES	Development Programme of National Energy Sources
EE	Energy Efficiency
EPDM	Ethylene propylene diene monomer
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GOC	Government of Cuba
GWh	Gigawatt (GW)-hours (1×10^6 kWh)
HDPE	High-density polyethylene
HQ	Headquarter (UNDP)
ICT	Information and Communication Technology
IMDL	Iniciativa Municipal para el Desarrollo Local
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
LPG	Liquefied Petrol Gas
kWh	kilowatt (kW)-hours
MEP	Ministry of Economy and Planning
MES	Ministry of Higher Education
MFP	Ministry of Finance and Prices
MINAG	Ministry of Agriculture

MINCEX	Ministry of Trade and Foreign Investment
MINDUS	Ministry of Industry
MINEM	Ministry of Energy and Mines
MOU	Memorandum of Understanding
MRV	Measuring, Reporting and Verification
MTR	Mid-term Review
MW	Megawatt (1×10^3 kW)
MWh	Megawatt (MW)-hours (1×10^3 kWh)
M&E	Monitoring and Evaluation
NAMA	Nationally Appropriate Mitigation Action
NPFE	National Portfolio Formulation Exercise
ONEI	National Statistics and Information Office
PIR	Project Implementation Review
PM	Project Manager
PMT	Project Management Team
PPG	Project Preparation Grant
PPR	Project Progress Report
PSC	Project Steering Committee
PV	Photovoltaic
PVC	polyvinyl chloride
QPR	Quarterly Progress Report
Q&A	Quality Assurance
RCU	Regional Coordinating Unit (UNDP)
RE(T)	Renewable Energy (Technology)
RTA	Regional Technical Advisor
RTE	Technical Regulation (voluntary)
SNC	Second National Communication
SRF	Strategic Results Framework
STAP	Scientific Technical Assistance Panel (GEF)
TA	Technical Assistance (GEF)
TE	Terminal Evaluation
TNA	Technology Needs Assessment
TPES	Total Primary Energy Supply
UNDAF	United Nations Development Assistance Framework
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention for Climate Change
USD	United States Dollar
W	watt

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SITUATION ANALYSIS

Policy conformity

The present Project "Clean Energy Technologies for the Rural Areas in Cuba (CleanEnergy-Cuba)" is supportive to GEF-5 CCM Objective #1 ("Promote the demonstration, deployment, and transfer of innovative low-carbon technologies"). The Project's objective is to increase access to bioenergy technology in Cuba by promoting the use of biodiesel and biogas technologies by rural farmers. This will be achieved through: (a) consolidation of technical, social, economic and environmental information as input for national policy development on small-scale bioenergies (review scope); (b) preparation of a concept paper for a national small-scale bioenergy strategy (c) transfer of technology to enable Cuba to design and produce state-of-the-art, cost-effective biogas and biodiesel equipment; and (d) institution building, training and promotion to create supportive expert networks to integrate these technologies in rural agriculture and livestock farms[1]. As a result of the proposed intervention, the identified barriers related to technology (know-how, designs and materials), policy framework, human and institutional capacity (trained human resources and adequate supportive institutional framework for end-users), as well as availability of and access to information, will be greatly reduced. GEF support is requested to assist Cuba during the internal process of sector transformation, and is deemed critical to reduce the indicated barriers.

Country ownership and drivenness

The Project responds to the priorities of the Ministry of Science, Technology and Environment (CITMA), the Ministry of Agriculture (MINAG), the Ministry of Energy and Mines, and the Ministry of Industry. Strengthening the renewable energy infrastructure and supply in the rural areas is a critical condition to increase food production and security, which is a key priority in Cuba's development policies. These priorities are also in line with the focus of Cuba's mitigation options on a greater efficiency and a better use of national energy resources, as indicated in its Initial National Communication (INC) to the United Nations Framework Convention on Climate Change (UNFCCC)[2]. Decentralized food and energy production also fits into the national plans to adapt to climate change. Governmental Groups for renewable energy development, which have an advisory task, have delivered a policy proposal (awaiting approval) for the development and utilization of renewable energy resources. This proposal provides a general framework under which more regulation for specific renewable energy technologies (RETs), including biogas and biodiesel, can be developed.

The high-level policy framework for the Project is set by the "Economic and Social Policy Guidelines of the Party, Government and State", approved by Cuba in April 2011. These Guidelines depict the priorities that will guide the socio-economic development of the country. Specifically, the policy aims towards "Longer-term sustainable development solutions that provide for a high level of food and energy self-sufficiency, an efficient use of the human potential and a high competitiveness in traditional productions, as well as the development of new goods and services of high value added". Key relevant priorities vis-à-vis this Project, are:

- Guidelines No. 113, Chapter III "External Economic Policy" of the mentioned guidelines declare priority on the use of international cooperation support for equipment and technology related to renewable energy sources, for the implementation of renewable energy technology applications.
- Guidelines No. 131, and 133, Chapter V "Science, Technology, Innovation and Environment Policy" prioritize: conservation and efficient use of land, water, the atmosphere, forests; conservation of biodiversity; and promotion of environmentally sustainable production methods.
- Guideline No. 247, Chapter VIII "Industry and Energy Policy" highlights the use of renewable energy technologies (RETs), including biogas, wind energy, hydropower, biomass, solar energy, and others. Priority should be given to RETs according to their economic benefits.

[1] The intervention strategy is designed considering the key elements necessary for successful technology transfer, as per UNFCCC's technology transfer framework: (1) technology needs assessment; (2) technology information; (3) enabling policy-level environment; (4) capacity building; (5) mechanism to facilitate institutional and financial support to technological cooperation, development and transfer. These elements were already highlighted by Cuba's Initial National Communication (INC) and will also be included in the Technology Needs Assessment (TNA) of the forthcoming Second National Communication (SNC).

[2] Please note that Cuba's Second National Communication (SNC) has been completed, pending revision and approval by the authorities. Work under the Third National Communication (TNC) has already started.

The proposed Project is further consistent with the Government program "Revolución Energética" launched in 2005[3]. The Project is also instrumental for implementing Environmental Law No. 81 (1997), and National Environmental Strategy 2011-2015[4], focused on the protection of the environment, conservation of biodiversity, and the rational exploitation of Cuba´s natural resources.

In December 2012 is enabled the Presidential Decree No. 3, that established the creation of Governmental Commission for elaboration of National Policy for the perspective development of renewable energy sources and energy efficient between 2014 and 2030. This policy was approved in June 2014 by Council of Ministries, this include the implementation schedule, and receive support from the National Parliament.

Country eligibility

Cuba is a signatory to the UNFCCC (signed June 13, 1992 and ratified January 5, 1993). The country is also signatory to the Kyoto Protocol (signed March 15, 1999 and ratified April 30, 2002)[5].

Alignment with UN Assistance Framework and UNDP Country Programme Document

The presented UNDP/GEF Project is aligned with UNDAF Outcome 5 and CPD Outcome 28: "Communities and key sectors develop and increase energy efficiency and use of renewable energy".

Country situation and development context

The Republic of Cuba is located in the westernmost of the Greater Antilles with a total area of 110,860 km^2. The main island, Cuba, is the fifteenth largest island in the world with an area of 104,945 km^2. The island of Cuba stretches from West to East over about 900 km, with a total coastline of 5,746 km. The population was estimated at 11,139,900 inhabitants (1998), with a density of 100.5/km^2. The mean annual growth rate is 0.42%. About 74.3% of the Cuban population is concentrated in 570 urban settlements[6], while 25.7% live in 6, 264 rural settlements. Cuba's climate is tropical and seasonally wet. The mean annual temperature varies between 24ºC in the plains to over 26ºC at the eastern coasts; at the highest point, mean temperatures are below 20ºC. The average rainfall is 1,300 mm annually in most part of the territory. Two seasons are recognised: the rainy season (May to October) and the "not very rainy" season (November to April). Approximately 80% of the annual rain falls in the first season. Tropical cyclones (TC) are frequent in Cuba: up to four TCs may hit the country in one season.

Environmental and climate issues

Many areas in Cuba suffer from soil degradation, salinization and desertification. Climate change scenarios indicate that the annual mean temperature could increase with 1.6-2.5°C in 2100. This temperature increase would exacerbate these, even if combined with increased rainfall. The most relevant factors affecting productivity are: the low content of nutrients and organic matter in the soil, limiting production levels to 50% of the reference value[7]; and acidity. The economic turmoil after 1990 aggravated land degradation, as large extensions of agricultural land were abandoned and subsequently invaded by aggressive spine plant varieties (*marabu* and *aroma*). About 65% of Cuba's agricultural land can be classified as degraded due to various processes, including land erosion (40%), compacting (24%) and salinization (15%), and acidification (26%). As a result, productivity of 19% of the land (1,618,900 ha) is considered as poor, and 47% (4,078,600 ha) as very poor. By consequence, yields are commonly below 50% of the potential value[8].

Climate change scenarios further predict a decrease of potential water resources, affecting all types of water uses, including for food production and human consumption. About 14% of the land exhibits arid conditions. In recent years Cuba has suffered long and severe periods of drought, with the largest impact felt in the central-eastern and the eastern parts of the country, affecting 47% of the national territory and 42% of the population. Moreover, the Cuban Environmental Agency anticipates for the year 2050 an increment of the sea level of 0.27 m at the coastline, and an

[3] A description of the main outputs of this program is presented in the next section.
[4] INC, Chapter II, caption 2.1
[5] Source: http://unfccc.int/.
[6] Of which 55 are cities (defined as places with 20,000 inhabitants, or more).
[7] Therefore, organic fertilizer ("bio-abono") is expected to play a key role in restoring degraded soils.
[8] Source: Cuba's INC, p. 2-19 and 2-23; and 9; and "Impacto del Cambio Climático y Medidas de Adaptación en Cuba", Planos, E., Rivero R., Guevara V. (ed.), Instituto de Meteorología. Agencia de Medio Ambiente (2013).

associated loss of 2.31% of land area. A number of 122 coastal towns and villages in Cuba, including beach resorts, would be severely affected or wiped out during the next decades. In response, the impact of rising sea water levels on the coastal areas is carefully studied, including local vulnerabilities and risks, and the effectiveness of sector programmes and territorial planning.

Energy sector[9]

Since 1959, Cuba embarked on an ambitious social and economic programme. The 1970s and 1980s were characterized by strong development, although often based on inefficient technologies. The total primary energy supply (TPES) in Cuba increased with 2.5% per year between 1970-1989, supporting fast social and economic development. During the 1990s, Cuba experienced a major economic crisis as a result of the termination of its favourable trade relationships with the CMEA (Council for Mutual Economic Assistance) countries. Cuba had to reduce its energy imports and for several years, energy demand could no longer be met. TPES fell by no less than 38% between 1990 and 1995, primarily due to the lack of hard currency for fuel imports[10]. Long blackouts hit the country, and especially industrial production contracted, as well as the sugar industry. The Government responded to the situation by implementing the Development Programme of National Energy Sources (DPNES) in 1993, which has been an important driving force for searching new energy solutions, creating energy professionals, and inducing behavioural changes in society leading to a more rational use of energy.

The energy sector reforms are framed into a national plan for sustainable development. In 1997, the National Environmental Strategy was approved and implementation was started in the main areas of the economy and services. The Strategy defines the principles of national environmental policy, identifies Cuba's main environmental problems, and proposes instruments to address them. It links environmental protection and the rational use of natural resources with the economic and social development of the country. Also in 1997, the National Assembly approved Law 81 on Environment, which creates the institutional and legal framework for managing the environment, including a national system of protected areas. Also, environmental licences became required for projects, works and activities, under the authority of the State Environmental Inspection. Environmental regulation now extends to the mining sector, forestry, and foreign investment, among others. The National Environmental Fund has been created for financing of projects and activities aimed at environmental conservation.

The reforms implemented after 1990 have resulted in a more reliable and self-sufficient energy system, contributing to economic recovery starting in 1994. The implemented changes include: (a) a major increase in the production of domestic crude oil and (since 1998) associated gas; (b) considerable reduction in energy demand through increased efficiency; (c) reduction of technical electricity losses; and (d) improvements in energy infrastructure. There has also been a gradual increase towards decentralized electricity production to supplement the obsolete large power plants. The reforms are accompanied by more rational energy use, more accurate estimates of the country's expenditures on energy supply, more independent regulation of the energy sector, and an increased emphasis on planning. Since 2000, TPES has stabilized at a value 44% below its peak year (1985) notwithstanding regained economic growth. This demonstrates the structural changes in the sector and the positive results achieved to reduce energy intensities.

Notwithstanding, national energy security remains vulnerable because of high dependency on imported petroleum and derived products. During 2005 – 2010, these imports represented 40-45% of total energy consumption and 43% of the total value of imports in Cuba during in 2010[11]. The introduction of renewable energy sources is still insufficient to keep up with demand growth; their share has actually declined from 17% to 12 %[12] over the mentioned period. Under the Governmental program "Energy Revolution", which has started in 2005, renewables were addressed by implementing a wind resource assessment programme (after which two commercial wind farms were built) and by demonstrating the use of vacuum tube solar water heaters in the country. Presently, a production facility for such systems is operational in the country. Positive is the decoupling of economic growth and energy consumption. While GDP raised 72% from 1997 to 2010, the total secondary energy consumption diminished to 61%. The contribution of the agricultural sector to the GDP has descended steadily from 13.7% in 1975 to 3.8 % in 2008. The sector's secondary energy consumption has increased

[9] For a comprehensive description of the development and changes in Cuba's energy sector, see, for example: "Cuba: A Country Profile on Sustainable Energy Development", ISBN 978–92–0–101708–6, International Atomic Energy Agency, Vienna, 2008.

[10] Decreases in domestic fuels were also observed in the same period for sugarcane biomass (55%), synthesis gas (49%) and hydropower (18%). Reduced gas production was caused by a diminished industrial activity. The hydropower reduction was a consequence of restrictions on the use of water to secure its use for the population and agricultural activities.

[11] The combined imports of food and petroleum products add to 55% of total imports in 2010.

[12] Excluding petroleum imports, renewable energy sources accounted for 31% of national energy sources in 2005 and 21% by 2010.

however, from 5% to 7.6% of the national energy consumption. Electricity and diesel oil are the two main energy carriers, with a share of 60.5% and 33.1% of the total energy consumption (2008) for the agricultural sector.

Food security

Food security is also vulnerable as Cuba relies heavily on food imports. Although decreasing, the value of food products in total imports was in the range of 18% (2000) to 13% (2009). Imported products include rice, milk, meat, and grain. To reduce this vulnerability, the Government is supporting a set of actions aimed at increasing national food production. Until the 1990s, the food production model was based on large agricultural and livestock companies owned by the State. As a result of the termination of Cuba's favourable trade relationships with the CMEA (Council for Mutual Economic Assistance) countries and the associated loss of income, most state-owned companies were socialized into different forms of cooperative ownership (these are currently local producers under decentralized local government oversight)[13]. Alongside these companies, independent farmers play an increasingly important role as national food producers. In 2011, non-state farms owned 75% of the dedicated land and produced 85% of the staple crops other than sugar cane (source National Statistics Office ONE, 2011), 68% of the pigs and 90% of the cows. These figures show the important role that the large number of private producers (typically involved in small and medium size farms) play for food production in Cuba. The approval of Decree-Laws 259 and 300 (2009 and 2012) on the distribution of unused land, and the Municipal Initiative for Local Development (2009)[14], which allowed payments in convertible currency to stimulate economic development in the primary sector, are supportive to the decentralization process as outlined and approved at the 6th Party Congress of April 2011.

Electricity sector

The electricity generating capacity in 2013 was composed as follows: thermal power plants (64.8%), fuel oil generators (18.2%), diesel engines (3%), natural gas associated to oil exploitations by ENERGAS (10.7%), cogeneration plants in the sugar cane industry (2.6%), small hydropower plants (0.6%) and wind farms (0.6%). In spite of a substantial reduction of oil imports compared to the early 1990s, Cuba's electricity sector remains largely dependent on fossil fuels and is characterized by high generating costs and low efficiencies. As of 2013 only 3.8% of the total electricity generation was obtained from renewable energy sources[15] . This rate has increased to 4.3% in 2014[16].

A substantial part (21%) of the total generating capacity is so-called distributed generation (DG): diesel and fuel oil generators connected to the distribution grid, or powering stand-alone grids. The total DG capacity in Cuba is 2,418 MW, of which 1,280 MW is diesel-based, 540 MW fuel oil, 529 MW sugar cane biomass cogeneration, and 75 MW other RETs (wind, solar, and small hydro). In addition, a diesel capacity of 600 MW is available as back-up power, mainly to secure electricity service for critical production processes and services. Faced with a lack of spare parts and investment capital to upgrade the large power plants, the modern DG systems introduced since 1995 restored and increased electricity service in the rural areas and small towns, and also have higher fuel efficiencies (thus lower operational costs) and a better environmental performance. Moreover, the introduction of fossil-based DG power systems demonstrates the strength of a decentralized supply structure, by avoiding transmission losses and creating redundancy and resilience in case of extreme weather events (especially the frequent hurricanes). The acceptance of DG as a new paradigm for the power sector paves the way for increasing the penetration rate of renewable energy technologies in Cuba.

Renewable energy technologies

The sugar industry continues to be a strategic sector for the development of domestic energy sources, given its potential for cogeneration. The hydropower resources in Cuba are small, but individual sites can be developed if technical and economic studies and evaluations of environmental impact demonstrate their feasibility. Solar radiation levels in Cuba are high, and PV systems have been introduced by social programmes for electrification of schools and to meet social objectives in isolated, mountainous areas. Wind energy has considerable market potential and the country has two small wind farms in operation. Depending on measurements to confirm the current potential estimate (700–1200 MW), its

[13] Legal figures for farmer groups in Cuba include: (i) UEB: Unidad Empresarial de Base (state-owned and operated); (ii) CCS: Cooperativa de Créditos y Servicios; (iii) UBPC: Unidad Básica de Producción Cooperativa (famer cooperatives with state-owned land in usufruct); and (iv) CPA: Cooperativa de Producción Agropecuaria (farmer cooperative holding the land).

[14] The IMDL: Iniciativa Municipal para el Desarrollo Local.

[15] Roughly ¾ of renewable energy is for heat production and only ¼ for electricity generation. This reflects the predominant use of biomass by the sugar factories in the total RE capacity.

[16] "Cuba apuesta por una energía más limpia, diversa y eficiente". www.cubadebate.cu August 14, 2014

development could be expanded with the participation of different industries. In addition, the development of biodiesel production from two plant species, *Jatropha curcas* and *Ricinus communis*, is being evaluated. This fuel can be mixed with diesel and can be used as a substitute for other diesel additives.

In 2013, Cuba counted a total of 31,125 installations based on renewable energy sources: 10,595 solar water heaters; 9,476 PV systems; 9,343 mechanical windmills for water pumping; 827 biogas systems (mainly small, traditional models); 647 brick kilns based on forestry biomass; 169 pico, micro and mini hydropower plants; 57 sugar factories producing steam and electricity using bagasse (470 MW); 7 PV power plants (7 MW); and 2 wind farms. Under the National Programme for the Development of Renewable Energy Resources[17], the number and size of modern RET systems in Cuba is expected to increase. On the other hand, an estimated 400,000 people in Cuba are still dependent on fuel wood for cooking, often using low-efficiency and polluting stoves – primarily affecting women's health. Many of these households have no access to the electric system[18], and are served by small diesel systems that operate only a few hours per day[19].

Economic and policy transformation

The approval of the "Economic and Social Policy Guidelines of the Party, Government and State" in 2011, initiated a process of economic transformations in Cuba covering, among others: (i) the approval of the new Foreign Investment Law; (ii) the establishment of a range of non-agricultural cooperatives[20]; (iii) allowance of self-employment; and (iv) issuance of Decree-Law No. 300 (2012), which expands the possibilities for delivery under usufruct of state-owned, idle lands areas to small farmers interested to exploit them. Since 2008, more than 1,580,000 hectares of idle lands have been handed over to small producers under Decree 259, benefitting approx. 170,000 persons. Decree 300 offers more flexibility, including the increase of the maximum land area per farmer from 40.3 ha to 67.1 ha. Out of a total agricultural area of 6,342,418 ha, roughly 1 million ha (16%) is classified as idle[21]. This process of idle land transformation is supported through projects to enhance productivity and sustainable exploitation. It should be noted that rural families who settle into the formerly unused lands face limitations in terms of energy supply and infrastructure, especially in remote areas.

The Guidelines (2011) also formalize the commitment of the Government to defer important functions to the municipal authorities. In 2009 a start was made with the implementation of the Municipal Initiative for Local Development (IMDL), led by the Ministry of Economy and Planning (MEP). Its goal is to support municipalities to develop and implement development strategies and generate surpluses to their own benefit through the exploitation of local resources[22]. This strategy is accompanied by: (i) a larger autonomy for state companies; (ii) the development of new business models, including land use under usufruct and lease, self-employment, cooperatives and small farmers; and (iii) different modalities for foreign investment. While focused at increasing food productivity and promoting sustainable economic development, these measures are also conducive to the decentralization process.

The Guidelines highlight a series of measures to stimulate economic development at the municipal and cooperative level, including: (i) the set-up of wholesale food markets with facilities and equipment for rent and operation by third parties (No. 9); (ii) the integration of market services into the national contracting system (No. 10); (iii) introduction of a local tax for companies and cooperatives, payable to the Municipal Administrative Councils (CAMs)[23] (No. 21); (iv) the establishment of new modalities for cooperatives (No.25-29); (v) conceptualization of agricultural and livestock activities such as food processing and services, to be initiated by the CAMs for increasing local food self-sufficiency (No. 37); (vi) financing for non-state business modalities (No. 53); (vii) a revised management system for the agriculture and livestock sector incorporating the increased share of non-state production modalities (No. 178); (viii) self-governance for cooperatives; and the introduction of local agroindustrial cooperatives (No. 180); (ix) urban and peri-urban agriculture (No. 205-6); (x) transformation of the agroindustrial sector (No. 207); (x) reorientation of industrial production to provide the necessary inputs to sustain small-scale production modalities and local industries (No. 217); (xi) local production of

[17] The "Programa Nacional de Desarrollo de las Fuentes Renovables de Energía".

[18] In total about 280,000 people, on a total population of approx. 11,000,000.

[19] Jiménez, O.; Curbelo, A. & Suárez, Y. 2012. Biomass based gasifier for providing electricity and thermal energy to off-grid locations in Cuba. Conceptual design. *Energy for Sustainable Development*, 16: 98-102.

[20] As of April 2014, already 452 cooperatives had been approved in a broad range of economic sectors: commerce, restaurants and services, construction, transport, industry, food, commercialization of produce from agriculture and livestock, renewable energies, and accountancy.

[21] Source: Ministry of Agriculture, Anual Balance 2013. See also the tables in Annex E.

[22] For more information, please consult: http://www.revistahumanum.org/revista/descentralizacion-gobernabilidad-local-y-desarrollo-humano-en-cuba-el-caso-del-municipio-el-salvador/#sthash.otyLRkmU.pdf

[23] CAM: Consejo de la Administración Municipal.

construction materials (No. 233); and (xii) modification of the business model for local industries, enabling elaboration of artisanal products, small series of consumer goods, and repair and maintenance services (No. 239).In the scope of the implementation of the "Economic and Social Policy Guidelines of the Party, Government and State", a Policy of the Future Development of Renewable Energy Sources and the Energy Efficiency was approved on June 2014[24].The policy is the result of a Governmental commission created by Presidential Decree on December 11, 2012[25]. The approved policy document recognizes the high costs of electricity generation, the high dependency on fuel imports and the negative environmental impact associated to the use of conventional fuels, and particularly to the fuel produced domestically. It in turn establishes that development of renewable energy sources is a fundamental approach to overcome this situation and aims to increase the weight of renewable energy sources in the electricity generation matrix from the present 4.3% to 24%.Development of renewable energy sources in electricity generation will be based mainly in the installation of 755 MW with surgarcane biomass, 700 MW photovoltaic and 633 MW eolic. Investments on electricity generation based on hydroenergy, agroindustrial residues and biogas have been identified.

Integrated rural energy production in Cuba

After 1990 the reduced availability of primary energy and materials had negative incidence on the agricultural system, which was based on intensive energy use and mechanization. This led to a remarkable reduction in food production. Large extensions of land could no longer be exploited, and were abandoned and successively invaded by ligneous weeds. This situation urged for alternative energy supplies to recover agricultural activity. One of the strategies to reconcile food production with energy security is to rely on local energy sources instead of imported energy carriers. The development of so-called bioenergy, or agroenergy, follows this concept. Agroenergy aims to combine food production and environmental conservation, opens new economic opportunities for rural communities; and provides alternatives to fossil fuels, thereby reducing the greenhouse gas footprint of agricultural activity. Different to the controversial, large-scale production of biofuels as a global commodity, the agroenergy farm is based on local productive cycles while respecting and improving environmental and social parameters.

Substantial work on the agroenergy concept is done by international organizations, including FAO, UNEP, UNDP, and the academic sector. In Cuba, the agricultural research institute "Indio Hatuey" (EEPF-IH) plays a leading role in this field and has conducted many studies and innovations aimed at the sustainable development of the Cuban agricultural sector, including the international project "Biomass as renewable energy source in Cuban rural areas" (BIOMAS-CUBA) with funds from the Swiss Cooperation and Development Agency SDC/COSUDE. The BIOMAS project started in 2009 with integrated food and bioenergy production in rural areas in Cuba, based on the agroenergy farm concept. The agroenergy farm encompasses a "productive system in which technologies and innovations for integrated food and energy production are developed, improved and evaluated, the generated energy being used to increase food production within the farm boundaries, with the goal to improve quality of life in the rural areas and preserve the environment"[26].

Within the framework of the BIOMAS project several production models have been developed based on this concept: (1) small farms for animal breeding equipped with anaerobic biodigesters; (2) a medium-size pig farm using anaerobic biodigester technology for effluent treatment, distributing biogas to the rural village; (3) private farms and one state farm producing *Jatropha curcas* for biodiesel production, in combination with short-cycle food crops and animal breeding; (4) a sawmill equipped with a biomass gasifier for electricity generation; (5) a mixed farm equipped with various renewable energy technologies, including a gasifier based on agro-forestry residues, biodigesters, water pumping windmills, solar water heaters, and Jatropha production. The second phase of the Project (2012-2016) will add new energy uses, including gasification of rice husk and rice stalk residues, usage of biogas for household refrigeration and cooking, irrigation, electricity generation, and the use of biodiesel in agricultural machinery.

The pig farming sector represents an important opportunity for integrated food and energy production through biogas production. It is a prioritized economic sector in Cuba and a major domestic supplier of high-quality proteins. As of December 2013, the state-owned Grupo Empresarial Porcino (GRUPOR) held 132 production centres totalling 556,000 animals[27]. Moreover, 92% of feeding is done by small- and medium-scale, private producers, which hold about 481,300

[24] "Cuba apuesta por una energía más limpia, diversa y eficiente". www.cubadebate.cu August 14, 2014

[25] This Commission is chaired by a Vice-President of the Government and integrated by 8 entities of the Central State Administration, 6 universities and the Permanent Commission for the Implementation and Development of the Guidelines of the Party and the Revolution.

[26] For more information, see: Suárez, J.; Martín, G. J.; Sotolongo, J. A.; Rodríguez, E.; Savran, Valentina; Cepero, L.; Funes-Monzote, F. R.; Rivero, J. L.; Blanco, D.; Machado, R.; Martín, C. & García, A. 2011. Experiencias del proyecto BIOMAS-CUBA. Alternativas energéticas a partir de la biomasa en el medio rural cubano. *Pastos y Forrajes*, 34 (4): 473-496.

[27] Of this total, 86 are breeding centres, 10 for reproduction, 12 for fattening, 13 for genetics, and 11 are integrated establishments, which cover the

animals under contract with GRUPOR (see Annex E). Both production chains are emitters of organic effluents contaminating the surface and groundwater systems, as well as large amounts of greenhouse gases. In the 1980s Cuba introduced technologies for manure treatment in large farms; later, small, traditional biodigesters were used by cooperative farms and small producers to produce biogas for cooking of animal food. While aerobic lagoons exist for manure treatment in some state farms, these do generally not perform as expected.

Involvement of UNDP

UNDP has identified renewable energies and energy efficiency as a key area of the development of the Country. As such, it was included in the Country Programme Document 2008-2012 and is defined as a stand-alone outcome in the CPD for the 2014-2018 period[28]: "To 2018- Communities and key sectors develop and increase energy efficiency and use of renewable energy".

In 2011, UNDP worked with Cubaenergía in the implementation of the project "Carbono 2012" financed by the Government of Spain, with the objective of promoting adaptation and mitigation of climate change, energy and the environment. Under this project Cubaenergía's technical capacities were strengthened, and three studies identifying opportunities for small-sized CDM projects in Cuba were conducted. One of these studies was related to the potential for energy use of residuals from porcine and rice producing entities as well as timber producing companies. These studies generated preliminary data in terms of feasibility studies for generation of biogas from such residuals.

In 2012, the EU and SDC-funded project "Bases Ambientales para la Sostenibilidad Alimentaria Local" started with the objective of supporting adaptation to climate change in the agricultural and livestock sector at the local and national level. Energy is one of the lines of action in this project, which is also led by Cubaenergía. The project supports comprehensive, closed-cycle energy analyses at the enterprise level and at the municipality level, in order to promote energy efficiency. The project further promotes the use of residues for energy generation. This project is implemented in three municipalities in the country (Los Palacios, Güira de Melena and Jimaguayú), each one of them having different characteristics in terms of primary productive activity (rice production, staple crop and grains production and milk production, respectively).

Since 2005, UNDP has worked at the community level on energy-related issues through the GEF Small Grants Programme (SGP). SGP-funded projects include electrification of isolated households and other buildings, and the installation of pumping devices using sources of renewable energy. The SGP supported early initiatives in Cuba to promote the use of tubular biodigesters in the country. To date, 43 biodigestors are installed and it is planned to install another 763 units. The SGP also provided initial support to *Jatropha curcas* plantations in Guantánamo,specifically to extract oil from the shrubs and promote the recovery of degraded lands.

Problem statement

The overarching problem is Cuba's vulnerability in terms of food and energy supply, which exists at both the national and the local level. Food and fossil fuel imports make up a large share of total imports, thereby putting a large burden on the fiscal budget. Moreover, adverse environmental phenomena including desertification, salinization, and severe droughts affect the country's natural resource base, which are aggravated by global climate change. In response, the Government has identified measures to preserve natural resources, foster food production, mitigate the impact of climate change, and strengthen resilience of local communities and livelihoods. These measures are framed into a national transformation process towards a more decentralized economy and administrative structure.

Specifically, increased food and energy production has been declared a national priority to reduce vulnerability, create more resilient communities and contribute to improving quality of life of the rural population while preserving environmental and biodiversity values. One approach towards this goal is through the concept of the agroenergy farm. The benefits of this concept are highlighted by, among others, the FAO[29], and are closely studied in Cuba by EEIH and universities. The primary energy source from which to take benefit is renewable biomass. In the Cuban context biogas and biodiesel are particularly relevant. The SDC/COSUDE-funded programme BIOMAS has yielded positive experiences with the application of this concept[30]. Integrated food and energy production also fits into the transformational process in Cuba towards a more decentralized economy, which is supported by a stronger mandate for the municipalities.

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full life cycle.

[28] For the CPD 2014-2018, please consult: http://www.cu.undp.org/content/cuba/es/home/library.html

[29] Bogdanski, Anne; Dubois, O.; Jamieson, C. & Krell, R. 2011. Making Integrated Food-Energy Systems Work for People and Climate: An Overview. FAO, Rome, 136 pp.

[30] Suárez, J. & Martin, G. (Eds.). 2012. La biomasa como fuente renovable de energía en el medio rural: La experiencia de BIOMAS-CUBA.

The specific problem statement can be formulated as follows: "Replication and up-scaling of integrated food and energy production by rural farmers in Cuba is impeded by: (i) the lack of adequate designs, materials, and production facilities, by (ii) low levels of awareness among decision makers, and by (iii) inadequate institutional support structures for outreach, maintenance, promotion, and finance." The BIOMAS programme pointed out that a number of barriers are in place hampering the production of biogas and biodiesel plants in Cuba. For biogas the main barrier is the unavailability of modern materials in the market, including plastic liner for biodigesters (so-called "geomembrane"). The national industry would need investment in production lines (equipment) to produce such materials, as well as the corresponding know-how, and technical assistance for optimization and quality assurance[31]. With respect to biodiesel technology, designs and would need to be down-scaled for farm and community use[32], tested and transferred to national metal-mechanic industries. Access for manufacturers to imported raw materials and equipment relies on Government authorization to allocate currency reserves, which highlights the importance to create awareness at the decision-making level. There is limited knowledge and understanding among policy makers. This can be addressed by demonstration of successful agro-energy farms and providing information and tools for decision-making, to policy makers. This also applies to the lack of available appliances for biogas usage, including adapted burners, gas lights, and absorption refrigerators[33].

The baseline programme does not address institution building for outreach, technical support, knowledge management, and promotion. Moreover, there is a void to be bridged between the existing institutional framework and local energy development. The recent creation of the Ministry of Energy and Mines (MINEM) is a first, important, measure taken by the Government to improve sector governance. Meanwhile, EEIH and Cubaenergía have taken the lead to support the introduction of the agroenergy concept at the lowest level (farmers)[34]. Within this context, an increased supportive role for the municipalities is envisaged, in line with their strengthened mandate.

Baseline project

The baseline project consists of decentralized initiatives to support food production by small and medium-scale private farmers and make a start with local bioenergy production, specifically biogas and biodiesel. These initiatives are sustained with financial and institutional support from international donor organizations, and from national sector institutions. Simultaneous to increasing local agricultural output, an effort is made to make production chains more sustainable and to revert soil degradation processes. While encouraged by the national Government, it must be noted that these initiatives operate locally. Field experiences and consolidated knowledge and information on bioenergy production technologies, and their application in the context of Cuba, is needed. Once available, the central Government can benefit from this knowledge to devise supportive technology transfer and development policy instruments.

The baseline project is led by the “Centre for Information and Energy Development – Cubaenergía” and the agricultural research institute “Estación Experimental Indio Hatuey - EEIH”. Cubaenergía is a unit within the Ministry for Science, Technology and Environment (CITMA) and acts as a knowledge centre for the Government. EEIH is a renowned agricultural research and development centre ascribed to the Ministry of Higher Education (MES). Both institutes work closely with international donor agencies, specifically the Delegation of the European Union in Cuba, the Swiss-based agency SDC/COSUDE[35] and UNDP, in a number of projects targeting energy and food supply technologies by the rural sector[36].

Within the framework of the BIOMAS I project, implemented by EEIH and financed by SDC/COSUDE, a *Jatropha curcas* plantation combined with food crops is being developed near Guantanamo, in the eastern part of the island. This experience is presently being replicated in a second area. The experiences from BIOMAS-I confirm that local energy

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Estación Experimental “Indio Hatuey”, Matanzas, Cuba, 216 p.

[31] Please note that conventional construction materials for biodigesters are demanded by other sectors in Cuba, primarily housing programmes. By consequence, their availability for other uses is very limited. Modern materials such as flexible geomembrane not only allow designing more appropriate and cost-effective biodigesters, but also reduce the dependence on resources competed for by other sectors.

[32] Typically down to a production rate of 100-400 litre of biodiesel per day.

[33] It is noted that national production is preferred in Cuba for several reasons, such as: (i) its potential to add economic value, (ii) local job creation, (iii) preservation of foreign currency reserves; and (iv) reduced dependence on foreign suppliers. Notwithstanding, proposals for national production are submitted to a review process to verify economic justification.

[34] Suárez, J. & Martin, G. (Eds.). 2012. La biomasa como fuente renovable de energía en el medio rural: La experiencia de BIOMAS-CUBA. Estación Experimental “Indio Hatuey”, Matanzas, Cuba, 216 p

[35] SDC/COSUDE: Swiss Agency for Development and Cooperation.

[36] The donor initiatives are coordinated by the Government of Cuba (MINCEX) and implemented with support from EEIH. UNDP has played an important channel for bilateral and multilateral agencies to coordinate and/or implement individual initiatives and programmes, and UNDP will continue playing this role.

supply effectively increases food production; and that the integrated, local production of food and energy enhances the economic and environmental feasibility of agricultural production chains. These positive impacts induced COSUDE to prepare a second phase.

The BIOMAS-II project[37] aims at transforming the pilot experiences from Phase I into municipal development strategies for integrated food and energy production and to establish direct links with national energy policy. This project is also implemented by EEIH in coordination with partner institutions in six (6) provinces[38]. Parallel initiatives are the AGROENERGY and CO-INNOVATION projects, jointly executed by EEIH and OIKOS[39]. All projects rely on inputs from the participating municipalities and from EEIH and the Government. The donor initiatives are coordinated by the Ministry for Foreign Trade and Investment (MINCEX), which has the national mandate of overseeing international cooperation, and are implemented with support from EEIH. UNDP has played an important role as a channel for bilateral and multilateral agencies to coordinate and/or implement individual initiatives and programmes, and it will continue to do so. This set of national and donor initiatives constitutes the baseline programme targeted at testing and implementing small-scale bioenergy technology systems integrated into small and medium-size farms; and demonstrating its potential to all stakeholders, including policy makers.

Specifically, the baseline project consists of the following: (a) institutional activities by EEIH in the field of research and outreach of agroenergy, as well as capacitation (US$ 2,034,900, of which 1,835,300 cash and 199,600 in-kind); liaison and policy support by Cubaenergía (US$ 50,000 in-kind); participatory processes to develop and implement local agroenergy strategies under leadership of selected municipalities; and baseline production assets and personnel, by manufacturers, combined (US$ 6,130,877 cash and in-kind); and financing of baseline activities under agroenergy pilots, by donor programmes from bilateral agencies SDC/COSUDE, and EU/Oikos both implemented by EEIH (US$ 11,683,332, of which7,706,870 cash and 3,967,462 in-kind[40]). UNDP has committed US$ 50,000 in cash TRAC funding to support strengthening of the institutional framework.

Identified barriers and rationale for GEF involvement

Policy and regulation barrier

While the development of renewable energy sources has been declared a priority in the Economic and Social Policy Guidelines, specific policy has only been issued to foster energy production by the sugar factories. A first measure involves a price setting for solid biomass (from shrubs) for power generation in the sugar industry outside the harvest season. A second measure is a special tariff (with a component in convertible currency) established for the net supply of electric energy by sugar cane factories to the national power network. An articulated programme to encourage innovative RETs is still lacking; this particularly holds true for biomass energy resources. The introduction of energy crops such as Jatropha to recover degraded land is now accepted in Cuba, as well as the application of intercropping schemes. Specific policy to promote the production and commercialization of bioenergy by private farmers is not in place[41]. There is a need to clarify and detail ownership, operation and financing modalities for rural energy (and food) production, which effectively involves the choice of a business model for the rural farmers. Such a choice should be based on social, economic, and technical analyses. The potential of bioenergy production to compensate environmental externalities can be included in such analysis.

Technology barrier

Notwithstanding substantial progress in recent years, the uptake of agroenergy in Cuba is hampered by a constrained technological resource base. In the case of biogas and biodiesel, limitations have been identified in the field of: (i) access to biogas digestor technology, auxiliary equipment and biogas appliances; (ii) availability of materials to construct modern digestor designs; (iii) biodiesel production facilities; (iv) availability of high-quality plant varieties for vegetable

[37] COSUDE Project No. 7F-06169.02, "BIOMAS Phase II – Biomass as a renewable energy for the rural area", to be implemented between April 2012 and 2015 with a budget of CHF 5,215,000.

[38] The provinces are: Matanzas, Sancti Spíritus, Las Tunas, Granma, Holguín y Guantánamo.

[39] A non-governmental organization based in Portugal. Funding for the Agro-energy and Co-innovation projects is obtained under European Commission Programmes.

[40] In-kind is the portion of equipment and infrastructure that were acquired/installed by BIOMAS I that has finished yet legal property has been transfered to BIOMAS II

[41] An overarching issue concerns the lack of a well-developed framework for contractual arrangements between private parties and the State, (including intellectual property rights facilitating modalities for technology transfer).

oil production, which is the basis material for biodiesel production; and (v) theoretical and empirical knowledge about integration of agroenergy technologies into rural production systems and communities.

Practical experience with biodigesters in Cuba is mostly limited to the fixed and floating dome technologies[42] but there is also some experience using tubular digesters from imported PVC to produce biogas. More recently, a national manufacturer has produced some test units of tubular EPDM digesters with volume of 10 m^3. The primary target group consists of small, pig raising farmers. This biodigester type is cheap to produce; several units can be placed in parallel to process the dung of up to 100 animals. For larger establishments, this becomes unpractical. Since environmental legislation in Cuba demands treatment of waste flows from animal farms[43], modern biodigester designs such as covered lagoons would have a large market. However, the materials for producing this type of digestor are not available in Cuba.

This barrier is closely linked to the lack of industrial capacity in Cuba to produce synthetic geomembrane liners. The production limitations for non-flexible foils (such as HDPE and PVC) are mainly size (width) and quality. Presently, smaller sheets are bond together and vulcanized, which is labour-intensive and an impediment for faster production and up-scaling. This procedure further requires careful checks to ensure that all bonds are perfectly sealed. Lagoon-type biodigesters require larger sheets of flexible material, such as EPDM, which is presently not produced in Cuba[44]. This barrier can be addressed by upgrading production facilities in chemical (plastic and rubber) industries in Cuba, product innovation and adequate quality assurance.

At the incipient stage of biogas usage in rural Cuba, specialized or adapted appliances to benefit from the biogas produced are extremely rare. These include cook stoves and furnaces with suitable burners, gas lights, (absorption) refrigerators, and generator sets. Manufacturing of such devices can be done in Cuba, but specific components must be adapted or imported. Within the concept of the agroenergy farm, it is sought to maximize the usage of the available biogas resource and extend it to as many energy services as possible, thereby minimizing the dependence on centrally generated (non-renewable) energy. The adaptation of appliances and their demonstration at farm and community level is envisaged to alleviate this barrier.

Technologies for large-scale biodiesel production available abroad are not well suited for use in the context of agroenergy farms, which require small-size, yet efficient, conversion units with typical outputs of 100-400 litre/day. Under the BIOMAS-I Project, a first demonstration biodiesel plant, based on trans-esterification technology, was installed in Guantanamo. This plant is now fully operational. Given the limited use -and by consequence availability- of methanol within Cuba, biodiesel production based on ethanol would be more convenient and cost-effective, moreover given Cuba's large production of sugar cane. In order to disseminate this technology in Cuba, national industries would need access to this technology and invest in production lines to manufacture at least part of the equipment locally. Other business qualities would also need strengthening, including product testing and quality control, and the delivery of support services for the owners and operators. A specific technological barrier related to biodiesel production is further the absence of a certified production system for non-edible vegetal oil crops, including *Jatropha curcas*. While field experiments are conducted by EEIH and rural farms, the availability and distribution of certified seeds are critical to sustain the widespread introduction of small-scale biodiesel technology.

Experts within EEIH and universities in Cuba contribute to the global knowledge base in this field with scientific research and publications[45]. Empirical work in rural communities provides strong indications that the combined production of food and energy actually leads to higher production at a reduced energy-intensity, while strengthening environmental, biodiversity, social and economic factors that improve overall resilience. However, more research is needed to test this hypothesis under different conditions, and to improve methodologies to assess overall impact. Integration of agroenergy technology extends to the adaptation of energy solutions and designs to user's demands and capabilities, which is critical to ensure successful operation and maintenance. Finally, the production and usage of by-products, including bio-fertilizers and glycerine, requires further investigation.

Information barrier

Departing from a centralized organization of the power sector, policy makers need to get acquainted with the potential of renewable, local energy resources before they will consider them as a viable and relevant alternative. During the last decade, Cuba has set major steps with respect to the implementation of energy efficiency technologies, wind energy, small

[42] The Chinese (fixed) and Indian (floating) dome models are examples of "appropriate technologies".
[43] Ley 81 de Medio Ambiente y Estrategia Nacional Ambiental 2011-2015.
[44] EPDM = ethylene propylene diene monomer.
[45] For a list of relevant sources, please consult "Biomas" publication. Some work has been funded under BIOMAS-I project.

hydro and solar photovoltaic systems. There is still an informational void concerning bioenergy resources and technologies. Within the Ministry of Science, Technology and Environment (CITMA), Cubaenergía plays a pivot role to provide information to high-level decision makers and coordinate with designated sector institutions (including EEIH). However, there is a lack of capacity and information tools (specifically: ICT-based data applications) to access and analyse relevant information, produce scenarios and assist policy and decision makers in their work.

Moreover, consolidated baseline information with respect to small-scale biogas and biodiesel production in Cuba is hardly available. Estimates exist for selected economic sectors with large-scale enterprises, including the sugar factory (bagasse) and the large, state-run pig and poultry farms. For an integrated approach at municipal or farm level, such information is not available. In addition, abandoned land has been given in use to small private farmers[46] with the aim to revert land degradation and increase food production. The physical properties and potential for agriculture of these land areas are poorly characterized. Among others, intercropping of food and vegetable oil crops (primarily Jatropha and Neem) is devised as a strategy for such farmers; small-scale energy plantations are another option[47]. Positive results have been made by EEIH and the pilots under the BIOMAS-I project, which are operational.[48] However, a systematic evaluation combined with additional field data is needed to forecast the bioenergy potential in these areas[49]. Such an effort needs to be supported by parallel research into the composition and quality of soils, water availability, sloping, etcetera, at municipal level.

There is further ample scope to improve access to relevant information for end-users (farmers). Besides producing appropriate information carriers (leaflets, manuals, instruction films, electronic media), this involves strengthening the institutional structures and human capacity to reach the target beneficiaries (see next paragraph).

Institutional and human capacity barrier

In the baseline situation, state and municipal institutions are not prepared to promote and implement cost-effective bioenergy solutions, integrated into small-scale agricultural farms. EEIH, supported by SDC/COSUDE´s BIOMAS project, is the leading entity in Cuba with specialization in the subject. It is envisaged to further strengthen its capacity to act as the expertise centre for bioenergy in Cuba. However, a full-fledged structure for outreach and promotion, project development and after-sales support is not in place yet. The municipalities are envisaged to play a stronger role to initiate and support local economic development (including energy security at community level), but this is a long process as part of the transition towards a more decentralized development model in Cuba. Support to small farmers is also outside the scope of the traditional energy sector institutions. As such, their staff is not trained in the field of small-scale biogas or biodiesel technology, and not familiar with the concept of the agroenergy farm. However, positive experiences in the field of rural electrification have been achieved by setting up a decentralized structure of community-based technicians who are trained to maintain and supervise clusters of energy systems (PV and small-hydro) and report anomalies to a central support unit. A similar approach may be followed to support bioenergy development at community level.

In the industry, engineers have basic knowledge of renewable energy technologies but their expertise to design and implement biodiesel and biogas systems is limited. There is also limited knowledge and hands-on experience concerning clean agro-industrial processes, which is particularly relevant for (small- and large-scale) pig farming, poultry farming and sewage water treatment. National manufacturing industries have virtually no expertise with the design and production of biogas and biodiesel equipment; by consequence, personnel lacks basic knowledge and competences. The current institutional framework for technology transfer exhibits the following weaknesses: (1) incomplete technology needs assessment; (2) lack of access to latest technology information; (3) inadequate technology-oriented regulation; (4) insufficient capacity to provide adequate support to stakeholders; and (5) weak mechanisms or procedures to encourage and facilitate cooperation and technology development and transfer. The preparation and implementation of rural energy systems demand new roles and/or actors: (i) renewable energy project developers; (ii) suppliers of equipment, such as bio-digesters, biogas systems, biodiesel plants and appliances; (iii) skilled installation and service personnel; and (iv) agronomic experts knowledgeable in integrated energy production.

[46] Under Decree-Law No.299 and its successor No.300 (2012).
[47] Under the BIOMAS-I project, approx. 100 ha of Jatropha curcas was successfully planted in a degraded area in Guantánamo.
[48] See BIOMAS publication, pp. 101-104.
[49] At municipal level and ultimately for the whole territory.

Financial barrier

Financial barriers are faced at all levels in Cuba. To some extent, these can be mitigated through high-level policy by assigning financial resources to relevant industries and sectors. However, prioritization is hampered by the absence of input data and methodologies to assess the economy of bioenergy applications, including: (i) quantification of its full benefits for end-users and national industries, as well as avoided externalities; (ii) forecasting of attainable cost reductions, efficiency gains, and scale benefits; and (iii) demonstration of technical maturity. Such analysis may extend to local bioenergy markets, including aspects such as the availability of suitable land for bioenergy production, logistics and commercialization of bioenergy products and by-products. Based on a more profound insight in the benefits of local energy generation, the Government may decide to provide financial incentives to rural farmers to accelerate market introduction of bioenergy technologies.

Access to foreign capital is a major barrier for Cuba; therefore, international cooperation programmes are an important source of financing to trigger development, especially in the rural sector. However, additional capital investments must be leveraged to support market growth. Farmers are highly motivated to get access to this technology and often able to finance low-cost solutions themselves, given the expected improvement in quality of life and income as a result of stable energy supply. Other beneficiaries such as larger pig farmers would need to invest more heavily in biodigester technology to comply with regulation of agro-industrial effluents. However, they are usually not in a position to take full advantage of the biogas produced and would benefit from mechanisms to supply other people. Financial incentives may be devised to cover remaining cost barriers after a process of reducing investment costs and optimizing business models for larger bioenergy producers. More detailed and quantified information is needed before deciding upon such incentives.

Long-term solution

The barrier analysis indicates that all types of barriers exist impeding the rapid deployment of bioenergy systems among small farmers in Cuba. At the present stage of market introduction, the key barriers are: (i) the lack of technical know-how and appropriate biogas and biodiesel system designs to serve a variety of end-users; (ii) the inadequate industrial capacity to produce such systems; and (iii) the weak local and national institutional capacity to implement such systems, including training of human resources. These barriers can be addressed in a limited time-frame by targeted support interventions. For medium-term market development, additional barriers are found in place which are partly systemic: (iv) the low level of prioritization of small-scale bioenergy, as its benefits and potential are not fully acknowledged at the decision-making level; as a result, few industrial, institutional and human resources are directed to this market; (v) the lack of financial capital for investment in bioenergy development; and (vi) the lack of detailed data supporting bioenergy development (including energy demand and resources at municipal and farm level, soil characteristics, water supply, empirical knowledge of combined food-energy production systems) which is an impediment for policy design and the optimization of energy solutions. While a contribution can be made to address these barriers, their full removal will take a longer process to strengthen governance of local economic development and increase resilience of rural communities.

The proposed solution is to upgrade the technological know-how and industrial capacity in Cuba for designing and manufacturing small-scale bioenergy systems, and to increase the know-how for integrating such systems into rural agro-businesses. By successful demonstration, and by making available factual information and data, supportive policies and incentives can be fine-tuned to the targeted beneficiaries. Building upon initial experiences under the baseline project, the actors involved in the value chain need to be strengthened and coordinated to deliver and sustain energy solutions. Given its track record in the subject, EEIH has been assigned as the national entity to lead this process, thereby closely interacting with Cubaenergía (CITMA).

STRATEGY

Project rationale

The rationale behind the proposed UNDP/GEF Project "Clean Energy Technologies for the Rural Areas in Cuba (CleanEnergy-Cuba)" is to reduce global GHG emissions by increasing access to biogas and biodiesel technology for the large group of small agriculture and livestock farmers in Cuba. The Project will be instrumental to assist the Government to design and articulate national policies to increase the use of agroenergy technologies, which is aligned with the prioritization of other energy technologies and energy conservation by the national Government. In this respect, the Project aims to assist Cuba to further diversify its energy matrix by demonstrating the relevance and benefits of small-scale bioenergy sources to policy makers. While other renewable energy technologies are fairly well known in Cuba, this is much less the case for small-scale bioenergy.

The Project builds forth on baseline activities initiated by EEIH and Cubaenergía, supported with funding under international cooperation programmes. During the PPG phase, the Project proponents have worked towards the involvement of higher-level authorities[50]. Direct involvement was further sought from metal-mechanical and chemical enterprises, after a process of selection and short-listing of candidate manufacturers for biodiesel installations and synthetic geomembranes, respectively. Through the corresponding state business clusters, these companies have committed their support to the Project and will be one of its key beneficiaries. These steps have contributed to increase the profile of the Project to a higher political level, compared to PIF stage.

The baseline activities are hampered by several barriers, which are primarily related to the inadequate manufacturing capabilities to deliver bioenergy systems to meet the market potential; the lack of technological know-how to adapt plant designs and appliances to local market conditions; the lack of experience with the integration of such technology in agricultural production systems; the scarcity of appropriate appliances for use with biogas and biodiesel in Cuba; and the incipient institutional framework to support rural farmers with the implementation of energy solutions and to increase economic productivity. In fact, there is a need to clarifying roles and responsibilities along the whole value chain, bearing in mind the overall context of the transformation towards a more decentralized economy which is currently taking place.

The chosen approach is therefore to build upon capacities at farm and community level, strengthen these where necessary, and combine these into supportive platforms at municipal level. EEIH will act as the overall expertise centre and will oversee the capacity building process, to start in a small number of selected municipalities. This approach is comparable to that followed by earlier energy interventions in the rural areas in Cuba[51]. The link with the policy-making level is established by strengthening of Cubaenergía, which is located within CITMA. Considering the incipient stage of market development for biogas and biodiesel in Cuba, the Project is presented under the GEF-5 focal area CCM, Objective 1.

Project goal and objective

The objective of the Project is to increase access to bioenergy technology in Cuba by promoting the use of biodiesel and biogas technologies by rural farmers. This will be achieved by supporting a process of technology transfer. This will contribute to the reduction of greenhouse gas emissions from fossil fuels used for electricity production, transport and cooking[52].

The project will complement and enhance the baseline project activities by providing technical assistance to key sector stakeholders. The project focuses on three main aspects; (a) strengthening the national technology basis -including manufacturing capabilities- for the successful design and production of biogas and biodiesel installations in compliance with applicable quality standards; (b) strengthening the institutional framework and human capacity for delivery of energy solutions to the target group of beneficiaries (small farmers), and ensuring adequate project design, installation, operation and after-sales services; (c) complementing available information and knowledge on bioenergy usage in rural farms in Cuba, thereby establishing a strong case for policy makers and other stakeholders to mobilize investment for further market development.

The GEF intervention will significantly strengthen the present industrial capacity to produce synthetic membrane material for biodigesters, and will set up a production line for biodiesel plants. It will support baseline initiatives by EEIH and

[50] Including the Ministries of: Energy and Mines (MINEM); Agriculture (MINAG); Industry (MINDUS); Higher Education (MES); Economy and Planning (MEP); and Science, Technology and Environment (CITMA).
[51] Including PV-based electrification coordinated by Cubasolar.
[52] Additional greenhouse gas reductions are expected to occur in agroenergy farms by closing nutrient cycles, more effective use of water resources, and carbon sequestration in reclaimed lands.

SDC/COSUDE, and establish an expertise centre on bioenergy within EEIH. It will further demonstrate the technical viability of national manufacturing, and the installation and operation of biogas and biodiesel systems in small farms, and it will extract lessons learnt through ongoing monitoring. This information will feed into baseline research work done by EEIH staff (funded by national resources and the SDC/COSUDE BIOMAS project). The total project budget is estimated at US$ 22,657,810 for which a grant US$ 2,737,524 is requested from the GEF. Total co-financing amount to US$ 19,949,107.[53]

The Project will pursue its objective through the following components, which are described in detail in the next sections:

I Information and policy development;
II Biodiesel and biogas technology transfer and development; and
III Institution building, training and promotion.

Project components:

Component I. Information and policy development.

Outcome 1: Policy instruments supportive of small-scale bioenergy development have been formulated and recommended for approval. (GEF US$ 246,000; co-finance US$ 525,500). The objective of this project component is to create a solid information base about bioenergy potential and opportunities in the rural areas in Cuba, and provide inputs and recommendations to policy makers based on analysed data and realistic market penetration scenarios for bioenergy technologies. Work under this component will be focused on small and medium-size farms in Cuba under the concept of integrated food and energy production, in which energy is generated for self-supply and/or local distribution. The supporting studies and analyses performed under this Component will feed into a policy concept (a "green paper") for consultation with involved stakeholders, including local actors; this concept will be used to formulate a national bioenergy strategy. It will further provide suggestions and recommendations for enhancement of the regulatory framework to foster biogas, biodiesel, and other bioenergy options. In the end-of-project situation, decision makers are expected to have access to detailed sector information and advice for establishing a conducive regulatory framework for small-scale bioenergy applications, including climate change policy instruments such as Nationally Appropriate Mitigation Actions (NAMAs).

Output 1.1. Collection and analysis of information concerning the economic, production, social, gender and environmental aspects of integrated food and small-scale bioenergy production by rural farmers. This output has the objective to characterize in detail the opportunities and constraints for integrated food and small-scale bioenergy production in Cuba. Cubaenergía will lead the work, with support of MINAG, ONEI and ANAP. Information will be collected from existing databases as well as the conducting of specific surveys to farmers and other national and local strakeholders. The scope of the work will extend to economic, social, gender, agricultural and environmental aspects of integrated food and small-scale bioenergy production by small- and medium-scale farmers. Constraints such as water availability, soil quality, as well as adverse effects such as land degradation, desertification, salinization and droughts will be considered as part of this assessment.

Output 1.2. Information tools to design, implement and monitor national bioenergy policies and strategies. This output pursues developing tools for: (i) the collection of data about the potential and current usage of bioenergy sources at municipality level; and (ii) the evaluation of bioenergy energy resources based on suitable methodologies. These tools will be implemented using appropriate technological solutions to facilitate access to information on bioenergy technology (as collected under Output 1.1) at an aggregated level, including technical key figures, typical applications, cost levels, main economic parameters and associated benefits, including GHG reduction potential. It is envisaged to produce appropriate ICT-based tools such as databases, maps and reports for implementation. This output will assist in consolidating information which is presently not collected, fragmented, or difficult to access. The proposed tools will support MINAG and ONEI to perform more adequately their role to collect, analyse and publish primary statistical data, in line with its mandate. Strengthened baseline information and monitoring capabilities are deemed critical for attaining continued GHG emission reductions by the sector and therefore a necessary condition to implement climate policy instruments, such as

[53] Please refer to the section Baseline Project for a detailed description of the cofinancing resources for the Project.

Nationally Appropriate Mitigation Actions (NAMAs). GEF funding will finance international consultancy, travel, contractual services to national companies, IT equipment, training and workshops.

Output 1.3. Updated assessment of the technical and economic potential for biodiesel and biogas production and usage in small-scale agriculture and livestock farming. This output will deliver a detailed analysis of the data collected (under Output 1.1), resulting in an accurate and updated assessment of the technical and economic potential for the selected bioenergy technologies (biogas and biodiesel). The assessment shall envisagedly cover the national potential and include small- and medium-scale farmers in all relevant sectors (traditional agriculture, pig farming, dairy farmers; as well as innovative agroenergy farms). A set of market growth scenarios will be identified as a basis for bioenergy potential prognoses. The assessment will consider several modalities for utilization of the bioenergy produced, including the use of biogas in agricultural machinery, local distribution of biogas and electricity, and opportunities for satisfying the latent demand for energy services in rural areas. GEF funding for this output will fund one or more consultancies to produce the mentioned assessment and provide methodological advice and technical review; also IT equipment, a motorcycle, training and workshops.

Output 1.4. Drafting of concepts for a national small-scale bioenergy strategy (green paper), and consultation thereof with stakeholders and incumbent authorities. The aim of this output is to assist the national authorities to draft a national bioenergy strategy, focused on the decentralized deployment of small-scale biogas and biodiesel technology. Under this output, it is envisaged to devise a "green paper" for small-scale bioenergy development in Cuba. This paper will serve as a roadmap including quantitative targets, milestones and specific actions. Since the integrated production of food and energy by small- and medium-scale farmers involves multiple sectors (i.e. agriculture, energy, environment, socio-economic development, and others[54]) and levels, the energy problem needs to be viewed from different perspectives. It is therefore envisaged to hold workshops and consultation rounds with stakeholders at different levels (end-users, local authorities, ministries). GEF support to this output will fund international consultancies and contribute to the cost of meetings, workshops, and local travel.

Output 1.5. Policy inputs and recommendations on the legal, institutional and regulatory framework for facilitating the implementation of a small-scale bioenergy strategy. The aim of this output is to provide specific inputs and recommendations for decision makers on key aspects of bioenergy regulation, including: (i) policy instruments; (ii) regulation; (iii) government-supported interventions; (iv) coordination between public entities; (v) involvement of national industries; and (vi) financial incentives for small- and medium-scale farmers and other investors. The document will provide recommended policy actions as well as possible alternatives, and serve as a reference for policy makers. The activities under this output will be led by national staff within Cubaenergía and EEIH. GEF support to this output consists of international and national technical assistance on the mentioned topics, workshops etc. As a specific element, this output will explore the opportunities to design and implement a NAMA instrument aimed at GHG emission reductions by small- and medium-size farmers in Cuba.

Component II. Biodiesel and biogas technology transfer and development.

Outcome 2: State of the art knowledge on the application of small-scale biodiesel and biogas systems has been transferred and assimilated (GEF US$ 1,789,400; co-finance US$ 16,663,154). The objective of this component is to enhance the existing capacities in Cuba to produce biodiesel and biogas technology systems. It will consolidate the production chain for small-scale biodiesel, ranging from oil production and biodiesel plant manufacturing to the effective and innovative utilization of locally produced biodiesel. To this purpose, production facilities within existing metal-mechanical industries will be habilitated for the manufacture of components and final assembly of the biodiesel plant. Applied research will be supported to assess the operational parameters and conditions for the utilization of biodiesel blends in existing engines. This component will further establish the technological know-how, production capacity and expertise for the effective application of biodigester technology in Cuba. To attain this goal, it will clarify the roles necessary for project design and development, provision of maintenance and repair services, and promotion, and will strengthen the required skills at the intermediate (municipality) level. Existing production lines will be upgraded to enable the production of larger sheets of different geomembrane materials (including EPDM, which is presently not available in

[54] For example, the transport, health and education sectors, which can benefit from the improved supply of energy in rural communities.

Cuba) for this application. Industrial strengthening of biodiesel and biogas manufacturing includes the implementation of quality assurance mechanisms. Practical experience and knowledge with the application of both bioenergy technologies is created through the implementation and systematic monitoring of a number of demonstration pilots, which provide a test environment to improve delivery skills and enhance the effective use of energy in the context of integrated food and energy production. Oil production will be based on non-edible plants, such as *Jatropha curcas*, using intelligent production schemes (such as intercropping) to avoid compromising local food production[55]. It is expected that, at the end of the Project, adequate technological, industrial and outreach capabilities will be in place enabling a rapid deployment of biogas and biodiesel technology for rural applications.

Output 2.1. Establishment of a national system to produce certified seeds for vegetal oil plants (Jatropha curcas). The basis for a certified seed production system in Cuba has been laid in EEIH by establishing a germplasm bank of basic seeds for *Jatropha curcas* varieties, which enables reproduction of plants with controlled characteristics, as well as registered seeds banks in different regions of Cuba. These banks will implement a process of further improvement and selection of Jatropha varieties according to diverse soil and climate conditions. The present challenge is rolling out a mechanism enabling the controlled distribution and reproduction of Jatropha seeds and seedlings to four regional production farms, which will need laboratory equipment for the analysis and certification of seeds. EEIH's seed analysis laboratory will be the certifying entity and responsible for the supply of high-quality seeds to these farms. GEF support will consist of co-investment to put in place laboratory procedures and test protocols, lab materials, field equipment for the seed banks, procedures and facilities for labelling, storage and transport of seeds, and technical assistance for optimization of the production and quality control processes.

Output 2.2. Determination of the technical conditions and parameters for the application of locally produced biodiesel blends in agroindustrial equipment and engines. This output encompasses laboratory and field research into the application of locally produced biodiesel fuel in the agroindustrial equipment and engines that are actually being used in Cuba. It is the intention to use blends of bio- and conventional (mineral) diesel, but tests are critical to determine which blends can be used without compromising the operation of equipment and engines. Aspects requiring investigation include: (i) need for purification of crude oil; (ii) need for standardized vegetal oil composition; (iii) design of effective methods to control oil quality by local plant operators; (iv) engine tests with different biodiesel blends; (v) endurance tests for engine components, injectors, oil filters, etc.; (vi) preparation of instructions and guidelines for biodiesel plant operators, and for end-users of biodiesel (local farmers). GEF funding under this component will be used for: (a) procurement of laboratory equipment and consumables; (b) international consultancy for technical advice (South-South/North-South cooperation); and (c) other costs to carry out the research programme (local transport, fuel, communication, printing costs).

Output 2.3 Management and evaluation of the biodiesel and biogas technology transfer process. Enabling small- and medium-size rural farmer to access biodiesel technology involves a complex set of actions that must be linked and integrated. Moreover, technical activities are required to perform as designed. This output will design and implement a management plan to accompany the biodiesel and biogas technology transfer process, identify critical parameters and factors to achieve the performance levels set forth, and take corrective action as and if necessary. Such parameters and factors include: cost and quality of production by national industry; yield and composition of produced biodiesel; performance of agro-machinery fuelled with biodiesel; suitability of processed Jatropha curcas varieties (seeds); performance of locally manufactured appliances and biodigesters, and reliability and performance of biogas plant designs and installations. Technical evaluation by the Project of the performance of the biodiesel and biogas chain is expected to prepare the country to design product and quality standards in this field. This output will further monitor and assess the overall social, economic, and environmental impact of biodiesel and biogas supply under the proposed demonstration projects (Output 2.6). The evaluation thereof will provide useful lessons as input for developing the national strategy for biodiesel production and for replication of the project results. GEF financing will support an international consultancy, travel, IT equipment and workshops.

Output 2.4. Enhanced national manufacturing capabilities for producing small-scale biodiesel plants through investment in production facilities, quality assurance systems, and product and process innovation. This output

[55] See BIOMAS publication, pp. 101-104.

provides technical assistance and equipment to selected national manufacturers (metal-mechanical enterprises) to enable the efficient and cost-effective production of small biodiesel plants in Cuba. GEF funding will be used for co-investment to habilitate production facilities and to acquire specialized equipment. Technical assistance will be provided to implement a system of quality assurance procedures in the company, and to strengthen product engineering capabilities. Furthermore, a mechanism will be implemented to collect feedback from plant operators as input for ongoing product improvement and innovation, and to provide quick user assistance when required. The technical design and prototype engineering will be done by the manufacturing company "*Cubana de Acero*" under the supervision of the Project. The designs will draw upon existing plant layouts, as described in international literature, as well as on the experiences gained by technology transfer under the BIOMAS project[56]. These will be re-dimensioned (downscaled) and adapted to locally available materials and production processes, specifically with respect to the vessels, reactors and piping. Other components, including stirrers, electric motors, controllers, and software, will be imported. The objective is to produce a first series of three different types of biodiesel installations with capacities of 100, 200 and 400 litre/day. GEF support will be used for the purchase of materials and components to build the systems, including auxiliary equipment, spare parts and tools for local servicing. The units produced will be transferred to their respective end-users under an appropriate sales-purchase mechanism in alignment with national regulation and UNDP/GEF requirements. The plants will be manufactured with national funds whereas GEF funding will focus on the quality assurance of the production / manufacturing, as part of this mechanism. GEF will also fund international consultancy, travel and a national company, which will be contracted to implement a quality control system.

Output 2.5. Increased national capacity to produce synthetic membrane liners and auxiliary equipment for small-scale biogas plants, as well as biogas appliances, through investment in production facilities, quality assurance, and product and process innovation. This output provides technical assistance and equipment to a selected national chemical industry (*Unidad Empresarial de la Goma "Conrado Piña"*) to upgrade its facilities and capabilities, thereby enabling the production of synthetic foils (geomembranes) suitable for the construction of a variety of biodigesters types and sizes. Presently, this capacity is limited to small sheets of PVC material (which are successfully used to assemble the 10-m^3 bag-type digesters supplied to small pig farmers). However, covered lagoon-type biodigesters are not applied in Cuba due to the lack of flexible geomembrane materials such as EPDM. This output will therefore: (i) habilitate production lines needed to enable manufacturing of larger sheets[57]; (ii) improve product quality and avoid product faults; (iii) allow the use of different synthetic materials (granulate mixes), including HDPE and EPDM, which is particularly suitable for covered-lagoon type biodigesters; and (iv) increase the output rate of the vulcanization process.. Technical assistance will be provided to implement effective production and quality assurance procedures in the company, and to strengthen engineering capabilities. This output will strengthen the production facilities and further provide technical assistance to the identified manufacturers of household appliances in Cuba "*Marcel Bravo", "INPUD" and "Varona*" to produce equipment adapted for operation on biogas, such as lighting, burners, stoves, refrigerators, and small engines for electricity generation. GEF financing will be used for the purchasing of equipment, material and components for an initial production batch (5 systems), and cover the costs of international consultancy, travel and the hiring of a national company to implement a quality control system.

Output 2.6. Demonstration pilots of small-scale biodiesel and biogas technology including the use of by-products, integrated into selected rural farms. This output comprises the integration of small biodiesel and biogas plants in rural farms and communities in Cuba. The target communities will be chosen on the baseline information collected under Outputs 1.1-1.3. The pilots will be based on the principle of integrated food and energy production. The biodiesel pilots will include: (i) local production of vegetal oil under appropriate production schemes; (ii) storage and distribution of seeds to cover seasonal fluctuations in energy demand; and (iii) opportunities to establish markets for biodiesel and by-products at municipal level. The biogas pilots will be implemented among three types of farmers: (a) small farmers without electricity; (b) small farmers with electricity; and (c) medium-size pig farmers. The demonstration pilots will cover: (i) electricity generation for self-supply and local distribution; (ii) mechanical power applications, for traction and machinery; (iii) opportunities for storage of biogas and distribution to houses for cooking; (iv) utilization of by-products (bio-fertilizer) at farm and community level; and (v) optimization of anaerobic biodigester technology for effluent treatment. Prior to implementing the biodiesel and biogas pilots, baseline values and targets will be drawn, including environmental, land recovery and biodiversity parameters; energy-intensity of food production schemes; and energy

[56] Specifically, the first biodiesel plant installed under this project at Guantánamo.
[57] Based on Rotocube equipment.

services, productivity, quality of life, access to basic services, among others. The pilots will monitor the operation and performance of biodiesel and biogas plants, anomalies, and quality of technical service. GEF funding to this output will cover: (a) civil works and set-up of equipment; (b) co-investment in appliances using biodiesel, basically agricultural machinery and engines, small electric generators and local grids for demonstration projects; (c) local facilities and equipment for biodiesel analysis and storage; (d) investment in biogas installations, including equipment, materials, project supervision, and biogas-operated appliances; (e) co-investment in local electricity and biogas grids, gas engine-generator sets, and electric appliances for household and productive uses; and (f) capacity building and safety instructions for local operators. Based on its prior experience, EEIH has pre-identified the municipalities of Yaguajay, in Sancti Spiritus province, and Manatí, in Las Tunas as the location for the pilots of the project. Final locations will be defined during the first months of the project implementation.

Component III. Institution building, training and promotion.

Outcome 3: Bioenergy technology diffused through increased knowledge and demonstration of biodiesel and biogas systems (GEF US$ 563,766; co-finance US$ 2,447,600). The objective of this component is to establish an effective institutional framework for accelerating the market introduction of biodiesel and biogas energy systems in Cuba. Besides strengthening of institutions and human resources for project development, technical support and outreach activities with rural farmers, it is further pursued to facilitate access to updated and reliable information and raise awareness among policy- and decision-makers about the potential and benefits of small-scale bioenergy technologies. In order to establish this outcome, a national expertise centre on bioenergy will be created within EEIH and a training and certification system for key technical stakeholders will be implemented. Furthermore, the formation of stakeholder networks at municipal level will be facilitated, initially backed by EEIH. At Ministry level, the institutional capacity of Cubaenergía to coordinate relevant programmes, and to provide inputs to the Government, will be strengthened. In the end-of-project situation, it is expected that: (a) farmers and other potential beneficiaries of biodiesel and biogas technologies in rural Cuba, have full access to information and are effectively assisted by project developers and technicians; (b) expertise and best practices about bioenergy applications in Cuba are documented and institutionalized within EEIH; and (c) high-level policy makers have adequate access to information about biogas and biodiesel technology in Cuba.

Output 3.1. Establishment of national expertise centre on integrated bioenergy production within EEIH to support the implementation of biodiesel and biogas systems in rural farms. This output will establish a national expertise centre on bioenergy production at the EEIH. The purpose of this centre is to provide scientific and technical information to project developers of bioenergy systems in Cuba, agronomic entities and municipal authorities, and the national Government. Information will be made available through several means, including a help desk and electronic media (e.g. database, web applications). It will further initiate and implement events such as national and international seminars, as well as training courses for technicians, public officers, project developers and manufacturers. GEF funding for this output will consist of transport support, international consultancies, equipment and specialized services to establish the required infrastructure (including ICT-services), facilitation of laboratories and trial fields, facilitation of training facilities and workshops. Staff for the expertise centre will be recruited by the EEIH conform national procedures and legislation.

Output 3.2. Implementation of national training and educational activities on small-scale biodiesel and biogas production and use. This output encompasses the design of a national system for training and certification of biodiesel and biogas professionals from industry, project developers and installers, agronomic institutes, municipalities, the academic sector, as well as (prospective) plant operators. It is the intention to implement a recognized certification system for critical functions, such as plant designers, installers and operators. GEF support to this output consists of: (i) international consultancies to support design, and formalization of the training programme and certification mechanism; (ii) development and delivery of training material, tutorials and manuals; (iii) rehabilitation and strengthening of spaces for education and (iv) training activities. It is envisaged to extract additional publications to be used by national universities and vocational schools.

Output 3.3. Bioenergy technology unit set up within Cubaenergía to support decision makers, promote inter-institutional coordination, and sharing of knowledge and information on bioenergy supply. This output envisages strengthening the institutional and human capacity of Cubaenergía (CITMA), enabling it to play a more proactive role in promoting and coordinating bioenergy programmes in the country, in line with its mandate. Among other stakeholders of

bioenergy in Cuba, including EEIH, industries and ministries, Cubaenergía is expected to play a bridge function with higher-level policy, essential for increasing awareness and for inserting biodiesel and biogas technologies into the national energy agenda. To this purpose, Cubaenergía will organize national and international seminars and workshops and prepare reports and informational notes for decision makers. The GEF contribution to this output will fund incremental costs of the mentioned activities and support Cubaenergía to fully assume its role, including international consultancies, travel and IT equipment.

Output 3.4. Establishment of networks of trained bioenergy professionals and local agronomic organizations in selected municipalities. This output comprises activities aimed to set up networks at the municipal level with the purpose to provide effective support to small farmers to access bioenergy technology, to design and implement biogas and biodiesel installations, and to provide expertise for the integrated production of food and energy. Technical skills will be developed to ensure the proper installation of biogas systems (including the civil works), verification of installation quality, and provision of maintenance services and repair. GEF funding under this output will be used to habilitate local workshops and prepare technical staff to assume these tasks (envisagedly in 2 municipalities) by procurement of equipment and by training (consultancy). The networks will consist of the local project developers, as well as agronomic organizations and farmers' organizations (including ANAP), with technical back-up from equipment suppliers and EEIH. It is envisaged to transfer ownership of these networks gradually to the involved municipalities. GEF funding under this output will consist of: (a) international consultancies or services to organize the networks; (b) contribution to costs of office equipment; (c) hosting of events, meetings and workshops; and (d) office costs, communication, local travel and sundries.

Output 3.5. Database of case studies of bioenergy technology and manuals documenting best practices from completed and disseminated pilot demonstrations. This output will collect the experiences gained with biodiesel and biogas production and utilization in Cuba, as well as abroad, and make it available to national and international stakeholders. GEF funding under this output will finance: (i) the costs of international consultancy to collect lessons learnt, describe case studies and best practices from the demonstration pilots and develop a database, and (ii) costs of publishing (prints, electronic media, integration into EEIH expertise centre). The products delivered under this output will be used by UNDP for further programming in Cuba and other countries, and shared with peer organizations and the GEF.

Economic and social benefits

The Project "Clean Energy Technologies for the Rural Areas in Cuba" is expected to be instrumental for attaining a series of social and economic benefits.

1. Investments in small-scale integrated food and energy production are rewarded by higher production yields of agricultural produce and by-products. The BIOMAS-CUBA I project reports total income generation from a range of activities in the target municipalities, of the order of US$ 1.1 mln[58]. SDC/COSUDE estimates the internal rate of return (IRR) at 7.4%, and the cost/benefit ratio (CB) at 3.4.

REVENUES GENERATED BY BIOMAS-CUBA PROJECT (PHASE I), 2009-2011			
Item	Production (tons)	Value (CUP)	
Food production (vegetal and animal)	3,196	20,653,619	87%
Tree nursery		984,828	4%
Biogas production	600,060 m^3	947,748	3%
Bio-fertilizer production	2,061 t	1,056,354	4%
Total		**23,642,549**	**100%**

As can be seen, the economic benefits are mainly associated to the value of food production. As additional data will become available, more accurate assessments of the economic value of secure energy supply for food production can be made.

[58] Total revenues over 2009-2011 of CUP 23,642,549 (Cuban pesos) were reported. Source: BIOMAS publication, p. 192.

2. At the national level, local generation of biomass-based energy increases energy security and reduces Cuba´s dependency on imported fuels. The potential for energy generation from biogas and biodiesel in Cuba is potentially very large, as presented in Annex E. With respect to biodiesel based on Jatropha production, large extensions of idle land are theoretically available. A conservative estimate can be based on the first pilot in Guantanamo (approx. 100 ha), by assuming a 100-fold replication over the next 10 years, resulting in a total Jatropha producing area of 10,000 ha. Assuming a production of 750 litre/yr per ha under an intercropping scheme of 3:10, total annual production would be around 750 mln litre. The economic value would be of the order of USD 8 mln. Converted to biodiesel, about USD 18 mln would be added yearly.

With respect to biogas, the small- and medium-scale private farmers directly targeted by the Project hold no less than 500,000 pigs. At a typical manure production of 4 kg per animal per day, the total pig manure production is estimated at approx. 2.0 mln kg/day. The biogas production is 110,000 m^3/day[59], equivalent to 241,000 MWh/yr (20,700 ton oil equivalent). In terms of energy content, this replaces 148,000 barrels of oil, with an indicative market value of USD 14.8 mln per year. However, only part of this biogas potential can actually be used, since many farmers produce more biogas than needed. Local distribution networks and the introduction of biogas-based appliances can enable a higher penetration rate of biogas in the rural areas. Even if biogas is used for electricity generation in combination with local electricity grids, the total biogas utilization factor will likely be no more than 50%. Hence, the effective value of the biogas produced would be between USD 7-8 mln.

3. Important social benefits are expected all along the production chain. Locally, increased productivity and energy security will strengthen resilience of rural communities and increase income generation. Experiences under the BIOMAS-CUBA I project report job creation with incomes similar to, and higher than, the local average (CUP 451 per month); 14% of these jobs were occupied by women under similar conditions than men. The increase of local opportunities further encouraged women to become economically independent. These benefits are expectedly reproduced under the GEF Project. Community-level services, including health, education, communication and transport are also expected to benefit from increased energy supply. At the municipal level, new social, human and technological capital is created by establishing expert centres, workshops and service providers in the field of agroenergy development. Nationally, these efforts are sustained by EEIH and other Government agencies, including Cubaenergía. Finally, the Project will support the Cuban Government to design and implement effective bioenergy development strategies, enhance the national energy supply system, and reduce expenditures in hard currency to access international fuel commodity markets. Job creation is and innovation is expected in the national industries, where the Project aims to establish an initial production output of up to 10 small-scale biodiesel systems per year, and 68,000 m^2 of flexible geomembrane.

Environmental benefits

There is large scope for the application of biogas and biodiesel technologies in Cuba. However, present estimates are still largely theoretical; therefore, more realistic estimates have been made following a bottom-top approach. Assuming a realistic production of 7.0 mln litre Jatropha oil per year (obtained form 10,000 ha intercropped Jatropha plantations), the emission savings from replaced fossil fuel (diesel) are of 129,319 ton CO_{2eq}[60]. Assuming a GEF causality factor of 60%, indirect benefits to a total of 77,591 ton (77.6 kton) CO_{2eq} can be ascribed to the Project[61].

For biogas, an estimate can be obtained by only considering the small- and medium-size private pig farmers, which produce about 110,000 m^3 biogas daily, equivalent to 148,000 oil barrels per year. Assuming that about 50% of this potential is effectively used by the farmers or the local community, the biogas produced would replace about 74,000 barrels per year, with associated emission savings of 36,900 ton CO_{2eq} per year[62]. Assuming that biogas technology is introduced proportionally over a 10-year time period, the total accumulated, indirect benefits would be about 202,875 tons CO_{2eq}. By assuming a GEF causality factor of 60%, a total of 121,725 ton (121.8 kton) CO_{2eq} per year can be ascribed to the Project. The combined, indirect benefits attained by biodiesel and biogas technologies are: 199.4 kton CO_{2eq}.

Direct emission reductions achieved under the presented Project are delivered by the envisaged pilots (three biodiesel systems and five biogas plants). The biodiesel plants will process Jatropha seeds from a total area of, indicatively, 170

[59] One kg of pig manure produces approx. 0.054 m^3 of biogas (see Annex E).
[60] At a CO_2 intensity for diesel fuel of 3.135 kg CO_2eq per litre.
[61] Note that the national biodiesel programme aims at a volume of 90,000 tons (100 mln litre) in the longer term, which would require an area of around 135,000 hectares. In this perspective, the assumed 10,000 ha is highly conservative.
[62] Considering a barrel content of 159 litre and a CO_2 intensity of 3.135 kg CO_2 eq per litre.

hectare, producing 127,750 litre of biodiesel per year. The equivalent volume of replaced conventional diesel implies emission savings of the order of 400.5 ton CO_{2eq}/yr, and 6.0 kton CO_{2eq} over lifetime (15 years).

The biogas pilots, drawing manure from 500 pigs, will produce an energy volume equivalent to 23,094 litre diesel per year (assuming similar efficiencies). The annual greenhouse gas emission savings are: 72.4 ton CO_{2eq}/yr, and 0.72 kton CO_{2eq} over lifetime (10 years). The combined direct benefits (biogas and biodiesel) are 6.7 kton CO_{2eq}. The total (direct and indirect) benefits delivered by the Project are estimated at 207.1 kton CO_{2eq}. It must be noted that this figure is based on a market transformation limited to the subsector of private, small- and medium-size farmers. Biogas technology has substantial additional market potential in other sectors, including cattle farming (largely private) and poultry (state-owned).

Sustainability and replicability

The proposed outcomes are deemed highly sustainable and replicable in Cuba. Support to bioenergy policy development is firmly anchored in the Social and Economic Guidelines. The primary challenge in this aspect is to increase awareness at all levels about the potential and benefits of decentralized energy generation, which implies a paradigm away from a centralized power system. State-supported investments in decentralized generation and grass-roots initiatives initiated by NGO's and bilateral organisations (including COSUDE and the EU) have yielded positive precedents on which the present UNDP/GEF Project builds forth. Specifically, the Project will link local initiatives and national priorities by enabling the municipalities to foster local socioeconomic development, for which energy is a critical input. This approach is embedded in the Municipal Initiative and as such, well-aligned with national policies.

Project component II is designed to enable national industries to supply the incipient biogas and biodiesel markets in rural areas. The economy of domestic manufacturing and assembly of components and installations has been evaluated as positive, implying a substantial reduction in production cost and end-user price in comparison to imported equipment. Additional economic benefits are expected due to the creation of skilled jobs, and supply security. Assuming sustained market demand for bioenergy equipment, production by the targeted enterprises is expected to be economically and financially attractive[63]. The Project addresses the full supply chain for biogas and biodiesel production, with a focus on adequate technological solutions (plant designs) and support services, for which expertise is created at community and municipal levels. This approach builds forth on earlier experiences in Cuba to implement rural energy technologies (including PV and small hydro), with close involvement of local technicians for daily operation and maintenance.

Under component III, the Project will strengthen the national support structure for bioenergy, including the establishment of an expertise centre within EEIH, training facilities, manuals and best practices, enhanced access to information, and the creation of networks of bioenergy experts linking the involved municipalities. The proposed outputs draw upon existing work by EEIH and Cubaenergía and, besides supporting dissemination of bioenergy technology, aim to increase visibility of rural energy production. Given the expected positive social, environmental, and economic impact of biogas and biodiesel technology for small farmers in Cuba, the proposed outcomes are expected to be fully sustainable.

The replication potential for anaerobic biodigesters in Cuba is large, even considering the sector of small- and medium-scale pig farmers alone (about 6,000 establishments). For decentralized biodiesel plants, the market is given by the future volume of Jatropha production and its geographical distribution. The national biodiesel programme strives at an annual production of 65,000 tons of biodiesel by small-scale production units, in the longer term (15 years) increasing to 90,000 tons per year, equivalent to approx. 270 tons per day. Assuming unit capacities of 400 litre per day, one would need 650-700 units to be operational by that time. This market potential can be satisfied by an output of the national industry of approx. 40-45 small-scale biodiesel plants per year. Assuming an oil production of 850 litre/ha per year, a total of 134,000 hectares would be needed (which is about 10% of the total of non-cultivated and idle land in Cuba)[64].

The Project includes valuable approaches to rural development that may be replicated by UNDP and the GEF in other countries, specifically to strengthen community resilience and increase local food production by securing the availability of energy inputs.

Socio-environmental safeguards

The UNDP Environmental and Social Screening Template has been used to assess project impacts. The Project has been classified as Category 3a, *"Impacts and risks are limited in scale and can be identified with a reasonable degree of*

[63] For more details, please consult the Risk Matrix for identified risks related to national production.
[64] See table Idle Land Area per Province in Cuba, Annex E. Total non-cultivated and idle land area in Cuba is estimated at 1,365,200 ha.

certainty and can often be handled through application of standard best practice, but require some minimal or targeted further review and assessment to identify and evaluate whether there is a need for a full environmental and social assessment" given the implications that the project will have towards national and local level policy and strategies for fostering the use of small—scale bioenergy and the implementation of demonstrative pilots on the ground.

The Project design covers the execution of a comprehensive survey of social, economic, environmental, and gender aspects of biodiesel and biogas technology, as well as an assessment of the national potential. These are programmed for the first year of the Project. Although predominantly positive impacts are expected from the Project, the survey will also assist in identifying potential adverse effects, and will propose measures to address them

In particular the project will monitor the impact of Jatropha plantations on local natural resources, biodiversity, soils, and land use patterns. Initial experiences with plantations and intercropping have been collected by the SDC/COSUDE BIOMAS project. The present Project foresees activities to supervise and monitor the anticipated demonstration pilots. These activities should enable PM to closely monitor eventual adverse impacts and take corrective actions if needed. As such, monitoring is an integrated element of the Project design.

Please refer to Annex G for the completed Screening Template.

PROJECT RESULTS FRAMEWORK:

This project will contribute to achieving the following Country Programme Outcome as defined in CPAP or CPD: Communities and key sectors develop and increase energy efficiency and use of renewable energy					
Country Programme Outcome Indicators: CP Component: Sustainable and Equitable Management of the Environment: : Renewability of energy consumption (up to provincial level)					
Primary applicable Key Environment and Sustainable Development Key Result Area (same as that on the cover page, circle one): Mainstreaming environment and energy					
Applicable GEF Strategic Objective and Program: GEF-CCM 1: Promote the demonstration, deployment, and transfer of innovative low-carbon technologies.					
Applicable GEF Expected Outcomes: 1. Technologies successfully demonstrated, deployed, and transferred; 2. Enabling policy environment and mechanisms created for technology transfer.					
Applicable GEF Outcome Indicators: 1. Percentage of technology demonstrations reaching its planned goals; 2. Extent to which policies and mechanisms are adopted for technology transfer.					
Strategy	**Indicators**	**Baseline**	**Target (End of Project)**	**Sources of verification**	**Assumptions**
Project Objective: To increase access to bioenergy technology in Cuba by promoting the use of biodiesel and biogas technologies by rural farmers.	A. Products based on the technology transfers that are approved by the relevant authorities for commercial manufacturing.	A. No products (0).	A. Four products[66] (4)	Project reports, visual inspection, official documents, independent verification.	Sustained commitment of, and dialogue with, national authorities. Project activities can be implemented as planned. Effective engagement of all stakeholders. Adequate technical performance of biodiesel and biogas systems. Successful integration of technologies into local farms and communities.
	B. Extent to which policies and mechanisms are adopted for technology transfer[65]	B. No policies and mechanisms adopted (0)	B. Four policies/ mechanisms adopted (4)[67]		
	C. MWh/yr produced using biogas and biodiesel attributable to project	C. 0	C. 1,540.1 MWH/yr		
	D. Number of people directly and indirectly benefitted from RE due to project action	D. 0	D. 88,100 people		
	E. GHG emissions avoided (tons CO2eq).	E. No (0) GHG emission avoided.	E. 6.7 kton CO2eq (direct) and 199.4 CO2eq (indirect) avoided emissions.		
Outcome 1[68]: Policy instruments supportive of small-scale bioenergy development have been formulated and recommended for approval.	1a) Information tools developed for bioenergy policy and strategy formulation	1a) No tools existing focused on bioenergy.	1a) Information tools focused on bioenergies developed at three levels (information gathering, processing and compilation)	Project documents, official publications, meeting minutes, interviews.	Sustained commitment of, MINISTRY of Agriculture and National Statistics and Information Office, and dialogue with Ministry of Energy and Mines among other national authorities. Project activities can be implemented as planned.
	1b) Draft small-scale bioenergy strategy (green paper) consulted with incumbent authorities.	1b) No draft bioenergy strategy (0)	1b) Draft strategy compiled and consulted with incumbent authorities (1)		
	1c). Policy inputs and recommendations on the legal, institutional and regulatory framework for facilitating the	1c) No policy inputs and recommendations (0).	1c) Policy inputs and recommendations formulated and presented to incumbent authorities		

[65] It is suggested to use a scale (0 to 8) in correspondence to the row 29-36 in the GEF CC Tracking Tool (Objective 1).
[66] Biogas plant, biodigestor membrane, diverse equipment that use biogas, components for the use of biodiesel generation residues.
[67] These are: (i) Innovation and technology centre and network; (ii) Applied R&D support; (iii) Information dissemination; and (iv) Institutional and technical capacity building.
[68] All outcomes monitored annually in the APR/PIR. It is highly recommended not to have more than 4 outcomes.

	implementation of a small-scale bioenergy strategy.		(1)		
Outcome 2: State of the art knowledge on the application of small-scale biodiesel and biogas systems has been transferred and assimilated.	2a). Production capacity for small-scale (100, 200 and 400l/day) biodiesel plants of national industry (units produced per year). 2b) Flexible geomembrane production (m2/yr) 2c) Litre of biodiesel annually produced in demonstration pilots and put to use (l/yr) 2d) Cubic meters of biogas generated in demonstration pilots and put to use (m^3/yr).	2a) No production capacity (0 per year). 2b) No geomembrane production (0). 2c) No production (0 l/yr) 2d) No production in demonstration pilots (0 m^3/yr)[69]	2a) Production capacity for small-scale biodiesel plants (100, 200 and 400 l/day) of 10 units per year. 2b) Production capacity for flexible geomembrane material of 68,000 m^2/yr. 2c) 127,500 l/yr 2d) 39,400 m^3/yr biogas produced.	Progress reports, site visits, official publications, interviews, mid-term review	Baseline situation of national manufacturers allows for successful facilitation of bioenergy production lines. Effective engagement of all stakeholders. Sustained commitment of national industries in engagement with project developers and servicing agents. Project activities can be implemented as planned. Successful integration of technologies into local farms and communities.
Outcome 3: Bioenergy technology diffused through increased knowledge and demonstration of biodiesel and biogas systems.	3a) Bioenergy expertise centre established in EEIH. 3b) Number of farmers (m/f) assisted on bioenergy. 3c) Number of advisory/consulting services provided by Cubaenergía to decision-makers on bioenergy	3a) Good track record and individual competences on bioenergy within EEIH. 3b) No (0) farmers assisted. 3c) On average 3 services on bioenergy provided per year	3a) Formal bioenergy expertise centre habilitated within EEIH. 3b) 120 farmers assisted 3c) 8 services on bioenergy provided per year	Progress reports, contracts, physical verification, official publications.	Baseline situation within EEIH allows for successful facilitation of bioenergy expertise centre. Effective engagement of all stakeholders. Project activities can be implemented as planned. Sustained commitment by relevant national authorities
Project Management	4a) Annual progress monitoring reports delivered. 4b) Mid-Term Review (MTR) and Terminal Evaluation (TE) implemented.	4a) No annual progress reports 4b) No evaluations.	4b) four (4) annual progress reports delivered. 4b) MTR and TE evaluations executed and reports approved.	Progress reports, evaluation reports.	Project activities can be implemented as planned.

[69] However, biogas is produced in Cuba in traditional biodigesters used by small farmers.

TOTAL BUDGET AND WORKPLAN

Award ID:	**00085068**	**Project ID(s):**	**00092389**
Award Title:		**Clean Energy Technologies for the Rural Areas in Cuba (CleanEnergy-Cuba)**	
Business Unit:		**CUB10**	
Project Title:		**Clean Energy Technologies for the Rural Areas in Cuba (CleanEnergy-Cuba)**	
PIMS no		**4899**	
Implementing Partner (Executing Agency)		**Estación Experimental Indio Hatuey (EEIH)**	

GEF Outcome/Atlas Activity	Responsible Party/ Implementing Agent	Fund ID	Donor Name	Atlas Budgetary Account Code	ATLAS Budget Description	Amount Year 1 (USD)	Amount Year 2 (USD)	Amount Year 3 (USD)	Amount Year 4 (USD)	Amount Year 5 (USD)	Total (USD)	Budget note
Outcome #1 Policy instruments supportive of small-scale bioenergy development have been formulated and recommended for approval.	EEIH	**62000**	**GEF**	71200	International Consultants	15,000	0	8,000	8,000	4,000	**35,000**	**1-3**
				71600	Travel	7,000	8,000	6,170	4,340	5,000	**30,510**	**4, 5**
				72100	Contractual Services - Companies	5,000	5,000	0	0	0	**10,000**	**6,7**
				72200	Equipment and Furniture	10,000	10,000	5,000	3,260	0	**28,260**	**8, 9**
				72400	Communication and Audiovisual Equipment	0	2,000	2,500	2,335	0	**6,835**	**10**
				72500	Supplies	2,000	2,000	2,895	0	0	**6,895**	**11**
				72800	Information Technology Equipment	10,000	10,000	11,000	0	0	**31,000**	**12**
				73400	Rental and Maintenance of Other Equipments	3,000	5,000	3,000	3,000	2,000	**16,000**	**13**
				74200	Audio Visual & Print Prod Cost	3,000	10,000	2,000	1,000	7,000	**23,000**	**14**
				74500	Miscellaneous	4,000	4,000	2,500	1,000	1,000	**12,500**	**15**
				75700	Workshops and Training	15,000	5,000	11,000	8,000	7,000	**46,000**	**16, 17**
					sub-total GEF	**74,000**	**61,000**	**54,065**	**30,935**	**26,000**	**246,000**	
Outcome #2 State of the art knowledge on the application of small-scale biodiesel and biogas systems has been transferred and assimilated	EEIH	**62000**	**GEF**	71200	International Consultants	7,000	21,200	13,000	6,000	5,000	**52,200**	**18-22**
				71600	Travel	8,000	13,000	7,000	5,000	2,000	**35,000**	**23-25**
				72100	Contractual Services - Companies	0	27,000	47,000	0	0	**74,000**	**26-30**
				72200	Equipment and Furniture	219,460	485,124	148,916	128,000	10,000	**991,500**	**31-34**
				72300	Material and Goods	9,000	351,900	80,000	20,000	10,000	**470,900**	**35-39**
				72400	Communication and Audiovisual Equipment	0	3,000	3,500	0	0	**6,500**	**40**
				72500	Supplies	0	2,000	2,000	2,000	700	**6,700**	**41**
				72800	Information Technology Equipment	7,000	6,000	0	0	0	**13,000**	**42**
				73400	Rental and Maintenance of Other Equipments	12,000	25,000	15,000	15,000	7,500	**74,500**	**43**
				74200	Audio Visual & Print Prod Cost	0	1,900	2,000	1,100	2,500	**7,500**	**44**

				74500	Miscellaneous	5,000	7,000	5,000	5,000	3,600	**25,600**	**45**
				75700	Workshops and Training	8,000	5,000	5,000	9,000	5,000	**32,000**	**46, 47**
					sub-total GEF	**275,460**	**948,124**	**328,416**	**191,100**	**46,300**	**1,789,400**	
Outcome #3 Bioenergy technology diffused through increased knowledge and demonstration of biodiesel and biogas systems.	EEIH	**62000**	**GEF**	71200	International Consultants	8,000	19,000	23,000	8,000	8,000	**66,000**	**48-51**
				71600	Travel	13,000	17,000	17,000	11,000	10,000	**68,000**	**52**
				72100	Contractual Services - Companies	0	14,000	14,000	3,000	2,000	**33,000**	**53-55**
				72200	Equipment and Furniture	40,000	10,000	32,919	4,081	0	**87,000**	**56-58**
				72300	Material and Goods	0	20,000	30,400	10,000	0	**60,400**	**59**
				72400	Communication and Audiovisual Equipment	0	5,000	5,100	0	0	**10,100**	**60**
				72500	Supplies	0	6,000	5,200	4,000	1,000	**16,200**	**61**
				72800	Information Technology Equipment	11,400	15,000	16,000	0	0	**42,400**	**62**
				73400	Rental and Maintenance of Other Equipments	10,000	20,000	20,000	7,000	6,400	**63,400**	**63**
				74200	Audio Visual & Print Prod Cost	0	14,000	14,000	5,000	9,000	**42,000**	**64**
				74500	Miscellaneous	7,000	4,000	3,000	3,000	1,500	**18,500**	**65**
				75700	Workshops and Training	7,000	15,000	18,000	10,000	14,766	**64,766**	**66**
					sub-total GEF	**96,400**	**159,000**	**190,619**	**65,081**	**52,666**	**571,766**	
Project Management	EEIH	**62000**	**GEF**	71200	International Consultants	0	0	18,000	0	18,000	**36,000**	**67**
				71600	Travel	5,000	5,000	5,000	5,000	0	**20,000**	**68**
				72200	Equipment and Furniture	2,300	0	0	0	0	**2,300**	**69**
				72400	Communication and Audiovisual Equipment	0	1,000	1,000	0	0	**2,000**	**70**
				72500	Supplies	1,500	2,500	2,000	2,000	1,000	**9,000**	**71**
				72800	Information Technology Equipment	1,000	3,000	3,000	3,000	0	**10,000**	**72**
				73400	Rental and Maintenance of Other Equipments	2,000	5,000	3,000	2,000	1,000	**13,000**	**73**
				74200	Audio Visual & Print Prod Cost	0	0	0	2,305	7,695	**10,000**	**74**
				74500	Miscellaneous	0	6,000	6,000	6,000	2,000	**20,000**	**75**
				75100	Professional Services	0	2,000	1,000	1,000	1,000	**5,000**	**76**
				75700	Workshops and Training	0	1,258	0	1,800	0	**3,058**	**77**
					Total Management	**11,800**	**26,758**	**42,000**	**24,105**	**33,695**	**138,358**	
					PROJECT TOTAL	**457,660**	**1,193,882**	**620,100**	**310,221**	**155,661**	**2,737,524**	

Summary of Funds: [70]

	Total
GEF	$2,737,524
EEIH / MES	$2,034,900
Cubaenergía / CITMA	$50,000
Local and manufacturers	$6,130,875
EEIH / MES (donor programmes)	$11,683,332
UNDP	$50,000
TOTAL	**$22,686,631**

FUND \ YEAR	Year 1	Year 2	Year 3	Year 4	Year 5	Total
GEF FUNDS	**457,660**	**1,193,882**	**620,100**	**310,221**	**155,661**	**2,737,524**
Co-financing	**4,934,400**	**8,069,200**	**4,894,954**	**1,068,253**	**982,300**	**19,949,107**

[70] *Summary table should include all financing of all kinds: GEF financing, co-financing, cash, in-kind, etc...*

Budget Notes

OUTCOME 1

1. One rural energy (policy) expert for technical backstopping and advice in design and implement information tools.
2. One rural energy expert for evaluation of technical and economic potential of biogas and biodiesel
3. One rural energy (policy) expert for: (i) advice on specific policy, regulation and incentives; (ii) review of proposals
4. Domestic travel to collect relevant data for output 1.1, domestic travel of experts to attend meetings for validation of products developed under outputs 1.2 through 1.5
5. International travel to exchange experiences on assessment of the technical and economic potential for biodiesel and biogas production and usage in small-scale agriculture and livestock farming and for the development and implementation on small-scale bioenergy policy and strategy. Also international travel of foreign consultants.
6. One company/institute for: design and implementation of ICT solutions to access and evaluate bioenergy data, including associated GHG emissions and emission reductions
7. One company/institute for: support to the assessment of technical and economic potential of biogas and biodiesel energy focused on small- and medium-scale farmers
8. Equipment to support information collection and analyses activities, as well as publication of primary statistical data
9. Procurement of equipment and a light transport for the assessment of the technical and economic potential for biodiesel and biogas production and usage
10. Communications equipment (mobile and land phones)
11. Office supplies e.g. paper, toner, memory sticks, as well as fuel for activities in the outcome.
12. IT equipment to strengthen the institutions involved in outcome 1, especially Cubaenergía but also MINAG, ONEI and ANAP in support of the collection and analysis of data/information on economic, production, social, gender and environmental aspects of integrated food and the instruments and recommendations developed from it
13. Cost of vehicle maintenance in support of all outputs in outcome 1
14. Printing od surveys for data collection, documents results of data compilation and analysis, methodologies and reports related to outputs 1.3, 1.4 and 1.5
15. Contingencies related to possible fluctuations in Exchange rates and other ítems, including insurance for vehicles
16. Workshops and training on collection and analysis of information on economic, social, and environmental aspects of integrated food and small-scale bioenergy production by rural farmers; as well as the relevant information tools for decision makers
17. Workshops for preparing policy inputs and recommendations on the legal, institutional and regulatory framework for facilitating the implementation of a small-scale bioenergy strategy, as well as consultation rounds with stakeholders

OUTCOME 2

18. One biodiesel expert for: (i) technical backstopping; (ii) design of biodiesel test programme
19. One independent biodiesel expert; and one independent biogas expert, for monitoring of technology transfer process
20. One expert on biodiesel conversion for: (i) advice and technical backstopping; (ii) technology transfer
21. One or two experts on biodigester design and materials for: (i) advice and technical backstopping; (ii) technology transfer
22. Two experts on biogas and biodiesel utilization for: (i) project design; (ii) advice and technical backstopping

23. International travel to exchange knowledge and experiences with (i) national system to produce certified seeds for vegetal oil plants; (ii) application of biodiesel blends in agroindustrial equipment and engines
24. International travel of foreign consultants
25. Domestic travel to supervise the technology transfer processes to each of the facilities and the implementation of the pilots in the municipalities of Yaguajay and Manatí
26. One company/institute for: support to implementation of certified seed production system
27. One company/institute for: hosting and execution of biodiesel blend test programme.
28. One national/institute company for: implementing a quality control system in the biodiesel plant production line
29. One national institute/company for: implementing a quality control system in the production line for modern geomembrane materials for biodigesters (EPDM).
30. One or more national companies for: civil work and equipment assembly for the biodiesel and biogas pilots
31. Procurement of agricultural machinery, equipment, irrigation systems and hand tools for germplasm bank of basic seeds for Jatropha curcas, as well as laboratory equipment for seed certification and quality assurance
32. Procurement of laboratory equipment and inputs to execute biodiesel test programme
33. Procurement of industrial equipment for habilitating (i) manufacturing and assembly line for small-scale biodiesel plants (ii) the production line for modern geomembrane material (EPDM), (iii) appliances for biogas utilization and (iv) instruments for quality inspections and control
34. Procurement of equipment to undertake demonstration pilots of small-scale biodiesel and biogas (field equipment, light transport for supervision)
35. Procurement of lab and field materials for implementation of the national system to produce certified seeds of Jatropha curcas
36. Procurement of fuel for evaluation of blends diesel-biodiesel in agroindustrial equipment and engines.
37. Procurement of raw materials for manufacturing the three biodiesel plants.
38. Procurement of raw materials and components to produce synthetic membrane liners and auxiliary equipment for the five small-scale biogas plants, as well as biogas appliances.
39. Procurement of field materials for the implementation of the demonstration pilots of small-scale biodiesel and biogas technology.
40. Audio-visual equipment for training (cameras, datashow, etc); mobile and landphones
41. Office supplies e.g. paper, toner, memory sticks, as well as fuel for activities in the outcome
42. Basic and specialized IT equipment at participating industries, MINAG and pilot municipalities to support activities under outputs 2.1 through 2.6
43. Cost of vehicle maintenance in support of all outputs in outcome 2
44. Printing of norms and protocols related to seed certification, and test of biodiesel use. Printing of technical documentation and results from the pilot activities.
45. Contingencies related to possible fluctuations in Exchange rates and other ítems, including insurance for vehicles
46. Workshops and training on production of certified seeds for Jatropha curcas,
47. Workshops and training on: (i) implementation and operation of biodiesel and biogas systems as well as your use in small agricultural farms in energy generation for self-supply and local distribution; (ii) establishment of markets for biodiesel, biogas and by-products at municipal level; (iii) utilization of by-products (bio-fertilizer) at farm and community level; (iv); optimization of technologies and systems

OUTCOME 3

48. Experts in facilitation of training courses, workshops, national and international seminars
49. One or more specialists on bioenergy to participate in training activities and events
50. Experts in support decision makers, promote inter-institutional coordination, and sharing of knowledge and information on bioenergy supply
51. One specialist on bioenergy for advice and technical backstopping
52. Domestic travel of (i) EEIH staff to provide the advisory role defined in output 3.1, 3.4; (ii) Cubaenergía to create awareness of its role in output 3.3 and liaise with decision makers at the local level; (iii) for relevant participants to attend trainings organized under output 3.2 ; and (iv) collect the necessary information for the activities foreseen in output 3.5
53. National institute for design and hosting of bioenergy expertise centre
54. One or more national companies/institutes for: rehabilitation of classroom buildings in the local training schools as well as hosting and organization of training and educational activities
55. One company/institute for support of database development of case studies of bioenergy technology.
56. Procurement of furniture and office equipment for the Bioenergy Unit in Cubaenergía and the Expertise Centre in EEIH. Procurement of a vehicle for this Centre
57. Procurement of furniture for strengthening a training classroom
58. Procurement of equipment for cooperatives of services of construction, mechanics and electric, as well as furniture of local support centres
59. Procurement of materials for strengthening the expertise Centre in EEIH, classroom buildings in the local training schools and the buildings of the agronomic institutes part of the local level networks
60. Audiovisual equipment for the expertise Centre and Bioenergy Unit in EEIH and Cubaenergía respectively. Mobile and landphones
61. Office supplies e.g. paper, toner, memory sticks, as well as fuel for activities in the outcome
62. IT equipment for the bioenergy technology unit set up within Cubaenergía and national expertise centre on integrated bioenergy production within EEIH, as well as ANAP and other stakeholders to support training activities and technical support to farmers.
63. Cost of vehicle maintenance in support of all outputs in outcome 3
64. Printing of educational materials for capacity building activities with producers and decisión makers. Printing of technical manuals for members of the bioenergy networks. Printing of case studies and good practices manuals by the bioenergy unit in Cubaenergía and the expertise centre in EEIH.
65. Contingencies related to possible fluctuations in Exchange rates and other ítems, including insurance for vehicles
66. Workshops and specialized training on design, implementation and improvement of biodiesel and biogas technology/systems in rural farms, integrated food and energy production, local management and entrepreneurship, policy instruments, and climate change mitigation

PROJECT MANAGEMENT

67. Mid-term and Terminal Evaluation consultants.
68. Project management team domestic traveling to undertake monitoring and evaluation of the project
69. Equipment for the setting-up and functioning of the Project Management Team (furniture, light transport for allowing mobility in supervision activities)
70. Audiovisual equipment (cameras, datashow)
71. Supplies for the coordination of the Project including toner, external drives, office supplies etc., as well as fuel for transport at national level

72. Procurement of IT equipment to support the Project Management Team and the Leaders of Working Groups for Outcomes 2 y 3
73. Cost of vehicle rental and maintenance
74. Printing of project management and supervision documents such as EMT and TE reports, lessons learned, etc.
75. Contingencies related to possible fluctuations in Exchange rates and other ítems, including insurance for vehicles
76. External financial audits
77. Workshops for collection, systematization and dissemination of lessons learnt

International consultants	
Outcome 1	One rural energy (policy) expert for technical backstopping and advice in design and implement information tools.
	One rural energy expert for evaluation of technical and economic potential of biogas and biodiesel.
	One rural energy (policy) expert for: (i) advice on specific policy, regulation and incentives; (ii) review of proposals.
Outcome 2	One biodiesel expert for: (i) technical backstopping; (ii) design of biodiesel test programme.
	One independent biodiesel expert; and one independent biogas expert, for monitoring of technology transfer process.
	One expert on biodiesel conversion for: (i) advice and technical backstopping; (ii) technology transfer.
	One or two experts on biodigester design and materials for: (i) advice and technical backstopping; (ii) technology transfer.
	Two experts on biogas and biodiesel utilization for: (i) project design; (ii) advice and technical backstopping.
Outcome 3	One or two experts in facilitation of training courses, workshops, national and international seminars.
	One or more specialists on bioenergy to participate in training activities and events.
	One or two experts in support decision makers, promote inter-institutional coordination, and sharing of knowledge and information on bioenergy supply.
	One specialist on bioenergy for advice and technical backstopping.
Project Management	Mid-term and Terminal Evaluation consultants.
Contractual services (companies)	
Outcome 1	One company/institute for: design and implementation of ICT solutions to access and evaluate bioenergy data, including associated GHG emissions and emission reductions.
	One company/institute for: support to the assessment of technical and economic potential of biogas and biodiesel energy focused on small- and medium-scale farmers.
Outcome 2	One company/institute for: support to implementation of certified seed production system.
	One company/institute for: hosting and execution of biodiesel blend test programme.
	One national/institute company for: implementing a quality control system in the biodiesel plant production line.
	One national institute/company for: implementing a quality control system in the production line for modern geomembrane materials for biodigesters (EPDM).

	One or more national companies for: civil work and equipment assembly for the biodiesel and biogas pilots.
Outcome 3	One national institute for design and hosting of bioenergy expertise centre.
	One or more national companies/institutes for: rehabilitation of classroom buildings in the local training schools as well as hosting and organization of training and educational activities.
	One company/institute for support of database development of case studies of bioenergy technology.
Equipment & furniture	
Outcome 1	Equipment to support information collection and analyses activities, as well as publication of primary statistical data. .
	Procurement of equipment and transport support for the assessment of the technical and economic potential for biodiesel and biogas production and usage
Outcome 2	Procurement of agricultural machinery, equipment, irrigation systems and hand tools for germplasm bank of basic seeds for *Jatropha curcas*, as well as laboratory equipment for seed certification and quality assurance.
	Procurement of laboratory equipment and inputs to execute biodiesel test programme.
	Procurement of industrial equipment for habilitating (i) manufacturing and assembly line for small-scale biodiesel plants (ii) the production line for modern geomembrane material (EPDM), (iii) appliances for biogas utilization and (iv) instruments for quality inspections and control
	Procurement of transport support to supervise the implementation, monitoring and evaluation of demonstration pilots of small-scale biodiesel and biogas technology in two municipalities in Cuba.
Outcome 3	Procurement of furniture and office equipment for the Bioenergy Unit in Cubaenergía and the Expertise Centre in EEIH. Procurement of a vehicle for this Centre
	Procurement of furniture for strengthening a training classroom.
	Procurement of equipment for cooperatives of services of construction, mechanics and electric, as well as furniture of local support centres.
Project Management	Furniture and transport support for the Project Management Team.
Travel	
Outcome 1	Domestic travel to collect relevant data for output 1.1, travel of experts to attend meetings for validation of products developed under outputs 1.2 through 1.5
	International travel to exchange experiences on assessment of the technical and economic potential for biodiesel and biogas production and usage in small-scale agriculture and livestock farming and for the development and implementation on small-scale bioenergy policy and strategy.
Outcome 2	International travel to exchange knowledge and experiences with national system to produce certified seeds for vegetal oil plants.
	International travel to exchange experiences on the application of biodiesel blends in agroindustrial equipment and engines.
	Domestic travel to supervise the technology transfer processes to each of the facilities and the implementation of the pilots in the municipalities of Yaguajay and Manatí
Outcome 3	Domestic travel of (i) EEIH staff to provide the advisory role defined in output 3.1, 3.4; (ii) Cubaenergía to create awareness of its role in output 3.3 and liaise with decision makers at the local level; (iii) for relevant participants to attend trainings organized under output 3.2 ; and (iv) collect the necessary information for the activities foreseen in output 3.5
Project Management	Project management team domestic traveling to undertake monitoring and evaluation of the project.

Information Technology Equipment	
Outcome 1	IT equipment to strengthen the institutions involved in outcome 1, especially Cubaenergía but also MINAG, ONEI and ANAP in support of the collection and analysis of data/information on economic, production, social, gender and environmental aspects of integrated food and the instruments and recommendations developed from it
Outcome 2	Basic and specialized IT equipment at participating industries, MINAG and pilot municipalities to support activities under outputs 2.1 through 2.6
Outcome 3	IT equipment for the bioenergy technology unit set up within Cubaenergía and national expertise centre on integrated bioenergy production within EEIH, as well as ANAP and other stakeholders to support training activities and technical support to farmers.
Project Management	Procurement of IT equipment to support the Project Management Team and the Leaders of Working Groups for Outcomes 2 y 3.
Materials and Goods	
Outcome 2	Procurement of lab and field materials for implementation of the national system to produce certified seeds of *Jatropha curcas.*
	Procurement of fuel for evaluation of blends diesel-biodiesel in agroindustrial equipment and engines.
	Procurement of raw materials for manufacturing the three biodiesel plants.
	Procurement of raw materials and components to produce synthetic membrane liners and auxiliary equipment for the five small-scale biogas plants, as well as biogas appliances.
	Procurement of field materials for the implementation of the demonstration pilots of small-scale biodiesel and biogas technology.
Outcome 3	Procurement of materials for strengthening the expertise Centre in EEIH, classroom buildings in the local training schools and the buildings of the agronomic institutes part of the local level networks.
Workshops and Training	
Outcome 1	Workshops and training on collection and analysis of information on economic, social, and environmental aspects of integrated food and small-scale bioenergy production by rural farmers; as well as the relevant information tools for decision makers.
	Workshops for preparing policy inputs and recommendations on the legal, institutional and regulatory framework for facilitating the implementation of a small-scale bioenergy strategy, as well as consultation rounds with stakeholders.
Outcome 2	Workshops and training on production of certified seeds for *Jatropha curcas,*
	Workshops and training on: (i) implementation and operation of biodiesel and biogas systems as well as your use in small agricultural farms in energy generation for self-supply and local distribution; (ii) establishment of markets for biodiesel, biogas and by-products at municipal level; (iii) utilization of by-products (bio-fertilizer) at farm and community level; (iv); optimization of technologies and systems
Outcome 3	Workshops and specialized training on design, implementation and improvement of biodiesel and biogas technology/systems in rural farms, integrated food and energy production, local management and entrepreneurship, policy instruments, and climate change mitigation.
Project Management	Workshops for collection, systematization and dissemination of lessons learnt.

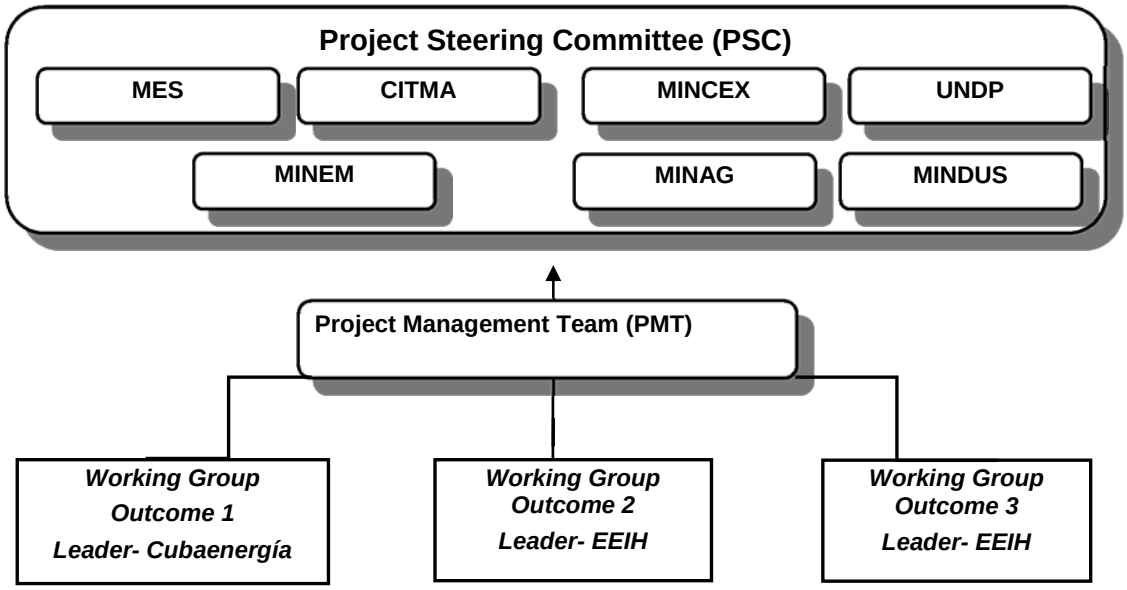
MANAGEMENT ARRANGEMENTS

The project will be implemented under UNDP's National Implementation modality (NIM). This modality assists in developing ownership within the host country and helps creating conditions for sustainability.

The Ministry for Foreign Trade and Investment (MINCEX) is the national public authority in charge of coordinating international cooperation and its execution in Cuba. The designated Implementing Partner of the project will be the Estación Experimental "Indio Hatuey" (EEIH), belonging to the Ministry of Higher Education. EEIH is ultimately responsible for the timely delivery of inputs and outputs and for the coordination of all other responsible parties including other line ministries, relevant agencies, and local government Authorities. From within CITMA, the project is accompanied by Cubaenergía, which will provide specialized technical inputs and assist with coordination with other institutions at the national level.

Implementation of the project will be carried out under the general guidance of a *Project Board* (Project Steering Committee - PSC), specifically formed for this purpose. The composition, responsibilities and rules of operation of the PSC will be confirmed during its first meeting. Subject to the decision of this meeting, it is proposed that the PSC will be composed of senior-level representatives of MINCEX, MES, CITMA, MINEM, MINAG, MINDUS and UNDP.

Figure: Institutional arrangements of the CLEANENERGY Project



The PSC provides the political and technical strategic vision of the Project. It is responsible for the operational implementation of the Project. Among the main functions of the PSC are:

- Defining policies and guidelines for implementation of the project;
- Providing political support and facilitate the implementation process;
- Knowing and approving the general programming and reprogramming;
- Approving terms of reference and appointments of key staff; and
- Overseeing monitoring and evaluation.

The Project Steering Committee (PSC) will be constituted at Project inception. The PSC will be chaired by MINCEX, MES and UNDP and meet twice per year to review progress and to decide upon strategic

and critical Project issues. The Project Manager will be non-voting member of the PSC and can be assisted by the Project Administrator to provide detailed project information as needed. The PSC meetings will be timely convened by the Chair allowing PSC members to prepare duly. The Project Management Team will act as Secretariat of the PSC. Extraordinary PSC meetings can be held if deemed necessary by one of the PSC members. If appropriate, the PSC can invite external parties to report and assist in specific issues.

UNDP, as the GEF Implementing Agency, is ultimately responsible to the GEF Council for the financial administration of the project and for obtaining the envisaged project outcomes.

Project Management Team

The Project Management Team (PMT) will consist of one Project Manager and one Project Administrator based in EEIH, a Specialist in Cubaenergía and the Coordinators for each of the project results. The Project Manager and Administrator will be hosted by the EEIH. The Project Manager will be appointed by the MES/EEIH and will be responsible for the day-to-day project operations, financial accounts, periodic reporting to UNDP CO and for the elaboration of annual work plans and budgets in coordination with UNDP CO. The PM will be the primary contact person for the Project for external communications.

The PMT will have responsibility for, among others: (i) managing and executing the project; (ii) coordinating the management of financial resources and procurement; (iii) reporting on the application of resources and results achieved; (iv) preparing reports for the PSC, UNDP, and the GEF; (v) promoting inter-institutional linkages; and (vi) monitoring and evaluation, and disseminating project results. During the Project's inception phase the signatures required for validating project procedures and transactions will be determined and approved.

Workgroups

Under the supervision of the PMT, working groups will be created to guide the implementation of the outcomes of the Project. These groups will be composed by the relevant national institutions involved in the activities scheduled in each outcome. The working group for outcome 1 will be led by Cubenergía, while the workgroups for outcomes 2, 3 and 4 will be led by EEIH. Coordinators of each working group shall be responsible for planning and implementing the necessary activities to achieve the proposed outputs and outcomes as well as estimating the costs associated to these activities.

Stakeholders

An overview of the Project's stakeholders and partners is presented in the following table:

STAKEHOLDER	**ROLE**
Estación Experimental "Indio Hatuey" (EEIH)	National project coordination (PMT) and leader of Working Groups for Outcomes 2 and 3.
Cubaenergía	As Coordinator of Working Group for Outcome 1, Cubaenergía will coordinate the tasks related to the strengthening of the regulatory frameworks, access and analyses of information to base decision-making and the formulation of strategy and program proposals. To this end, Cubaenergía will work closely with national entities such as the Direction of Renewable Energies of the Ministry of Energy and Mines, the Direction of Integral Energy of the Ministry of Agriculture, the National Association of Small Farmers and the National Office of Statistics and Information.
Ministry of Science, Technology and Environment (CITMA)	Supervise the alignment of the project with climate change and environmental policies. The Director of International Relations of CITMA is the GEF Focal Point. CITMA is also the state institution with the mandate coordinate the national policy on technology matters.

STAKEHOLDER	ROLE
Ministry of Trade and Foreign Investment (MINCEX)	MINCEX is the national state organization that supervises the overall international cooperation activities. One of its enterprises (EMED) is in charge of importing equipment required for international cooperation projects.
Ministry of Energy and Mines (MINEM)	Define local, sector and national renewable energy strategies; to evaluate and select pilot investments; to implement training activities for stakeholders; to provide support for the installation, operation and maintenance of equipment; dissemination of the technology among potential end-users; to evaluate the national potential of bio-energy options; and to carry out economic evaluations.
Ministry of Industry (MINDUS)	Establishes industrial development policies and strategies. It is also responsible for the companies in charge of the manufacturing of the biodiesel plants, geomembrane for bio-digesters, and biogas appliances
Ministry of Economy and Planning (MEP)	Provide inputs for the development and implementation of policy and regulation to incentivize national markets for biogas and biodiesel; to establish financial mechanisms and incentives to stimulate these technologies in synergy with national programmes targeting the agricultural, farming and rural sectors; to identify opportunities to stimulate participation of the national industry in the design and production of biogas and biodiesel systems, and to provide technical support for installation and maintenance.
Ministry of Finance and Prices (MFP)	Define a pricing methodology for Jatropha nuts and for marketable products, including biogas, biodiesel, bio-fertilizer, co-products, and for electric energy produced from biomass and biogas
Ministry of Agriculture (MINAG)	Definition of supportive policies and regulation for biogas and biodiesel markets; to define financial mechanisms and incentives; to test and evaluate the operation of bio-energy systems by the target group under field conditions; to assist in training activities; to adapt and evaluate effluent management practices, the production and application of bio-fertilizers; installation and O&M aspects; end-user awareness and training; and economic evaluation of technologies
National Association of Small Farmers (ANAP)	Support to testing and evaluation of the operation of bio-energy systems by the target group under field conditions; to assist in training activities; to adapt and evaluate effluent management practices, the production and application of bio-fertilizers; installation and O&M aspects; end-user awareness and training; and economic evaluation of technologies.
Ministry of Higher Education (MES)	Implement innovation and local knowledge management strategies; to assess climate change benefits; to assess and select appropriate technologies; to participate in training activities and to accompany the design, installation, operation and evaluation process of pilot plants

MONITORING FRAMEWORK AND EVALUATION

Project monitoring and evaluation (M&E) will be conducted in accordance with established UNDP and GEF procedures and be led by the project team and the UNDP Country Office (UNDP CO) with support from UNDP/GEF. The Strategic Results Framework (SRF, see Section II) provides performance and impact indicators with their corresponding means of verification. The SRF will be the reference for monitoring the Project's implementation and for (independent) evaluation of performance and impact. The Project Management Team will prepare a detailed M&E plan to be presented at the Inception Workshop. This Workshop (see below) provides a platform for reviewing and fine-tuning of indicators and means of verification, in a manner consistent with the expected outcomes for the project.

Inception workshop

A Project Inception Workshop will be held within the first 2 months of Project commencement with those entities with assigned roles in the Project's organization structure, UNDP Country Office and, when appropriate / feasible, regional technical policy and programme advisors (RTAs), as well as other stakeholders. The Inception Workshop is crucial to building ownership for the Project's results and to plan the first year annual Work Plan (AWP). The Inception Workshop should address a number of key issues including:

a) Assist all partners to fully understand and take ownership of the Project. Detail the roles, support services and complementary responsibilities of UNDP CO and RCU staff vis à vis the project team. Discuss the roles, functions, and responsibilities. Within the Project's decision-making structures, treats reporting and communication lines, and conflict resolution mechanisms. The Terms of Reference for project staff will be discussed again as needed.

b) Based on the Project's results framework and GEF-CC Tracking Tool, finalize the first Annual Work plan. Review and agree on the indicators, targets and their means of verification, validate assumptions and re-assess risks.

c) Provide a detailed overview of reporting, monitoring and evaluation (M&E) requirements. The Monitoring and Evaluation work plan and budget should be agreed and scheduled.

d) Discuss financial reporting routines and obligations, and arrangements for annual audit.

e) Roles and responsibilities of all Project organization structures should be clarified and meetings planned. The first Project Board meeting should be held within the first 12 months following the inception workshop.

The Inception Report is a key reference document and must be prepared and shared with participants to formalize various agreements and plans decided during the Inception Workshop.

Quarterly Monitoring (QPR)

- Progress made shall be monitored and recorded in the UNDP Enhanced Results-based Management Platform.
- Based on the initial risk analysis submitted, the risk log shall be regularly updated in ATLAS. Risks become critical when the impact and probability are high. Note that for UNDP GEF projects, all financing risks associated with financial instruments: such as revolving funds, micro-finance schemes, or capitalization of ESCOs are automatically classified as critical on the basis of their innovative nature (high impact and uncertainty due to no previous experience justifies classification as critical).
- Based on the information recorded in Atlas, a Project Progress Report (PPR) can be generated in the Executive Snapshot.
- Other ATLAS logs can be used to monitor issues, lessons learned etc. The use of these functions is a key indicator in the UNDP Executive Balanced Scorecard.

Annual Progress

Project Implementation Reports (PIR) will be prepared annually by the Project Manager to monitor progress made since project start and in particular for the reporting period (30 June to 1 July). The PIR combines both UNDP and GEF reporting requirements.

The PIR includes, but is not limited to, reporting on the following:

- Progress made toward project objective and project outcomes - each with indicators, baseline data and end-of-project targets (cumulative)
- Project outputs delivered per project outcome (annual)

- Lesson learned/good practice
- AWP and other expenditure reports
- Risk and adaptive management
- ATLAS QPR

A GEF focal area tracking tools will be used several times during project life (inception, mid-term, and closure) to measure progress towards focal area specific objectives.

Periodic Monitoring

UNDPCO and the UNDP RCU will conduct visits to project sites based on the agreed schedule in the project's Inception Report/Annual Work Plan to assess first hand project progress. Other members of the Project Board may also join these visits. A Field Visit Report/BTOR will be prepared by the CO and UNDP RCU and will be circulated no less than one month after the visit to the project team and Project Board members.

Mid-Term Review (MTR)

The project will undergo an independent Mid-Term Review at the mid-point of project implementation (insert date). The Mid-Term Review will identify the progress being made toward the achievement of outcomes and suggest course corrections if needed. It will focus on the effectiveness, efficiency and timeliness of project implementation; highlight issues requiring decisions and actions; and present initial lessons learned about project design, implementation and management. Findings of the MTR will be incorporated as recommendations for enhanced implementation during the final half of the project's term. The organization, terms of reference and timing of the mid-term evaluation will be decided after consultation between the parties to the project document. The Terms of Reference for this Mid-Term Review will be prepared by the UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF. The management response and the evaluation will be uploaded to UNDP corporate systems, in particular the UNDP Evaluation Office Evaluation Resource Centre (ERC).

Terminal Evaluation (TE)

An independent Terminal Evaluation will take place three months prior to the terminal meeting. The TE will focus on similar issues as the MTR and further look at impact and sustainability of results, including the Project's contribution to capacity development and to the achievement of global environmental goals and lessons learnt. The TE will also provide recommendations for follow-up activities. The terms of reference will be prepared by UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF[71]. The selection and contracting process will be assumed by UNDP CO. The associated budget commitments will be charged to the GEF resources allocated to the Project.

End of Project

During the last three months, the Project Management Team will prepare the Project Terminal Report. This comprehensive report will summarize the results achieved (objectives, outcomes, outputs), lessons learned, problems met and areas where results may not have been achieved. It will also lay out recommendations for any further steps that may need to be taken to ensure sustainability and replicability of the Project's results.

[71] See: "Handbook on Planning, Monitoring and Evaluating for Development Results", UNDP, 2009 (www.undp.org)

M&E budget

The Budget for M&E is US$ 90,000 (US$ 70,000 GEF grant and US$ 20,000 co-financing) and included under Project management. Day-to-day monitoring of the status of the activities under implementation, standard reporting including the preparation of PIR, is considered as part of Project Management and financed from the PM budget.

M&E workplan and budget

Type of M&E activity	**Responsible Parties**	**Budget US$** *Excluding project team staff time*	**Time frame**
Inception Workshop and Report	• Project Manager • UNDP CO, UNDP GEF	US$ 5,000 (GEF) US$ 10,000 (GOC)	Within first two months of project start up
Measurement of Means of Verification of project results.	▪ UNDP GEF RTA/Project Manager will oversee the hiring of specific studies and institutions, and delegate responsibilities to relevant team members.	To be finalized in Inception Phase and Workshop.	Start, mid and end of project (during evaluation cycle) and annually when required.
Progress monitoring using indicated means of verification on outputs and implementation	▪ Oversight by Project Manager ▪ Project team	To be determined as part of the Annual Work Plan's preparation.	Annually prior to ARR/PIR and to the definition of annual work plans
PIR preparation and approval	▪ Project Manager and team ▪ UNDP CO ▪ UNDP RTA ▪ UNDP EEG	None	Annually
Periodic status and progress reports	▪ Project Manager and team	None	Quarterly
Mid-term Review & Terminal Evaluation	▪ UNDP CO and UNDP RTA ▪ EEIH ▪ External Consultants	US$ 55,000 (GEF) US$ 5,000 (GOC)	24 months after Project start and End of project
Project Terminal Report	▪ Project manager and team ▪ UNDP CO ▪ local consultant	0	At least three months before the end of the project
Audit	• UNDP CO • Project Manager and team • EEIH	US$ 5,000 (GEF)	Yearly (from year 2)
Visits to field sites	• UNDP CO • UNDP RCU (as appropriate) • Government representatives	For GEF supported projects, paid from IA fees and operational budget	Yearly
Dissemination of lessons learnt	• Project Manager and team • Local consultant	US$ 5,000 (GEF) US$ 5,000 (GOC)	At least three months before the end of the project
TOTAL indicative COST Excluding project team staff time and UNDP staff, including travel expenses		Total: US$ 90,000 (GEF: US$ 70,000, GOC: US$ 20,000)	

LEGAL CONTEXT

This Project Document shall be the instrument referred to as such in Article 1 of the Standard Basic Assistance Agreement "*Acuerdo Básico modelo de Asistencia entre el Gobierno de Cuba y el Programa de las Naciones Unidas para el Desarrollo*", signed by the Government of Cuba and the UNDP on May 17th, 1975. The host country implementing agency shall, for the purpose of the Standard Basic Assistance

refer to the government cooperation agency described in that Agreement. The objectives and results foreseen in the Project are in line with the Country Programme Document signed between the Government of Cuba and UNDP for the period 2014-2018.

The UNDP Resident representative in Cuba is authorized to effect in writing the following types of revisions to this Project Document, provided that he/she has verified the Agreement thereto by the UNDP-GEF Unit and is assured that the other signatories to the Project Document have no objection to the proposed changes:

- Revision of, or addition to, any of the annexes to the Project Document;
- Revisions which do not involve significant changes in the immediate objectives, outputs or activities of the project, but are caused by the rearrangements of the inputs already agreed to or by cost increases due to inflation;
- Mandatory annual revisions which rephrase the delivery of agreed project inputs or increased expert or other costs due to inflation or take into account agency expenditure flexibility, and;
- Inclusion of additional annexes and attachments only as set out here in this Project Document.

OTHER ARRANGEMENTS

Communications and visibility requirements

Full compliance is required with UNDP's Branding Guidelines. These can be accessed at http://intra.undp.org/coa/branding.shtml Specific guidelines on UNDP logo use can be accessed at: http://intra.undp.org/branding/useOfLogo.html Amongst other things, these guidelines describe when and how the UNDP logo needs to be used, as well as how the logos of donors to UNDP projects need to be used. For the avoidance of any doubt, when logo use is required, the UNDP logo needs to be used alongside the GEF logo. The GEF logo can be accessed at: http://www.thegef.org/gef/GEF_logo. The UNDP logo can be accessed at http://intra.undp.org/coa/branding.shtml

Also full compliance is required with the GEF's Communication and Visibility Guidelines (the "GEF Guidelines"). The GEF Guidelines can be accessed at: http://www.thegef.org/gef/sites/thegef.org/files/documents/C.40.08_Branding_the_GEF% 20final_0.pdf. Amongst other things, the GEF Guidelines describe when and how the GEF logo needs to be used in project publications, vehicles, supplies and other project equipment. The GEF Guidelines also describe other GEF Requirements regarding promotional press releases, press conferences, press visits, visits by Government Officials, productions and other promotional items. Where other agencies and project partners have provided support through co-financing, branding their policies and requirements should be similarly applied.

Auditing arrangements

Audit on Project will follow UNDP Financial Regulations and Rules and applicable Audit policies.

Learning and knowledge sharing

Results from the Project will be disseminated within and beyond the Project's intervention zone through existing information sharing networks and forums. The Project will identify identity and participate, as relevant and appropriate, in scientific, policy-based and/or any other networks, May be of benefit to Project Implementation lessons learned. The Project will identify, analyse, and share lessons learned that might be beneficial in the design and Implementation of like future projects. Finally, there will be a two-way flow of information between this Project and other projects of a same focus.

ANNEXES

ANNEX A List of documents

1. Suárez, J.; Martín, G. J.; Sotolongo, J. A.; Rodríguez, E.; Savran, Valentina; Cepero, L.; Funes-Monzote, F. R.; Rivero, J. L.; Blanco, D.; Machado, R.; Martín, C. & García, A. 2011. Experiencias del proyecto BIOMAS-CUBA. Alternativas energéticas a partir de la biomasa en el medio rural cubano. Pastos y Forrajes, 34 (4): 473-496.
2. Bogdanski, Anne; Dubois, O.; Jamieson, C. & Krell, R. 2011. Making Integrated Food-Energy Systems Work for People and Climate: An Overview. FAO, Rome, 136 pp.
3. Suárez, J. & Martin, G. (Eds.). 2012. La biomasa como fuente renovable de energía en el medio rural: La experiencia de BIOMAS-CUBA. Estación Experimental "Indio Hatuey", Matanzas, Cuba.
4. Cuba: A Country Profile on Sustainable Energy Development, ISBN 978–92–0–101708–6, International Atomic Energy Agency, Vienna, 2008.
5. Statistical Yearbook of 2012 (Anuario Estadístico de Cuba 2012), Oficina Nacional de Estadística e Información, La Habana, Cuba, ISBN: 978-959-7119-62-3 (edition 2013).
6. Jiménez, O.; Curbelo, A. & Suárez, Y. 2012. Biomass based gasifier for providing electricity and thermal energy to off-grid locations in Cuba. Conceptual design. Energy for Sustainable Development, 16: 98-102.
7. Arrastía Avila, M.A., Distributed generation in Cuba feature, Cogeneration and On-Site Power Production, Nov-Dec 2008.
8. Initial National Communication of Cuba to the UNFCCC (2000).
9. Planos, E.; Rivero R.; Guevara V. (Eds.), Impacto del Cambio Climático y Medidas de Adaptación en Cuba. Instituto de Meteorología. Agencia de Medio Ambiente (2013).

ANNEX B Risk analysis

#	Description	Date Identified	Type	Impact & Probability	Countermeasures / Mgmt. response	Owner	Submitted, updated by	Last Update	Status
1	Limited government support would hamper market development for small-scale bioenergy technologies in Cuba	PPG	Strategic	Enter probability on a scale from 1 (low) to 5 (high) P = 2 Enter impact on a scale from 1 (low) to 5 (high) I = 5	The Government has given political support to the present initiative through MINCEX, CITMA (Cubaenergia), and MES (EEIH), enabling the Executing Agency to take full ownership of the Project. As such, implementation risks are expected to be very low. On the other hand, the Project aims to prioritize small-scale bioenergy on the national agenda; presently, awareness and knowledge among policy-makers is still limited, partly because decentralized energy systems represent a paradigm shift for the sector. In the context of the Cuban economy, policy support is a necessary condition to supply the market. The Project design includes specific actions targeting the high policy levels, including: information and policy tools, strengthening of Cubaenergia, and demonstration of the benefits and relevance of bioenergy for Cuba.	Cubaenergia	UNDP CO	Submission date	No change
2	Complex national processes regarding project approval and timely delivery of project activities and contracts, including procurement of good and services.	PPG	Operational	P = 3 I = 3	The Project context and institutional set-up, involving multiple Government entities, may slow down project execution. This risk is deemed probable, although impact is limited to a prolonged project implementation time. This risk is controlled by adequate monitoring and proactive planning. Moreover, the project components can largely be implemented in parallel, hence accumulative delays should be minimal.	Project Manager	UNDP CO	Submission date	No change
3	Economic underperformance of the proposed bioenergy solutions would impede sustainability and the development of local markets.	PIF	Regulatory	P = 1 I = 5	Economic underperformance of bioenergy solutions supported by the project could be caused basically by higher cost; lower price or limited market in comparison with planned ones. The approach to reduce this risk would be focus on the development of an appropriate regulatory framework. This framework would be introduce incentive for acquisition of equipment and raw materials, establish price schemes for bioenergy products and facilitate	Project Manager	UNDP CO	Submission date	No change

#	Description	Date Identified	Type	Impact & Probability	Countermeasures / Mgmt. response	Owner	Submitted, updated by	Last Update	Status
					the access to the market. The approval of the policy for the development of renewable energy by the National Assembly creates a positive environment for this proposal				
4	Lack of work capital to produce bioenergy systems (digesters, biodiesel plants) in substantial numbers, would impede a successful market transformation	PPG	Financial	P = 3 I = 4	In the Cuban context, the Government is responsible for assigning resources to the national industry. Locally applied bioenergy technologies are expected to be economically attractive, providing a strong rationale for the Government to invest. However, fiscal resources are always competed for, hence scarce. The Project addresses this risk by presenting a strong bioenergy case for rural farmers in Cuba and transmitting this message at high political level.	Cubaenergia	UNDP CO	Submission date	No change
5	Inadequate plant operation would jeopardize the efficient and cost-effective production of biogas and biodiesel	PIF	Operational	P = 1 I = 3	Proper operation is a key factor for biodigesters and biodiesel plants. The importance thereof will be highlighted throughout the Project and end-users will be trained on O&M aspects.	Project Manager	UNDP CO	Submission date	No change
6	Project development capabilities, maintenance services and technical assistance would not be available for end-users	PIF	Organizational	P = 3 I = 4	The Project will build upon EEIH, acting as a national expertise centre and positive experiences with the role of community-based technicians in past renewable energy projects. Multi-stakeholder consultations will be held to ensure effective support structures and political backing. The project will promote the establishment of local markets for biodigesters and biodiesel production plants. The network of local industries, technicians and service providers will enable the users to access technical assistance at an affordable cost level.	Project manager	UNDP CO	Submission date	No change

ANNEX C Agreements

Co-financing letters are included in the project co-financing budget and listed in Part I, Section C of the CEO Endorsement Request. The following table summarizes the letters, which are submitted as a separate file:

Letter source	**Amount**	**Type**
Cubaenergía	50,000	In-kind
Estación Experimental "Indio Hatuey" (EEIH)- Executing Agency	2,034,900	Cash and In-kind
Local manufacturers • *Industria Nacional Productora de Utensilios Domésticos (INPUD)* • *Empresa de Equipos Industriales Marcel Bravo (INTEC)* • *Empresa Cubana de Acero* • *Empresa de la Goma (POLIGOM)*	6,130,875	Cash and In-kind
EEIH/ Donor Programmes • *SDC / Biomas Cuba* • *EU-OIKOS / Agroenergía*	11,683,332	Cash and In-kind
UNDP	50,000	Cash
TOTAL	**$19,949,107**	

ANNEX D Calculation of GHG benefits

The global environmental benefits of the Project are associated with (i) the implementation of on-grid renewable energy (biomass-based electricity generation); and (ii) market development of renewable energy based electricity generating capacity. The following table (based on the GEF Manual[72], page 3) summarizes the methodology used:

Type of GHG emission reduction	**Direct (A)**	**Indirect (B, C)**	
Component of GEF intervention that can cause this type of GHG emission reduction	Direct implementation of RE technologies	The Project does not establish a direct replication mechanism. GHG benefits obtained from leveraged investments are considered as effects of market transformation.	Market transformation
Logframe (SRF) level	Output 2.8	n/a	Medium-term impact after project termination (10 years)
Quantification method	Direct evaluation of environmental benefits over lifetime (verification of installed RE capacity and baseline assumptions)	n/a	Bottom-top approach based on expected market development of small-scale biodiesel and biogas technologies to replace diesel fuel used by farmers and communities in rural Cuba.
Quality of Assessment	Based on expected performance 2 biodiesel production units (200 and 400 l/day); and 5 biogas systems (for total of 500 pigs). Error range is estimated at +/-50%.	n/a	Based on: (i) assumption that 1,000 ha of Jatropha will be added yearly over 10-year time period, yielding 750 l/ha; (ii) over a 10-year period, a total biogas production of 110,000 m^3/day is achieved from the sector's 500,000 pigs, of which 50% is effectively used; (iii) baseline shifts are included in the applied GEF causality factors (60%); (iv) CO2-intensity of diesel fuel is 3.135 kg CO_{2eq}. The error range in the assessment is expected to be -50% to +150%.

Indirect benefits

Project stakeholders acknowledge that there is large scope for the application of biogas and biodiesel technologies in Cuba, but present estimates are still largely theoretical, as can be derived from Annex E. There is little information available however, to make a realistic top-bottom estimate of the technical and

[72] GEF/C.33/Inf.18, April 16, 2008

commercial potential. Therefore, a bottom-top approach is followed to evaluate the indirect GHG benefits over a 10-year period.

Biodiesel

The first Jatropha pilot in Guantanamo, implemented under the SDC BIOMAS I Project, covers approx. 100 ha. This is taken as a (realistic) limit for plantation sizes in a community. Instead of Jatropha monoculture, it is further assumed that Jatropha is intercropped with other (food) plants, with an intercropping ratio of 3:10. Empirical data with Jatropha production in Cuba report an annual production of 0.7 litre of Jatropha oil per tree. At the indicated intercropping rate, oil production would be of the order of 700-800 litre per ha per year[73]. For the present calculation, a mean value of 750 l/ha is taken.

It is assumed that this model is replicated 100-fold over the next years, adding to total of 10,000 ha planted with Jatropha. (For comparison: this area is equal to 6.4% of the total idle and non-used land in the Las Tunas Province.) The total Jatropha oil production (obtained form 10,000 ha intercropped Jatropha plantations) would be about 7.5 mln litre per year. The GEF Project will contribute to achieving environmental benefits by enabling the conversion of plant oil into biodiesel, which will replace fossil fuel (diesel). It is assumed that similar conversion efficiencies are obtained for biodiesel and conventional diesel technologies, which is expectedly the case within an accuracy range of less than 10%.

Assuming 1,000 ha of mature Jatropha plants are added yearly during a 10-year time horizon, additional 700,000 litre oil is being produced yearly, reaching the target production of 7.5 mln litre (corresponding to 10,000 ha under production) in Year 10. The total oil production over this time series (with N = 10 years) would be:

$1/2*N / (N-1) * N * 750{,}000 \text{ litre} = 5.5 * 10 * 750{,}000 \text{ litre} = 41{,}250{,}000 \text{ litre}.$

At a CO_2 intensity for diesel fuel of 3.135 kg CO_{2eq} per litre, the emission savings from replaced fossil fuel (diesel) are of the order of:

$41{,}250{,}000 * 3.135 \text{ kg } CO_{2eq} \text{ per litre} = 129{,}318{,}750 \text{ kg } CO_{2eq}$, or 129,319 ton $CO_{2eq.}$

By assuming a GEF causality factor of 60%[74], a total of 77,591 ton CO_{2eq} can be ascribed to the Project over a 10-year period (approximately 77.6 kton CO_{2eq}).

Biogas

For biogas, an estimate can be obtained by only considering the small- and medium-size private pig farmers. This group, which is targeted by the Project, holds no less than 500,000 pigs. At a typical manure production of 4 kg per animal per day, the total pig manure production is estimated at approx. 2.0 mln kg/day. The biogas production is 110,000 m^3/day[75], equivalent to 241,000 MWh/yr (20,700 ton oil equivalent)[76]. In terms of energy content[77], this replaces 148,000 oil barrels (of 159 litre).

However, only part of this biogas potential can actually be used, since many farmers produce more biogas than needed. Local distribution networks and the introduction of biogas-based appliances can enable a higher penetration rate of biogas in the rural areas. Even if biogas is used for electricity generation in

[73] SDC Biomas publication, p. 97 and p.189.
[74] Level 3, "The GEF contribution is substantial, but modest indirect emission reductions can be attributed to the baseline". See Manual GEF/C.33/Inf.18, April 16, 2008.
[75] One kg of pig manure produces approx. 0.054 m^3 of biogas (see Annex E).
[76] 1 m^3 of biogas has an energy content of 6 kWh (heat).
[77] Assuming an energy density per litre oil of 10.24 kWh.

combination with local electricity grids, the total biogas utilization factor will likely be no more than 50%. However, additional biogas potential is found in the state sector, and in cattle farming.

Assuming that about 50% of this potential is effectively used by the farmers or the local community, the biogas produced would replace about 74,000 barrels of oil per year. The GHG emission intensity of oil varies per source. As a reference value, the figure for diesel fuel is taken (3.135 kg CO_{2eq} per litre). Then, the associated emission savings would be of the order of:

74,000 barrels * 159 litre * 3.135 kg CO_{2eq} / litre = 36,900 ton CO_{2eq} per year.

Assuming that biogas technology is introduced proportionally over a 10-year time period (yielding an additional 3,690 tons CO_{2eq} savings per year, the total accumulated, indirect benefits would be:

1/2*N / (N-1) * N * 3,690 ton CO_{2eq} = 5.5 * 10 * 3,690 ton CO_{2eq} = 202,875 ton CO_{2eq}.

By assuming a GEF causality factor of 60%, a total of 121,725 ton CO_{2eq} per year can be ascribed to the Project (approximately 121.8 kton CO_{2eq}).

The total indirect emission reductions attributable to the GEF project are estimated at:

77.6 + 121.8 = 199.4 kton CO_{2eq} over a 10-year time horizon.

However, market development for biogas may well develop faster, with attributable emission reductions approaching 200 kton CO_{2eq}. For biodiesel, total planted area can also be larger, possibly 20,000 ha after 10 years. In this case, the associated emission reductions would double (150 kton CO_{2eq}). If combined, the total indirect emission reduction would become 320 kton CO_{2eq}. In the absence of more specific data, the indirect emission reductions are likely to be in the range of 100 - 350 kton CO2eq.

Direct benefits

Biodiesel

It is envisaged to build and install at least three fully operational biodiesel production plants under the Project, with capacities of 100, 200 and 400 l/day, respectively (together 700 l/day). It is assumed that these units will be operated at an average 50% of the nominal capacity. The total yearly biodiesel production will be:

365 days/year * 50% * (100 + 200 + 400) litre/day = 127,750 litre/year.

Based on similar Jatropha planting scheme as above, which yearly deliver 750 litre per hectare, the total area required to supply Jatropha oil seeds to the units, would be:

(127,750 litre/year) / (750 litre/year-ha) = 170 hectare.

At a CO_2 intensity for diesel fuel of 3.135 kg CO_{2eq} per litre, the emission savings from replaced fossil fuel (diesel) are of the order of:

127,750 litre/year * 3.135 kg CO_{2eq} per litre = 400,496 kg CO_{2eq}/yr, or 400.5 ton CO_{2eq}/yr.

Assuming a 15-year economic lifetime of the biomass plants, the accumulated direct emission reductions would be:

15 years * 400.6 ton CO_{2eq}/yr = 6,007 ton CO_{2eq} (or 6.0 kton CO_{2eq}).

Biogas

The Project pursues the installation of five demonstration pilots using biogas technology under the agroenergy farm concept. These pilots will be selected and detailed in the first phase of the Project. For simplicity, here it is assumed that the five biodigesters will, in total, process the manure of 500 pigs (100 animals per farm is a representative figure for the sector, which ranges from 20 to more than 200 animals per producer). The total manure produced is:

500 animals * 4 kg /day per animal = 2,000 kg/day.

The daily volume of biogas produced is:

2,000 kg/day * 0.054 m^3/kg = 108 m^3/day.

The annual energy production is:

108 m^3/day * 365 days * 6 kWh/m^3 = 236.5 MWh/yr.

This is equivalent to the energy content (heat) of: 23,093 litre of diesel fuel (equivalent to 145.2 barrels).

At a CO_2 intensity for diesel fuel of 3.135 kg CO_{2eq} per litre, the emission savings from replaced fossil fuel (diesel) are of the order of:

23,093 litre/year * 3.135 kg CO_{2eq} per litre = 72,397 kg CO_{2eq}/yr, or 72.4 ton CO_{2eq}/yr.

Assuming a 10-year economic lifetime of the biomass plants, the accumulated direct emission reductions would be:

10 years * 72.4 ton CO_{2eq}/yr = 724 ton CO_{2eq} (or 0.72 kton CO_{2eq}).

The total direct emission reductions attained by the Project are:

6.0 + 0.72 = 6.7 kton CO_{2eq}.

Total emission reductions

The combined, total emission reductions attributable to the GEF project are estimated at:

199.4 + 6.7 = 207.1 kton CO_{2eq}.

ANNEX E Market potential for biogas and biodiesel technology for small-scale farming

1. Indicative estimate of land area suited for Jatropha production

The following table provides an overview of land use for agricultural and cattle farming in Cuba. The data are based on the Report "Land use and ownership in Cuba" published by the National Office for Statistics and Information (ONEI) in May 2008.

LAND AREA FOR AGRICULTURE, FORESTRY AND OTHER USES IN CUBA		
Description	Area (in 1,000 ha)	
Total	**10,988.6**	**100.0%**
Keys	312.6	2.8%
Mainland	10,676	97.2%
Agriculture	**6,619.5**	**60.2%**
Cultivated	2,988.5	27.2%
Temporary	1,187.2	10.8%
Not cultivated	**3,631**	**33.0%**
Pasture and fodder	2,398.2	21.8%
Idle	1,232.8	11.2%
Non-agriculture	**4,369.1**	**39.8%**
Forestry (including deforested areas)	3,047	27.7%
Unsuitable	469.7	4.3%
Water surfaces	345	3.1%
Settlements	507.5	4.6%

Using the data published by ONEI in its Annual Bulletin 2012, one can determine the total idle or not cultivated areas per province and aggregated, for the national territory. This allows making an estimate of the theoretically available area for cultivating Jatropha curcas.

IDLE LAND AREA PER PROVINCE IN CUBA (IN HA)					
Province	**Total area**	**Not cultivated**	**Idle**	**Total**	
Total Cuba	10,988.4	389.7	975.5	1365.2	12%
Pinar del Río	888.4	8.8	67.4	76.2	9%
Artemisa	400.3	13.2	22	35.2	9%
La Habana	72.8	0.2	0.1	0.3	0%
Mayabeque	374.4	29.5	15.4	44.9	12%
Matanzas	1,179.2	42.6	49.8	92.4	8%
Villa Clara	841.2	26.7	67.8	94.5	11%
Cienfuegos	418.9	15.9	62.3	78.2	19%
Sancti Spíritus	677.7	17.6	19.3	36.9	5%
Ciego de Ávila	697.2	49.4	99.1	148.5	21%
Camagüey	1,538.6	52.2	299.9	352.1	23%
Las Tunas	659.3	29.7	126.1	155.8	24%
Holguín	921.6	38.5	13.7	52.2	6%
Granma	837.4	35.8	70.3	106.1	13%

Stgo. de Cuba	622.8	10.7	27	37.7	6%
Guantánamo	616.8	12.2	28.1	40.3	7%
Isla de la Juventud	241.9	7	6.9	13.9	6%

As can be deduced from the table, about 12% of the total land area is presently not used, especially in the provinces Camagüey (24%) and Las Tunas (23%).

2. Preliminary estimate of biogas potential in Cuba.

A preliminary study of the biogas potential in Cuba was carried out during the PPG, covering the sectors MINAG, MINAL, and AZCUBA (Sugar industry). It is observed that sector data were found to be outdated, incomplete and not always consistent, which greatly limits the accuracy of the present study. The livestock sector (MINAG) was divided into the subsectors poultry, pig farms (state and cooperatives), and bovine. For the industrial sector (MINAL and AZCUBA), the 12 most relevant industries and distilleries were considered.

Poultry:

Poultry production in Cuba is predominantly controlled by the State. The organization of the sector in the National Union of Combined Poultry Enterprises (UECAN) is as follows:

- 11 food producers
- 19 poultry enterprises
- 1 goose farm
- 1 poultry genetics enterprise
- 1 poultry industry supplier enterprise
- 1 input provider
- 1 research institute

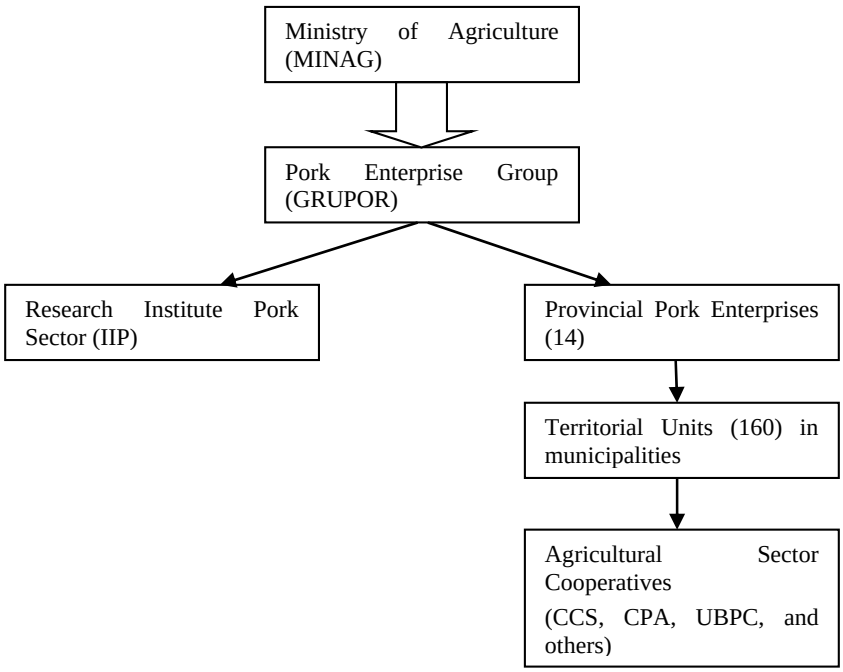
There are at least 134 poultry production units in the country. The poultry enterprises are subdivided in chicken farms for egg production, substitution, and reproduction. Using a key figure for chicken manure values of 0.15 kg/day (equiv. to 0.054 m^3/day), the biogas production per farm type can be estimated.

BIOGAS POTENTIAL IN POULTRY SECTOR IN CUBA			
Farm type	Number of animals	Biogas production (m^3/day)	Energy equivalent (toe/year)
egg production	11,636,000	95,315	18,059
substitution	2,227,000	18,044	3,419
reproduction	71,000	582	110
Total	13,936,000	113,942	21,589

It is observed that the present egg production process does not allow continuous recollection of chicken manure. The manure is neutralized by mixing with chalk and removed after the productive cycle. Therefore, a technology change is needed in the sector in order to take benefit from the manure for energy production. Moreover, the carbon-nitrogen (C-N) ratio in the manure is insufficient for biogas production by anaerobic digestion. This can be solved by adding a carbon-rich material, such as grass, wood particles, and paper, etcetera.

Pig farms

The production of pork meat in the country is concentrated in the Pork Enterprise Group, which is directly responsible for about 60% of the total production, the remainder being produced by small and medium-sized private producers[78]. One of the links between the state-owned companies and the private producers consists in contracts determining the delivery of mature animals by the latter. The organizational structure of the production chain in the pig farming sector is:



At the end of 2007, Cuba has 14 provincial pork enterprises and 160 municipalities with territorial units linked to these enterprises, which belong to the Pork Enterprise Group (GRUPOR). Also in 2007, non-specialized pork meat production has started by the Agricultural Sector Cooperatives, which transforms this sector into the largest food production sector in Cuba. In total there are 122 state farms and approximately 6,000 private pig raising farms in the country.

The farms owned by the state enterprises are classified into the following types: production, genetics, reproduction, and integrated. The following key figure for pig manure is used to estimate the biogas production: 0.05 kg/day per kg animal weight (equiv. to 0.054 m^3/day). The animal weight is obtained from the ONEI data as an average value (80 kg); hence manure production is typically 4 kg per animal per day. The number of animals held by the state and private sector is provided by MINAG. The biogas potential and energy content is presented in the following table.

[78] Source: National Statistics and Information Office ONEI, Ganaderia en cifras 2010.

BIOGAS POTENTIAL IN PIG FARMING SECTOR IN CUBA					
Enterprise type	Number of animals	Weight (kg)	Manure production (kg/day)	Biogas production (m^3/day)	Energy content (toe/yr)
Private	510,972	80	2,043,888	110,370	20,912
State	286,693	80	1,146,772	61,925	11,733
Total	833,175	80	3,332,700	179,965	34,098

Bovine

Milk and cow meat are mainly produced by the private sector, which holds over 80% of all cattle stock. For this sector, there is no state-controlled enterprise system. Information on the number of cattle is managed by the (private and state) enterprises, which report their data to the National Livestock Control Centre (CENCOP) and MINAG. Bovines are usually semi-stabulated. Only milk cows enter the stables regularly, supposedly about 5 hours per day, during which their manure can be collected. By assuming that 5 kg of manure per animal can be recovered per day, the biogas production by the sector is estimated as shown in the next table.

BIOGAS POTENTIAL IN DAIRY SECTOR IN CUBA				
Animal type	Number of animals	Manure production (kg/day)	Biogas production (m^3/day)	Energy content (toe/yr)
Productive milk cows	4,084,642	20,423,210	1,029,329	195,030

The total number of bovine holders/enterprises in Cuba has been estimated at 3,033.

Food industry (MINAL)

Within the food industry, the establishments with the largest impact on the environment are the meat processing factories (15), the breweries (5), the dairy factories (15), and the alcohol distilleries. The following table presents the biogas potential estimated for a selection of 12 establishments (1 distillery, 3 dairy factories, 6 meat factories, and 2 breweries).

BIOGAS POTENTIAL IN FOOD INDUSTRY SECTOR IN CUBA			
Sector	Number of establishments	Biogas production (m^3/day)	Energy content (toe/yr)
MINAL	12	25,959	4,896

Sugar sector (AZCUBA)

The sugar industry produces two main streams of effluents that can be treated with anaerobic technologies:

- the residues and juice filtrate ("cachaza");
- the vinasse, which is left after the distillation process.

There is very little quantified information available about the potential related to the cachaza. Treatment of vinasse of the 12 largest distilleries provides the following potential.

BIOGAS POTENTIAL IN SUGAR SECTOR IN CUBA			
Sector	Number of establishments	Biogas production (m^3/day)	Energy content (toe/yr)
AZCUBA	12	142,465	26,992

ANNEX F Empirical results with Jatropha production under BIOMAS Project

This annex briefly presents key results with Jatropha production under the agroenergy concept. The text and data are based on the section *"Producción integrada de biodiesel y alimentos: la concepción de una tecnología agroindustrial apropiada para Cuba"* by J.A. Sotolongo, J. Suárez, et al. For the original text (in Spanish) please refer to corresponding chapter in the BIOMAS publication[79].

In 2009, cultivation of non-edible vegetal oil varieties, mainly *Jatropha curcas*, for biodiesel production was started in Guantánamo, the eastern-most province of Cuba. Support was provided by the international project BIOMAS-Cuba, financed by SDC/COSUDE under the national coordination of the "Estación Experimental de Pastos y Forrajes Indio Hatuey" (EEIH - Matanzas) and the "Centro de Aplicaciones Tecnológicas para el Desarrollo Sostenible" (CATEDES - Guantánamo).

Between 2009 and 2011, a total of 109 ha were planted with Jatropha in combination with other crops. The land extensions involved the ranch "Granja Paraguay" and a number of small farms in Guantánamo, as well as minor extensions (6 ha) managed by EEIH (Matanzas) and by the "Estaciones de Pastos" in the provinces Sancti Spíritus and Las Tunas. Approx. 55% of this area involves soils that are unsuitable for conventional agricultural production and predominantly are fragile lands, exhibiting degradation of environmental and hydrological parameters. Priority was given to *Jatropha curcas* after an evaluation of the germplasm of different plant species.

Intercropping was studied at EEIH´s trial fields and in Guantánamo; in total, eight different combinations of plant distances were tested, of which the next patterns were found particularly relevant:

- 2.5 x 4 m (1,000 trees/ha), suitable for mechanized land operations, with 72% of the land area available for food production and 28% for energy;
- 2.5 x 3 m (1,333 trees/ha), adapted for animal traction (oxes), implying 64% land area for food production and 36% for energy.

Within these patterns, 21 different crops were tested in combination with Jatropha. Considerable yields were obtained for beans, soya, peanut, maize, cassave and sorghum, even applying minimum irrigation (basically focused to ensure plant survival during dry periods) and moderate bio-fertilization. The following table presents the crop yields obtained in combination with Jatropha.

AGRICULTURAL CROP YIELDS UNDER INTERCROPPING WITH JATROPHA (IN TON/HA)				
maize	rice	peanut	cassave	pumpkin
3-4	2.2	0.8	12-25	10

The productivity of Jatropha under these conditions was found to be as follows:

PRODUCTIVITY INDICATORS FOR JATROPHA AND BIODIESEL PER YEAR		
fruits	3.5	kg/tree
number of fruits per tree	989	/tree
shell weight	1.1	kg/tree

[79] Suárez, J. & Martin, G. (Eds.). 2012. La biomasa como fuente renovable de energía en el medio rural: La experiencia de BIOMAS-CUBA. Estación Experimental "Indio Hatuey", Matanzas, Cuba, p. 96 and following.

PRODUCTIVITY INDICATORS FOR JATROPHA AND BIODIESEL PER YEAR		
seed weight	2.4	kg/tree
seed press cake	1.7	kg/tree
oil	0.7	kg/tree
	0.8	l/tree
biodiesel	0.7	kg/tree
	0.8	l/tree
glycerine	62.8	ml/tree

Based on these experiences, the annual biodiesel production per ha is estimated between 800 and 1,025 l/ha. Given the local soil conditions, irrigation scheme and fertilization levels in Guantánamo, it is similar yields should also be attained in other area. However, more field data are needed to confirm this hypothesis.

ANNEX G Environmental and social screening template

ANNEX H Tracking Tool for Climate Change Mitigation Projects

ANNEX I Endorsement Letter

ANNEX J Cofinancing Letters