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## SRI LANKA

### GLOBAL ENVIRONMENT FACILITY PROJECT DOCUMENT

**Project Title:** Promoting Sustainable Biomass Energy Production and Modern Bio-Energy Technologies

**UNDAF Outcome(s):** Policies, programmes and capacities to ensure environmental sustainability, address climate change, mitigation and adaptation and reduce disaster risks in place at national, sub national and community levels

**Expected Output(s):**

Technologies and approaches used by government and private sector towards Climate Change Mitigation (CCM) improved

Development agencies are equipped with policies, strategies, methodologies and tools to integrate sustainable development and disaster resilience principles

**Expected Output Indicator(s):**

Amount of Green House Gas (GHG) emissions reduced as a result of promotion of modern biomass to Energy technologies

Number of policies, and strategies contributing towards sustainable and resilient development updated or developed

**Implementing Partners:** Ministry of Environment

Responsible Parties; Sustainable Energy Authority, Forest Department, UNDP and FAO


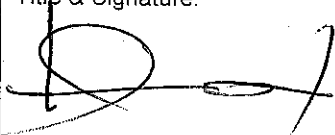

**Project Summary:**

The goal of the project is to reduce greenhouse gas emissions from the use of fossil fuel for thermal energy generation in the Sri Lanka industrial sector. The goal will be reached by means of removing barriers to the realization of sustainable biomass plantation, increase of market share of biomass energy generation mix and adoption of biomass-based energy technologies in Sri Lanka. The project consists of the following components: (1) Policy-institutional support for effective implementation; (2) Barrier removal for sustainable fuel wood production; (3) Enabling environment for fuel wood suppliers; (4) Wood-based energy technology development. The project is expected to generate global benefits in directly avoided greenhouse gas (GHG) emissions of almost 203 kilotons of CO<sub>2</sub> due to switching from fossil fuels to wood-based technologies (over the lifetime of 10 years) and almost 609 – 1,378 ktCO<sub>2</sub> as indirect emission reduction impact.

Programme Period: 2013-2017  
 Key Result Area: Environment and Sustainable Development  
 ATLAS Award ID: 00062498  
 ATLAS Project ID: 00080012  
 GEF Sec Project ID: 4096  
 PIMS: 4226  
 Start date: March 2013  
 End date: July 2017  
 Management Arrangement: NIM  
 PAC Meeting date: 20-9-2010

Total resources required:	USD 19,149,960
Total allocated:	USD 19,149,960
• Regular (UNDP):	USD 0
• Other (cash):	
o GEF (FAO)	USD 950,000
o GEF (UNDP)	USD 1,046,250
o Government	USD 9,759,320
o Private	USD 6,181,092
o NGOs:	USD 85,000
o FAO	USD 461,755
o Cost-sharing : (AusAID)	USD 402,000
• In-kind	USD 264,543

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Agreed by Government:	Title & Signature: 	Date: 10/7/2013
Agreed by UNDP:	Title & Signature: 	Date: 10/7/2013

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## ACRONYMS

APR-PIR	Annual Performance Report / Project Implementation Review
BEASL	Bio-Energy Association of Sri Lanka
BET	biomass energy technology
BPL	Balangoda Plantations Plc.
CBC	Commercial Bank of Ceylon
CCB	Coconut Cultivation Board
CRI	Coconut Research Institute
CP	UNDP Country Programme
CPAP	UNDP Country Programme Action Plan
CDM	Clean Development Mechanism
DEAC	Department of Export Agriculture (Crops)
EE	energy efficient
FAO	Food and Agricultural Organisation
FD	Forest Department (Dept. for Forest Conservation)
GEF	Global Environment Facility
GNP	gross national product
GWh	gigawatt-hour (1000 million watt-hours)
IDB	Industrial Development Board
ICRE	Inter-ministerial Committee on Renewable Energy
IUCN	International Union for the Conservation of Nature
ktCO <sub>2</sub>	1000 tonnes of carbon dioxide equivalent
kW	kilowatt (1000 Watt)
kWh	kilowatt-hour
LGF	loan guarantee facility
LKR	Sri Lanka rupee (USD 1 = LKR 110), also written as Rs.
LPG	liquid propane gas
MDG	Millennium Development Goals
M&E	monitoring and evaluation
MJ	megajoule (million of Joules)
MW	megawatt
MWh	megawatt-hour (1000 kilowatt-hour)
NCRE	non-conventional renewable energy
NDB	National Development Bank
NERDC	National Engineering Research and Development Centre
NGO	non-governmental organization
NSF	National Science Foundation
PEP	Promotion of Eco-efficiency Productivity project
PISCES	Policy Innovation Systems for Clean Energy Security
PPG	GEF project preparation grant
PMU	Project Management Unit
ProDoc	Project document
QPR	quarterly progress report
PV	photovoltaic
R&D	research and development
SEA	Sri Lanka Sustainable Energy Authority
SME	small and medium-sized enterprise
tCO <sub>2</sub>	tonne of carbon dioxide equivalent
TSHDA	Tea Small Holdings Development Authority
UN	United Nations
UNDAF	UN Development Assistance Framework
UNDP	UN Development Programme
UNFCCC	UN Framework Convention on Climate Change
USD	US dollar

# TABLE OF CONTENTS

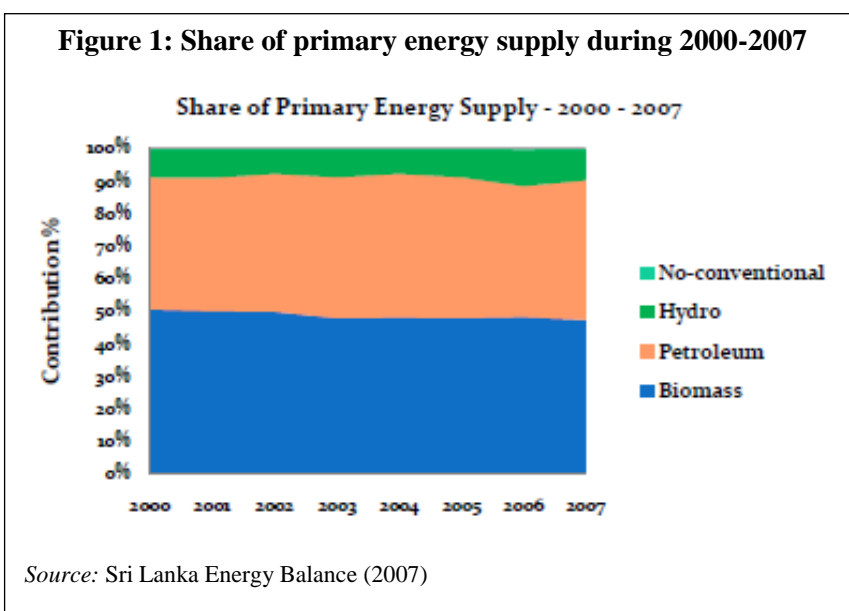
TABLE OF CONTENTS .....	5
PART 1. SITUATION ANALYSIS .....	6
1.    CONTEXT AND GLOBAL SIGNIFICANCE: ENVIRONMENTAL, POLICY AND INSTITUTIONAL .....	6
2.    POLICY AND INSTITUTIONAL CONTEXT .....	10
3.    ENERGY SOLUTIONS AND ‘NON-STATE’ STAKEHOLDERS.....	14
4.    BARRIER ANALYSIS .....	21
PART 2. PROJECT STRATEGY.....	25
5.    PROJECT RATIONALE, DESIGN PRINCIPLES AND STRATEGIC CONSIDERATIONS .....	25
6.    POLICY CONFORMITY AND COUNTRY OWNERSHIP .....	29
7.    PROJECT OBJECTIVE, OUTCOMES AND OUTPUTS .....	29
8.    KEY INDICATORS, RISKS AND ASSUMPTIONS .....	39
9.    GEF INCREMENTAL REASONING; COST-EFFECTIVENESS .....	41
10.   PROJECT RESULTS FRAMEWORK .....	44
11.   TOTAL BUDGET AND WORKPLAN .....	53
12.   MANAGEMENT ARRANGEMENTS .....	63
13.   STAKEHOLDER INVOLVEMENT .....	64
14.   MONITORING AND EVALUATION .....	66
15.   LEGAL CONTEXT AND OTHER AGREEMENTS.....	69
PART 3. ANNEXES .....	70
ANNEX A. TERMS OF REFERENCE OF KEY BODIES AND STAFF .....	70
ANNEX B. AGREEMENTS .....	73
ANNEX C. ENERGY SAVINGS, EMISSION REDUCTION CALCULATIONS AND COST-BENEFIT ANALYSIS.....	74
ANNEX D. IMPLEMENTATION ARRANGEMENTS.....	77

## Part 1. SITUATION ANALYSIS

### 1. CONTEXT AND GLOBAL SIGNIFICANCE: ENVIRONMENTAL, POLICY AND INSTITUTIONAL

#### Energy and bioenergy use in Sri Lanka

According to estimates made by the Sri Lanka Sustainable Energy Authority (SEA) in 2007, the major forms of primary energy used in Sri Lanka were biomass (47.4%), petroleum oil (43.0%), hydro- electricity (9.5%) and non-conventional (0.1%) (SEA, 2007). As such, Sri Lanka depends largely on imported oil and firewood to meet its energy requirements. Large dam hydroelectric plants were once the main source of electrical energy. Today, diesel and oil-fuelled thermal power plants provide the major share of the power requirements to the central grid.



The most common forms of biomass available in Sri Lanka are fuel wood (from forestry, arboricultural activities and wood processing), agricultural residues as well as animal, industrial and municipal organic waste. The use of biomass in the country's energy mix showed a decreasing trend in the recent past, down from 64.78% in 1990 to 47.4% in 2007, while the use of petroleum products

showed an increase, as indicated in Figure 1.<sup>1</sup>

Fuel wood includes wood harvested from main stems, branches and other parts of trees coming from natural forests, and other sources such as tea, rubber, coconut plantations, homesteads and roadsides. It also includes wood fuel from indirect sources such as wood processing industries (e.g. saw dust).

Traditional biomass fuel, primarily wood fuel, continues to play an important role in the energy balance of Sri Lanka. About 48% of biomass energy used in Sri Lanka is fuel wood extracted from various sources. The balance consists of agricultural and wood residues. Biomass energy is the most common source of energy in the household sector, small commercial and manufacturing applications consume around 20.3% and agro industries consume about 7.3% of the total biomass consumption (see Table 1).

<sup>1</sup> Attributed largely to domestic fuel switching in preference of petroleum products and increased oil-based power generation

**Table 1: Fuel wood consumption by sector**

Sector/industry	Fuel wood consumption (tonnes)	%
<i>Agro industry</i>		
Tea	610	5.4
Rubber	92	0.8
Coconut	120	1.1
<i>Manufacturing</i>		
Brick	950	8.4
Tile	630	5.6
Lime	280	2.5
<i>Commercial</i>		
Bakeries, hotels and eating places	430	3.8
<i>Household</i>		
Cooking	8,200	72.5

**Source:** Leelaratne, M.W, 2005. *Some Recent Technological Advancements in the Efficient Use of Biomass as an Energy Source in Sri Lanka*, Paper presented at the International Conference on "Issues of the Sustainable Use of Biomass Resources for Energy" National Engineering Research and Development Centre of Sri Lank, August 2005

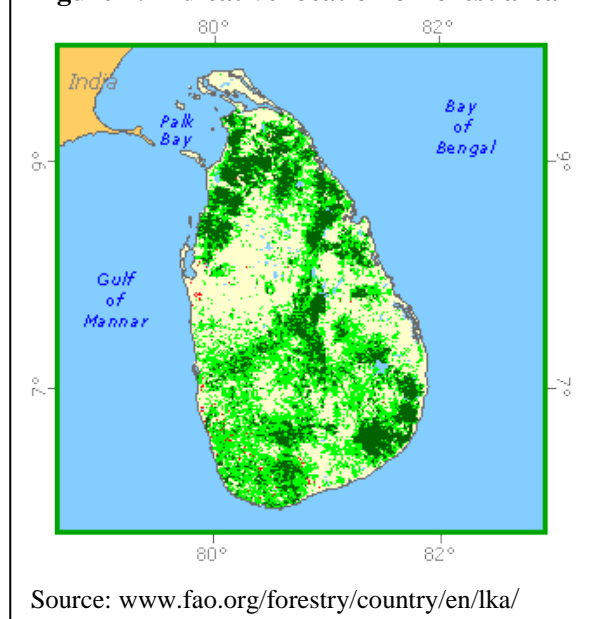
Under the Policy, the remaining natural forests are to be conserved while buffer-zones and plantation forests used sustainably to provide for the growing demand for bio-energy, wood- and non-wood forest products. Annually, over 4,000 hectares of forests have been planted and at present, the total plantation area stands at approximately 316,000 hectares. The plantings included industrial planting, enrichment planting in degraded natural forests. Protective planting with short-term four year lease agreements supported by payment of incentives have been carried out under the Participatory Forestry Programme (PFP). The activities under the PFP programme included developing home gardens and woodlots and awareness enhancement amongst farmers<sup>3</sup>.

The Government of Sri Lanka and international environmental organizations have made several steps to address the problem over the years, establishing national parks, forest reserves and sanctuaries, which now cover as much as 15% of the island's total area as of 2007.

## Deforestation and protected areas

Deforestation is one of the most serious environmental issues in Sri Lanka. In the 1950s, the island had a 49% forest cover but by 2005 this had fallen by approximately 20%<sup>2</sup>. Between 1990 and 2000, Sri Lanka lost an average of 26,800 ha of forests per year. This amounts to 1.1% of average annual deforestation rate. Between 2000 and 2005 rate accelerated to 1.4% per annum. However increasing legislation and regulations towards environmental protection, deforestation rates of primary cover have actually decreased 35% since the end of the 1990s, thanks to a series of conservation measures, such as wildlife protection, ban on logging, and introduction of a National Forest Policy.

**Figure 2: Indicative location of forest area**



<sup>2</sup> Forest Department forest cover maps

<sup>3</sup> Source: FAO website <http://www.fao.org/forestry/country/57478/en/lka/> with additional info from [http://en.wikipedia.org/wiki/Deforestation\\_in\\_Sri\\_Lanka](http://en.wikipedia.org/wiki/Deforestation_in_Sri_Lanka)

## Energy and bioenergy use in industries

Biomass is the main source of energy in industry (72%), followed by petroleum products (18%), and electricity (12%). However, this gives a skewed picture, because biomass is traditionally used in certain industries, located in areas where biomass is readily available. The dominant consumer is the tea industry (which is the largest industrial consumer of fuel wood, consuming about 455,000 tonnes

a year, representing 43% of industrial fuel wood consumption). Biomass is also used as source of process heat in certain small and medium industries, such as brick, tile and rubber-processing industries.

**Table 2: Biomass availability in Sri Lanka (2005)**

Sector/industry	kilotonnes/year	%
Rice husks available from commercial mills	179	6
Biomass from coconut plantations	1,062	37
Bio-degradable garbage	787	8
Saw dust and timber mills off-cuts	100	3
Biomass from home gardens, plantations, such as <i>Gliricidia</i>	506	18
	2,874	100

*Source:* BEASL (Bio-Energy Association of Sri Lanka) ([www.bioenergysrilanka.org](http://www.bioenergysrilanka.org))

About 10% of the petroleum fuels (coal, fuel oils and gas) amounting to 350,000 to 400,000 tonnes per annum, presently imported onto this country, is utilized by the industrial sector to generate process heat. Consumption level of furnace oil in 2007 was 186,210 tonnes. As mentioned earlier, due to high fossil fuel prices, fuel wood demand in industry has been fluctuating around 72% in the period 2000-2007 (but has increased in absolute terms from 1,052 thousand toe to 1,506 thousand toe)<sup>4</sup>. Even larger industries, traditionally reliant on furnace oil, diesel or LPG are planning to convert their processes to use wood.

Industrial thermal energy can be regarded as one of the major thrust areas for fuel switching (from fossil fuels to fuel wood or other biomass) as it offers the best economic justification. Another reason is formed by recent technological developments related to the conversion technology (such as gasification, see Section 3) and improved energy crop production. These developments have made it possible to produce bio-energy at lower cost and with higher conversion efficiencies, which could make it competitive with other commercialized fuels. This has been confirmed during the analysis performed consultants and stakeholder consultations in the project preparatory grant (PPG) phase. Regarding cost-effectiveness of diesel or furnace oil fired equipment vs. employing biomass gasification, refer to Annex C.

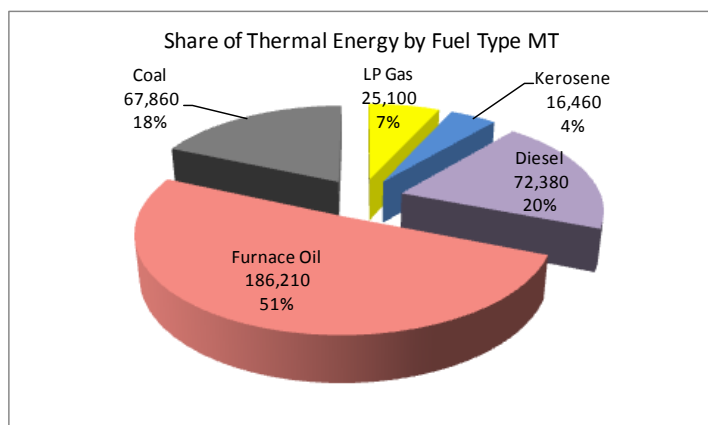
## Environmental aspects

It should be noted that most existing biomass technologies in Sri Lanka are traditional (in the household sector and small enterprises) and based on relatively inefficient burning by direct combustion in ovens, furnaces and inefficient boilers. These result in health problems and local environmental issues. For example, the increased demand for fire wood has placed additional pressure upon forests (both natural and planted).

<sup>4</sup> *Source: Energy Balance, 2007, (SEA). Toe: ton of oil equivalent*



**Figure 3: Fossil fuel types and proportions used in the industry**



Source: I. Gallage (2011), based on the 2007 Energy Balance

The biomass availability in 2005 was 2,873,880 tons per year (see Table 2). Woody biomass is an important component<sup>5</sup>, coming from tea estates, rubber and coconut plantations, home gardens, private farms that together supply some 70-75% of fuel wood in Sri Lanka. Rubber plantations and coconut may decline in the long term because of converting in to other land uses.

According to the First National Communication to the UNFCCC (2000),

greenhouse gas emissions were 33,630 ktCO<sub>2</sub> in 1994, of which 5,447 ktCO<sub>2</sub> due to energy-related emissions (and 27,882 ktCO<sub>2</sub> from land-use change and forestry). In spite of years of civil war, the country has recorded strong growth rates in recent years. Consequently, energy demand has been growing rapidly and greenhouse gas emissions have increased accordingly, as is indicated in Figure 3.

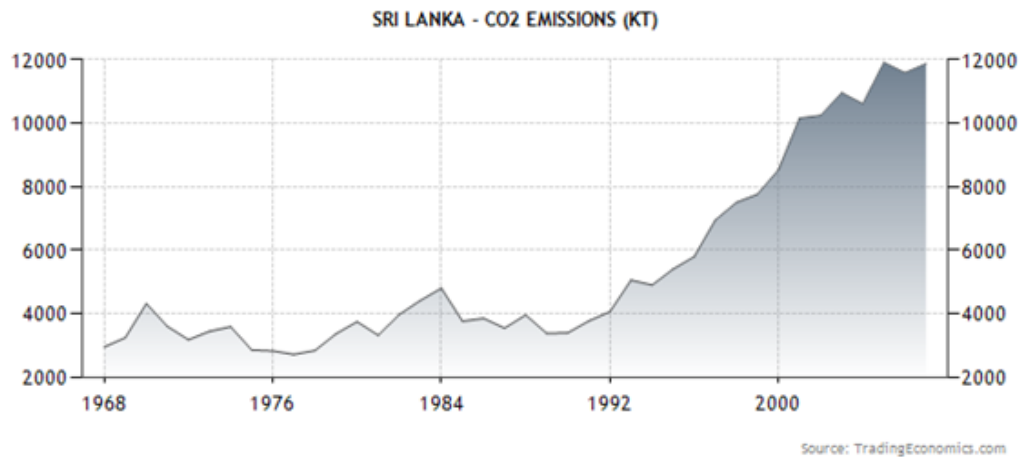
The *National Communications to then UNFCCC* (2000) mentions a number of mitigation options in the energy sector, including fuel switching (of fossil fuel with low-GHG emitting fuels), use of energy-efficient technologies, loss reduction in power transmission and distribution, renewable energy systems, pricing of fossil fuels reflecting its true cost, energy conservation, and, last but not least, encouraging (commercial) fuel wood plantations.

The *Technology Needs Assessment* report (UNFCCC) refers to the following climate change mitigation options that are relevant to this project proposal:

- Conservation of existing carbon pools such as forests; carbon sequestration by increasing the size of the carbon pool by reforestation and afforestation of degraded forests, croplands in marginal and waste lands (section 9);
- Considerable amount of biomass such as coconut husks, coconut shells and coconut leaves could be harvested annually to be used as an alternative fuel for electricity power generation if coconut cultivation is properly promoted. Various other economic benefits could be derived by taking to large-scale coconut cultivation in Sri Lanka. Recommendations of experts on climate change include fixing more and more CO<sub>2</sub> in trees and switching on to alternative fuels such as biomass (in its section 4.1.7). The Sri Lankan desiccated coconut (DC) sector contributes 2% to Gross National Product (GNP) being the second largest DC supplier to the world. By doing so, it guaranteed an annual foreign income of over USD 65 Million. The sector consumes approximately 10 GWh of electricity from the national grid and around 12 million liters of fuel

<sup>5</sup> This includes wood harvested from main stems, branches and other parts of trees coming from natural forests, plantations, and other wooded land such as tea, rubber, coconut, palmyrah, etc. and homesteads and roadsides. It also includes wood fuel from indirect sources such as industrial by-products (industrial residues) derived from primary and secondary wood industries, recovered sources (wood waste from construction sites demolition, packaging etc.

**Figure 4: Sri Lanka CO<sub>2</sub> emissions (in kilotons), energy sector**



Source: www.tradingeconomics.com

oil annually. Boilers provide most of Sri Lanka's thermal power requirement in factories. Most of boilers operate at low efficiencies (section 4.3.1);

- Greenhouse gas (GHG) emissions can be reduced by improving combustion efficiencies and by fuel switching. Wood gasification technologies are considered as zero GHG emission technologies and will save foreign exchange for fuel oil (and increase the income of the rural poor through the growth of forests for boilers).

## 2. POLICY AND INSTITUTIONAL CONTEXT

As mentioned earlier, the escalation of oil prices in 2008 undermined the profitability and competitiveness of many local enterprises. This has led to an increased demand for fuel wood as a source of cheaper energy. Due to the rapid and unstable fluctuation of oil prices in the recent years, demand for fuel wood has increased. The government also promotes the use of indigenous energy sources, renewable energies, against imported fossil fuels. Several policy initiatives have been formulated by the government to create an enabling environment for the development of the biomass energy sector.

### Energy

The *National Energy Policy and Strategies of Sri Lanka* (2006) was approved by Parliament and came to effect in 2008. The policy emphasizes indigenous forms of energy, seeking to reduce the country's dependence on fossil fuels, which are 100% imported. The policy has addressed the promotion, utilization and development aspects of renewable energy. Specific new initiatives are included in this policy to expand the delivery of affordable energy services to a larger share of the population, to ensure energy security and to improve energy sector planning, management and regulation as well as adopting appropriate pricing policies. It specifically mentions that 'the use of biomass will be promoted by elevating its status to a modern, convenient energy source', i.e. as commercial crop as well as a fuel option for energy supply. All the efforts at the national level for biomass power plant development are coordinated through the National Energy Policy and Strategies of Sri Lanka that came into effect in 2008. The policy is on the promotion, utilization and development aspects of renewable energy. It emphasizes the use of indigenous forms of energy

instead of importation of fossil fuels. In order to encourage the participation of the private sector, high buy-back tariff was provided to those that generate electricity based on fuel wood. New initiatives are being rolled out to promote the delivery of affordable energy services to a larger share of the population including energy intensive industries. When it comes to the fuel wood use, the proposed project focuses on industrial and plantation districts. There will not be competition for fuel wood as these are dedicated plantations and efforts are closely coordinated as the geographical focus is entirely different. It is too early to comment on price competition of fuel wood as it is left to the market emergence and replication projects that may be implemented.

On the promotion of indigenous resources the policy mentions the following implementation strategies:

- The use of economically viable, environment friendly, non-conventional renewable energy resources (NCRE) will be promoted by providing a level playing field;
- Necessary incentives will be provided and access to green funding including Clean Development Mechanism (CDM) will be facilitated;
- A facilitation agency dedicated to the systematic planning and promotion of nonconventional renewable energy resources will be established;
- Biomass-based energy projects will be developed in areas where land resources are available, enabling new industrial activities in such areas, emphasizing rural income generation avenues;
- Dedicated energy plantations will be encouraged;
- Focused attention will be drawn on development of bio-fuels as an alternative energy resource for the transport sector;
- Initiatives of other sectors and institutions to enhance biomass supplies, convert biomass and other waste to energy will be encouraged and supported;
- The Government recognizes that certain NCRE technologies would require incentives to ensure their capacity build-up to contribute to the national NCRE target. These incentives shall be provided on a competitive basis, in which the NCRE developers shall bid for a share of the NCRE target, subject to a price ceiling. NCRE incentives shall be technology-specific and based on actual energy.

One element in the Policy is the establishment of a facilitation agency dedicated to renewable energy sources, which was achieved by means of the establishment of the Sri Lanka Sustainable Energy Authority (SEA). Regarding bioenergy, the *Corporate Plan* of the SEA proposes the replacement of 10% of annual industrial thermal by the year 2017 through biomass sourced from multiple sources (including plantation fuel wood plus waste biomass). This translates into a target of replacing more than 40,000 tonnes of fossil fuels over the next six years. To realize this target the SEA proposes to invest in technologies for fuel switching and introduce attractive financing scheme for conversion. SEA has set up a loan guarantee scheme to promote such investment, but the impact of the scheme is likely to be limited, if the complex web of barriers that inhibit the more widespread dissemination of modern bioenergy technologies remains (which will be discussed in Section 4).

### **Biomass and fuel wood cultivation**

Sri Lanka's *Ten Year Development plan*<sup>6</sup> also looks favorably upon energy plantations. The trust of this development plan is poverty reduction, food and energy security and emphasis is put on increasing land productivity, agricultural diversity and home-grown energy.

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<sup>6</sup> *Mahinda Chintana* Sri Lanka's Ten Year Horizon Development Plan 2006-2016

The *National Forest Policy* (1995)<sup>7</sup> was drawn up to provide clear directions for safeguarding the remaining natural forests of the country in order to conserve forests, biodiversity, as well as soil and water resources. It mentions regarding the management of private forests and tree resources:

- Tree growing on homesteads, and other agroforestry, will be promoted as a main strategy to supply wood and other forest products for meeting household and market needs.
- The establishment, management and harvesting of industrial forest plantations by local people, communities, industries, and others in the private sector will be promoted.
- The state will promote tree growing by local people, rural communities, NGOs and other non-state sector bodies for the protection of environmentally sensitive areas.

The *Forestry Master Plan (1995-2000)* was formulated to implement the Policy. One of its 13 programmes is dedicated to bioenergy development. The Plan mentions the development a national bioenergy strategy, and the establishment of a single agency responsible for coordinating the implementation of this strategy, although this has not happened yet. The following strategies are highlighted for the promotion of fuel wood plantation as the main biomass source for future energy applications:

- Maintain an adequate percentage of fuel wood plantations in national reforestation programmes;
- Encourage planting multiple tree species in home gardens with the objectives of increasing productivity and providing an additional income to the owners;
- Plant multipurpose tree species on available spaces along the state roads, stream banks and other available lands owned by institutions to create a supplementary source of fuel wood as a by-product;
- Provide state lands on a long-term lease with suitable tree tenure arrangements to anyone willing to plant trees;
- The fuel wood-consuming industries should make every effort to have their own fuel wood plantations wherever possible;
- Make arrangements to provide credit facilities and other necessary incentives, including tax concessions;
- Convert around 15 % of uneconomical tea lands into fuel wood plantations with fast-growing and high calorific value fuel wood species having coppicing ability;
- Design training courses for governmental, NGO and plantation organizations working in forestry and tree production systems at different levels to plan and implement integrated tree-based farming systems.

In order to promote biomass for power generation as well as for the thermal applications in the industry and commercial sectors, the Government in 2005 took a progressive policy decision to promote the commercial cultivation and utilization of fuel wood. The Ministry of Plantation Industries has decided to support and promote fuel wood crops by including *Gliricidia* as the fourth major plantation crop (in addition to tea, rubber and coconut), and endorsed in a special Cabinet decision the eligibility of getting subsidy for the planting and use of this major plantation crop. An incentive scheme has been devised (that is discussed next), but has been functioning with less applicants than expected, as a number of inter-related gaps and barriers remain (see Section 4). Part of the activities that will deliver Output 2.2 is a study will be carried out for the design and implementation of possible similar schemes for other species such as *Calliandra Calothyrsus*, *Acacia decurrens*, *Acacia auriculiformis*, *Paraserianthes falcataria*, *Casurina equisitifolia*, *Leucaena leucocephala*, *Clusia rosea*, and *Eucalyptus grandis* (see Box 2). From the results of such study, pertinent recommendations will be made on their promotion (through broader schemes) and use.

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<sup>7</sup> See for example the website [www.environmentmin.gov.lk/menr/](http://www.environmentmin.gov.lk/menr/) of the Ministry of Environment

## Incentives for bioenergy promotion

During the PPG exercise, there were extensive discussions with banks and financial institutions to improve the sustainability of project interventions through a credible system of development finance and government guarantee for future fuel-switching efforts. Representatives from these institutions attended the consultation workshops. The lobbying efforts that were done with banks, along with the Ministry of Environment and Sustainable Energy Authority (SEA) have resulted in the commitment from the stakeholders and the issuance of a letter of cooperation in the form of co-financing letters. Institutions such as DFCC Bank, one of the foremost development banks in the country and a key player in renewable energy financing, expressed their strong commitment to support the proposed project.

Incentives may consist of grants, subsidies or concessionary-terms loans. Two schemes are of relevance here for the theme of bioenergy production and utilization:

- The Coconut Cultivation Board provides a subsidy of LKR 7,500/- per ha given by the for inter-planting *Gliricidia* in coconut lands;
- Some credit schemes are available for the promotion and utilization of renewable energy options:
  - The Commercial Bank of Ceylon (CBC) is backed up by 50% risk sharing by IFC for loans for renewable energy projects;
  - The RERED (Renewable Energy for Rural Enterprise Development) Finance Scheme by the World Bank and managed by DFCC (Development Finance and Credit Cooperation) which has supported a number of rural electrification and grid-connected renewable energy projects in Sri Lanka.
  - The National Development Bank (NDB) through participating credit institutions can provide long-term low-interest loans to enable industries to reduce their pollution and is also providing a credit line (through a JICA loan) called the ‘Environmentally Friendly Solutions Fund’ (E-Friends) which has benefitted some biomass-based power generation projects;
  - SEA has set up a Loan Guarantee Facility, which will become operational during project implementation (and forms a major part of SEA’s co-financing).

These incentives have failed to make much impact on modern bioenergy as a complex web of barriers remains, which will be discussed in Section 4.

## Institutions and ‘government’ stakeholders<sup>8</sup>

The *Ministry of Finance* (MOF) is responsible for determining the relevance and viability of subsidies and their application through the national budgetary process to provide relief to certain sections, either for the purpose of maintaining industrial competitiveness or for welfare. The MOF has intervened in the past by providing subsidies for the price of industrial fossil fuels - diesel and furnace oil - to prevent undue economic shocks on industry and public transport<sup>9</sup>. The *Department of National Planning*, under the Ministry of Finance regularly evaluates the costs of such subsidy schemes and makes recommendations for their future direction.

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<sup>8</sup> More detailed info on stakeholders and their role in the project is given in Table 14 of Section 14

<sup>9</sup> For example, by mid-2011 the real price of furnace oil was 1.4 times higher than the actual price in Sri Lanka. By early 2012 prices of all fossil fuels have risen and the subsidy on furnace oil has de facto disappeared. These changes were taken into account in the cost-benefit analysis of gasifiers presented in Annex C.

The *Ministry of Power and Energy* is the Ministry responsible for implementing the government of Sri Lanka's policies and regulations related to the energy sector which encompasses renewable and non-renewable conventional sources of energy. Renewable energy includes small-scale, hydropower, solar power, bioenergy, and wind power.

The *Sri Lanka Sustainable Energy Authority (SEA)* operating under the Ministry of Power and Energy is positioned as the apex body with wider powers in both regulation and facilitation in the area of sustainable energy, including bioenergy. SEA was established in 2007. Its mission is to guide the nation in all its efforts to develop indigenous energy resources and conserve energy resources through exploration, facilitation, research & development and knowledge management in the journey of national development, paving the way for Sri Lanka to gain energy security by protecting natural, human and economic wealth by embracing best sustainability practices.

The *Ministry of Environment* is responsible for the policy making and promotion regarding the management of the environment and natural resources of the country. These policies are implemented with the participation of stakeholders, including government agencies, NGO's and communities. Sri Lanka ratified the UN Framework Convention on Climate Change (UNFCCC) in 1993. The Ministry is the focal point for the UNFCCC and also acts as the operational and political focal point for the Global Environment Facility (GEF).

The *Forest Department* was established in 1887 and is now one of the implementing agencies of the Ministry of Environment with responsibility for protecting forests and woodlands in Sri Lanka. Over the years many initiatives have been taken to minimize the rate of deforestation by effective application of the National Forest Policy.

Main functions of the *Ministry of Plantation Industries* are policy development with respect to tea and rubber sectors (plantation crops), promotion the cultivation of these crops as well as research and development related to tea and rubber crops. The Coconut Cultivation Board (CCB) and the Coconut Research Institute (CRI) fall under the auspices of the Ministry of Coconut Development.

### **3. ENERGY SOLUTIONS AND 'NON-STATE' STAKEHOLDERS**

#### **Target groups in industry**

In the industrial sector, biomass is widely used for a variety of thermal energy applications that employ a range of energy conversion devices utilizing direct combustion technology. The tea processing industry is the largest industrial consumer of fuel wood. It uses furnaces for drying and weathering tea. The coconut industry utilizes fuel wood furnaces, coconut shell-fired copra kilns, fuel wood boilers and carbonization gas-fired furnaces to meet its energy requirement. The rubber processing industry employs furnaces and boilers. The tobacco industry uses fuel wood barns and paddy husk-fired barns. Bagasse-fired boilers are available only in the sugar industry. The brick, tile, lime, pottery and bakery industries use fuel wood kilns for their production processes. Distilleries use fuel wood furnaces and paddy husk-fired boilers in their manufacturing process. The paddy processing industry utilizes paddy husk-fired boilers for parboiling operation. The energy efficiencies of many of the above devices are reported to be not satisfactory and there is considerable potential for energy conservation and utilization of improved biomass energy technologies in each application.

A significant amount of fuel wood is also consumed in the commercial sector (bakeries, hotels and restaurants) for cooking and baking. Often, the ovens and cook stoves still operate in traditional ways, with low efficiencies. LPG, kerosene and diesel are also used as alternative fuels, mainly for convenience, but the increasing costs of these fuels have compelled users to seriously consider switching to improved biomass energy technology.

### **Combustion of biomass**

In industries, furnaces and boilers have been developed that use various types of biomass, including wood and wood wastes. The heat may be used directly or passed to a working medium (e.g., water, air, steam). Industrial wood combustors can be reasonably efficient, about 60%, although less than fired with gas (fossil fuels or from biomass gasifiers, which can reach 70-85% in energy conversion efficiency). The combustion system consists of a furnace where the fuel is burnt, to which a heat exchanger can be added that contains the working medium. The furnace and heat exchanger are known as the boiler. Other parts of the system are biomass preparation and storage, transport and system for the handling of ashes.

The efficiency of biomass-fired boilers and furnaces can be improved, e.g. by carefully controlling the air flow<sup>10</sup> or by using more advanced systems, such as suspension furnaces or fluidized bed systems instead of pile and grate burners<sup>11</sup>.

### **Biomass gasification**

In recent times, interest in biomass gasification has been building up rapidly as a feasible option of energy generation for a wide variety of applications. The key areas of application in the present context include small-scale electricity generation in remote villages and industrial thermal energy generation.

As described above, companies use liquid fuels, such as furnace oil, to provide process heat or already use biomass, for example by direct combustion in boilers or furnaces. The price hike of fossil fuel has led to a very high cost of energy, which is the main problem faced by the local industry today. There is an urgent need for switching to cheaper, indigenous fuels, of which the only feasible option in the country is biomass. However, burning biomass (direct combustion) is not efficient from an energy conversion point of view, with efficiency ranging from 15-35% in view of the typical uncontrolled air/oxygen ratio in air supply to the process. Biomass gasification uses controlled conditions of temperature and oxygen level to convert the original biomass feedstock into 'producer gas' or 'wood gas' (if the feedstock is wood) and more of the heat content of the biomass is captured, up to 85% (see Box 1 for more details). The increasing cost of fuel wood, together with its limited supply, has adversely affected the development and survival of many rural industries. Hence, the growing interest in gasification technology as it utilizes firewood more efficiently. For a given thermal energy requirement, the utilization of the more efficient wood gasifier systems would lessen the use of fuel wood. With that energy performance, potential users can be expected to switch over to wood gasifier systems, and considering the increasing use of wood gasifiers, that could mean

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<sup>10</sup> Too much air reduces the temperature of the gases passing through the heat exchange and reduces heat transfer efficiency; too little air can result in incomplete combustion

<sup>11</sup> In pile burners the biomass fuel lies on a fixed metal bed grate through which the combustion ash falls and the air flows. The design is easy to operate, but less efficient. Suspension furnaces burn small fuel particles, which are suspended in the ingoing air stream. This effectively increases the reaction volume and the efficiency of the combustion process. Fluidised systems use a heated bed kept in motion by an air stream and pre-heated to reach a desirable temperature to keep the combustion process going.

increased pressure on sustainable fuel wood production. Such eventuality will be addressed by the proposed project in a holistic approach by facilitating the establishment of the supply system for sustainable wood and meet increasing demand through: (a) increased fuel wood availability by promoting various fuel wood species; and, (b) wider application of sustainable fuel wood for meeting industrial thermal and electricity requirements.

Another important barrier that has affected the development of the sector was the lack of availability of technically sound gasifiers. Although several studies on biomass gasification have been carried out in Sri Lanka during the past few decades, none of these activities were able to make any significant impact on the development of the biomass energy sector, because most of these were limited to feasibility studies, and design and testing at laboratory level and field testing, but not on commercial technology development. Another problem was that the issue of biomass supply (sustainable in terms of price and guaranteed supply) was not addressed. However, there has been a tremendous technological development of small- and medium-scale fuel wood gasifiers in the region, especially in India, providing a base for developing the sector in Sri Lanka. Technology transfer and adaptation from this region have made it possible for local institutes and companies to establish a solid foundation to support the development of the sector.

Up to now, however, only two companies are involved with the design and manufacture of gasifiers in Sri Lanka:

1. EnerFab (Pvt) Ltd. manufactures gasifiers for both thermal and electricity generation applications. The capacities of thermal gasifiers range from 100 kWh to 1 MWh.
2. Lanka Gasifiers (Pvt) Ltd. is engaged in the development and manufacturing of small biomass gasifier generators that can be deployed for rural electrification and small enterprise applications.

### **Box 1: Biomass energy conversion and gasification**

There are various technologies available world-wide for conversion of biomass and biomass residues in useful energy, which can be categorized as physical (densification, biochemical and thermochemical).

**Physical treatment** includes densification of biomass (in particular of agricultural and forestry residues) to briquettes or pellets, thus increasing the energy content per unit volume. This thus reduces transport and handling cost. Also, densification produces a fuel with more uniform and predictable burning characteristics than the original residue feedstock.

Anaerobic fermentation (or digestion) is a **biochemical process** that occurs naturally whenever organic material decomposes without any contact with air (hence the name anaerobic), Biogas (mainly methane and carbon dioxide) can be used for cooking and lighting as well as to power generators and engines. The other main biochemical route is the fermentation of a number of cellulose, starch and sugar-containing substances to ethyl alcohol (alcoholic fermentation).

The most well-known **thermochemical** processes is:

- Thermal oxidation or *direct combustion*. Any organic matter can in principle be burned. Feedstock for *direct combustion* (burning) is firewood or biomass residues such as woodchips, sawdust, bark, hog fuel, black liquor, straw, municipal solid waste (MSW) and wastes from the food industry. Direct-combustion furnaces are used to produce either direct heat or steam
- *Pyrolysis*, which is the heating of biomass to a high temperature in the absence of air -and gasification. In this method, organic material is heated in an inert, oxygen-starved environment and decomposed in a range of products. These comprise solids (charcoal, ash), liquids (pyrolysis oils, tars, acids) and gases. By far the



largest application of pyrolysis is charcoal production, also called carbonization. Despite the energy inefficiency of the carbonization process, charcoal has a higher energy density (some 30 megajoules [MJ] per kg) than wood per unit mass (15-16 MJ per kg). This makes it more economical to transport.

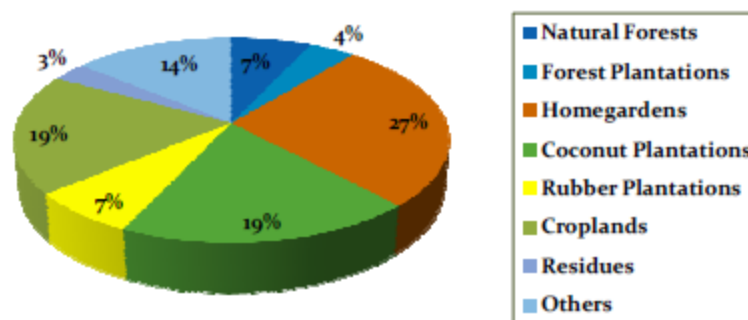
- With careful control of temperature and oxygen level it is possible to convert virtually all of the raw material into gas. *Gasification*, which is a further development of pyrolysis, takes place in two stages. It involves an initial pyrolysis step (as in charcoal production), producing char and oils. Through admission of limited amounts of air or oxygen partial combustion takes place of the char and oils into a predominantly gaseous product. In this second stage, the carbon dioxide and water produced in the first stage are chemically reduced by the charcoal, forming carbon monoxide and hydrogen. The composition of the resulting gas is 18–20% hydrogen, 18–20% carbon monoxide, 2–3% methane, 8–10% carbon dioxide and the rest nitrogen. Gasification requires temperatures of around 800°C or more to minimize the residues of tars and high hydrocarbons in the product gas. The value of the gas, known as wood gas or producer gas, is about 4-8 MJ per m<sup>3</sup>, or 10-20% of the heating value of natural gas (36 MJ/m<sup>3</sup>).

Producer gas can serve multiple uses. Producer gas has been used most widely in direct heat applications in industry, a replacement of fuel oil in industrial boilers, furnaces and kilns, in which the gasifier is closely coupled with to the gas burner. Producer gas can be used to fuel internal combustion engines to drive a generator or as shaft power. To avoid contaminant deposition and corrosion damage to the engine, the gas requires cleaning. Careful design of the scrubber and filter are critical to ensure adequate gas cooling and cleaning. Diesel engines are usually favored. Gas can replace some 60-70% of the diesel engine’s fuel requirement (some diesel is needed to assist ignition) and commercial diesel engines require only minor modifications to the air intake.

### Fuel wood production and supply

An estimation of the sources of fuel wood was carried out as part of the formulation of the Forestry Sector Master Plan (1995) and the results are shown in Figure 5. Unfortunately, no systematic study on sources of fuel wood and other biomass has been carried since then. The 1993 data show that non-forest lands supplied 93% of fuel wood. Given stringent protective and managerial measures, it is likely that the percentage of wood from natural forest has dropped. However, it is likely that some fuel wood continues to be sourced from plantation forests.

**Figure 5: Sources of fuel wood supplies (1993)**



Sources: Forestry Sector Master Plan (1995)

Sri Lanka has a tree cover of about 65% in forests, home gardens, plantations, etc. which has an enormous potential to sustainably produce fuel wood. To be able to meet the growing demand by commercial and industrial establishments for fuel wood and facilitate fossil fuel-using industrial SMEs to change part of their current & future energy needs to dendro (i.e. wood-based) energy, it is

necessary to develop sustainably grown fuel wood and biomass supply chains. To help achieving this goal, the Ministry of Plantation Industries has declared the *Gliricidia* wood as ‘fourth’ plantation species (alongside tea, rubber and coconut); the reader is referred to Box 2 and Figure 6 for more details on *Gliricidia* and other fuel wood species.

Table 3 gives an overview of the models for sustainably grown fuel wood, which can be applied in community-based and private-sector and models. Many lands in Sri Lanka are owned by the State and in custody of agencies such as the Forest Department and that have traditionally out of bounds for villagers. However, there is potential for fuel wood species in marginal, underutilized lands in the outlying provinces and districts that are recovering from conflict- areas that largely depend on agriculture for livelihood. The use of abandoned farms or marginal lands unsuited for food crops would minimize land use conflicts. In fact, as part of the post-conflict development, Government is already providing assistance to previous inhabitants who are moving back to their lands, including the re-surveying support to re-issue their lost titles and deeds. Abandoned farm lands (small holdings) due to conflict will be re-cultivated by populations who were living in those lands before. Fuel wood cultivation will be mixed with food crop production either as under-planting (such as in coconut or pepper/vanilla cultivations) or as co-planting to provide structural support to food crops. Live fences, again using *Gliricidia*, will be established to safeguard the boundaries of small plots.

Another option is to give State lands to business (individual or institutional) on long-term lease. A number of private companies have set plans for large-scale plantations with and a few other companies have shown interest in buying, processing and selling *Gliricidia* wood chips.

#### **R&D; NGOs**

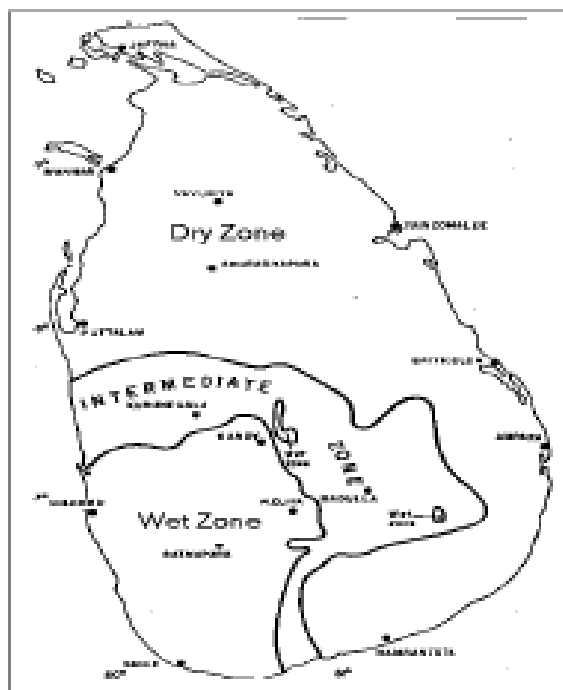
Among the institutions under Ministry of Technology and *Research National Engineering Research and Development Centre (NERDC)*, *National Science Foundation (NSF)*, and *Institute of Fundamental Studies (IFS)* are the key institutions related to bioenergy activities. NERDC was incorporated in 1974 and has emerged as one of the premier engineering research and development centers in the country. A number of universities are also involved in R&D and education on biomass technologies, such as the University of Sri Jayawardanapura, University of Moratuwa, University of Peradeniya, University of Ruhuna and the University of Uva.

**Table 3: Characteristics of growing models**

<b>Growing model (based on <i>Gliricidia</i> wood)</b>	<b>Institutions involved</b>	<b>Trees density (number of trees or length of tree rows)</b>	<b>Woody biomass production (tons per ha)</b>
Dedicated plantation	Private plantation companies FD, Mahaweli Authority, HABADIMA Authority	8,000	40
Coconut intercropping	CCB; Private companies	2,250	12
With pepper and vanilla	Dpt. of Export Agriculture	1,500	8
Home gardens	HADABIMA, Provincial Agricultural Departments	1,000	5
Alley cropping in rain-fed uplands		4,000	15
Erosion prevention (SALT, sloping agriculture land technology)	HADABIMA, Provincial Agricultural Departments	3,000	10
Shade trees for coffee, cocoa, trees	Dept. of Export Agriculture	400	2

Note: 1. SALT and alley cropping: double rows at 0.5 m x 0.5 m spacing; 2. Home gardens with live fence: perimeter 400-500 m (single row at 0.5 m x 0.5 m); 3. Average woody biomass production of a *Gliricidia* tree is 5 kg.  
 Source: *Opportunities for Increasing Woody Biomass Production*, G. Hitinayake (presentation, 2011); *Strategy to Replace 10% of the Fossil Fuels used for Industrial Heat Applications in Sri Lanka*; I. Gallage (2011);

**Figure 6: Climatic Zones Determined by Rainfall Regime**



**Box 2: Wood as an energy crop**

*Gliricidia* is a well-known multipurpose leguminous tree species with the ability of fixing the soil with nitrogen in the air. *Gliricidia* supply tree products such as fuel wood, construction poles, crop supports, green manure and fodder. In addition, it is used in living fences, to stabilize soils and prevent) and to shade plantation crops Recognizing the importance of this tree species, the government of Sri Lanka has named *Gliricidia* as the fourth plantation crop, next to tea, rubber and coconut. This species grows well under various soil and climatic conditions, and it is draught resistant once established. The easy coppicing nature of *G. sepium* contributes to its acceptability as a source of fuel wood; e.g. it can be coppiced at heights of 20, 40 or 609 cm without much difference in biomass production. Fuel wood is obtained through the occasional lopping of branches or by completely coppicing trees to low levels above ground. Accumulation of woody biomass is very much dependent on climate and soils, management, planting density and length of rotation.

Acacias were purposely introduced and planted in Southeast Asia as a source of firewood and good quality charcoal. *Acacia auriculiformis* was introduced to the Forest Department around in early 1980s on a trial basis and extended its cultivation on plantation scale around 1984 as a medium to long-term rotation crop. It is a leguminous tree species which contains nitrogen fixing bacteria which can help rejuvenate these poor soils. The tree prevents soil erosion because of its extensive and dense roots and heavy leaf litter. It has a capacity of produce good fuel wood on poor soils, even in areas with extended dry seasons. Best results are obtained if the stump is cut at a height of 0.6-1 m above the ground. An increment in height of 2-4 m per year in the first few years is common even on soils of low fertility. The average annual increment of about 10-12 m<sup>3</sup>/ha can be obtainable from 4-5 year rotations. Damage to *Acacia auriculiformis* by pests and diseases is minor, and no significant pest and diseases are reported from Sri Lanka. Both *Gliricidia*, *Acacia*, as well as another species, *Calliandra*, grow in both the wet and dry zone of the country (see map above).

Characteristics of some commonly grown fuel wood species are:

Species	Avg. wood Production (cum/ha)	Calorific Value (kcal / kg)	Uses / region (in Sri Lanka)
<i>Gliricidia sepium</i>	25-40	4,900	Tea, pepper, vanilla, coffee, cocoa plantations, live fences and other hedge rows: Low and mid elevations
<i>Calliandra calothyrsus</i>	15-50	4,500-4,750	Tea lands: Mid and high elevations
<i>Acacia decurrens</i>	15-25	3,530-3,940	Tea lands: high altitudes
<i>Acacia auriculiformis</i>	05-60	4,800-4,900	Wide spread: Low and mid altitudes
<i>Pariserianthus falcata</i>	30-50	2,865-3,357	Mainly on tea lands: Low and mid altitudes
<i>Casurina equisetifolia</i>	30-50	4,950	Coastal areas
<i>Leucaena leucocephala</i>	24-60	4,200-4,600	Wide spread in low altitudes
<i>Clusia rosea</i>	125-150	4,154	Tea lands in: Mid and high elevations
<i>Eucalyptus grandis</i>	40-200	4,700-4,800	Mid and high elevations

There are many non-governmental organizations (NGOs) active in the bioenergy sector in the country. They play a key role in awareness-raising among the general public and capacity building of rural communities. Further, the NGO sector in the country collaborates efficiently with private and state sector institutions. Some of the NGOs are instrumental in establishing community organizations. Amongst the NGOs most active in the area of bioenergy are:

- *Bio-Energy Association of Sri Lanka (BEASL)*

The main objectives of BEASL are to build support for the industry throughout the country's legislature administration and funding agencies, through tax incentives, increased biomass research and regulations and other policy initiatives.

It also interacts directly with the general public, farmer organizations and other relevant institutions to ensure that bio-energy provides a sustainable development means to alleviate poverty. BEASL was instrumental in convincing the government to declare *Gliricidia* as the 4th commercial plantation crop in Sri Lanka;

- *Energy Forum*

Energy Forum has been established to create an environment that enables the promotion and adoption of renewable and distributed energy, energy efficiency and integrated sustainable resource management mechanisms to alleviate poverty, to address energy capacity deficiencies and to protect the environment. Composed of individuals and organizations from government institutions, Provincial Councils, the private sector, NGOs, utilities, universities, and research institutions, the Energy Forum serves as a network hub.

- *Practical Action*

The main areas of involvement of Practical Action in bioenergy include liquid bio-fuel (biodiesel), biogas and solid fuel (fuel wood and other biomass). It also conducted biomass availability surveys in one province. The proposed project used information generated through Practical Action's Policy Innovation Systems for Clean Energy Security (PISCES) initiative during the PPG exercise. The intention is also to work closely with experts of Practical Action in relevant aspects of the development of the sustainable fuel wood market in Sri Lanka. PISCES is an energy research program aimed at contributing to innovation and providing new

policy-relevant knowledge in the energy sector leading to better practices. The proposed project will definitely benefit from inputs from Practical Action, as well as from the synergy in the conduct of market analyses and supply chain development for sustainable fuel wood.

#### 4. BARRIER ANALYSIS

Unfortunately, there still remain many issues and constraints for the development of biomass resources for energy utilization in Sri Lanka. These can be roughly divided in policy-institutional, technical, financial and informational issues. These will be analyzed in this section with recommended actions to overcome or mitigate the impact of these barriers upon the project objectives of:

- Promoting biomass as a viable renewable energy source for industrial thermal applications
- Ensuring quality-assured and sustained supply of biomass as an industrial fuel

The issues together form a kind of the ‘hen-and-the-egg’ problem. Industrial and commercial establishment have an increasing appetite for fuel wood to replace high-cost fossil fuels using modern biomass energy technologies, such as gasification of biomass. While a few pioneers have entered in the market, others are reluctant to follow due to the uncertainty regarding the longer-term availability of high quality fuel wood (or residues) and the reliability in supply thereof.

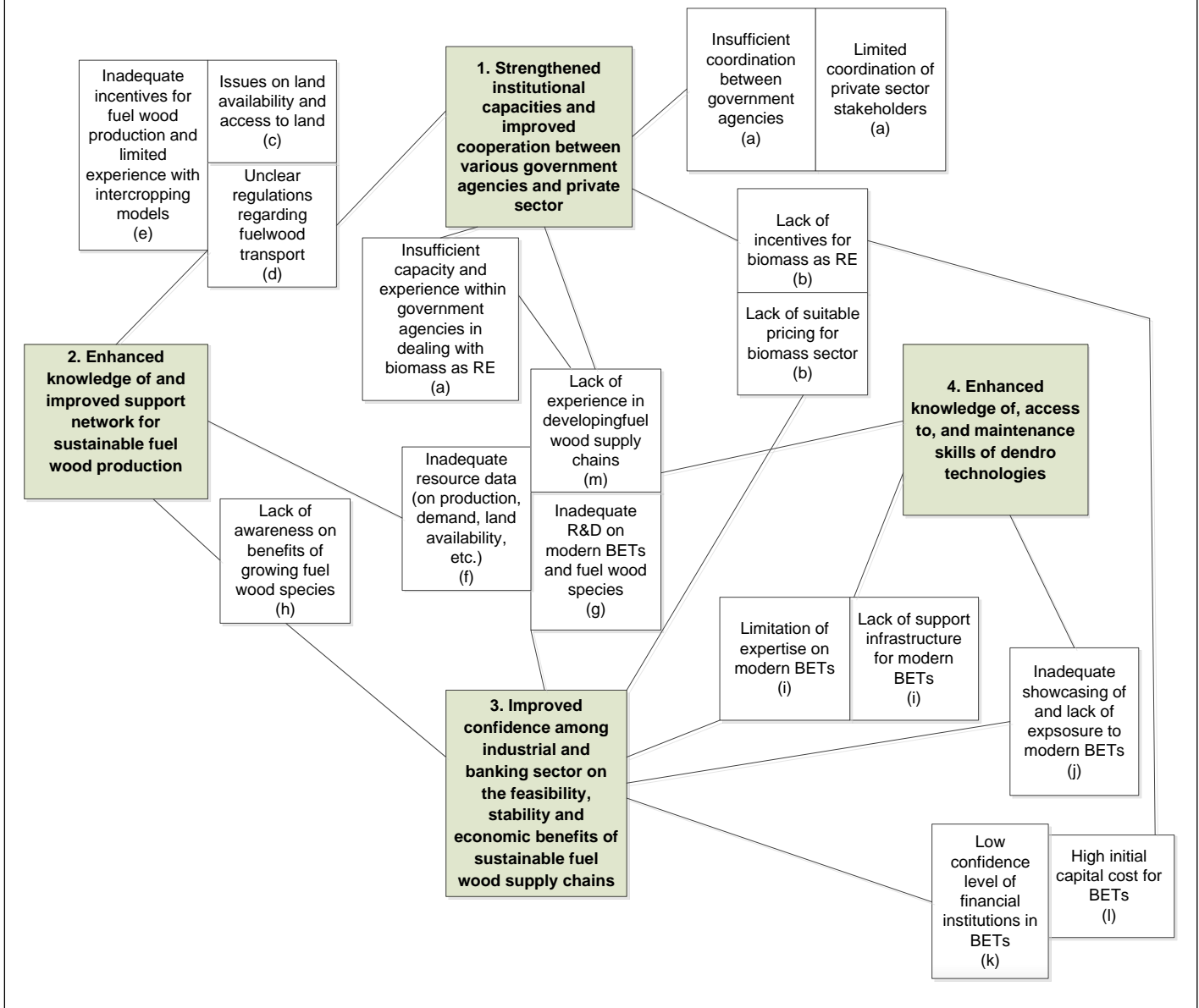
On the other hand, private companies will be hesitant to invest in large-scale fuel wood plantation if the market is uncertain. Companies may decide not to switch from fossil fuels if the prices drop again or if the subsidy on furnace oil remains. Regarding small holders, these may be turn away from *Gliricidia* if they notice that their time and money can be better spent on alternative cash crops that fetch a higher price or the price of their fuel wood produced drops according to market fluctuations following the price of fossil fuels.

An overview of barriers and the relation with the main outcomes of the project (that will be presented in the next Section 5) is given in Figure 7. The following text describes gaps and barriers in detail:

- (a) An institutional setup to establish a close coordination among state and non-state institutions for the development and promotion of biomass sector activities has not been effectively established. While placing much emphasis on renewable energy development in the National Energy Policy, the government continues to subsidize fossil fuel importation for industry with as argument maintaining competitiveness of exports;  
Biomass still remains a sub-sector not formally organized unlike the electricity and petroleum sub-sectors. Although biomass energy use has a departmental ‘home’ at the Sri Lanka Sustainable Energy Authority (SEA), biomass production and supply needs to be coordinated with the varied stakeholders in government (e.g. Forest Department), NGOs) and with private sector players. There is a nascent, but still insufficient, capacity within agencies to deal with biomass as a renewable source of energy in an integrated way, encompassing production, supply, end/use and technology support;
- (b) One of the main constraints to the development of the biomass energy sector is the fluctuation and uncertainties in both fossil fuel and fuel wood prices. Lack of regulations and (financial) incentives make it difficult for companies to get involved in the development of supply chains of biomass (wood) for energy;

- (c) There are a number of on-paper assessments of land availability for energy crops shows that marginal lands could be made available for energy crops, especially *Gliricidia*. However, the Forest Department, which manages some large parts of these areas of the country has made available only very limited extents of land suited for energy crops.  
Even when land is identified and there is agreement to lease it for development; a number of bottlenecks prevent developers from accessing these lands, such as encroachment, red-tape in processing and political interference in the process are the most common;
- (d) The forest product transport regulations issued under the Forest Ordinance need some amendments to facilitate the utilization of biomass resources by relaxing the transport permit requirement for fuel wood produced in private lands. Currently, the transport permit requirement hinders the expansion of fuel wood plantations in the country. Provisions should be available to transport fuel wood freely without any disruption. There is limited awareness amongst law enforcement officers on the regulations regarding the transport of biomass and fuel wood;

**Figure 7: Overview of barriers and main barrier-removal options (outcomes mentioned in Section 5)**



- (e) *Gliricidia* has been declared the fourth plantation crop, but this declaration has not been translated yet in a meaningful cultivation practice. Currently, incentive available for energy plantations is the LKR 7,500.00 incentive given by Coconut Cultivation Board for intercropping *Gliricidia* in coconut plantations. However, it has been reported that this grant scheme is not making a considerable impact on establishment of energy plantations yet as this inadequately addresses the upfront cost of planting and other barriers are not removed. As a result, by the year 2009 only around 500 acres of *Gliricidia* intercropping in coconut plantations had come under this grant scheme<sup>12</sup>;
- (f) Lack of resource data, including information on production, demand, availability of land, etc. for project planning, is one of the main constraints in developing bioenergy projects. Collection

<sup>12</sup> APCTT, 2009, Renewable Energy Report, Sri Lanka, Asian and Pacific Centre for Transfer of Technology of the United Nations — Economic and Social Commission for Asia and the Pacific (ESCAP)

and analysis of data on energy supply and demand should be carried out in selected places to design appropriate bioenergy projects. Lack of information on available, currently utilized efficient technologies is another key issue in popularizing bioenergy. As a result of this, already developed bio-energy technologies have failed to gain public acceptance.

- (g) A number of universities (Ruhuna, Moratuwa, Peradeniya, Uva, etc.) and R&D organizations such as NERDC, NSF, IDB, CRI, etc. implement bioenergy research programmes, but they are as yet undeveloped because of the lack of well-coordinated and appropriately funded research projects. Regarding biomass technology, more research and development should be in sync with the needs of industrial and commercial end users, as mentioned earlier in Section 3; At present work has focused on the suitability of *Gliricidia* for energy plantations. Other species available in the country with suitable characteristics for energy plantations have been identified (see Box 2). However, more studies and field works need to be carried out to confirm the suitability of these species on various climatic and soil conditions in various regions, as well as their growth rates, potential yield, pest and diseases etc.
- (h) In general, there exists lack of awareness on the additional benefits of *Gliricidia*. Awareness is basically limited to the process of mixed cropping/intercropping with fuel wood, but this is largely focusing on nitrogen fixing species for fertilizing effect rather than for the wood. However there is greater potential to incentivize and encourage mixed cropping models, especially in pepper growing areas, under coconut, and as erosion barriers in sloping areas, as fertilizer replacement among farmers and coconut/spice small holders or as shade tree for coffee and tea cultivation. In general, there is limited experience with various biomass growing models;
- (i) The technical expertise and facilities for design, manufacture, promotion, sale, operation and maintenance of modern biomass energy technology, such as gasification, are still lacking for the successful implementation of these projects. There are a few local manufacturers and agents, who are involved in such projects, but this is not adequate for the required services and maintenance work on a larger scale. This lack of expertise and facilities forms a major technical barrier in the biomass sector. Related to the latter, there is lack of a maintenance and troubleshooting support for wood-fired gasifiers, which causes delay and high expenditure for repairs and regular maintenance work and operational inconveniences;
- (j) In general, there exists a lack of exposure of entrepreneurs (large and SMEs) to modern bioenergy conversion technologies, such as gasification. The lack of visible installations and familiarity with renewable energy technologies can lead to perceptions of greater technical risk than for conventional energy sources to which the risk of confidence in reliability of the supply chain of feedstock can be added. Information of biomass equipment suppliers, best suited equipment and the most efficient technologies is not in the public domain. This remains exclusively with a handful of equipment importers and a few engineering firms and there is considerable lack of awareness of where neutral information could be found;
- (k) For the same reason, most finance sectors are reluctant to support bioenergy projects. If they have credit lines available, these meet longer delays in approval, higher interest rates (to cover the higher perceived technical and supply chain risks) than conventional (energy) projects;
- (l) The high initial cost (e.g., investment needs to be done in the gasifier equipment before the gas flows) and lack of financial instruments are barriers for the more widespread dissemination in Sri Lanka. High transaction cost (resource assessment, planning, developing project proposals, negotiating finance, etc.) further add to the initial cost.
- (m) There exists limited experience with successfully operating biomass supply chains for fuel wood (including handling and processing of fuel wood). At present the sourcing of fuel wood is largely from a range of private suppliers. This includes homesteads, small holdings cultivations of tea, spices and coconut, rubber plantations, and small farms. There is no assured supply or



regular sources, which is also very weather-dependent. Many suppliers would like to have access to government/or other lands to grow a ‘buffer’ stock which can regulate supply when traditional sources fail. The fuel wood should be as dry as possible and ready for combustion at the point of delivery. This is achieved through size reduction (i.e., manual chopping of the woody biomass into smaller sizes prior to air drying (not thermal drying) at site. Through this process, it is expected that the fuel wood will have moisture content in the range of 15-20%. The manual chopping and air drying of the fuel wood do not require additional costs (e.g., electricity for mechanical size reduction, and fuel for thermal drying) and therefore no associated GHG emissions. This requires some wood species, such as *Gliricidia*, *Leucaena*, *Calliandra* and *Acacia* to be chopped and air-dried prior to delivery. Lack of large, weather-proof storage also affects suppliers’ ability to maintain buffer stocks to tide over rainy seasons and long holidays.

## Part 2. PROJECT STRATEGY

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### 5. PROJECT RATIONALE, DESIGN PRINCIPLES AND STRATEGIC CONSIDERATIONS

#### GEF-supported alternative scenario

The project will support the aim of the Sustainable Energy Authority (SEA) to replace 10% of the fossil fuels used in the industry by 2017 by biomass-derived energy (the year after the proposed end of the project). In view of the barriers mentioned in Section 4 it is doubtful if this target can be reached without any additional intervention. To be able to achieve this target a strategy is formulated for which GEF-support is requested.

The GEF intervention will support the Government in achieving this target in a two-pronged approach:

- *Biomass (wood and waste) is promoted as a viable renewable energy source for industrial thermal applications over (imported) fossil fuels*  
This would entail government policy intervention at the highest (Ministry of Finance) level to provide concessions, credit facilities and government-backed guarantee schemes that would steer industrialists away from imported fossil fuel in favor of wood-or-waste based indigenous fuel. The objective also looks at upgrading of existing technology for efficient biomass-fired boilers and gasifiers, filling technology gaps, improved local manufacture, improved operation and maintenance of existing facilities to address the other barriers that hold back industrial fuel switching;
- *Continuous and sustained supply of quality-assured biomass as an industrial fuel is ensured*  
This implies increasing the availability of biomass-based fuel by planting fuel wood species and developing supply chains with facilities for pre-processing and storage. The choice of *Gliricidia sepium* as fuel wood is supported by government policy (i.e., by declaring the species as a plantation crop in line with tea, rubber and coconut) and a number of on-going government-supported schemes to promote it as an organic fertilizer in coconut, tea, spice plantations and in farms/home gardens. Supply chain development through the project will demonstrate the viability of both private sector-owned and community-owned models meeting industrial demand for low-moisture wood fuel that lends to easy handling.

To achieve these aims, the GEF-supported project will employ the following broad strategies:

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1. Removal of policy-institutional barriers that hinder the production, supply and use of fuel wood (in industrial thermal applications);
2. Increase fuel wood availability by incentivizing planting of *Gliricidia sepium* and other fuel wood species mentioned in Box 2, through a number of private-based and community-based models implemented by both state and non-state partners;
3. Development of an enabling environment for sustainable fuel wood supply and utilization:
  - Develop or revitalize at least six supply chains to deliver quality-assured and cost-effective wood fuel to industrial or commercial end users in a reliable way,
  - Support R&D efforts on fuel wood production, supply and modern biomass energy technologies,
  - Strengthen support infrastructure (manufacturers, importers, operation and maintenance,
  - Develop technical expertise on modern wood energy technologies, in particular gasification;
4. Implement and demonstrate modern wood energy technologies (gasification)

The project will build on the experiences obtained in the Dutch-sponsored Promotion of Eco-Efficient Productivity Project (PEP)<sup>13</sup>, which was implemented by the Ceylon Chamber of Commerce. The project has been instrumental in introducing dendro power as an alternative to fossil fuels in industry. The introduction of wood gasifiers was introduced for heating purposes heat (to produce heat, steam and hot water) in about 10 companies in the ceramics, coconut processing, hotel, food processing and rubber industries. The project also provided support for introduction of biomass-fired heaters, boilers and dryers in rice mills and rubber plants as well as pelletization of rubber industry and biomass residues. Although limited in size and scope, PEP has made an effort to popularize biomass energy technology (BETs), so that the proposed UNDP/GEF intervention does not need to start entirely from scratch. It is well known that the PEP project has been instrumental in introducing dendro power as an alternative to fossil fuels in industry. The PEP pilots also served to build confidence in banks and financial institutions in financing dendro-thermal projects. During the PPG phase of the proposed project, the project development team liaised closely with the PEP project and derived good practices and lessons learned. It was possible due to a close coordination with companies and experts supported by the PEP, especially the Ceylon Chamber of Commerce which implemented the PEP. The failure of some the PEP pilots provided the project design with information on risks and barriers.

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<sup>13</sup> Promotion of Eco-efficient Productivity (PEP) project was implemented during 2006-2008 by The Ceylon Chamber of Commerce with the financial assistance from The Royal Netherlands Embassy. PEP provided technical and financial assistance to private sector organizations to adopt best practices in cleaner production and environment management. Renewable energy projects (including some gasification) project also benefited from this project. Eligible projects received up to 50% of the total project cost as a grant subjected to a ceiling of LKR 5 million (USD 43,500)

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<b>Output</b>	<b>Barrier</b> (as mentioned in the list given above)
<b>Component 1: Policy-institutional support for effective fuel-switching using fuel wood</b>	
1.1 Established and enforced mechanisms for effective cooperation between various government agencies and private sector involved in (regulating) fuel wood production, supply and use for thermal energy generation	a, b
1.2 Completed awareness raising campaigns and general trainings	a, c, d, e, f, h, l, m
1.3 Proposed, approved and implemented policies/incentive schemes for fuel switching	b, e, l
1.4 Existing policies on fuel switch enhanced and implemented	a, b, k, l
<b>Component 2: Barrier removal for sustainable fuel wood production</b>	
2.1 Prepared and disseminated information and knowledge products on fuel wood growing (models)	f, g, m
2.2 Tested and implemented supportive regulations and policies for sustainable fuel wood production	b, c, d, e, h
2.3 Completed demonstration of applied approaches and models in sustainable fuel wood production systems	g, h
2.4 Completed awareness raising campaigns and specific training programmes for key stakeholders on growing of species for fuel wood production	e, f, g, h, m
<b>Component 3: Enabling environment for fuel wood suppliers</b>	
3.1 Proposed, approved and implemented policies and incentive schemes for sustainable fuel wood supply	b, d, m
3.2 Completed training & outreach programmes for key stakeholders and published and disseminated knowledge products	d, k, m
3.3 Six sustainable biomass supply chains established and operational	b, c, d, e, h, i, k, m
<b>Component 4: Wood-based energy technology development</b>	
4.1 Twelve fuel wood thermal energy projects implemented, operational and monitored	i, j, k, l, m
4.2 Completed trainings and research aimed at improving services to promote fuel-switching in industry	g, i, j, l, m
4.3 Established information exchange system	f, g, j, k

### **Strategic considerations; consistency with UNDP Country Program and FAO Strategic Framework**

One of the priorities mentioned in the UN Development Assistance Framework (UNDAF) 2008-2012 is “equitable and sustainable pro-poor growth”, which will be supported in three main areas: (a) pro-poor policies and achievement of the MDGs; (b) aid coordination; and (c) environment and energy and disaster risk management. The UNDP Country Programme Action Plan (2008-2012) (CPAP) mentions that its Environment and Energy programme consists of three key elements: (a) the development of Sri Lanka’s capacity to manage and ensure good governance in environment and energy sectors; (b) the creation of an enabling environment for communities to reap the benefits of ecosystems and natural resources through improved management and extraction of natural and biological resources and (c) the promotion of environment and energy best practices, technologies, market access and financial mechanisms to increase the efficiency and effectiveness in poverty reduction and climate change adaptation interventions.

The CPAP mentions the following outputs:

- Improved policies and strategic interventions ensure sustainable environment management and climate change adaptation (with as indicator being mentioned ‘number of environmental management policies and strategies implemented’)
- Communities in selected areas adopt and benefit from improved environment and energy best practices, technologies and related investment (with as output indicators ‘number of sustainable community level enterprises established’; ‘number of communities having adopted sustainable energy and water management related technologies’; ‘Perception of communities on quality of life improvement due to projects interventions’).

The project ‘Promoting Sustainable Biomass Energy Production and Modern Bio-Energy Technologies’ addresses priorities identified in the FAO Strategic Framework 2010-2019 under Strategic Objective E – Sustainable management of forests and trees and Strategic Objective F Sustainable management of land, water and genetic resources and improved response to global environmental challenges affecting food and agriculture. Specifically, it addresses the following Organizational Results (ORs):

E3 – Institutions governing forests are strengthened and decision-making improved, including involvement of forest stakeholders in the development of forest policies and legislation, thereby enhancing an enabling environment for investment in forest and forest industries. Forestry is better integrated into national development plans and processes, considering interfaces between forests and other land uses;

E5 – Social and economic values and livelihood benefits of forests and trees are enhanced, and markets for forest products and services contribute to making forestry a more economically-viable land-use option;

E6 – Environmental values of forests, trees outside forests and forestry are better realized; strategies for conservation of forest biodiversity and genetic resources, climate change mitigation and adaptation, rehabilitation of degraded lands, and water and wildlife management are effectively implemented;

F5 – Countries have strengthened capacities to address emerging environmental challenges, such as climate change and bioenergy.

**This project addresses the regional priority E:** Coping with the impact of climate change on agriculture and food and nutritional security and in particular the objective: reducing the contribution of agriculture, including livestock and aquaculture and deforestation to GHG emissions and integrate climate change adaptation and mitigation into strategies for agriculture and rural development.

### **Gender and poverty reduction**

A recent report ‘Gender and Energy in Sri Lanka: A Brief Analysis of the Situation’ (2009)<sup>14</sup> explores the issue of mainstreaming gender in renewable energy projects. Biomass and gender is commonly associated with the women’s responsibility to fetch firewood as part of the household chores and obligations. The less explored areas are associated with renewable energy technologies, decentralized energy development potentials for addressing gender related concerns and energy enterprises. In this respect, exploring new avenues to create opportunities for women as small scale farm operators to become entrepreneurs and be engaged in supply chain is a challenge as well as an opportunity. However, the report mentions that ‘no sound attempts have been made by the agencies working on gender and women’s well-being to work with the energy sector to mainstream gender into energy policies, programmes and projects and negotiate for cleaner fuels’.

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<sup>14</sup> By Prof. Anoja Wickramasinghe (National Network on Gender and Energy)

The proposed project will look, for instance, in women's involvement and enhancing managerial capabilities through capacity building in promoting *Gliricidia* as a commercial crop and in the management of resources including soil, and water for sustainable development.

## 6. POLICY CONFORMITY AND COUNTRY OWNERSHIP

### Policy conformity

The proposed project is consistent with the GEF Strategic Program (SP) 3 – “Promoting market approaches for renewable energy” and SP 4 – “Promoting Sustainable Energy Production from Biomass”. As per the objectives of SP-3 in particular prioritizing low-cost, low-GHG-emitting, efficient biomass gasifiers and lead to growth in markets of renewable energy technologies. As per SP-4<sup>15</sup>, it will lead to the adoption of modern and sustainable practices in biomass production, conversion and use. The project aims to remove barriers to the large-scale application, implementation, and dissemination of modern and sustainable practices in biomass production, conversion and use as energy.

### Country ownership, country eligibility and country drivenness

According to the Instrument for the Establishment of the Restructured Global Environment Facility, Sri Lanka:

- It has ratified the United Nations Framework Convention on Climate Change in 1993;
- It receives development assistance from UNDP's core resources.

The proposed project is consistent with Sri Lanka's energy and forestry policies, legislation and country's strategy of promoting sustainably produced fuel wood to substitute for fossil fuels, as described in detail in Section 2):

- Ten Year Development plan
- Sri Lanka's Energy Policy (October 2006)
- National Energy Policy and Strategies of Sri Lanka (2008)
- National Forest Policy (1995)

## 7. PROJECT OBJECTIVE, OUTCOMES AND OUTPUTS

### Project objective

The Project goal is “the reduction of greenhouse gas emissions from the use of fossil fuel for thermal energy generation in the Sri Lanka industrial sector”. The objective is “the removal of barriers to the realization of sustainable biomass plantation, increase of market share of biomass energy generation mix and adoption of biomass-based energy technologies in Sri Lanka”

The project's objective is to be achieved through delivery of the following Components:

1. Policy support for effective implementation
2. Barrier removal for sustainable fuel wood production and supply
3. Enabling environment for fuel wood suppliers and wood energy end-users
4. Wood-based energy technology demonstration

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<sup>15</sup> In GEF-5 called “Promote Investment in Renewable Energy Technologies” (CC Objective 3)

## Geographical focus

The country's main industrial areas are concentrated in its Western Province in the districts of Colombo and Gampaha. Therefore, the primary demand is expected to emanate from this industrial center, although other demand sources are considered under the project:

- Plantation product processing areas, such as:
  - Coconut processing (desiccated coconut) in Kurunegala District,
  - Rubber processing in Kalutara District,
  - Tea and rubber factories in areas at low-to-high elevation,
- Trincomalee (port town) in Eastern Province (major industrial demand base in that area);
- Vavuniya and Mulaitivu Districts (where future industrial demand will be located);
- Hotels, rice mills, bakeries, etc. that are spread throughout the country.

In the first phase (1-3 years) the project would consider the demand to emanate from western and north-western province (from the districts of Colombo, Gampaha, Kurunegala primarily). The idea is to identify and develop potential supply chains that will cater to those industries located in the current industrial areas, especially looking at industries that have expressed interest in fuel switching. The supply in these areas would emanate primarily through intercropping in existing plantation and agricultural landscapes, since the scope for dedicated planting is unpromising (low availability of marginal and scrub lands) in these districts.

In the longer term (the 4<sup>th</sup> and 5<sup>th</sup> year) the project would consider the demand locations of Trincomalee and Vavuniya, aiming to improve both raw material availability and sustained supply in the peripheral areas where land is readily available.

### Component 1: Policy-institutional support for effective fuel-switching using fuel wood

*Outcome 1* A set of approved and implemented policy instruments that promote and support the use of sustainably produced fuel wood in industrial thermal applications.

This component is intended to address barriers related to the lack of supply of sustainably produced fuel wood in the industrial (and commercial) sector. The expected outputs that will help realize this outcome are detailed below, and focus on *strengthened institutional capacities and improved cooperation between various government agencies and private sector to promote sustainable production, supply and use of fuel wood (in industrial thermal applications)*

Output	Barrier addressed	Activities <sup>16</sup>	<u>Co-financing<sup>17</sup></u> <u>Co-operation</u>
1.1 Established and enforced	A, B (Figure 6)	1.1.1 Conduct analysis of institutional constraints related to sustainable fuel wood production, supply chain	<i>Co-fin:</i> SEA

<sup>16</sup> Activities in this Component are supported with GEF co-financing (USD 139,814) and counterpart co-financing, consisting of cash contributions and additional staff by SEA (USD1,686,545), for budgetary allocations (baseline activities) as well as for guarantees provided to companies under its new Guarantee Facility (noting that co-fin for companies that participate in the demo Component 4 has been put there to avoid double counting)

<sup>17</sup> In this Component 1 and other Components, co-financing entities deliver co-financing as confirmed in the accompanying co-financing letters. Co-operation entities have not confirmed co-financing, but are likely to co-operate (and although not defined at this stage) might have an in-kind or even co-financing contribution during project implementation.

<p>mechanisms for effective cooperation between various government agencies and private sector involved in (regulating) fuel wood production, supply and use for thermal energy generation</p>		<p>and efficient utilization of fuel wood energy</p> <p>1.1.2 Conduct a holistic in-depth review of all current policies, rules and regulations that affect fuel wood production, supply and use for thermal energy purposes</p> <p>1.1.2 Provide technical assistance (TA) to improve coordination between government agencies engaged in promoting biomass energy</p> <p>1.1.3 Draft recommendations on the most suitable set-up, mandate, membership and operational procedures of the Inter-Ministerial Committee on Renewable Energy (ICRE); Assist in establishing ICRE</p> <p>1.1.6 Conduct a SWOT<sup>18</sup> analysis of the Bio-Energy Association of Sri Lanka (BEASL)</p> <p>1.1.7 Draft recommendations on improving effectiveness of BEASL as representative of private sector stakeholders, including establishing linkages with the ICRE</p> <p>1.1.8 Implementation of identified and agreed improvements to the functioning of BEASL</p> <p>1.1.9 Draft long-term strategy and enforcement plan on biomass-based thermal energy within existing renewable energy plan of the Sustainable Energy Authority (SEA)</p> <p>1.1.10 Establishment of a separate division in SEA with the primary responsibility of enforcing and implementing the policy instruments to develop the bio-energy sector as well as to co-ordinate other agencies involved in enforcement (Ministry of Transport; Police Department)</p>	<p><i>Co-op:</i> BEASL, Energy Forum, Min Env</p>
<p>1.2 Completed awareness raising campaigns and general trainings</p>	<p>A, C, D, E, F, H, L, M</p>	<p>1.2.1 Organize and conduct awareness raising campaigns in specific industries on available fuel switching options and energy efficiency (EE) measures in thermal energy generation to reduce fossil fuel consumption</p> <p>1.2.2 Organize and conduct awareness training courses for governmental staff on opportunities of growing fuel wood species, supply chain and available biomass energy technologies</p>	<p><i>Co-fin:</i> SEA <i>Co-op:</i> BEASL, CCB, Energy Forum</p>
<p>1.3 Proposed, approved and implemented policies/incentive schemes for fuel switching</p>	<p>B, E, L</p>	<p>1.3.1 Conduct in-depth economic, environmental, financial and social cost-benefit analysis of fossil fuel subsidies</p> <p>1.3.2 Establish a monitoring system on use of fossil fuel in different industries</p> <p>1.3.3 Conduct advocacy activities to discuss the benefits and disadvantages of fossil fuel subsidies</p> <p>1.3.4 Prepare road-map to scale down fossil fuel subsidies and improve enabling environment for RE</p> <p>1.3.5 Prepare mechanism to inject a subsidy for fuel wood use in industry</p>	<p><i>Co-fin:</i> SEA</p>

<sup>18</sup> Strengths, weaknesses, opportunities, threats

		1.3.6 Prepare operational procedures and feasible options for implementation of a subsidy scheme on use of fuel wood	
1.4 Enhanced and implemented policies on fuel switching	A, B, K, L	1.4.1 Draft enhanced operational procedures for functioning of Sustainable Guarantee Facility <sup>19</sup> 1.4.2 Implementation of operational procedures of the Facility and M&E of the SGF performance	<i>Co-fin:</i> SEA, Enerfab <i>Co-op:</i> Ministry of Finance/Petroleum corporations.
1.5 Monitoring and evaluation		1.5.1 Monitoring and evaluation of project progress and impact indicators <sup>20</sup> 1.5.2 Mid-term evaluation 1.5.3 Final evaluation	

## Component 2: Barrier removal for sustainable fuel wood production

*Outcome 2 Enhanced knowledge of and improved support network and increased sustainable fuel wood production*

This component is comprised of activities that will address technical and coordination issues that hinder large scale fuel wood plantations and biomass supply chain development. It is designed to address the lack of confidence in both supply (fuel wood production/ sourcing biomass) and demand (industrial needs) sectors by raising awareness, developing standards for sustainable fuel wood certification schemes<sup>21</sup>, and demonstrating viability of plantations through a livelihood-based approach with a broader scope for its application and implementation at the national level. The fuel wood will be chopped into small sizes and air-dried at site (i.e., where it will be used as gasifier fuel). Usually, at site, the biomass can't be stored beyond certain capacity due to space constraints, and storage facilities are usually not weather-proofed. Since the adequate supply of processed fuel wood (i.e., sized and air-dried) will significantly influence the operation of biomass energy systems, activities on the proper handling and processing of biomass fuel (in this case fuel wood) have been incorporated in the proposed project. The activity "Implementation of fuel wood quality improvement techniques (air-drying) and weather-proof storage to maintain its quality" is included as part of the activities that will deliver Output 2.3, i.e. "Implemented R&D on locally suitable sustainable growing models and biomass species for fuel wood production".

The aim is to demonstrate commercially viable and innovative models for fuel wood supply in partnership with the Forest Department and other land-owning agencies, i.e., plantation companies:

<sup>19</sup> The Sustainable Energy Authority will work with the project to enlarge the Sustainable Guarantee Facility, established as a credit mechanism to guarantee loans taken by the private sector from commercial banks to implement energy efficiency improvement and fuel switching projects. SEA commits to guaranteeing loans amounting to LKR 400 million as co-financing for the project, in particular for the first set of demonstration projects supported a part of Component 4 as well as project applicants thereafter. Discussions during the project preparation (PPG) phase indicate that this idea is quite plausible and acceptable to banks. GEF will not supply financial support, but technical assistance in making SGF effectively operational, by helping to mitigate the barriers mentioned in Section 4.

<sup>20</sup> These activities are in fact cross-cutting through the various Components. The M&E activities will help to monitor and assessments and will be feed-back through reports, workshops, into policy instruments of Component 1, but also improve the activities of the other Components. The activities will be linked with the impact analysis performed as part of project management.

<sup>21</sup> Sustainable certification scheme shall include appropriate environmental criteria with regard to conservation of biodiversity and local ecosystems, the use of agro-chemicals and water use. This is the reason for the inclusion of 'sustainable' certification scheme under the project so as to avoid negative environmental impacts while establishing sustainable biomass supply chain. The recommended fuel wood species are those that have very low water requirement; are generally hardy species with few or no known pests. Environmental criteria will be built into the sustainable certification scheme that will be developed and introduced through the project.



- Dedicated fuel wood plantations,
- Intercropping with coconut,
- Inter cropping with pepper and vanilla,
- Home gardens
- Alley cropping in rain-fed uplands,
- Sloping agriculture land technology (SALT),
- As shade trees for coffee, cocoa and tree cultivation.

<b>Output</b>	<b>Barrier addressed</b>	<b>Activities<sup>22</sup></b>	<b>Co-financing Co-operation</b>
2.1 Prepared and disseminated information and knowledge products on fuel wood growing (models)	F, G, M (Figure 6)	<p>2.1.1 Conduct surveys in selected regions on available biomass resources, land use and land availability for different growing models and establish a database on this</p> <p>2.1.2 Draft menu to show various government approval procedures for accessing different land parcels depending on ownership (linked with output 1.3)</p> <p>2.1.3 Prepare stock-taking and analysis of issues and options on different growing models and their acceptability for (small and large) fuel wood growers, including:</p> <ul style="list-style-type: none"> <li>○ Dedicated plantations (plantation companies, forest buffer zones and contour planting in sloping lands</li> <li>○ Intercropping with coconut and pepper/vanilla;</li> <li>○ Fuel wood / bamboo cultivation for catchment conservation</li> <li>○ Preventive fire belts and demonstrating the fuel wood/ timber model</li> </ul> <p>2.1.4 Conduct survey to identify gaps in the current management practices and socio economic benefits that could be derived through different biomass production models promoted in project</p> <p>2.1.5 Compile and disseminate through mass media/ other channels all knowledge related to cultivation and management systems, environmental benefits, managing of planting materials and planting techniques/nurseries</p> <p>2.1.6 Prepare and disseminate handbook on</p>	<p><i>Co-fin:</i> Min. Env (Forest Dept.), FAO, Coconut Cultivation Board</p> <p><i>Co-op:</i> Land Use Policy Planning Dept., (LUPPD), Land Commissioner's Dept., Practical Action, Energy Forum, Mahaweli, Authority and regional plantation companies</p>

<sup>22</sup> The activities mentioned in the table of this Component are supported with GEF co-financing (USD 878,250). To this will be added counterpart co-financing, consisting of cash contributions by the Forest Department (USD 1,540,728) as part of its annual programme, CCB (USD 1,818,181) to encourage Gliricidia-coconut inter-planting, the Hadabima Authority (USD 2.7 million) for the design and implementation of biomass production activities, DEAC (USD 232,955) and NGOS HelpO and Arunalu (USD 85,000) for promotion of Gliricidia growing in plantations and community plots, as well as private sector investment in dedicated fuel wood plantations (USD 1,670,925). FAO co-financing of USD 461,755 will support the knowledge generation and training outputs of this component.

		best available approaches for sustainable growing models for different species of fuel wood in Sri Lanka	
2.2 Tested and implemented supportive regulations and policies for sustainable fuel wood production	B, C, D, E, H	<p>2.2.1 Establish and publish transparent lease rates and lease procedures for fuel wood plantations</p> <p>2.2.2 Drafting of example standard contracts for lease agreements of land parcels depending on ownership</p> <p>2.2.3 Pilot a certification scheme for sustainably produced fuel wood</p> <p>2.2.4 Establishment and implementation of certification scheme for sustainably produced fuel wood at the national level</p> <p>2.2.5 Analyze and draft recommendations on improvements to existing subsidy scheme for <i>gliricidia</i> intercropping in coconut plantations to include other potential fuel wood species</p> <p>2.2.6 Draft operational procedures for (improved) subsidy scheme for fuel wood intercropping in coconut plantations</p> <p>2.2.7 Formulate post-project action plan for replication of newly identified approaches</p>	<p><i>Co-fin:</i> Min Env (Forest Dept.); CCB, DEAC, HADABIMA, FAO</p> <p><i>Co-op:</i> LUPPD/Land Commissioner's Dept.; Energy Forum;</p>
2.3 Completed demonstration of applied approaches and models in sustainable fuel wood production systems	G, H,	<p>2.3.1 Research and identification of suitable tree species (apart from <i>gliricidia</i>) for short- rotation tree growing and identify best growing approaches for all species</p> <p>2.3.2 Provide TA support to tree growers for improving tree-planting, improving planting materials, setting up tree multiplication units, management of nurseries, land management for planting as well as field testing of new fuel wood production systems using different fuel wood species grown based on using best growing approaches/practices</p> <p>2.3.3 Provide TA support for the demonstration of new fuel wood production approaches</p> <p>2.3.4 Implement fuel wood quality improvement techniques (air-drying) and weather-proof storage to maintain its quality</p> <p>2.3.5 Strengthen co-operation with Sri Lankan and foreign universities on research on alternative fuel wood species and integration of topic into the curricula (cooperation agreement signed)</p> <p>2.3.6 Draft recommendations for improving silvicultural practices in fuel wood plantations and new approaches based</p>	<p><i>Co-fin:</i> Min. Env. (Forest Department); Silvermill (support to Coconut-<i>gliricidia</i> intercropping model) BPL</p> <p><i>Co-op:</i> LUPPD/ Land Commissioner's Department, Practical Action, Energy Forum,</p>

		on research and experiences with fuel wood planting carried out	
2.4 Completed awareness raising campaigns and specific training programmes for key stakeholders on growing of species for fuel wood production	E, F, G, H, M	2.4.1 Conduct trainings for staff working on plantations 2.4.2 Conduct training of extension officers on various fuel wood growing models 2.4.3 Organize awareness raising events for farmers <sup>23</sup> and plantation owners on benefits of producing fuel wood 2.4.4 Implement promotional activities for various growing models 2.4.5 Prepare outreach materials for the Coconut Cultivation Board (CCB) to develop fuel wood intercropping model and fuel wood markets 2.4.6 Support CCB to conduct outreach activities related to production of fuel wood	<i>Co-fin:</i> Plantation companies (e.g. Silvermill, Kahawatte, BPL, Watawalla) DEAC, HADABIMA FD NGOs, Arunalu Help-O

### Component 3: Enabling environment for fuel wood suppliers

*Outcome 3 Improved confidence among industrial and banking sector on the feasibility, stability and economic benefits of sustainable fuel wood supply chains*

This component is primarily aimed at building the enabling environment for commercial investment for fuel wood suppliers and biomass energy technology companies, in order to build a larger local market for sustainably grown fuel wood. The expected outcome from this component is increased number of investment projects from commercial banks, and increased the confidence in the industrial sector on the longer term sustainability of supply.

Output	Barrier addressed	Activities <sup>24</sup>	<u>Co-financing</u> <u>Co-operation</u>
3.1 Proposed, approved and implemented policies and incentive schemes for sustainable fuel wood supply	B, D,, M (Figure 6)	3.1.1 Draft proposal and criteria for fuel wood supplying industry to be recognized as official industrial sector (allowing policies/incentive schemes to be developed and implemented). 3.1.2 Achieve registration for fuel wood supplying industry (providing necessary technical assistance) 3.1.3 Draft recommendations on enabling policies and incentive schemes for fuel wood supplying industry (e.g. tax breaks) 3.1.4 Carry out promotional, advocacy and	<i>Co-fin:</i> UNDP <i>Co-op:</i> BEASL, SEA, Min. Env

<sup>23</sup> The project will generate socio-economic benefits for the small farmers and surrounding populations in the establishment of viable and sustainable biomass supply chains.

<sup>24</sup> The activities mentioned in the table of this Component are supported with GEF co-financing (USD 276,604). To this will be added counterpart co-financing, consisting of in-kind contributions (USD 17,270) from the private company MAP, and cash contributions by the private sector investors (to help develop the biomass supply chains), valued at USD 1,503,635), supplemented by UNDP's contribution of USD 402,000 for supply chain development linked with its Community Forestry project. This component also has in-kind co-financing input from two national NGOs Arunalu and HelpO which have developed community wood-collecting centres.

		lobbying activities to secure approval of proposed policies/incentive schemes 3.1.5 Assist in the implementation of approved policies/incentive schemes	
3.2 Completed training & outreach programmes for key stakeholders and published and disseminated knowledge products	D, K, M	3.2.1 Design and conduct training of financial institutions on benefits and risks involved in fuel wood production, supply and use for thermal energy generation 3.2.2 Design and conduct training of fuel wood supplier industries on operational issues and best approaches for securing a constant supply meeting minimum quality standards 3.2.3 Design and conduct training of fuel wood supply companies in developing viable businesses and bankable proposal 3.2.4 Analysis on costs involved in fuel wood supply chain, including recommended fair pricing, presented to SEA and Forest Department for their approval and recommendation to the Cabinet 3.2.5 Publish example contracts for supply chain and approval of at least six contracts for supply chains 3.2.6 Design and conduct training of law enforcement officers (e.g. local police) on transport policies of fuel wood	<i>Co-fin:</i> HELP-O, Arunalu <i>Co-op:</i> DFCC Bank
3.3 Six sustainable biomass supply chains established and operational	B,C, D, E, H, I, K, M	3.3.1 Drafting of feasibility studies and bankable proposals for biomass projects and associated supply chains (integrating: production, supply and technology) 3.3.2 Establishment of 6 biomass supply chains (production, handling/processing biomass and supply) and meeting the required quality standards 3.3.3 Monitoring and evaluation of the operations of the established biomass supply chains (incl. handling/processing) and assist in trouble-shooting 3.3.4 Identification of innovative approaches for drying , processing, storing, handling and transport of biomass	<i>Co-fin:</i> Enerfab: (investment in supply chain) Aitken Spence, Lalan, MAP (biomass supply chain and processing/handling of biomass (saw dust, paddy husk <sup>25</sup> , fuel wood) <i>Co-op:</i> DFCC Bank

<sup>25</sup> The project will explore the possibility of using biomass residues, especially agricultural waste including paddy husk, wood chips, coconut refuse, etc. The proposed activities that will deliver Output 3.3 focus on the establishment and operationalization of sustainable biomass supply chains that include the use of biomass residues that are not being used. However, it should be noted that much of these biomass residues are already in use for meeting the energy needs in various small-, and medium-size industries.

		(incl. semi-mechanization such as producing pellets and briquettes) to reduce costs and improve quality	
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#### **Component 4: Wood-based energy technology development**

*Outcome 4 Enhanced knowledge of, access to, and maintenance skills of biomass energy technologies as well as increased number of wood-based gasification projects*

The component aims at promoting is the commercialization of improved and modern dendro-energy technologies for heat applications in the industrial sector in Sri Lanka. GEF resources will be used to finance incremental activities that would ensure the effective implementation of bioenergy technologies (BETs). The pilots are intended to demonstrate to the government and the private sector (particularly in the energy, industry, and banking/financial sectors) the techno-economic viability and benefits of BETs. The demonstrations will be carried out to showcase the planning, design, engineering, financing, installation, operation, maintenance and performance evaluation of specific BETs (gasification and energy-efficient biomass-fired boilers, furnaces and kilns). The lack of technical expertise and facilities especially for the maintenance of gasifiers has been identified as a key barrier. Due to the lack of maintenance and trouble-shooting support, high operation & maintenance costs are usually incurred in the operation of wood gasifiers. Although there are local entities in the country that can provide engineering services for the repair and maintenance requirements for wood gasifiers, their number and capabilities are limited. Knowing the nature and extent of this barrier, the proposed project intends to address it through the conduct of Activity 4.2.4, which involves strengthening capacity for equipment maintenance and post-installation servicing by training the personnel of the local engineering and repair/maintenance service providers in the country. Capacity needs assessments will be done in order to ascertain the specific aspects of the design, installation, operation and maintenance of wood gasifiers that should be enhanced, including follow-up work to ensure that the skill sets that are learned are properly and adequately applied. It is expected that with the provision of technically capable and qualified designers, the difficulties in the installation and operation of wood gasifiers will be minimized. With the availability of technicians the response to trouble-shooting and maintenance would eliminate the delay and wider availability of such technicians would bring down the cost of operation and maintenance. As mentioned earlier, one or two pilots showcase the cogeneration technology using fuel wood and electricity generation is one of the selection criteria for pilots. Thus the proposed project covers a spectrum of biomass energy technologies.

The demonstrations will consist of investments in BETs in at least 12 companies that have expressed their commitment to replace furnace oil, diesel or LPG with BETs), as evidenced by the attached co-financing letters. Details on cost of investments of the BET demonstrations are given in Annex C. To deliver the necessary outputs that would help realize the expected outcome from this component of the project, the following activities are envisaged:

<b>Output</b>	<b>Barrier addressed</b>	<b>Activities<sup>26</sup></b>	<b><u>Co-financing</u> <u>Co-operation</u></b>
4.1 Twelve fuel wood thermal energy	I, J, K, L, M	4.1.1 Prepare detailed technical and financial feasibility studies for the 12	<i>Co-fin:</i> 12 private sector

<sup>26</sup> The activities mentioned in the table of this Component are supported with GEF co-financing (USD 505,582), including TA support to have the demo projects developed (estimated at USD 330,909 or 10% of private sector investment cost). To this will be added SEA funding for investment projects under its Sustainable Guarantee Facility.

<p>projects implemented, operational and monitored</p>	<p>(Figure 6)</p>	<p>demonstration projects</p> <p>4.1.2 Finalize and secure approval of designs of demonstration projects</p> <p>4.1.3 Monitor construction of demonstration projects (total 17 MW<sub>th</sub> and a cogeneration system of 1 MW<sub>e</sub> and 3 MW<sub>th</sub>)</p> <p>4.1.4 Evaluate the operation and performance of the demonstration projects and document and disseminate the lessons learned</p>	<p>investments in fuel wood technologies, of which letter received of the following:</p> <ul style="list-style-type: none"> <li>• Aitken,</li> <li>• LeFerme,</li> <li>• Watawala,</li> <li>• BPL,</li> <li>• Apollo Marine,</li> <li>• Nilmini,</li> <li>• Lanka Polymer,</li> <li>• Brandix,</li> <li>• Mahaweli,</li> <li>• Melbourne Tex</li> </ul>
<p>4.2 Completed trainings and research aimed at improving services to promote fuel-switching in industry</p>	<p>G, I, J, L, M</p>	<p>4.2.1 Conduct a survey of existing fuel wood energy projects identifying successful technologies and challenges in operation of plants</p> <p>4.2.2 Conduct monitoring campaigns in existing fuel wood projects to determine actual performance (incl. establishing feasible approaches for monitoring)</p> <p>4.2.3 Draft recommendations for improvements in operations of fuel wood energy plants</p> <p>4.2.4 Strengthen capacity for equipment maintenance and post-installation servicing by training staff of technology supply companies</p> <p>4.2.5 Conduct research to adapt available fuel wood technologies to local circumstances and local biomass species</p> <p>4.2.6 Prepare manual on fuel switch options (adapted to local situations) and related maintenance issues</p> <p>4.2.7 Organize and conduct a ‘matchmaking’ event for Sri Lankan and foreign fuel wood businesses</p>	<p><i>Co-fin:</i> SEA; Enerfab (for research gasification technology)</p>
<p>4.3 Established information exchange system</p>	<p>F, G, J, K</p>	<p>4.3.1 Gather data on industries in Sri Lanka involved in fuel wood business and establish database with local and international suppliers of fuel wood technologies and service companies (maintenance)</p> <p>4.3.2 Draft technical standards for gasification equipment and proposals on enforcement of standards</p> <p>4.3.3 Capacity building for manufacturers on implementation of and compliance with</p>	<p><i>Co-fin:</i> SEA</p>

		standards	
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Note: More details on demo biomass-for-energy projects (output 4.1) are given in Annex C.

## 8. KEY INDICATORS, RISKS AND ASSUMPTIONS

### Indicators

Key indicators of the project's results are:

- CO<sub>2</sub> emissions are reduced by switching from fossil fuels in commercial and industrial establishments to biomass (fuel wood) using biomass energy technologies (BETs). Investment in BETs by companies directly supported under the demo scheme with technical assistance by the GEF project will lead to fuel substitution of 230,265 GJ annually, electricity substitution of 4,680 MWh and corresponding CO<sub>2</sub> emission reduction of 203 ktCO<sub>2</sub> over the lifetime of the technology (conservatively assumed to be 10 years)
- A set of approved policy instruments is in place with appropriate incentives for biomass production, transportation and use in industrial and commercial establishments;
- Incentive mechanisms provided by various government agencies, such as CCB (for *Gliricidia* intercropping), SEA (Sustainable Guarantee Facility), and soft loan schemes provided by development banks
- Hectareage which is under cultivation for fuel wood production and annual fuel wood production, using various schemes, such as dedicated plantations, intercropping with coconut, pepper, vanilla or other plants, home gardens, as part of coffee/tea/cocoa production or as anti-erosion measure on sloping land;
- Number of commercially viable biomass (fuel wood) supply chain developed that can guarantee producers a fair price, be financially viable themselves and can fuel wood users guarantee a reliable and affordable source of biomass supply;
- Number of commercial and industrial establishments that have switched from fossil fuels (diesel, furnace oil, LPG) to biomass fuels (fuel wood or other biomass) using improved biomass energy technologies (gasification, efficient biomass furnaces or boilers).

A detailed set of outcome and output indicators is given in the project results framework in Section 11.

### Risks and assumptions

The main risks and mitigation options are listed in Table 4 below. The reader is also referred to the risks/assumptions column in the project results framework in Section 11.

**Table 4: Risks and proposed mitigation responses**

Risk	Rating	Mitigation actions
Supply chain disruptions due to plantation production failure, time	M	The project will, in its Component 3, build upon existing research and use local knowledge on biomass availability

<b>Risk</b>	<b>Rating</b>	<b>Mitigation actions</b>
constraints, extreme weather shifts and biomass quality issues.		and work with existing local co-operatives, private sector plantation companies, government agencies that specialize in plantation techniques, storing, handling and transport of woody biomass as well as looking at financial and pricing issues
Modern biomass energy (in particular gasification) technologies are not economically viable and locally unavailable proper capacities for operation and maintenance of wood fuel gasification installations.	M	The economic viability depends on feedstock price and availability, cost of alternative fuels (diesel, or furnace oil) and cost of the gasification technology. Indications that the technology is both technically and economically viable (see Annex C of UNDP ProDoc) in thermal applications (boilers, furnaces, ovens), but a number of barriers nonetheless inhibit its dissemination on a wider-scale. The project focuses on removing these barriers including the capacity strengthening of technology suppliers and service providers.
Biomass production is not continuously available and there could be competition for fuel wood supply from other users or uses (such as electricity generation)	L	This is often a problem in the case of biomass gasification. In the past, technical assistance projects have often either focused on the demand-side (end-use technology) or fuel wood production (supply side) but not both. The proposed project has followed a holistic approach of combining the production of fuel wood through dedicated plantations using different production models, processing of fuel wood, establishing its supply linkage, and transportation to the site of use along with promotion of efficient biomass energy technologies i.e., gasification.
Regulatory framework not put into place and absence of cooperation of other concerned entities (Ministry of Transport, Ministry of Planning, Police Department)	L	The policy of Sri Lanka favors growing fuel wood as an indigenously available alternative to fossil fuels. However, regulations are not fully in place. And also the institutional setup needs improvement, which is an issue the project, will help address in its Component 1. The Inter-Ministerial Committee on Renewable Energy (ICRE), established under Component 1 will include the Ministry of Transport, Police Department and other concerned government agencies that need to cooperate with SEA on renewable energy implementation and enforcement issues.
Commitment of national and local government entities (ministries, agencies)	M	Both forestry and energy policy stress the importance of indigenous energy sources, notably biomass (if sustainably produced). Currently, there is no fossil fuel subvention. While the commitment is there, the practical translation into suitable regulations and incentives is partly missing, which the project will help to address in its Component 1.
Commitment of project beneficiaries (fuel wood growers, intermediaries, BET-using companies)	L	A fair number of private sector players have been willing to sign co-financing letters to the amount of USD 6.1 million. This interest is likely to remain, unless political or economic upheavals would affect the investment climate in general.
Impact of civil conflict on enabling environment	L	Albeit the recent declaration of ending of the conflict, the project will only work on those sites that have been made sure of its safety and stability and in locations where UNDP already has adequate field presence.
Insufficient genetic diversity linked to the widespread distribution of a	L	<i>Gliricidia sepium</i> has been so far promoted by the government as plantation crop, next to tea, rubber and



Risk	Rating	Mitigation actions
single elite variety of <i>Gliricidia sepium</i>		coconut, and therefore listed as foremost fuel wood crop. However, the project also promotes other fuel wood species and some of these are already in use but limited to small scale. During the course of the project implementation, some of the other species will be researched and field tested. Refer to the proposed project activity project activity 2.3.1.

## 9. GEF INCREMENTAL REASONING; COST-EFFECTIVENESS

### *Business-as-usual*

Section describes existing policy instruments for promotion of renewable energy. These have not much favored so far biomass-for-energy, because of the existence of a complex web of interrelated barriers (described in Section 4) that inhibits the realization of the production, supply and utilization of biomass energy technologies (BETs) on a wider scale. If these barriers (policy-regulatory-institutional, technology and financial, support, capacity and awareness, targeted research and development) are not mitigated in a concerted effort, the penetration of BETs in the energy supply mix of Sri Lanka will remain limited, despite the large potential resource availability, leading to an increased use of (imported) fossil fuels.

### *GEF alternative*

The proposed UNDP/FAO/GEF intervention seeks to address the barriers in a holistic approach, as described in Sections 5 and 7. The impact of GEF intervention will be visible by means of the results of demonstrations (investments made by industrial and commercial establishments in BETs at a total capacity of 20 MW<sub>th</sub> (17 MW<sub>th</sub> stand-alone thermal units, and 3 MW<sub>th</sub> from a wood-fired cogeneration system, in which the demo cogeneration unit is also rated at 1MW<sub>e</sub> capacity). This is expected to result in annual electricity substitution of 4,680 MWh and fuel substitution totals 230,265 GJ (gigajoules), resulting in greenhouse gas emission reduction due to the avoided use of fossil fuels of 20.3 ktCO<sub>2</sub> annually. Assuming a lifetime of 10 years of the BET, cumulative direct emission reduction will be 203 ktCO<sub>2</sub> (*direct emission reduction*).

The capacity of the gasifiers installed varies per plant/location and it depends on the energy requirements of the plant<sup>27</sup>. For purposes of estimating emission reductions in thermal applications, two cases have been elaborated, namely wood-fired gasifiers replacing diesel and furnace oil for three different sizes, 300 kW, 650 kW and 1,000 kW. The overall targeted capacity of 17 MW for stand-alone wood gasification units, corresponds with the fuel consumption of the companies that have signed co-financing letters. Based on the experience with existing systems in the country, the gasifier equipment will cost about USD 189/kW for a 300 kW system, USD 124/kW for a 650 kW system and USD 109/kW for a 1 MW system. In addition, support to a cogeneration gasification unit is contemplated, although a site/company will only be identified during project implementation. For this 1 MW<sub>e</sub> cogeneration unit, the 3 MW<sub>th</sub> capacity is based on the typical heat-to-power ratio for wood-fired cogeneration units, which is about 3:1.

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<sup>27</sup> Table 16 in Annex C shows the initial list of companies that have expressed interest to implement wood-fired gasification projects as demonstrations/pilots of the proposed GEF project.

Obviously, for smaller units the magnitude of benefits of wood-fired gasification replacements of fossil fuel-fired combustion units in terms of CO<sub>2</sub> emission reductions will also be commensurately smaller than when applied to larger boilers and/or furnaces. At maximum continuous rating (MCR), smaller gasifier units have relatively lower energy efficiency performance than larger units. Below MCR, smaller units operate at much lower energy efficiencies compared to larger units because the latter have better turndown capabilities. Nonetheless, the demonstration of the operation of small capacity wood-fired gasifiers operating at MCR is not only more manageable for the project but also will be of interest to industrial small and medium enterprises (SMEs). Successful showcasing of the technology application will open up potentials for realizing increased deployment of the wood gasification technology in large scale industries and SMEs. Over a period, with an anticipated increased demand, it is expected that the technology cost, i.e. cost per kW may reduce.

A portfolio of another 12 BET investment projects would be supported to complete feasibility and proposal formulation support by the end of the project (and that can apply in principle to SEA's Loan Guarantee Facility). These will become operational after the project's termination in 2016 and their GHG emission impact is counted as '*post-project direct emission reduction*' and valued at 203 ktCO<sub>2</sub>).

Indirect impacts as a result of the project's institutional and capacity building activities can be estimated as follows as ranging between 609 and 1,378 ktCO<sub>2</sub>. The lower value of the range is calculated by multiplying the direct emission reduction estimate by a replication factor of three (*bottom-up indirect emission reduction*). The upper value looks at the alternative to the baseline scenario and assumes that the Government's stated target of substituting fossil fuels by biomass-derived fuels in industry by 2017 by 10% will be met. Assuming furthermore that in 2025 about 25% of fossil fuels would be met by biomass fuels, the cumulative emission reduction would be 2,297 ktCO<sub>2</sub>. The project would have positively influenced this trend through its capacity building and institutional strengthening efforts and this can be quantified by applying a causality factor of 60%. More details on the emission reduction calculations are given in Annex C. The emission reduction estimates can be related with the monetary value of the GEF intervention as follows:

Impact	Emission reduction (ktCO <sub>2</sub> )	Cost-effectiveness USD/tCO <sub>2</sub>
Direct	203	9.84
Direct+ post-project direct	203	
Indirect, bottom-up	609	
Indirect, top-down	1,378	

Note: Calculated based on the GEF budget (USD 1,996,250) and the direct and direct post-project CO<sub>2</sub> emission reductions

The demonstrations that are planned under the proposed project will not go for CDM project registration. This is one of the criteria for the selection of demonstrations/pilots. The proposed demonstrations/pilots will be asked to sign an agreement stating that they would not go for CDM registration during the lifetime of the project unless otherwise there are major changes proposed within the project boundary during its lifetime. However, the replication projects that come on board at a later stage during project implementation are most likely intending for registration under CDM.

## 10. SUSTAINABILITY AND REPLICABILITY

### *Sustainability*

The project seeks to address the barriers that inhibit the more widespread of biomass energy technologies (BETs) in a holistic way. In the past, many technical assistance initiatives have not had the desired impact as they focused on biomass demand only (e.g. gasification technology) without looking at sustainable supply or on biomass supply only (production of wood without looking at barriers to the application of BETs) without integrating supply and demand issues. The project supports actions biomass-for-energy (promotion of biomass as a viable renewable energy source for industrial thermal applications) and simultaneously supporting activities on the quality-assured and sustained production and supply of biomass as an industrial fuel.

### *Replicability*

The project will not only support the development of a limited number of pilot activities (12 companies have expressed willingness to participate), but will support the development of a pipeline of bankable BET investment proposals. A number of activities to mitigate the policy-institutional, technical, financial and informational barriers will pave the way for scaling up BET investments and the further development of the nascent market for BET application in Sri Lanka.

## 11. PROJECT RESULTS FRAMEWORK

**Table 5: Logical framework**

The project will contribute to achieve the following UNDP and FAO country program objectives:

*Project:* Promoting Sustainable Biomass Energy Production and Modern Bio-Energy Technologies in Sri Lanka

UNDAF/UNDP CPD:

*UNDAF and UNDP CPD Outcome:* Policies, programmes and capacities to ensure environmental sustainability, address climate change, mitigation and adaptation and reduce disaster risks in place at national, sub national and community levels

*UNDP CPAP Outputs:*

4.3 Technologies and approaches used by government and private sector towards Climate Change Mitigation (CCM) improved

4.1 Development agencies are equipped with policies, strategies, methodologies and tools to integrate sustainable development and disaster resilience principles

*UNDP CPAP Output indicators:*

1. Amount of Green House Gas (GHG) emissions reduced as a result of promotion of modern biomass to Energy technologies
2. Number of policies, and strategies contributing towards sustainable and resilient development updated or developed

**FAO's new Strategic Framework for 2010-2019** is embedded in a results-based approach to implementing all of FAO's work aiming at poverty alleviation and sustainable development. Its **11 Strategic Objectives** express the impact, in countries, regions and globally, expected to be achieved over a long-term time frame, based on FAO's value-added interventions. Under these Strategic Objectives, the more specific **Organizational Results** represent the outcomes expected to be achieved over a four-year period – for which FAO will be held accountable – through the taking up and use by Member Countries and partners of FAO's products and services. The Organizational Results, as measured by indicators, constitute the backbone of the Organization's four-year Medium Term Plan and biennial Programme of Work and Budget, exemplifying the substantive priorities upheld by the Membership.

FAO's new results-based management approach means that **Country Programming Frameworks** (CPFs) (formerly National Medium Term Priority Frameworks) are developed together with the concerned governments to identify FAO's contributions to well-identified national needs which are subsequently operationalized in FAO country work plans. The priorities identified at the country level also feed into the sub-regional and regional areas of priority action, which are developed via the Regional Conferences and the specialized Regional Commissions. These, together with the advice of FAO's technical Council Committees, serve to inform the organization-wide Medium Term Plan 2010-2013 and Strategic Framework 2010-2019 that is ultimately approved by FAO's members in the biennial FAO Conference.

The project 'Promoting Sustainable Biomass Energy Production and Modern Bio-Energy Technologies' addresses priorities identified in the Strategic Framework 2010-2019 under Strategic Objective E – Sustainable management of forests and trees and Strategic Objective F Sustainable management of land, water and genetic resources and improved response to global environmental challenges affecting food and agriculture. Specifically, it addresses the following Organizational Results (ORs):

E3 – Institutions governing forests are strengthened and decision-making improved, including involvement of forest stakeholders in the development of forest policies and legislation,

<p>thereby enhancing an enabling environment for investment in forest and forest industries. Forestry is better integrated into national development plans and processes, considering interfaces between forests and other land uses;</p> <p>E5 – Social and economic values and livelihood benefits of forests and trees are enhanced, and markets for forest products and services contribute to making forestry a more economically-viable land-use option;</p> <p>E6 – Environmental values of forests, trees outside forests and forestry are better realized; strategies for conservation of forest biodiversity and genetic resources, climate change mitigation and adaptation, rehabilitation of degraded lands, and water and wildlife management are effectively implemented;</p> <p>F5 – Countries have strengthened capacities to address emerging environmental challenges, such as climate change and bioenergy.</p>
<p><b>Primary applicable key environment and sustainable development result area:</b> Mainstreaming environment and energy</p>
<p>2 Applicable GEF strategic objective and program: Climate Change Strategic Objective: 6) To support new low-GHG emitting energy technologies GEF-4 Strategic Programme (SP): SP 3 – “Promoting market approaches for renewable energy” and SP 4 – “Promoting sustainable energy production from biomass”</p>
<p><b>Applicable GEF expected outcomes:</b> Adoption of modern and sustainable practices in biomass production, conversion, and use for modern energy</p>
<p><b>Applicable GEF outcome indicators:</b> Outcome Indicators: tons CO<sub>2</sub>eq avoided, MW installed, kWh or W steam generated from sustainable biomass</p>

Strategy	Indicator	Baseline	Targets	Source of verification	Risks and Assumptions
<p><b>Project goal:</b> <i>Reduction of greenhouse gas emissions from the use of fossil fuel for thermal energy generation in the Sri Lanka industrial sector</i></p> <p><b>Project objective:</b></p>	<ul style="list-style-type: none"> <li>No. of companies operating BETs by end-of-project (EOP)</li> <li>Number of proposed BET investments by EOP;</li> <li>Total installed</li> </ul>	Limited experience with BETs in industry;	<ul style="list-style-type: none"> <li>At least 12 companies are operating BETs and another 12 companies have detailed feasibility studies completed or started installation of gasifier systems by the end of the project (post-project direct emission reduction) in</li> </ul>	<ul style="list-style-type: none"> <li>Project reports, progress reports, M&amp;E reports</li> <li>Statistical information</li> </ul>	<ul style="list-style-type: none"> <li>Continued commitment of project partners, including Government agencies and private sector</li> </ul>

<p><b>Removal of barriers to the realization of sustainable biomass plantation, and adoption of biomass-based energy technologies in Sri Lanka</b></p>	<p>capacity and resulting fossil fuel reduction and direct GHG emission reduction of these projects by EOP</p> <ul style="list-style-type: none"> <li>• % share of biomass in energy mix by EOP;</li> <li>• Annual fossil fuel consumption reduction starting Year 1</li> <li>• Cumulative GHG emission reduction by EOP</li> </ul>		<p>particular gasification with total capacity of 20 MW<sub>th</sub> and 1 MW<sub>el</sub>, resulting in fossil fuel savings of about 230,265 GJ annually, 4,680 MWh of electricity and direct emission reduction (cumulative over 10 year lifetime) of 203 ktCO<sub>2</sub></p> <ul style="list-style-type: none"> <li>• Indirect emission reduction impacts between 609 (bottom-up) and 1,378 ktCO<sub>2</sub> (top down)</li> </ul>		
<p><b>Outcome 1</b> <b>A set of approved and implemented policy instruments that promote and support the use of sustainably produced fuel wood in industrial thermal applications.</b></p>	<p>1) No. of approved and implemented policy instruments that promote and support the use of sustainably produced fuel wood in industrial thermal applications) by EOP</p>	<p>Various barriers limit in practice the wider-scale application of BETs by industry</p>	<p>One conducive policy-regulatory framework is in place with appropriate incentives for the production, transportation and use of biomass for energy in industrial and commercial establishments</p>	<ul style="list-style-type: none"> <li>• As given under each output</li> </ul>	<ul style="list-style-type: none"> <li>• Commitment of the various Government institutions and agencies</li> <li>• Cooperation of government staff</li> </ul>
<p><b>Output 1.1</b> Established and enforced mechanisms for effective cooperation between various government agencies and private sector involved in (regulating) fuel wood production, supply and use for thermal energy</p>	<p>2) Inter-Ministerial Committee on Renewable Energy (biomass) established (ICRE) by year 2 3) Number of government agencies that actively participate in ICR by year 3</p>	<p>No ICRE  0</p>	<p>ICRE established by year 2  At least 4 agencies participating by year 3</p>	<ul style="list-style-type: none"> <li>• Official notifications, project reports, minutes of meetings</li> </ul>	

generation	4) Number of private sector parties actively involved in BEASL by year 5 5) Number of approved and implemented policies that were formulated and enforced by BEASL by EOP	Institutional and individual members	Membership doubled by Year 5 since project inception;  5 policy recommendations made and enforced	<ul style="list-style-type: none"> <li>• BEASL reports and newsletters; minutes of meeting; website <a href="http://www.bioenergysrilanka.org">www.bioenergysrilanka.org</a></li> </ul>	
	6) Long term strategy for biomass energy government established	No strategy	Strategy has been endorsed by the Government by year 2	<ul style="list-style-type: none"> <li>• Official notification; project progress reports</li> </ul>	
	7) Establishment of a biomass division in SEA	No dedicated biomass division	One biomass division established by year 2 for enforcement of strategy	<ul style="list-style-type: none"> <li>• SEA annual report; official notification; project progress report</li> </ul>	
<b>Output 1.2</b> Completed awareness raising campaigns and general trainings	8) Number of awareness raising events and trainings organized	0	About 18 events	<ul style="list-style-type: none"> <li>• Announcements; event proceedings and websites; training materials</li> </ul>	
	9) Number of trained officials by 2016 10) Rating of the training events by participants	0	450 national and local-level officials trained, of which 80% rates the training events as good/excellent	<ul style="list-style-type: none"> <li>• Evaluations completed by participants; training completion reports</li> </ul>	
<b>Output 1.3</b> Proposed, approved and implemented policies/incentive schemes for fuel switching	11) Incentive schemes for use of fuel wood for energy generation approved by 2016	Incentives for Gliricidia planting offered by CCB; Some soft loan schemes available	Integrated incentive scheme for biomass-for-energy production and use, implemented by agencies participating in ICRE	<ul style="list-style-type: none"> <li>• Official notifications, newspaper articles, project progress reports</li> </ul>	
<b>Output 1.4</b> Existing policies on fuel switch enhanced and implemented	12) Amounts of loans guaranteed by Sustainable Guarantee Facility	N/A	Loans to the amount of LKR 400 million are guaranteed by year 5;	<ul style="list-style-type: none"> <li>• Reports of the SGF</li> <li>• Evaluation reports completed by applicants</li> <li>• Project reports</li> </ul>	

	(SGF) 13) Number of applicants to the SGF		40 applicants have applied to the fund		
<b>Outcome 2 Enhanced knowledge of and improved support network for sustainable fuel wood production</b>	14) Hectarage of sustainable fuel wood production	Hectarage to be determined in surveys	Hectarage needed for supplying demo projects (outcome 4) with fuel wood is 1,822 ha (established by year 3)	<ul style="list-style-type: none"> <li>As given under each output</li> <li>Publications reports from project and participating project partners</li> <li>Statistical info</li> </ul>	<ul style="list-style-type: none"> <li>Interest by small-scale (farmers) and large-scale (plantations) actors to grow fuel wood</li> </ul>
<b>Output 2.1</b> Prepared and disseminated information and knowledge products on fuel wood growing (models)	15) Number of surveys undertaken	Info available at NGOs and government by studies undertaken before 2011	Surveys conducted in 10 regions on biomass resources, use, land and land use plus survey on current management practices, socio-economic benefits and challenges by 2012	<ul style="list-style-type: none"> <li>Project technical reports (survey results)</li> <li>Project progress reports</li> <li>Official statistics</li> </ul>	<ul style="list-style-type: none"> <li>Institutions and companies willing to release staff for training; beneficiaries are willing to participate</li> <li>No major supply chain disruptions due to production failure, time constraints, extreme weather shifts and biomass quality;</li> <li>Policy-regulatory framework improvements (component 1) are put in place</li> </ul>
	16) Publication of handbook on sustainable approaches to biomass growing models	0	Handbook published by year 1	<ul style="list-style-type: none"> <li>Project technical and progress reports</li> <li>Handbook</li> </ul>	
<b>Output 2.2</b> Tested and implemented supportive regulations and	17) Number of lease procedures approved	0	Lease rates, lease procedures and example contracts published by 2015	<ul style="list-style-type: none"> <li>Reports / official notification with procedures and sample contracts</li> </ul>	



policies for sustainable fuel wood production				<ul style="list-style-type: none"> <li>• Project progress reports</li> </ul>	
	18) Certification scheme of sustainable fuel wood established	0	Certification scheme established by 2014		
	19) Subsidy provided by CCB 20) Number of applicants to the scheme	CCB provides subsidy for <i>gliricidia</i> intercropping	CCB expanded the subsidy scheme to cover other fuel wood species and provides at least USD 1.8 million for coconut inter-cropping over the project period; Number of applicants has tripled since project inception by year 5 Disbursement of subsidy by CCB has increased by the current 5-10% to 33%	<ul style="list-style-type: none"> <li>• Official notification; project progress reports; evaluation of subsidy scheme</li> </ul>	
	21) Post-project action plan	NA	Post-project action plan formulated by 2015 for replication of the new approaches	<ul style="list-style-type: none"> <li>• Report with action plan</li> </ul>	
<b>Output 2.3</b> Completed demonstration of applied approaches and models in sustainable fuel wood production systems.	22) Improved growing models and identified best growing approaches for suitable fuel wood species	0	Field trial reports on growing models and at least 2 wood species other than <i>gliricidia</i>	<ul style="list-style-type: none"> <li>• Field trial reports; project progress reports</li> </ul>	
	23) Improved and expanded sustainable fuel wood production	0	The gasifier demonstration project (Outcome 4) as well as other market demand provided with sufficient sustainably and viably produced fuel wood	<ul style="list-style-type: none"> <li>• Reports with feasibility analysis, financial proposals</li> <li>• Report with results of demo projects; sustainable fuel wood growing; documentary videos; press releases</li> </ul>	
<b>Output 2.4</b> Completed awareness raising campaigns and specific training programmes for key stakeholders on growing of species for fuel wood	24) Number of trainings and awareness creating events carried out	0	About 40 events held in various places in Sri Lanka with 20 participants each and 120 training days at community level (with 40 participants each); 80% rate workshops and events as good/excellent	<ul style="list-style-type: none"> <li>• Workshop proceedings; training materials and completion reports; project reports; evaluations completed by participants</li> </ul>	
	25) Rating of training and community level events				

production					
<b>Outcome 3</b> <b>Improved confidence among industrial and banking sector on the feasibility, stability and economic benefits of sustainable fuel wood supply chains</b>	26) Number of supply chains developed in a feasible way	Supply chains meet constraints (see barrier section)	At least six supply chains developed that are sustainable on the longer term	<ul style="list-style-type: none"> <li>As given under each output;</li> <li>Reports from enterprises and financial institutions</li> </ul>	<ul style="list-style-type: none"> <li>Biomass (fuel wood) production can be made continuously available and is able to meet peaks in demand</li> <li>Policy-regulatory framework improvements are put in place (component 1)</li> <li>Institutions and companies willing to release staff for training</li> </ul>
<b>Output 3.1</b> Proposed, approved and implemented policies and incentive schemes for sustainable fuel wood supply improved,	27) Enabling policy and incentive scheme formulated and approved	0	Enabling policy approved by year 2 and incentive scheme approved by year 3;	<ul style="list-style-type: none"> <li>Official notifications</li> <li>Project progress reports</li> </ul>	
	28) Number of applicants scheme	0	At least 15 applicants to the scheme by 2016	<ul style="list-style-type: none"> <li>Reports provided by incentive scheme management; project progress reports</li> </ul>	
<b>Output 3.2</b> Completed training & outreach programmes for key stakeholders and published and disseminated knowledge products	29) Number of training events and rating of stakeholder participation	0	Approximately 18 events held by 2016 with about 450 participants in total of which 30% staff from finance institutes, 40% staff from fuel wood suppliers and technology end-use beneficiaries and 30% government and law enforcement officers; 80% of participants rate the training event as excellent	<ul style="list-style-type: none"> <li>Training materials, workshop proceedings; evaluations completed by participants; completion reports; project progress reports</li> </ul>	
	30) Rating of trainings and workshops by participants				
	31) Guidelines on supply chain development established; Number of companies that use the guidelines	0	Document on supply chain development with cost estimates, fair pricing guidelines and draft contracts; 10 companies have used the guidelines in their investment decision	<ul style="list-style-type: none"> <li>Project technical report</li> </ul>	
<b>Output 3.3</b> Six sustainable biomass supply chains established and operational	32) Number of feasibility studies and bankable proposals prepared;	0	Ten feasibility studies prepared, of which 8 have resulted in bankable proposals and 6 have started operations	<ul style="list-style-type: none"> <li>Activity reports; progress reports on supply chain demonstration projects</li> </ul>	

	Number of biomass supply chains established				
<b>Outcome 4</b> Enhanced knowledge of, access to, and maintenance skills of biomass energy technologies	33) Number of companies implementing BETs (gasification, fuel switching, EE improvements)		At least 12 companies implement BETs, directly supported by the project by 2016; Number of companies all over Sri Lanka that use BETs (t.b.d. in 2 surveys, baseline and end of project)	<ul style="list-style-type: none"> <li>As given under each output</li> <li>Official statistics</li> <li>Results of survey amongst industrial and commercial establishments</li> </ul>	<ul style="list-style-type: none"> <li>Prices of alternative fuels (diesel, LPG, furnace oil) are at such level to make BETs viable</li> </ul>
<b>Output 4.1</b> Twelve implemented, operational and monitored fuel wood thermal energy projects	34) Number of feasibility studies and project designs	9 companies have expressed willingness to participate (see co-fin letters)	About 24 companies have carried out identification and completed feasibility studies by 2016, of which have resulted in operational BETs and improved wood storage in 12 companies	<ul style="list-style-type: none"> <li>Reports with feasibility analysis, construction design; financial proposals</li> </ul>	<ul style="list-style-type: none"> <li>Interest by industrial and commercial establishment to switch to biomass-based energy</li> <li>Companies are willing to release staff for training</li> </ul>
	35) Number of companies with operational BETs	0	12 companies have operational BETs by 2016	<ul style="list-style-type: none"> <li>Report with results of demo projects; documentary videos</li> </ul>	
<b>Output 4.2</b> Completed trainings and research aimed at improving services to promote fuel-switching in industry	36) Number of trainings workshops held	0	At least 10 events, organized (including matchmaking events) with 250 participants in total over 2011-2016 from technology and service providing companies; At least 80 staff (in particular operators from the participating companies) trained within the country in O&M	<ul style="list-style-type: none"> <li>Workshop proceedings, training materials; project progress reports</li> <li>Operators O&amp;M Practical training reports; project progress reports</li> </ul>	<ul style="list-style-type: none"> <li>Policy-regulatory framework improvements (component 1) are put in place</li> </ul>
	37) Number of matchmaking event organized for Sri Lankan and foreign BET-using companies and technology providers				
	38) Number and amount investments resulting from the matchmaking and training events		At least 12 companies have taken BET-related investment decisions (in addition to the 12 demonstrations)		
<b>Output 4.3</b> Established information exchange system	39) Number of companies that use the database on BET-using industries, national	0	At least 15 companies have used the database info in their BET investment decision	<ul style="list-style-type: none"> <li>Project report</li> </ul>	

	and international technology suppliers and service providers				
	40) Performance standard formulated; number of projects that are designed in compliance with the standards	0	Technical standards drafted for biomass gasification (and other BETs) by year 2; All the demo projects supported by the project are in compliance with the standards.	<ul style="list-style-type: none"> <li>• Project reports</li> </ul>	

## 12. TOTAL BUDGET AND WORKPLAN

**Table 6: UNDP budget (ATLAS)**

<b>Award ID:</b>	00062498
<b>Project ID:</b>	00080012
<b>Award Title:</b>	Promoting Sustainable Biomass Energy Production and Modern Bio-Energy Technologies in Sri Lanka
<b>Business Unit:</b>	LKA10
<b>Project Title:</b>	Promoting sustainable biomass energy production and modern bio-energy technologies in Sri Lanka
<b>Implementing Partner (Exec. Agency):</b>	Sri Lanka Sustainable Energy Authority; Forest Department of Min. of Environment

GEF Outcome / Atlas Activity	Resp. Party (Impl. Agency)	Fund ID / donor name	Atlas Budget Account Code	ERP/ATLAS Budget Description/Input	Year 1	Year 2	Year 3	Year 4	Year 5	Total (USD)	
Component 1 Policy-institutional support for effective fuel-switching using fuel wood	MoE	GEF 62000	71200	International Consultants	5,000	8,000	5,000	8,000	10,000	36,000	1
			71300	Local Consultants	6,000	9,000	6,000	5,000	10,000	36,000	2
			71600	Travel	1,500	3,000	3,000	4,000	4,888	16,388	
			72100	Subcontracts	12,000	10,000	12,000	13,000	5,500	52,500	3
			72200	Equipment and furniture					-	-	
			72500	Supplies	500	500	500	500	982	2,982	4
			73400	Rental and Main Equip	500	500	500	500	982	2,982	5
			74200	Audio visual & Printing Prod.costs	1,200	1,000	1,200	1,300	1,300	6,000	6
			74500	Miscellaneous	400	462	400	300	400	1,962	7
			<b>sub-total</b>					<b>27,100</b>	<b>32,462</b>	<b>28,600</b>	<b>32,600</b>
Component 3 Enabling environment for fuel wood suppliers	MoE	GEF 62000	71200	International Consultants	24,000	30,000	22,000	22,000	34,000	132,000	8
			71300	Local Consultants	12,000	12,000	12,000	12,000	16,500	64,500	9
			71600	Travel	4,000	4,000	4,000	6,000	6,225	24,225	

GEF Outcome / Atlas Activity	Resp. Party (Impl. Agency)	Fund ID / donor name	Atlas Budget Account Code	ERP/ATLAS Budget Description/Input	Year 1	Year 2	Yeas 3	Year 4	Year 5	Total (USD)		
			72100	Subcontracts	8,000	9,000	9,000	8,000	3,500	37,500	10	
			72200	Equipment and furniture								
			73400	Rental and Main Equip	1,000	1,000	1,000	1,000	-	4,000	5	
			72500	Supplies	2,000	2,000	2,000	2,000	1,000	9,000	4	
			74200	Audio visual & Printing Prod.costs	1,000	1,000	1,000	1,000	-	4,000	6	
			74500	Miscellaneous	250	260	250		619	1,379	7	
			<b>sub-total</b>				<b>52,250</b>	<b>59,260</b>	<b>51,250</b>	<b>52,000</b>	<b>61,844</b>	<b>276,604</b>
Component 4 Wood-based energy technology development	MoE	GEF 62000	71200	International Consultants	5,000	6,000	7,000	14,000	13,000	45,000	12	
			71300	Local Consultants	4,500	5,500	7,000	11,000	8,000	36,000	13	
			71600	Travel	4,000	5,000	6,000	6,000	4,050	25,050		
			72200	Equipment and furniture	6,000	10,000	5,000	13,000	10,136	44,136	11	
			72100	Subcontracts		80,000	100,000	90,000	83,409	353,409	14	
			74500	Miscellaneous	500	300	300	400	487	1,987	7	
			<b>sub-total</b>				<b>20,000</b>	<b>106,800</b>	<b>125,300</b>	<b>134,400</b>	<b>119,082</b>	<b>505,582</b>
Project Management Unit	MoE	GEF 62000	71400	Contractual Services-Indv	17,650	17,850	17,650	17,850	17,250	88,250	16	
			71600	Travel	800	800	800	800	800	4,000		
			72100	Subcontracts	2,500					2,500		
			72200	Equipment and furniture	500	500	500	500	-	2,000	11	
			72500	Supplies	400	200	240	200	210	1,250	4	
			74100	Professional services	2,000	2,000	2,000	2,000	2,000	10,000	15	
			74200	Printing and audiovisuals	400	250	200	200	200	1,250	6	
			<b>Sub-total</b>				<b>24,250</b>	<b>21,600</b>	<b>21,390</b>	<b>21,550</b>	<b>20,460</b>	<b>109,250</b>

GEF Outcome / Atlas Activity	Resp. Party (Impl. Agency)	Fund ID / donor name	Atlas Budget Account Code	ERP/ATLAS Budget Description/Input	Year 1	Year 2	Yeas 3	Year 4	Year 5	Total (USD)	
<b>TOTAL</b>					123,600	220,122	226,540	240,550	235,438	1,046,250	

**General notes to the budget:**

- International consultants (IC) are budgeted at USD 3,000 per week and short-term national consultants (NC) are budgeted at \$ 750 per week. The travel budget is estimated at 25% of international consultant fee and 5% of national consultant fee. More details are given in Annex C of the GEF CEO Endorsement form.
- The cost of workshops organization (space rental, organization, food and DSA, presentation materials, etc.) is estimated at USD 1,500 per day (with 20 participants on average), while organizing trainings and workshops in communities is estimated at USD 700 a day (with 40 participants on average).

*Specific notes (the numbers correspond to the last column of Table 6)*

1. 12 person-weeks of international expertise
2. 48 person-weeks of national expertise
3. Subcontracts for workshop and trainings organization (USD 52,500)
4. Supplies and office stationary
5. Rental equipment and premises for project activities
6. Printing and reproduction cost of project reports, background studies, workshop proceedings
7. Miscellaneous for unforeseen expenses
8. 44 person-weeks of international expertise
9. 48 person-weeks of national expertise
10. Subcontracts for organization of training, workshops (USD 37,500)
11. Equipment (computers, etc.) for surveys, statistical software,
12. 15 person-weeks of international expertise
13. 86 person-weeks of national expertise
14. Subcontracts for organization of trainings and workshops (USD 22,500) and technical support for BET project formulation (identification, feasibility analysis, technical design, commissioning; USD 330,909)
15. Services for annual financial audit of the project
16. Project manager salary (PM 260 weeks @ USD 339/week)
17. National travel of project management. The budget for travel and admin is minimized to accommodate the budget constraints. However it is expected to that co-financing from the partner government agencies will supplement this budget

**Table 7: Summary of funds:**

<b>DONOR</b>	<b>Year 1</b>	<b>Year 2</b>	<b>Year 3</b>	<b>Year 4</b>	<b>Year 5</b>	<b>TOTAL</b>
GEF /UNDP	125,400	217,072	223,540	237,550	242,688	1,046,250
GEF / FAO	170,000	200,000	200,000	200,000	180,000	950,000
Government (cash & in-kind)	400,000	1,800,000	2,500,000	2,000,000	3,323,863	10,023,863
Private sector	500,000	1,000,000	1,098,537	2,000,000	1,582,555	6,181,092
NGOs	10,000	20,000	20,000	15,000	20,000	85,000
UNDP	80,000	83,000	80,000	79,000	80,000	402,000
FAO	90,000	93,000	95,000	90,000	93,755	461,755
<b>TOTAL</b>	<b>1,375,400</b>	<b>3,413,072</b>	<b>4,217,077</b>	<b>4,621,550</b>	<b>5,522,861</b>	<b>19,149,960</b>

**Table 8: Project budget, GEF financial support and co-financing**

	<b>GEF Financing</b>			<b>Co-financing</b>						<b>Total Amount</b>
	<b>Total</b>	<b>UNDP</b>	<b>FAO</b>	<b>Total</b>	<b>Government</b>	<b>Private</b>	<b>NGOs</b>	<b>UNDP</b>	<b>FAO</b>	
Policy support for effective implementation	154,814	154,814	0	1,706,545	1,686,545	20,000	0	0	0	1,861,358
Barrier removal for sustainable fuel wood production and supply	950,000	0	950,000	8,509,543	6,291,863	1,670,925	85,000	0	461,755	9,459,543
Enabling environment for fuel wood producers and suppliers	276,604	276,604	0	1,905,635	0	1,503,635	0	402,000	0	2,182,239
Dendro-energy technology demonstration	505,582	505,582	0	4,804,714	1,818,182	2,986,532	0	0	0	5,310,296
Project management	109,250	109,250	0	227,273	227,273	0	0	0	0	336,523
<b>Total Amount</b>	<b>1,996,250</b>	<b>1,046,250</b>	<b>950,000</b>	<b>17,153,710</b>	<b>10,023,863</b>	<b>6,181,092</b>	<b>85,000</b>	<b>402,000</b>	<b>461,755</b>	<b>19,149,960</b>



**Table 9: Budget breakdown for FAO part of GEF grant**

<b>Project Code</b>	<b>GCP/SRL/048/GEF</b>
<b>Project Title:</b>	Promoting sustainable biomass energy production and modern bio-energy technologies in Sri Lanka
<b>Implementing Partner (Exec. Agency):</b>	Sri Lanka Sustainable Energy Authority; Forest Department of Min. of Environment

GEF Component	Resp. Party (Impl. Agency)	Fund ID / donor name	Oracle Code	Description (ORACLE)	Total (USD)	Year 1	Year 2	Year 3	Year 4	Year 5	
Component 2: Barrier removal for sustainable fuel wood production	MoE	GEF 62000	5011	Salaries Professionals	57,600	12,000	12,000	10,000	10,000	13,600	
			5127	Salary & Allowances Professionals	57,600	12,000	12,000	10,000	10,000	13,600	
				<b>Sub-total ( Professionals)</b>	<b>57,600</b>	<b>12,000</b>	<b>12,000</b>	<b>10,000</b>	<b>10,000</b>	<b>13,600</b>	
			5013	Consultant	282,500	34,500	48,750	55,500	49,500	44,250	
			5542	Consultant-International							
				Tree Improving and Breeding	45,000	9,000	9,000	9,000	9,000	9,000	
				Sustainable Fuel wood Certification Expert	30,000	3,000	9,000	6,000	6,000	6,000	
				Community Forest//Woodlot expert	60,000	9,000	9,000	15,000	15,000	12,000	
				<b>Sub-total (international)</b>	<b>135,000</b>	<b>21,000</b>	<b>27,000</b>	<b>30,000</b>	<b>30,000</b>	<b>27,000</b>	
			5543	Consultant-National							
				Fuel wood energy and plantation	39,000	6,000	10,500	10,500	6,000	6,000	
				Silvo-agricultural economics experts	36,000	3,750	6,000	9,000	9,750	7,500	
				Community forest development expert	22,500	3,750	5,250	6,000	3,750	3,750	
	Finance & budget programme assistant	50,000	10,000	10,000	10,000	10,000	10,000				
	<b>Sub-total National</b>	<b>147,500</b>	<b>13,500</b>	<b>21,750</b>	<b>25,500</b>	<b>19,500</b>	<b>17,250</b>				
5014	Contracts			197,840	48,000	49,750	50,900	50,000	49,190		

GEF Component	Resp. Party (Impl. Agency)	Fund ID / donor name	Oracle Code	Description (ORACLE)	Total (USD)	Year 1	Year 2	Year 3	Year 4	Year 5
				<b>Sub-Total Contract</b>	<b>197,840</b>	<b>48,000</b>	<b>49,750</b>	<b>50,900</b>	<b>50,000</b>	<b>49,190</b>
			5021	Travel	45,625	9,125	9,125	9,125	9,125	9,125
			5684	Travel-Consultant-International		7,200	8,400	9,000	9,000	8,400
			5685	Travel-Consultant-Local		1,925	725	125	125	725
				<b>Sub-Total Travel</b>	<b>45,625</b>	<b>9,125</b>	<b>9,125</b>	<b>9,125</b>	<b>9,125</b>	<b>9,125</b>
			5023	Training	214,250	45,000	45,000	45,000	40,000	39,250
				<b>Sub-Total Training</b>	<b>214,250</b>	<b>45,000</b>	<b>45,000</b>	<b>45,000</b>	<b>40,000</b>	<b>39,250</b>
			5024	Expendable Procurement	12,000	5,000	5,000	1,000	1,000	0
				<b>Sub-Total Expendable Procurement</b>	<b>12,000</b>	<b>5,000</b>	<b>5,000</b>	<b>1,000</b>	<b>1,000</b>	<b>0</b>
			5025	Non-Expendable Procurement	85,000	0	20,000	20,000	25,000	20,000
				<b>Sub-Total Non- Expendable Procurement</b>	<b>85,000</b>	<b>0</b>	<b>20,000</b>	<b>20,000</b>	<b>25,000</b>	<b>20,000</b>
			5028	General Operating Expenses	55,185	7,805	9,990	14,430	15,080	7,880
				<b>Sub-Total GOE</b>	<b>55,185</b>	<b>7,805</b>	<b>9,990</b>	<b>14,430</b>	<b>15,080</b>	<b>7,880</b>
<b>TOTAL</b>					<b>950,000</b>	<b>161,430</b>	<b>199,615</b>	<b>205,955</b>	<b>199,705</b>	<b>183,295</b>

**General notes to the budget:**

International consultants (IC) are budgeted at USD 3,000 per week and short-term national consultants (NC) are budgeted at \$ 750 per week. The travel budget is estimated at 25% of international consultant fee and 5% of national consultant fee.

The cost of workshops organization (space rental, organization, food and DSA, presentation materials, etc.) is estimated at USD 1,500 per day (with 20 participants on average), while organizing trainings and workshops in communities is estimated at USD 700 a day (with 40 participants on average).

**Specific notes (the numbers correspond to the last column of Table 6)**

Budget Line: 5127 FAO share for the PMU-144 person weeks of Project Manager @ rate of 400/week

Budget Line: 5542 45 person-weeks of international expertise

Budget Line: 5543 216 person-weeks of national expertise

Budget Line: 5014 Subcontracts for workshop and trainings organization

Budget Line: 5021 Travel International (5684) budgeted at USD 600/wk plus ticket cost USD 1,000/per mission

Budget Line: 5021 Travel National (5685) balance of the original budget is kept here however as it is observed this budget is needed to be revised once project is in operational

Budget Line: 5024 Supplies and office stationary

Budget Line: 5028 Balance PMU cost plus M & E cost together with Rental equipment and premises for project activities, printing and reproduction cost of project reports, background studies, and workshop proceedings

**Table 10: Use of GEF funds per budget line**

	Total	UNDP	FAO
International consultants	348,000	213,000	135,000
National consultants and staff	387,000	224,750	162,250
Travel	115,538	69,913	45,625
Local subcontracts and training	907,999	445,909	462,090
Equipment (non-expendable)	131,136	46,136	85,000
Supplies and rental equipment (exp. equipment)	28,214	16,214	12,000
General operating expenses	63,285	15,250	48,035
Professional services / Tech. support services	10,000	10,000	-
Miscellaneous	5,328	5,328	
<b>Total</b>	<b>1,996,250</b>	<b>1,046,250</b>	<b>950,000</b>

	Components					Total
	1	2	3	4	PM	
International consultants	36,000	135,000	132,000	45,000		348,000
National consultants and staff	36,000	162,250	64,500	36,000	88,250	387,000
Travel	16,388	45,625	24,225	25,050	4,250	115,538
Subcontracts		247,840		330,909		578,749
- Training and workshop organization	52,500	214,250	37,500	22,500	2,500	329,250
Equipment (non-expendable)		85,000		44,136	2,000	131,136
Supplies and rental equipment (exp. equipment)	5,964	12,000	9,000		1,250	28,214
General operating expenses	6,000	48,035	8,000		1,250	63,285
Professional services / Tech. support services					10,000	10,000
Miscellaneous	1,962		1,379	1,987		5,328
<b>Total</b>	<b>154,814</b>	<b>950,000</b>	<b>276,604</b>	<b>505,582</b>	<b>109,500</b>	<b>1,996,500</b>

**Table 11: Co-financing table**

		Components						Total	Confirmed letter
		1	2	3	4	M&E	PM		
<i>Technology</i>	<b>Organisation</b>								
	SEA	1,686,545			1,818,182		131,637	<b>3,636,364</b>	<b>Y</b>
	FD		1,540,728				95,636	<b>1,636,364</b>	<b>y</b>
	CCB		1,818,181					<b>1,818,181</b>	<b>Y</b>
	DEAC		232,955					<b>232,955</b>	<b>y</b>
	Mahaweli								
	Hadabima		2,700,000					<b>2,700,000</b>	<b>Y</b>
	Arunalu		75,000					<b>75,000</b>	<b>y</b>
	Help-O		10,000					<b>10,000</b>	<b>y</b>
Fuelwood	Kahawatte		1,600,000					<b>1,600,000</b>	<b>y</b>
Supply chain invest	EnerFab	20,000		300,000	100,000			<b>420,000</b>	<b>y</b>
Supply chain development	Aitken			136,365	136,365			<b>272,730</b>	<b>y</b>
Drier / gasifier & fuelwood	LeFerne				55,000			<b>55,000</b>	<b>y</b>
Briquettes and pellets	Lalan			1,050,000				<b>1,050,000</b>	<b>y</b>
Fuelwood planting	Watawala								
Gasifier	Silvermill				300,000			<b>300,000</b>	<b>y</b>
Fuelwood	BPL		60,925		43,975			<b>104,900</b>	<b>y</b>
Gasifier / fuelwood	Apollo Marine				55,000			<b>55,000</b>	<b>y</b>
	DFCC Bank								
Drier / boiler	MAP		10,000	17,270				<b>27,270</b>	<b>Y</b>
	Nilmini				90,919			<b>90,919</b>	<b>y</b>
Gasification	Lanka Polym				150,000			<b>150,000</b>	<b>y</b>
	Brandix				528,000			<b>528,000</b>	<b>y</b>

	Mahaweli				27,273			27,273	y
Boiler / gasification	Melbourne Tex				1,500,000			1,500,000	y
	UNDP			402,000				402,000	y
	FAO		461,755					461,755	y
	<b>TOTAL</b>	<b>1,706,545</b>	<b>8,509,543</b>	<b>1,905,635</b>	<b>4,804,714</b>	<b>0</b>	<b>227,273</b>	<b>17,153,710</b>	

## 13. MANAGEMENT ARRANGEMENTS

### Project Organization

The two **GEF Implementing Agencies** involved are UNDP and FAO. The '**National Implementing Partner**' is the Ministry of Environment with the Forest Department (FD; under the same Ministry) and the Sustainable Energy Authority (SEA) as the key technical partners. Both agencies will work in close coordination with the Department of National Planning in making recommendations on existing and future subsidy schemes that support the biomass sector.

Primarily, FAO will support the Forest Department in the implementation of Component 2 on biomass (fuel wood) production. The role of the Forest Department as the key national technical partner is to support the further refining and implementation of the biomass production models identified during project preparation, specifically models involving the Department's own land resources. Forest Department will support the National Project Manager and other consultants and experts to identify the best locations for biomass production using state land resources given the areas of demand. FAO will support the project management unit both technically and financially to work with identified stakeholders to implement a range of practical growing models and support further research in biomass production. Monitoring of this component will be as per FAO procedures and guidelines overseen by FAO Sri Lanka and the Regional Office for Asia and the Pacific.

UNDP is primarily responsible for components 1, 3 and 4. Working with the financial and technical resources from the Sustainable Energy Authority, UNDP will support the Project Management Unit and specifically appointed technology consultants to improve fuel wood supply chains and institute a supporting mechanism to provide incentives for industries converting to fuel wood. While UNDP will be primarily responsible (financially) for the implementation of Component 1, however technical support from FAO would be required to fully realize the results in Component 1. A **Project Board** will be set up chaired by the Secretary, Ministry of Environment or his designate. The Department of National Planning, Forest Department, SEA, UNDP and FAO will be permanently represented on the Board. Potential members of the Project Board (PB) are reviewed and recommended for approval during the PAC meeting. Representatives of other stakeholders can be included in the Board as appropriate.

The PB is responsible for providing strategic guidance and making management decisions for the project, in particular when guidance is required by the Project Manager. The PB plays a critical role in project monitoring and evaluations by quality assuring these processes and products, and using evaluations for performance improvement, accountability and learning. It ensures that required resources are committed and arbitrates on any conflicts within the project or negotiates a solution to any problems with external bodies. In addition, it approves the appointment and responsibilities of the Project Manager and any delegation of its Project Assurance responsibilities. Based on the approved Annual Work Plan, the PB can also consider and approve the quarterly plans (if applicable) and also approve any essential deviations from the original plans. In order to ensure UNDP's ultimate accountability for the project results, PB decisions will be made in accordance to standards that shall ensure management for development results, best value for money, fairness, integrity, transparency and effective international competition.

A small **Project Management Unit (PMU)** will be set up, hosted by the Planning Division of the Ministry of Environment. Under the Project Board, the PMU will coordinate the project's operation on a day-to-day basis with the government agencies involved (Forest Department and Sustainable Energy Agency) and report to both UN agencies (UNDP and FAO) on the progress in implementation of the project activities. The PMU will consist at least of three staff, a Project Manager (PM) and Assistant Project Manager. **The Project Manager** will be the primary contact person for the Project

for external communication and will act as the convener for meetings between the national implementing partners and UNDP and FAO.

In terms of the cost of the Project Manager, FAO will pay for 144 weeks and UNDP will pay for 116 weeks. UNDP will transfer funds to the MoE using NEX modality and pay the PM accordingly. FAO will directly pay the PM for 144 weeks through a PSA.

## General

### Prior obligations and prerequisites

There have no prior obligations or prerequisites been identified

### Brief description of inputs to be provided

An overview is given in the accompanying GEF Request for CEO Endorsement. GEF contribution to project management is USD 170,000.

### Audit arrangements

The project will be audited according to UNDP Financial Regulations and Rules and applicable Audit policies.

Audit of the FAO GEF funds will be carried out in accordance with FAO's audit procedures.

### Agreement on the intellectual property rights and use of logo on the project's deliverables

In order to accord proper acknowledgement to GEF for providing funding, a GEF logo should appear on all relevant GEF-supported project publications, including among others, project hardware, if any, purchased with GEF funds. Any citation on publications regarding projects funded by GEF should also accord proper acknowledgement to GEF. The logos of the GEF, UNDP, FAO and the Government should be equal and appear on all communication and other public materials, as relevant.

## 14. STAKEHOLDER INVOLVEMENT

The following Table 12 describes the role of main stakeholders in the project:

**Table 12: Stakeholder list**

Stakeholder	Mandate and Role in Project
<b>Government</b>	
Ministry of Environment	Ministry of Environment is the national focal point for GEF and also the key government agency overseeing sustainable development in the country. As such, the project falls within the scope of the National Environmental Action Plan. The Ministry will be the National Implementing Partner and will establish the project board chaired by the Secretary to manage the project. The Ministry will also host the project management unit.
Department of National Planning, Ministry of Finance	The Ministry of Finance has intervened in the past to provide subsidies on industrial fossil fuels - diesel and furnace oil - in order to prevent undue economic shocks on industry and public transport <sup>28</sup> . The <i>Department of National Planning</i> , under the Ministry of Finance regularly evaluates the costs of such subsidy schemes and makes

<sup>28</sup> For example, by mid-2011 the real price of furnace oil was 1.4 times higher than the actual price in Sri Lanka. By early 2012 prices of all fossil fuels have risen and the subsidy on furnace has de facto disappeared. These changes are taken into account in the cost-benefit analysis of gasifiers presented in Annex C.



	recommendations for their future direction.
Forest Department	The Forest Department (FD) was established in 1887 and is primarily tasked with conserving forests and increasing the share of commercial forestry in the country. The government agency with a very large amount of land area within its control, the FD will release some marginal forest areas, such as buffer zones and fire belts, for community managed fuel wood lots.
Sustainable Energy Authority	The Sri Lanka Sustainable Energy Authority was established in 2007 to act as the apex institution promoting sustainability in energy generation and use, through increasing the share of renewables in the national energy mix and encouraging energy efficiency. As such the SLSEA will lead the project from both energy supply and energy generation. The Authority will be the focal point through which industrial fuel switching technology will be assessed, reviewed and improved.
Coconut Cultivation Board	Coconut Cultivation Board was established with the objective of providing necessary guidance and support to the coconut growers spread around the country. The CCB has an existing subsidy scheme through which growers are incentivized to cultivate gliricidia to replace nitrogenous fertilizer input. coconut-fuel wood intercropping model will be promoted through the CCB by strengthening and adding value to the existing scheme.
Mahaweli Authority	The Mahaweli Authority of Sri Lanka (MASL) has been responsible from 1979 for the development of water resources in the Mahaweli river basin and the adjacent basins for irrigation and hydropower facilities, along with related settlement based services. The Authority has large areas of reservations to protect the water shed and river banks, in which they are keen to grow multi-purpose tree crops such as bamboo and gliricidia community support.
Export Agriculture Crops Department	The Department of Export Agriculture Crops (DEAC) is responsible for the promoting and research and development of crops such as Cinnamon, Pepper, Cardamom, Clove, Nutmeg, Coffee, Cocoa, Vanilla, Betel, Citronella, Lemon grass, Areca-nut. As a best practice the Department encourages the cultivation of gliricidia as an intercrop or vine support. The DEAC gives financial support to farmers for cultivation and intercropping. The project hopes to exploit this scheme of assistance to improve the availability of gliricidia stick in pepper, vanilla and other price plantations.
<b>Private sector</b>	
Plantation Companies	These are large privately managed plantations on lease from government. These plantations need fuel wood for their own consumption (dryers in tea factories). The plantations also have large areas of land for cultivation, the staff, finances and planting experience. However, they have little experience in short rotation coppicing varieties. The plantation companies are interested in obtaining project technical assistance to cultivate SRC fuel wood lots on their lands.
Industries involved in switching fuel	Private sector industrialists who have expressed interest in switching their thermal energy generation from fossil-fuel based to biomass based. These industries will partner with the project to demonstrate holistic pilots that address both technology and supply. Some of these fuel switching applicants are also plantation companies that are seeking to switch their diesel powered dryers to biomass.
Supply chain managers (Lalan Group)	This company is involved in supplying processed fuel wood (chipped, dried, briquetted) to industries that use biomass boilers.
Silvermill Group	Silvermill is a large coconut processing industry that also provides energy services to other industries. The company will partner with the project to support CCB to expand the coconut intercropping model to increase fuel wood availability.
<b>NGOs</b>	
Practical Action	An International NGO with a wide experience in grassroots renewable energy solutions. They had recently conducted biomass availability surveys in one province. Such surveys need to be conducted in the industrialized districts of the western province to determine the available biomass resources to support fuel switching.
Energy Forum	A grouping of energy experts and organizations with the capacity to provide policy and technical inputs on biomass energy production.
Help-O	A local NGO with a regional presence, engaged in popularizing biogas systems using urban waste. They are already collectors of waste biomass for commercial purposes. They will be engaged in the project as a supplier of value added biomass for industrial

	use using community based supply chains that will enhance rural livelihoods.
Arunalu Foundation	A local NGO engaged in livelihood development in the Central Province. Arunalu is interested in establishing a supply chain sourcing gliricidia wood from pepper cultivations to supply hotels that have converted to biomass.
<b>Other</b>	
Bio-Energy Association of Sri Lanka	BEASL consists of individual and corporate members reflecting interest in developing the biomass energy sector in Sri Lanka. The organization has lobbying power with government and is represented on the Board of the Sustainable Energy Authority. They also have the technical capability to advice on technology mix and support supply chain developers to adhere to a quality standard.
Switch Asia Project	An EU-funded project that seeks to support the hotel and leisure industry towards better energy and waste management. The project could provide technical inputs to the biomass conversions in the hotel and leisure sector.

## 15. MONITORING AND EVALUATION

### Project start

A Project Inception Workshop will be held within the first two months of project start with those with assigned roles in the project organization structure. The Inception Workshop is crucial to building ownership for the project results and to plan the first year annual work plan. The Inception Workshop should address a number of key issues including:

- Understand objectives & other outputs and activities.
- Assist all partners to fully understand and take ownership of the project. Detail the roles, support services and complementary responsibilities of UNDP, FAO, SEA and FD vis-à-vis the Project Management Unit. Discuss the roles, functions, and responsibilities within the project's decision-making structures, including reporting and communication lines, and conflict resolution mechanisms. The Terms of Reference for project staff will be discussed again as needed.
- Based on the project results framework, finalize the first annual work plan. Review and agree on the indicators, targets and their means of verification, and recheck assumptions and risks.
- 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.
- Discuss financial reporting procedures and obligations, and arrangements for annual audit.
- Plan and schedule Project Steering Committee meetings. Roles and responsibilities of all project organization structures should be clarified and meetings planned. The first Project Steering Committee meeting should be held within the first 12 months following the inception workshop.

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

### Quarterly review

FAO and UNDP will agree on the formats for the Project Progress Reports. The project will be reported on as a whole to facilitate reporting by the Project Manager.

The six-monthly review will consist of:

- Progress made shall be monitored in the UNDP Enhanced Results Based Management Platform and in the FAO Field Programme Management Information System (FPMIS), as well as by the UNDP/FAO Country Offices, the UNDP regional coordinating unit (RCU) i.e. UNDP Asia Pacific Regional Centre (APRC) in Bangkok and the FAO-GEF Unit, in accordance with UNDP and FAO templates and procedures.

- 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. Based on the information recorded in Atlas, a Project Progress Reports (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 review**

Annual Project Review/Project Implementation Reports (APR/PIR): These key reports are prepared to monitor progress made since project start and in particular for the previous reporting period (30 June to 1 July). The APR/PIR combines UNDP, FAO and GEF reporting requirements. The APR/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 practices;
- AWP and other expenditure reports;
- Risk and adaptive management;
- ATLAS Quarterly Operation Reports (QORs);
- Portfolio level indicators (i.e. GEF focal area tracking tools) are used by most focal areas on an annual basis as well.

UNDP CO and the UNDP RCU (regional coordinating unit, based in Bangkok), as well as the FAO Country Office and Regional Office for Asia and the Pacific (in Bangkok) may 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. Field Visit/Back-to-Office Reports will be prepared by the CO, UNDP RCU, FAO CO and RAP, respectively, and will be circulated no less than one month after the visit to the project team and Project Board members.

### **Mid-term of project cycle:**

The project will undergo an independent Mid-Term Evaluation at the mid-point of project implementation. The Mid-Term Evaluation will determine progress being made toward the achievement of outcomes and will identify course correction if needed. It will focus on the effectiveness, efficiency and timeliness of project implementation; will highlight issues requiring decisions and actions; and will present initial lessons learned about project design, implementation and management. Findings of this review 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 evaluation will be prepared by the UNDP and FAO COs based on guidance from the Regional Coordinating Unit, UNDP-GEF, and FAO RAP, FAO-GEF and the FAO Office for Evaluation (OED). The UNDP and FAO evaluation offices will clear the final TORs and evaluation team and review and provide comments on the draft Evaluation Report. FAO and UNDP will jointly prepare a Management Response. The GEF Climate Change tracking tools will be reviewed and updated during the mid-term evaluation.

### **End of project:**

An independent Final Evaluation will take place three months prior to the final Project Steering Committee meeting and will be undertaken in accordance with UNDP, FAO and GEF guidance. The

final evaluation will focus on the delivery of the project’s results as initially planned (and as corrected after the mid-term evaluation, if any such correction took place). The final evaluation will look at impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental benefits/goals. The Terms of Reference for this evaluation will be prepared by the UNDP CO, based on guidance from the UNDP Regional Coordinating Unit, UNDP-GEF, in close consultation with FAO (RAP, FAO-GEF Unit) on all aspects of the evaluation. The UNDP and FAO evaluation offices will clear the final TORs and consultants, review and provide comments on the draft Evaluation Report, and review and clear the Management Response.

The Terminal Evaluation should also provide recommendations for follow-up activities and requires a management response which should be uploaded on the UNDP PIMS and to the UNDP Evaluation Office Evaluation Resource Center (ERC), as well as on the FAO FPMIS and sent to the FAO Office for Evaluation.

During the last three months, the project 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. UNDP and FAO will agree on the format of the joint Terminal Report.

**Table 13: Indicative M&E work plan and budget**

Type of M&E activity	Responsible Parties	Budget USD	Time frame
Inception Workshop/ Annual Work Plan finalization	<ul style="list-style-type: none"> <li>▪ Project Board</li> <li>▪ Project Team</li> <li>▪ UNDP CO/ FAO CO/ RAP</li> <li>▪ Hired consultant</li> </ul>	7,500	Inception is done at project start and work plan is prepared annually
Measurements of means of verification of project results (incl. End-of-Project Impact study)	<ul style="list-style-type: none"> <li>▪ PMU</li> <li>▪ UNDP-GEF RCU (suggested formats for measuring impacts, etc.)</li> <li>▪ FAO RAP and GEF Unit</li> <li>▪ Hired consultant</li> </ul>	10,250	Start and at the end of project.
Measurement of Means of Verification for Project Progress and Performance (measured annually)	<ul style="list-style-type: none"> <li>▪ Oversight by UNDP-GEF RCU &amp; Project Management</li> <li>▪ FAO RAP and GEF Unit</li> <li>▪ Counterpart organizations in the field or hired consultants on an as-needed basis</li> </ul>	As part of project activities	Annually prior to APR/PIR and to the definition of annual work plans
APR-PIR	<ul style="list-style-type: none"> <li>▪ PMU</li> <li>▪ UNDP-CO/FAO CO</li> <li>▪ UNDP-GEF/FAO GEF</li> </ul>	0	Annually
Steering Committee Meetings	<ul style="list-style-type: none"> <li>▪ NPD</li> <li>▪ UNDP CO/FAO CO &amp; RAP</li> </ul>	0	Following Project IW and held regularly
Technical reports	<ul style="list-style-type: none"> <li>▪ PMU</li> <li>▪ UNDP and FAO CO, RAP and FAO/HQ as necessary</li> </ul>	As part of project activities	To be determined by Project Team & UNDP-CO/FAO CO/RAP
Mid-Term Evaluation	<ul style="list-style-type: none"> <li>▪ PMU</li> <li>▪ UNDP and FAO CO</li> <li>▪ UNDP-GEF RCU/FAO-RAP</li> <li>▪ Hired consultants</li> </ul>	17,000	Mid project
Final External Evaluation	<ul style="list-style-type: none"> <li>▪ PMU</li> <li>▪ UNDP-CO/FAO CO</li> <li>▪ UNDP-GEF RCU/FAO Office of Evaluation (OED)/FAO RAP/GEF Unit</li> </ul>	17,000	At the end of project implementation

	<ul style="list-style-type: none"> <li>▪ External Consultants (i.e. eval. team)</li> </ul>		
Terminal Report	<ul style="list-style-type: none"> <li>▪ NPD/PMU</li> <li>▪ UNDP-CO/ FAO CO &amp; RAP/GEF Coordination Unit/TCS Reports Unit</li> </ul>	As part of project activities	At least one month before the project's end
Financial audits	<ul style="list-style-type: none"> <li>▪ UNDP-CO/FAO CO</li> <li>▪ NPD/PMU</li> </ul>	10,000	Yearly
Visits to field sites (UNDP staff travel costs not included as will be charged to IA fees)	<ul style="list-style-type: none"> <li>▪ UNDP CO/FAO CO RAP</li> <li>▪ UNDP-GEF RCU (as appropriate)</li> <li>▪ Government representatives</li> </ul>	0	Yearly
<b>TOTAL INDICATIVE COST (UNDP M&amp;E)</b>		<b>USD 61,750</b>	
Excluding project team staff time and UNDP staff and travel expenses.			
<b>FAO M&amp;E (staff and travel expenses)</b>		<b>USD 10,250</b>	

### Learning and knowledge sharing

Results from the project will be disseminated within and beyond the project intervention zone through existing information sharing networks and forums.

The project will identify and participate, as relevant and appropriate, in scientific, policy-based and/or any other networks, which may be of benefit to project implementation though lessons learned. The project will identify, analyses, and share lessons learned that might be beneficial in the design and implementation of similar future projects.

Finally, there will be a two-way flow of information between this project and other projects of a similar focus.

## 16. LEGAL CONTEXT AND OTHER AGREEMENTS

This document together with the CPAP signed by the Government and UNDP and FAO which is incorporated by reference constitute together a Project Document as referred to in the SBAA [or other appropriate governing agreement] and all CPAP provisions apply to this document. Consistent with the Article III of the Standard Basic Assistance Agreement, the responsibility for the safety and security of the implementing partner and its personnel and property, and of UNDP's and/or FAO's property in the implementing partner's custody, rests with the implementing partner.

The implementing partner shall:

- a) Put in place an appropriate security plan and maintain the security plan, taking into account the security situation in the country where the project is being carried;
- b) Assume all risks and liabilities related to the implementing partner's security, and the full implementation of the security plan.

Finally, there will be a two-way flow of information between this project and other projects of a similar focus. UNDP and FAO reserve the right to verify whether such a plan is in place, and to suggest modifications to the plan when necessary. Failure to maintain and implement an appropriate security plan as required hereunder shall be deemed a breach of this agreement. The implementing partner agrees to undertake all reasonable efforts to ensure that none of the UNDP and FAO funds received pursuant to the Project Document are used to provide support to individuals or entities associated with terrorism and that the recipients of any amounts provided by UNDP and FAO hereunder do not appear on the list maintained by the Security Council Committee established pursuant to resolution 1267 (1999). The list can be accessed via <http://www.un.org/Docs/sc/committees/1267/1267ListEng.htm>. This provision must be included in all sub-contracts or sub-agreements entered into under this Project Document.

## **ANNEX A. TERMS OF REFERENCE OF KEY BODIES AND STAFF**

### **Project Board**

#### *Duties and responsibilities*

The Project Board (PB) is the main body to supervise the project implementation in accordance with UNDP and FAO rules and regulations and referring to the specific objectives and the outcomes of the project with their agreed performance indicators;

The main functions of the PB are:

- General monitoring of the project progress in meeting of its objectives and outcomes and ensuring that they continue to be in line with the national development objectives;
- Facilitating the co-operation between the different Government entities, whose inputs are required for successful implementation of the project, ensuring access to the required information and resolving eventual conflict situations raising during the project implementation when trying to meet its outcomes and stated targets;
- Supporting the elaboration, processing and adoption of the required institutional, legal and regulatory changes to support the project objectives and overcoming of related barriers;
- Facilitating and supporting other measures to minimize the identified risks to project success, remove bottlenecks and resolve eventual conflicts;
- Approval of the annual work plans and progress reports, the first plan being prepared at the outset of project implementation;
- Approval of the project management arrangements; and
- Approval of any amendments to be made in the project strategy that may arise due to changing circumstances, after the careful analysis and discussion of the ways to solve problems.

#### *PB structure and reimbursement of costs*

The PB will be chaired by the Secretary, Ministry of Environment, acting as the National Project Director, or other person assigned by the executing agency. The PB will include a representative from national technical partners involved in the project (Sustainable Energy Authority, Forest Department), UNDP and FAO representatives and, as applicable and desirable, representatives of project's other co-financing partners, however by taking care that the PB still remains operational by its size. The Project Manager will participate as a non-voting member in the PB meetings.

The costs of the PB's work shall be considered as the Government's or other project partners' voluntary in-kind contribution to the project and shall not be paid separately by the project. Members of the PB are also not eligible to receive any monetary compensation from their work as experts or advisers to the project.

#### *Meetings*

It is suggested that the PB will meet at least twice a year. A tentative schedule of the PB meetings will be agreed as a part of the annual work plans (AWPs), and all representatives of the PB should be

notified again in writing 14 days prior to the agreed date of the meeting. The meeting will be organized provided that the executing agency, UNDP and at least 2/3 of the other members of the PB can confirm their attendance. The Project Manager shall distribute all materials associated with the meeting agenda at least 5 working days in prior to the meeting.

### **National Project Director**

As a representative of the Government and the project's national implementing agency, the National Project Director (from the Ministry of Environment) is having the main responsibility to ensure that the project is executed in accordance with the project document and the UNDP guidelines for nationally implemented (NEX) projects (for the UNDP-GEF funds) and in accordance with FAO procedures for the GEF funds through FAO.

His/her main duties and responsibilities include:

- Supervising the work of the Project Manager through meetings at regular intervals to receive project progress reports and provide guidance on policy issues;
- Certifying the annual and, as applicable, quarterly work plans, financial reports and requests for advance of funds, ensuring their accuracy and consistency with the project document and its agreed amendments;
- Authorizing the project contracts, following the approval of UNDP and FAO, respectively;
- Unless otherwise agreed, chairing the Project Steering Committee and representing the project in other required meetings;
- Taking the lead in developing linkages with the relevant authorities at national, provincial and governmental level and supporting the project in resolving any institutional or policy related conflicts that may emerge during its implementation;

### **Project Manager**

*Duties and responsibilities:*

Operational project management in accordance with the project document and the UNDP guidelines and procedures for nationally implemented projects for the GEF funds through UNDP and FAO procedures for the GEF funds through FAO, including:

- General coordination, management and supervision of project implementation;
- Managing the procurement and the project budget under the supervision of the Implementing Partner Agency and with support from UNDP and FAO to assure timely involvement of local and international experts, organization of training and public outreach, purchase of required equipment etc. in accordance with UNDP and FAO rules and procedures;
- Submission of annual Project Implementation Reviews and other required progress reports (such QPRs) to the PB, Implementing Partner, UNDP and FAO in accordance with the section "Monitoring and Evaluation" of the project document;
- Ensuring effective dissemination of and access to information on project activities and results, (including an regularly updated project website);
- Supervising and coordinating the contracts of the experts working for the project;
- As applicable, communicating with project's international partners and attracting additional financing in order to fulfill the project objectives; and

- Ensuring otherwise successful completion of the project in accordance with the stated outcomes and performance indicators summarized in the project’s log frame matrix (see Section 9) and within the planned schedule and budget.
- Submission of the final report to the PB, Implementing Partner, UNDP and FAO in accordance with the section “Monitoring and Evaluation” of the project document.

*Expected Qualifications:*

- Advance university degree and at least 7 years of professional experience in the specific areas the project is dealing with, including good knowledge of the international experiences in biomass energy technologies (gasification, wood-fired boilers and furnaces, pelleting and biomass densification) and biomass supply chain development and affinity with sustainable firewood production modalities;
- At least 2 years of experience in managing projects of similar complexity and nature in Sri Lanka, including demonstrated capacity to advise on policy-regulatory improvements and financial mechanisms to achieve the project objective;
- At least 3 years of demonstrated experience and success in the engagement of and working in Sri Lanka with the private sector and/or NGOs, creating partnerships and leveraging financing for activities of common interest;
- Good analytical and problem solving skills and the related ability to adaptive management with prompt action on the conclusion and recommendations coming out from the project’s regular monitoring and self-assessment activities as well as from periodical external evaluations;
- Ability and demonstrated success to work in a team, to effectively organize it works and to motivate its members and other project counterparts to effectively work towards the project’s objective and expected outcomes;
- Good communication skills and competence in handling project’s external relations at all levels; and
- Fluency in English, Sinhala and/or Tamil
- Familiarity and prior experience with the specific UNDP, FAO and GEF requirements and procedures are considered as an asset



## **ANNEX B. AGREEMENTS**

### **Co-financing letters**

Please refer to a separate attachment.

## ANNEX C. ENERGY SAVINGS, EMISSION REDUCTION CALCULATIONS AND COST-BENEFIT ANALYSIS

### Direct emission reductions calculations along with cost-benefit analysis

During the project preparation phase, selection of possible demo projects was made based on extensive stakeholder consultations. Over 15 companies have expressed their interest to participate in the project, of which, 11 companies have committed to host BET pilots/demonstrations and expressed their interest by means of co-financing letters. This is not the exhaustive final list of demonstration projects. During the project implementation, the final line up of demonstrations to meet the set installed capacity target will be determined. For purposes of estimating the emission reductions that are attributable to the project, a number of systems installed for a given capacity range are considered such as <250 kW<sub>th</sub> (21%), 250-500 kW<sub>th</sub> (32%) and > 500 kW<sub>th</sub> (47%).

The description of demo projects that are to be supported in Component 4 is based on the information provided by the interested companies. The energy requirement, and potential energy savings and associated CO<sub>2</sub> emission reductions from each demo were made by the project preparation team comprised of UNDP/FAO staff and consultants. About 11 companies have committed to host the BET demos/pilots under Component 4 of the project, refer to Table 14.

**Table 14: Characteristics of selected companies that have expressed interest in switching from fossil fuels to biomass**

Company Name	Industry Cluster	Fuel Type	Monthly Fuel Usage (liters)	Equipment	Probable Technology to use	Approx. investment (USD)	Biomass Type	kW	Wood Usage, kgs
Le-Ferne Laboratories (Pvt) Ltd	Rubber	Diesel	15,000	Boiler	Wood Boiler or Gasification system	55,000	Branches of renewably grown Gliricidia, Caliandra	438	214
Melbourne textiles washing plant (Pvt) Limited.	Textile	Furnace Oil	111,000	Boiler	Wood Boiler or Gasification system	1,500,000	Rubber Wood chips	2,158	1,057
Apollo Marine International (Pvt) Ltd	Food Processing Industry	Diesel	8,000	Burner for Dryer	Gasification System	55,000	Branches of renewably grown Gliricidia, Caliandra	467	229
Horana Plantations PLC	Tea	Diesel	18,000	Heat Exchanger	Gasification System or Direct fired furnace	54,500	Rubber Wood chips	449	220
Union Metals(Pvt) Limited	Steel Industry	Furnace Oil	19,200	Burner for Dryer	Gasification System	91,000	Rubber Wood chips	887	434
Lanka polymers (Pvt) Ltd	Activated Carbon industry	Furnace Oil	33,000	Boiler	Wood Boiler or Gasification system	150,000	Rubber Wood chips	1,283	629
BPL Balangoda Plantations PLC	Tea	Diesel	12,750	Furnace	Gasification System or Direct fired furnace	43,975	Branches of renewably grown Gliricidia, Caliandra	992	486

Company Name	Industry Cluster	Fuel Type	Monthly Fuel Usage (liters)	Equipment	Probable Technology to use	Approx. investment (USD)	Biomass Type	kW	Wood Usage, kgs
MPL Madulsima Plantations Olc	Tea	Diesel	13,125	Heat Exchanger	Gasification System or Direct fired furnace	91,000	Branches of renewably grown Gliricidia, Caliandra	1,021	500
Ma's Tropical Food Processing (Pvt) Ltd	Food Processing Industry	Diesel	7,000	Burner for Dryer and gas stoves	Gasification System	54,500	Agro Waste	175	86
Aitken Spence Hotel Mgmt (Pvt) Ltd	Hotel and leisure	Furnace Oil	20,000	Boiler	Wood Boiler or Gasification system	136,365	Branches of renewably grown Gliricidia, Caliandra	648	317
Micro Agro Products	Food Processing Industry	Diesel	2,000	Burner for Dryer	Gasification System	40,590	Branches of renewably grown Gliricidia, Caliandra	58	29
Silvermill Coco	Coconut					300,000			
Nilmini	Tea	Diesel		Furnace / heat exchanger	Gasification System or Direct fired furnace	90,919	Branches of renewably grown Gliricidia, Caliandra		
Mahaweli	Hotel and leisure	Diesel	8,000		Burner and gasification		Branches of renewably grown Gliricidia, Caliandra	292	
Brandix		Furnace Oil	170,000		Burner and gasification		Branches of renewably grown Gliricidia, Caliandra	2,917	

Note:

Yellow-highlighted companies have submitted co-financing letters.

The demos planned under the project will involve the replacement of fossil fuel-fired combustion units of boilers and/or furnaces with gasifiers that use fuel wood. Apart from that, some companies may also implement energy efficiency improvements in the boilers and/or furnaces as part of the replacement of the combustion units with wood-fired gasifier units. Such interventions are beyond the scope of the project and the emission reductions achieved due to efficiency improvements in the boilers/furnaces are not assessed and are excluded from the estimated CO<sub>2</sub> emission reductions attributable to the project. Since this will be the first time the companies to use fuel wood, energy savings and associated CO<sub>2</sub> emission reduction from the use of efficient fuel wood (i.e., processed fuel wood – properly sized and dried) will not be assessed. The wood gasifiers will make use of recommended fuel wood physical specifications that will ensure efficient wood gasification.

As promoted by the project, wood gasification technology applications will be showcased in the demonstrations. The producer gas from the gasification unit will be used as fuel for process heat (in

boilers and/or furnaces)<sup>29</sup> and electricity generation (cogeneration system). Depending on the economics of the wood-fired gasification applications, some companies may in the end opt for direct wood-fired combustion units for boilers and/or furnaces. Although this can change the resulting annual wood consumption in comparison with gasification, the amount of CO<sub>2</sub> emission reductions will be the same as this is based on the amount of fossil fuel to be replaced.

The following calculations of the estimated CO<sub>2</sub> emission reductions from about 19 demonstrations/pilots (including a cogeneration system) that will be carried out in the project is based on a total installed capacity of 20 MW<sub>th</sub> (17 MW<sub>th</sub> stand-alone units, and 3 MW<sub>th</sub> from a wood-fired cogeneration system). The demo cogeneration unit is also rated at 1MW<sub>e</sub> capacity. Private companies have made available about USD 2.98 million for investment in fuel switching, which would replace 230,265 GJ of fossil fuels and 4,680 MWh of electricity annually.

The expected energy savings (and thus GHG emission reduction) calculations are based on the estimates given in Table 14. The estimate is calculated based on the following formula and assumptions<sup>30</sup>:

CO<sub>2</sub> direct = E \* L \* C; where

- C = fuel specific CO<sub>2</sub> emission factor (emission factors of diesel and furnace (fuel) oil) or grid emission factor for electricity;
- L = average useful lifetime of equipment: considering the fact that a range of technologies will be demonstrated, which may have varying lifetimes, an average of 10 years has been assumed for the calculation; and
- E = annual energy replaced/saved, amounting to 230,265 GJ in thermal energy and 4,680 MWh of electricity is estimated to be saved by switching from fossil fuels to sustainably grown fuel wood (for thermal energy, 60% replacing diesel and 40% replacing furnace oil-based currently for 17 MW<sub>th</sub>)<sup>31</sup>.

Thus, applying the above formula separately to the three cases (thermal applications replacing diesel and furnace oil and electricity generation in cogeneration, replacing furnace oil), gives cumulative direct CO<sub>2</sub> emission reductions over 10-year investment lifetime are estimate at = **203 ktCO<sub>2</sub>**. A summary of results are given in Table 15.

**Table 15: Direct emission reduction calculation**

Particulars	Value	Remarks
<b>Thermal Biomass Gasification Systems</b>		
Total capacity, kW <sub>th</sub>	17,000	In 15-24 demonstration sites

<sup>29</sup> Depending on the economics of the wood-fired gasification applications, some companies may in the end opt for direct wood-fired combustion units for boilers and/or furnaces. Although this can change the resulting annual wood consumption in comparison with gasification, the amount of CO<sub>2</sub> emission reductions will be the same as this is based on the amount of fossil fuel to be replaced.

<sup>30</sup> The demos/pilots planned under the project will involve the replacement of fossil fuel-fired combustion units of boilers and/or furnaces with gasifiers that use fuel wood. Apart from that, some companies may also implement energy efficiency improvements in the boilers and/or furnaces as part of the replacement of the combustion units with wood-fired gasifier units. Such interventions are beyond the scope of the project and the emission reductions achieved due to efficiency improvements in the boilers/furnaces are not assessed and are excluded from the estimated CO<sub>2</sub> emission reductions attributable to the project.

<sup>31</sup> It is assumed that the fuel (fossil fuel or producer gas) is burned at the same efficiency of 67%. This is a conservative estimate, as employing high-efficiency boilers or burners a higher efficiency can be achieved of up to 80%. This is higher than efficiency in biomass-fired (direct combustion) boilers which achieve about 60%.

- Gasifiers replacing diesel (case 1), % of demos	60	
- Gasifiers replacing furnace oil (case 2), % of demos	40	
Investment Cost, US\$	2,899,033	Corresponding to private sector co-financing
Thermal energy requirement, MJ/yr	193,808,160	
CO <sub>2</sub> savings (cumulative)	147,213	
<b>Biomass Gasification and Cogeneration System</b>		
Total capacity (electrical), kW <sub>e</sub>	1,000	
Total capacity (thermal), kW <sub>th</sub>	3,000	
Investment Cost, US\$	1,800,000	Proposed; site to be identified during project implementation
Electricity generated, MWh/yr	4,680	
Thermal energy generated, MJ/yr	36,457,200	
Total CO <sub>2</sub> emission reductions from cogeneration, tCO <sub>2</sub> /yr	5,565	
Total CO <sub>2</sub> emission reductions from cogeneration (lifetime), tCO <sub>2</sub> /yr	55,645	
Total fossil fuel savings, GJ/yr	230,265	
Total direct CO <sub>2</sub> emission reduction (lifetime), tCO <sub>2</sub> /yr	202,858	Over an economic lifetime of 10 years

*Notes:*

The gasification units consist of <250 kW<sub>th</sub> (21%), 250-500 kW<sub>th</sub> (32%) and > 500 kW<sub>th</sub> (47%).

Variation in the cost of gasifiers with capacity and number of demos identified during PPG phase along with an overview of demos that needs to be identified during project implementation are as shown in Table 16 below:

**Table 16: Variation in cost of gasifier with capacity<sup>32</sup>**

Gasifier capacity (kW)	Cost of Equipment			No. of demos identified during PPG exercise	No. of demos to be selected during project implementation	Feasibility study cost (% of investment cost)
	LKR	US\$	US\$/kW			
60	2,100,000	19,091	318	2 (=250 kW)		
175	4,800,000	43,636	249			
250	5,800,000	52,727	211			
300	6,240,000	56,727	189	4 (250-500 kW)	3 (250-500 kW)	14%
450	7,320,000	66,545	148			
500	7,630,000	69,364	139	7 (>500 kW)	3 (>500 kW)	11%
650	8,880,000	80,727	124			
900	11,040,000	100,364	112			
1000	12,000,000	109,091	109			
<b>Total number of demos</b>				<b>13</b>	<b>6</b>	

<sup>32</sup> Overall, it could be seen from the above table that more number of demos involving capacities over 500 MW<sub>th</sub> are planned. Demos involving higher capacities will be prioritized and to ensure this, the gasifier plant capacity will be one of the important criteria for the selection of the demos that will be implemented under the project. The two demos that were identified during the PPG exercise which are below 250 kW will be encouraged to go for higher installation capacity and explore the options to supply excess thermal energy to adjacent industrial facilities.

**Figure 8: Cost of gasifier systems in Sri Lanka (2012) with reference to capacity; basic assumptions and data**

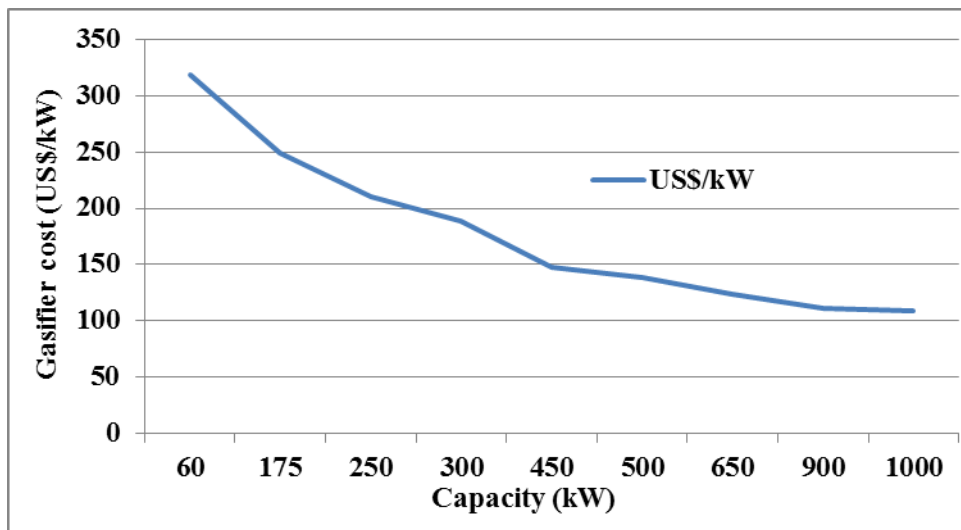
Source: EnerFab, I. Gallage (p.c.).

Investment cost includes:

- Cost of equipment (including gasifier and accessories, installation, weather-proof storage<sup>33</sup> and commissioning)
- Cost of preparation (feasibility study and design), taken as 8-14% of equipment cost (as shown in the Table 16)

Cost of operation and maintenance (O&M) are taken in the calculations as 28% of investment cost (based on a 300-400 kW system and estimated at USD 15,600) and includes salaries of operators; filters and spare parts, boiler-furnace maintenance and other cost.

The cost-benefit analysis is for a 650 kW<sub>th</sub> thermal system diesel and furnace (based on fuel prices) is listed as an example and Table 17 reflects



for a using oil 2012 listed as an case 18 the

same for a 1 MW<sub>el</sub> gasification-cogeneration system.

**Table 17: Cost-benefit analysis of gasifier thermal application**

Case 1 Replacing diesel by biomass-fired gasifier			Case 2 Replacing furnace oil by biomass-fired gasifier		
Size (thermal power)	650	kW <sub>th</sub>	Size (thermal power)	650	kW <sub>th</sub>
Diesel consumption rate	43.3	liter/hour	Fuel oil consumption rate	40.7	liter/hour
Avoided diesel consumption	202,800	liter/year	Avoided fuel oil consumption	190,252	liter/year
LHV diesel	42	MJ/kg	LHV furnace oil	41	MJ/kg
Cost of diesel	194,319	USD/y	Cost of furnace oil	144,280	USD/y
<i>Gasifier</i>			<i>Gasifier</i>		
Size	650	kW	Size	650	kW
Investment	89,607	USD	Investment	89,607	USD

<sup>33</sup> Fuel wood is air-dried, and will be stored at the site of use. The cost of the weather-proof storage is included in the equipment cost (i.e., for the installed gasifier and accessories and controls, weather-proof storage). Since there are no additional costs associated with the provision of the weather-proof storage, no potential barriers foreseen and the level of risk is very low.

Heat production	7,410,312	MJ/year	Heat production	7,410,312	MJ/year
Wood consumption	622,715	kg/y	Wood consumption	622,715	kg/y
Cost of wood	64,819	USD/y	Cost of wood	64,819	USD/y
Cost of wood storage	793	USD/y	Cost of wood storage	793	USD/y
<i>Annual fuel savings</i>	129,500	USD/y	<i>Annual fuel savings</i>	79,461	USD/y
<i>CO<sub>2</sub> emission reduction</i>	565	t/y	<i>CO<sub>2</sub> emission reduction</i>	560	t/y
<b>Cost comparison</b>					
<b>650 kW</b>	<b>Diesel-fired</b>	<b>Gasifier</b>	<b>Fuel oil</b>		
Annualized capital cost		14,583			
Fuel cost	194,319	65,612	144,280		
O&M cost	3,886	24,676	3,886		
TOTAL (USD)	198,206	104,871	148,167		
Difference (USD)	93,334		43,295		

Note:

- Calculations are based on diesel consumption in boiler systems is 20 liter/hr in 200 kW system, 43.3 in 650 kW and 66.7 liter/hour;
- Investment cost is taken from Table 16 and includes equipment cost and cost of preparation (feasibility, design). O&M cost are 28% of investment cost;
- Cost of sustainably produced wood is based on the calculation presented in Table 21.

**Table 18: Cost-benefit analysis of a cogeneration system**

<b>Case 3 Cogeneration system (Electrical + Thermal energy)</b>	
Total power capacity, kW <sub>e</sub>	1,000
Electricity generated, MWh/yr	4,680
Emission factor, tCO <sub>2</sub> /MWh	0.60
Emission reductions, tCO <sub>2</sub> /year	2,808
Grid feed-in tariff, US\$/kWh	0.18
<b>Thermal energy</b>	
Thermal capacity, kW <sub>th</sub>	3,000
Fuel oil consumption, liters/year	936,000
LHV furnace oil, MJ/kg	41
Cost of furnace oil, US\$	709,828
Emission reductions, tCO <sub>2</sub> /yr	2,757
<b>Investment and operating costs</b>	
Investment cost for wood-fired gasifier-based cogeneration system, US\$	1,800,000
Heat production, MJ/yr	36,457,200
Wood consumption, kgs/yr	3,063,630
Cost of wood and wood storage, US\$	322,795

Case 3 Cogeneration system (Electrical + Thermal energy)	
Annualized investment cost, US\$	292,942
Wood fuel cost, US\$	322,795
Net O&M, US\$	72,872
Annual cost, US\$	688,609
Avoided fuel oil cost, US\$	709,828
Power sales, US\$	850,909
Annual revenues, US\$	1,560,737
Simple payback period (y)	1.2

Note: For the 1 MW<sub>e</sub> cogeneration unit, the 3 MW<sub>th</sub> capacity is based on the typical heat-to-power ratio for wood-fired cogeneration units, which is about 3:1. The cost-benefit analysis shows that cogeneration is feasible, and encouraged by suitable feed-in tariffs i.e. LKR 20/kWh in 2012 (against purchase of electricity from grid would cost a company LKR 10/kWh). The application of wood gasifiers in cogeneration systems will be demonstrated (as part of capacity development and RE technology promotion) to showcase its economic viability. A suitable host demonstration company will be identified and selected during project implementation.

The cost-benefit sensitivity analysis for the assumed three gasifier capacities, i.e. for 300 kW, 650 kW and 1000 kW, that replace diesel or furnace oil in thermal applications is presented in the Table 19 below. This sensitivity analysis is based on variables such as the size of the gasifier system (cost in terms of USD/kW) and fluctuation in the prices of fossil fuels (i.e. mid-2011 fuel prices and early 2012 fuel prices). Note that the fuel oil price is no longer subsidized starting 2012.

**Table 19: Cost comparison between gasifier and fossil-fueled thermal applications for various sizes of the system (capacity in kW) and different fuel prices**

At February 2012 fuel prices					At June 2011 fuel prices				
Particulars	Diesel-fired	Gasifier	Fuel oil	Fuel oil (w/o subsidy)	Particulars	Diesel-fired	Gasifier	Fuel oil	Fuel oil (w/o subsidy)
<b>300 kW</b>					<b>300 kW</b>				
Annualized capital cost (USD)		10,525			Annualized capital cost (USD)		10,525		
Fuel cost (USD)	89,686	30,282	66,591		Fuel cost (USD)	70,915	30,282	39,913	62,264
O&M cost (USD)	1,794	17,809	1,794		O&M cost (USD)	1,794	17,809	1,794	1,794
TOTAL (USD)	91,480	58,616	68,385		TOTAL (USD)	72,708	58,616	41,707	64,058
Difference (USD)	32,864		9,769		Difference (USD)	14,093		-16,909	5,442
<b>Payback period (y)</b>	<b>1.7</b>		<b>5.8</b>		<b>Payback period (y)</b>	<b>4.0</b>		<b>-3.4</b>	
<b>650 kW</b>					<b>650 kW</b>				
Annualized capital cost (USD)		14,583			Annualized capital cost (USD)		14,583		



Fuel cost (USD)	194,319	65,612	144,280		Fuel cost (USD)	153,649	65,612	86,478	134,906
O&M cost (USD)	3,886	24,676	3,886		O&M cost (USD)	3,886	24,676	3,886	3,886
TOTAL (USD)	198,206	104,871	148,167		TOTAL (USD)	157,535	104,871	90,365	138,792
Difference (USD)	93,334		43,295		Difference (USD)	52,664		-14,507	33,921
<b>Payback period (y)</b>	<b>0.9</b>		<b>1.9</b>		<b>Payback period (y)</b>	<b>1.5</b>		<b>-5.6</b>	
<b>1000 kW</b>					<b>1000 kW</b>				
Annualized capital cost (USD)		19,174			Annualized capital cost (USD)		19,174		
Fuel cost (USD)	298,953	100,941	221,969		Fuel cost (USD)	236,383	100,941	133,043	207,548
O&M cost (USD)	5,979	32,445	5,979		O&M cost (USD)	5,979	32,445	5,979	5,979
TOTAL (USD)	304,932	152,561	227,948		TOTAL (USD)	242,362	152,561	136,680	213,527
Difference (USD)	152,371		75,388		Difference (USD)	89,801		-15,881	60,966
<b>Payback period (y)</b>	<b>0.7</b>		<b>1.4</b>		<b>Payback period (y)</b>	<b>1.2</b>		<b>-6.9</b>	

Main conclusions from Tables 15-19 can be described as follows:

In general, wood-fired gasifiers are economically viable compared to fossil fuel-fired units in thermal applications, such as boilers or furnaces. The demo wood-gasifier cogeneration system (1 MW<sub>e</sub>, 3 MW<sub>th</sub>) is also economically viable because of the double benefits of power generation (that can be sold to the grid at favorable feed-in tariffs) and the generation of sufficient heat that is needed in the thermal load following system that will be showcased in the project. From the above table, it is clearly shown that fossil fuel price subvention can have detrimental effect on the viability of wood-fired gasifier (in fact, any renewable energy) systems. In 2011 the *de facto* subsidy on furnace oil would have rendered wood-fired gasification not economically viable. In 2012, the subsidy has virtually disappeared. If restored in future, subvention could distort the energy market.

### Sustainable fuel wood production and related cost-benefit analysis

Table 20 provides an estimate of the hectarage and fuel wood production under various fuel wood growing models (plantations, intercropping, home gardens, etc.) to meet the annual fuel wood demand of the demonstration/pilot activities (as per the fuel wood demand assessed in Tables 17 and 18). Considering the average tonnage per ha as 11 tonne/ha/y, it is estimated that 1,822 ha of plantations are needed for producing 20,120 tonne of required fuel wood for supplying the demos/pilots.

The annual cost for this fuel wood production would be USD 275,399. It is assumed that the area under plantation would be ready in 2014 (year 2) for fuel wood production. To able to meet future growth in fuel wood demand for energy, it is assumed that another 1,822 ha are added in 2015 and another 1,822 ha in 2016. Given this expansion the total cost per hectare per year during 2014-2016 would be USD 1.65 million and this amount more than fits within the co-financing available in Component 2 (biomass production).

**Table 20: Wood needed to supply demonstration/pilot projects**

Yield per Tree (kg/tree)	Trees/ha	Tonnage per Ha	Ha	Cost/ha/y
Dedicated Plantation	8000	40	5%	81,200
Under coconut	2250	12	40%	18,000
With Pepper/ Vanilla	1500	8	14%	
Home garden	1875	15	14%	
Alley Cropping (Rainfed Uplands)	1250	8	3%	
SALT	3000	10	4%	15,960
Coffee/cocoa/Tea	400	2	20%	

100%

Average tonnage per ha	11	ton/ha
Hectarage	1,822	hectares
- dedicated new plantation	91	ha
- coconut plantation	729	ha

**Investment**

Number of trees needed	3,661,494	trees
Cost per tree (LKR), average	8.00	
Total cost of trees	266,290	USD
Wood consumption demos	20,120	tons/y
Cost	266,290	USD
<b>Annual cost, supply for demos</b>	<b>275,399</b>	<b>USD/yr</b>
Annual expansion	100%	
<b>Total cost, 3 years (2014-2016)</b>	<b>1,652,392</b>	<b>USD</b>
<b>Total cost, 10 yrs</b>	<b>2,753,987</b>	<b>USD</b>

Source: data are based on analysis done by UNDP/FAO consultants G. Hitinayake and I. Gallage. See Table 3.

The fuel wood price of sustainably produced fuel wood is USD 0.104 per kg and this value has been used in the cost-benefit analysis of Tables 15, 17, 18 and 19. The fuel wood price is based on the following analysis:

**Table 21: Cost estimate of sustainably produced fuel wood**

Transportation (5,000 kg per km)	60	LKR/km	
Labor	500	LKR/day	LKR/kg
Price paid to tree owner			0.63
Kg cut from tree per labor-day	500	kg	1.00
Kg chopped per labor-day	1000	kg	0.50
Kg bagged per labor day	500	kg	1.00
Transport cost (as above)	200	km	2.40
Kg loaded and unloaded per labor day	2500	kg	0.20
Price of wet wood transported to plant within 30km radius (at 60% moisture)			5.73
Price at 20% moisture		LKR	11.45
Price (in USD/kg)		USD/kg	0.104
Storage of wood at customer's site (included in wood cost of consumer)		LKR	0.14
		USD/kg	0.0013

Source: G. Hitinayake

The table 22 below shows that, at this price, fuel wood growing can be profitable. This is illustrated by the following example of growing fuel wood (*Gliricidia*) in coconut plantations for an average producer. The table 22 represents two cases, i.e. a producer who do not need loan, and a producer that needs bank loan (at 12% interest rate).

**Table 22: Costs and Benefits of Fuel Wood Growing under Coconut**

Planting and land development cost	18,000	LKR/ha	12%	Bank interest rate					
Sale price	630	LKR/tonne							
Yield	12	ton/ha							
<b>Without loan</b>									
Year	0	1	2	3	4	5	6	7	8
	-18,000								
		7,560	7,560	7,560	7,560	7,560	7,560	7,560	7,560
IRR		39%							
<b>With loan</b>									
Year	0	1	2	3	4	5	6	7	8
Remaining	18,000	15,750	13,500	11,250	9,000	6,750	4,500	2,250	0
Repay		-2,250	-2,250	-2,250	-2,250	-2,250	-2,250	-2,250	-2,250
Interest		-2,160	-1,890	-1,620	-1,350	-1,080	-810	-540	-270
Sales		7,560	7,560	7,560	7,560	7,560	7,560	7,560	7,560
Net	-18,000	3,150	3,420	3,690	3,960	4,230	4,500	4,770	5,040
Financial IRR		14%							

### Direct post-project emission reductions

SEAs Loan Guarantee Facility has been formally established and will become operational soon. As part the proposed project, local business entities that are interested in the application of wood-fired gasification for thermal and/or power generation purposes will be assisted in securing financial assistance in this facility. The facility will also be assisted in developing mechanisms for implementation (operating and managing the Fund) to meet the project objectives of industrial fuel switching. The aim is to use the Facility as an additional guarantee when developing bankable proposals for industrial end users of biomass and biomass supply chain operators. The target is that by 2016, the companies participating in the project (with investment or advanced feasibility study or financial proposal) would double. Although these will become operational after the project's end in 2016, we can count their contribution to greenhouse gas emission reduction as "direct post-project", estimated at double the direct emission reduction (203 ktCO<sub>2</sub>).

### Indirect emission reductions (bottom-up)

The GEF bottom-up approach implies the replication of the project demonstration investments to other industrial companies in Sri Lanka over the GEF project influence period of 10 years (i.e. 2017-2025), and is calculated per following formula:

CO<sub>2</sub> indirect BU = CO<sub>2</sub> direct \* RF, where

CO<sub>2</sub> direct = estimate for total direct emission reductions

RF = replication factor

For RF the value of ‘3’ has been chosen as a conservative estimate for the industry sector as a whole based on the market transformation and demonstration approach of the project. Thus, applying the above formula, indirect emission reductions (bottom-up) are estimated at  $203 \text{ ktCO}_2 * 3 = 609 \text{ ktCO}_2$ .

### **Indirect emissions reductions (top-down)**

An upper limit of indirect emission reduction can be estimated by looking at the technical and economic market potential for biomass fuels for industrial heat application (within 10 years after the project’s lifetime). Based on info provided by the Ceylon Petroleum Corporation, the consumption of fossil fuels in industry (mainly diesel and furnace oil) will be around 400,000 tons. Assuming a growth of the economy in the near future of around 5-8% (as predicted by the Central Bank), we take a growth of 3% of fossil fuel usage annually.

The Government (SEA) has set a target of switching 10% of fossil fuels by modern biomass fuels in industry by the year 2017. We assume the following percentage of fuel switching in the years up to 2017 and thereafter up to 2025, as given in Table 23. Based on the annual amounts of switched fuel can be calculated as well as the corresponding CO<sub>2</sub> emission reduction. Thus, cumulative emission reduction up to 2025 is 2,297 ktCO<sub>2</sub>.

Of course, this potential cannot be fully attributed to the GEF intervention. Uptake of EE technologies will take place due to on-going (and future) national effort. Given the importance of the GEF project for the market transformation of modern biomass technologies, we propose to apply a ‘causality factor’ 60%.

Thus, an upper limit to indirect emission reduction impacts can be calculated as:

$$\text{CO}_2 \text{ indirect TD} = \text{CO}_{2\text{TM}} * \text{CF}, \text{ where}$$

CO<sub>2TM</sub> = total market potential for CO<sub>2</sub> emission reductions

CF = causality factor

$$\text{CO}_2 \text{ indirect TD} = 2,297 \text{ ktCO}_2 * 60\% = \mathbf{1,378 \text{ ktCO}_2}$$

### **Total emission reductions**

Using the GEF *bottom-up* methodology (BU), indirect emission reductions over 10 years of project influence period attributable to the project have been estimated at **609 ktCO<sub>2</sub>** based on an average investment lifetime of 10 years and a replication factor of 3. GEF *top-down* methodology (TD) has yielded indirect emission reductions estimate attributable to the project of **1,378 ktCO<sub>2</sub>** based on an average investment lifetime of 10 years and a GEF causality factor of 60%.

The difference between BU and TD estimates can be explained by the fact that the BU approach considers only immediate replication of the project-supported investments; whereas the TD approach looks at total potential for fuel switching in the Sri Lankan industrial sector and inherently reflects additional fuel switching achievable through other investments not directly demonstrated by this project (as it would simply be impossible to cover the whole range of fuel switching in all industrial segments).

**Table 19: Indirect emission reduction calculation (top-down approach)**

Base data														
Fuel usage participating demos (2013)	5,482	tonnes												
Total industrial fuel usage (2013)	400,000	tonnes												
Economic growth	3%													
<b>Year</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>
Industrial fossil fuel usage ( t/yr)	388,000	400,000	412,000	424,360	437,091	450,204	463,710	477,621	491,950	506,708	521,909	537,567	553,694	570,304
Percentage of fuel switching	0.5%	1%	2%	4%	6%	10%	12%	14%	15%	15%	15%	15%	15%	15%
Switched fuel	1940	4,000	8,240	16,974	26,225	45,020	55,645	66,867	73,792	76,006	78,286	80,635	83,054	85,546
Required hectareage	645	1,329	2,738	5,640	8,714	14,960	18,490	22,219	24,520	25,256	26,013	26,794	27,598	28,425
Annual CO <sub>2</sub> emission reduction	5,210	10,742	22,129	45,585	70,429	120,902	149,435	179,572	198,170	204,115	210,239	216,546	223,042	229,733
Cumulative over 2012-2024	52,099	107,420	221,286	455,849	704,286	1,209,024	1,494,354	1,795,715	1,981,700	2,041,151	2,102,386	2,165,457	2,230,421	2,297,334
<i>Causality factor</i>	60%													
Top-down indirect emissions	1,378,400	tCO <sub>2</sub>												

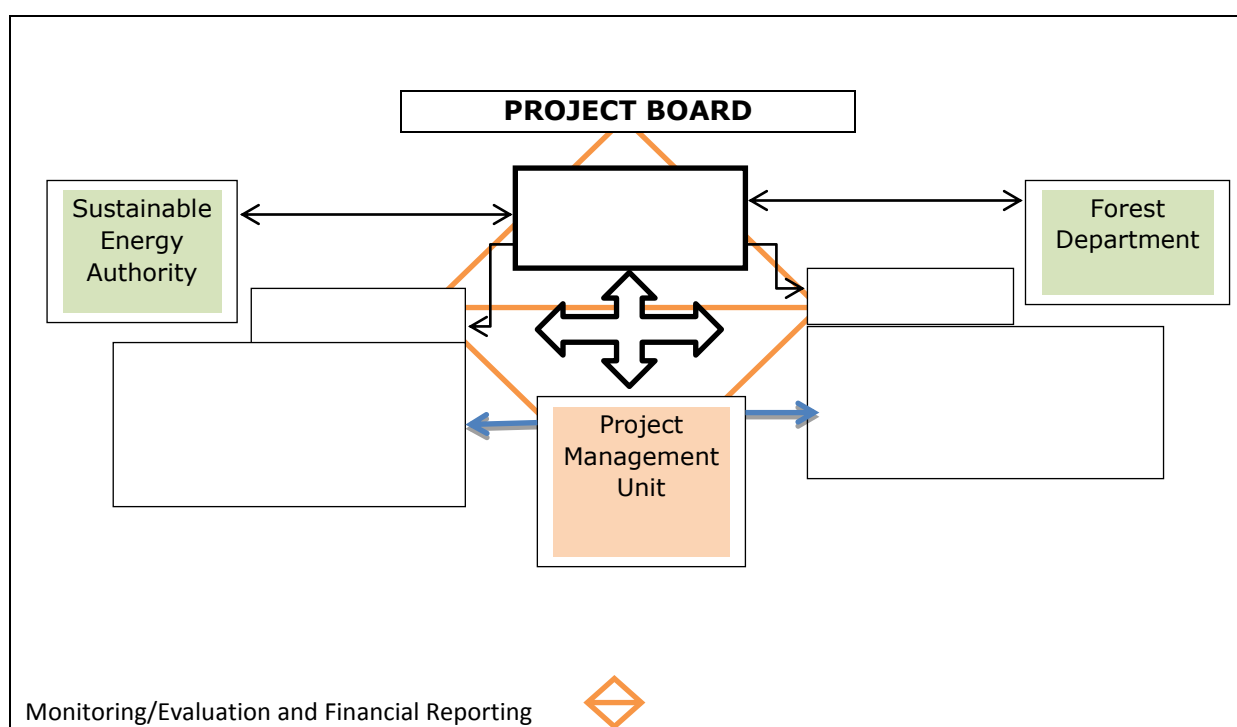
## ANNEX D: IMPLEMENTATION ARRANGEMENTS

The Project Board (or Project Steering Committee) will be chaired by the Secretary, Ministry of Environment or his designate. The Forest Department, Sustainable Energy Authority, UNDP and FAO are permanent representatives on the Board. Key implementing partners will be coopted to the project board as reviewed and recommended during the PAC/ Inception Meeting such as Ministry of Finance.

The project activities will be implemented through a project management unit (PMU) under the Ministry of Environment (MoE).

UNDP will transfer funds to the MoE using NEX modality. These funds will support the components managed by UNDP (Outcome 1, 3 and 4) as well as meet operational expenditure of the PMU.

FAO will disburse its funds directly to support the Forest Department and other partners implementing Outcome 2. FAO will also support the PMU's operational expenditure, including hiring of staff.



### The Project Management Unit

1. Project Manager: Contracted by UNDP (see also Annex C of CEO endorsement request)
2. Project Assistant (part-time): Provided by Sustainable Energy Authority (SEA)
3. Secretary (part-time): Provided by Sustainable Energy Authority
4. Project Accountant (part-time) : Provided by Ministry of Environment