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Haiti: Strategy to Alleviate the Pressure of Fuel Demand on National Woodfuel Resources




ESMAP

Energy Sector Management Assistance Program

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Technical Paper 112/07

Energy Sector Management Assistance Program (ESMAP)

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Haiti: Strategy to Alleviate the Pressure of Fuel Demand on National Woodfuel Resources

Ministry of Environment
Bureau of Mines and Energy

REPUBLIC OF HAITI

ENERGY SME PROGRAM

Small and medium size energy providers

Energy Sector Management Assistance Program (ESMAP)

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Abbreviations and Acronyms

BME	Bureau of Mines and Energy
BoDs	Board of Directors
CARE	International humanitarian NGO
CCI	Interim Cooperation Framework (Cadre de Coopération Intérimaire
CDM	Clean Development Mechanism
CIDA/ACDI	Canadian Agency for International Development
ECMU	Environmental Country Monitoring Unit
EdH	Electricity of Haiti (Electricité d'Haïti)
ESMAP	Energy Sector Management Assistance Program
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
HES	Household Energy Strategy
IPR	Internal Profitability Rate
IRR	Internal Rate of Return
LPG	Liquefied Petroleum Gas
NGOs	Non Governmental Organizations
NPV	Net Present Value
OPDES	Office Post-Désastres et de Secours
ORNL	Oak Ridge National Laboratory
PAE	Environment Action Plan
PV	Photovoltaic
RE	Renewable Energy
SMEs	Small and Medium Enterprises
SPC	Service of the Civil Protection (Service de la Protection Civile)
UNDP	United Nations Development Programme
UNDEERC	Research Center on Energy and Environment, University of Dakota
USAID	United States Agency for International Development
WHO	World Health Organization

Conversion Table

Type of Fuel	Barrel/toe		Toe/Ton
LPG	10.79		
Gasoline	8.10		
Kerosene	7.38		
Diesel	7.34		
Fuel Oil	6.83		
Lubricants	7.22		
Crude Oil	7.17		
Charcoal			0.70
Firewood (20%)			0.39
Bagasse (50%)			0.18
1 Toe = 10^9 calories	1 m^3	is equivalent to	625.00 kg
1 GWh = 86.0 toe	1 stère	" " "	468.75 kg
1 Toe = 0.01163 GWh	1 bag	" " "	35.00 kg

ha=hectare=10,000 square meters

Exchange Rate

US$1 = 40 Haitian Gourdes

Haitian $1 = 5 Gourdes

Units of Measure

bbl	Barrels
BTU	British Thermal Unit
GWh	Giga Watt (s) Per Hour
ha	Hectare (s)
kg	Kilogram (s)
km^2	Square Kilometer (s)
kT	Thousand Ton
ktoe	Thousand Tons of Oil Equivalent
kWh	Kilo Watt (s) Per Hour
lb	Pound(s)
m^3	Cubic Meter
m^3/ha	Cubic Meters Per Hectare (s)
MJ	Mega Joule
MW	Mega Watt (s) (10^6 Watt)
toe	Ton Equivalent of Oil
W	Watt

Acknowledgments

This report was the result of activity P092032 Haiti: Scoping Study for Household Energy Strategy financed by the World Bank's Energy Sector Management Assistance Program (ESMAP).

The fundamental objective of this work was to provide the government and the Bank with a better understanding of the issues and options for improving household energy services and ensuring affordable and sustainable domestic fuel supplies.

Both the Ministry of Environment and the Bureau des Mines et de l'Energie committed a substantial amount of time and resources to the Study which was formalized through a memorandum of understanding signed by the Bank and by the Haïtian Government. The Bureau des Mines and Energy, the Ministry of Environment covered all expenses related to the survey on woodfuel flows in/from Port-au-Prince, and the Bureau des Mines et de l'Energie assigned two staff for the realization of the survey work related to the charcoal production areas and the informal flows of charcoal with the Dominican Republic. The invaluable assistance provided by the Haitian staff, and the commitment of resources to conduct the one-week survey in Port-au-Prince brought significant leverage to ESMAP funds, and were reflected in the scope and quality of the resulting work.

The main author of this report was Mr. Robert Van der Plas. Bétonus Pierre, Jean-Robert Altidor, Edgar Jeanniton, Wista Delice and Jean Chesnel Jean wrote background documents that were incorporated & summarized in the main text. Ghislaine Kieffer provided invaluable comments and editing remarks on the original French version of the report.

Thanks also go to Mr. Douglas F. Barnes, Senior Energy Specialist, ESMAP who reviewed the final draft and provided valuable comments. Special thanks to CINER's staff who undertook the task of editing the French version and carrying out the English translation. To the ESMAP communications team staff Ms. Marjorie K. Araya for proofreading the English version and overseeing the overall production process together with Ms. Ananda Swaroop.

Executive Summary

Haiti suffers from a serious deterioration of its natural environment and, in particular, from a heavy pressure on its natural resources. The reasons for this deterioration are multiple (poverty level, demographic pressure, agricultural techniques and insecurity regarding land tenure) and, therefore, go beyond the strict scope of energy. However, the woodfuel consumption is one of the main factors of this deterioration. On a national scale, about 70 percent of the energy needs are met using firewood and charcoal. Although the local woodfuel resources have been overexploited for more than 20 years, the price of woodfuels does not reflect this scarcity phenomenon which constitutes a serious ecological threat at the countrywide level. The household energy sector remains, by far, the main consumer of woodfuels, in as much as it absorbs 70 percent of the overall supply. However, this sector is characterized by very low efficiency in terms of use outputs.

Consequently, due to financial constraints, the poorest households suffer from a double disadvantage: they use inefficient traditional stoves, while paying the highest unit price for their cooking fuel. Beyond its environmental impact, the massive use of firewood rests on important economic foundations, as this resource constitutes a source of activity and nonnegligible income in an impoverished farming environment, generating on an average 16 percent[1] of the rural income, and employing a substantial workforce in the context of chronic underemployment. A fair portion of the poor population depends on wood transformation activities to earn their living in the rural areas, and on the availability of firewood for their daily cooking in the urban areas.

Thus, the strategy proposed for reducing the pressure on the national wood resources aims, above all, to reach a sustainable balance between the supply and demand for cooking fuels.

[1] *Haiti: The Challenges of Poverty Reduction, August 1998, page 3.*

In July 2004, thanks to a financial contribution provided by the Energy Sector Management Assistance Program (ESMAP), a survey was launched to update theHousehold Energy Strategy (HES) in Haiti, based on a diagnosis of currently available experience and information. According to the initial data obtained and in consultations with the main actors involved, the general trends of the HES, identified by ESMAP back in 1991, not only had hardly changed, but had become more pronounced due to demographic growth. This is why the approach adopted by the present study is to carry out a critical review of past recommendations, by collecting essentially qualitative information through interviews and complementary investigations.

Six surveys were thus developed in order to update the understanding of some key issues:

- The fuel consumption in urban areas;
- The incoming flux of charcoal in Port-au-Prince;
- The charcoal production chain;
- The production of industrial briquettes;
- The cross-border flux of charcoal between Haiti and the Dominican Republic; and
- The energy conversion of Small and Medium Enterprises (SMEs).

During the design stage, it was decided that the strategy would target the demand and supply of cooking fuels, which is a part of the "alleviation of the pressure of fuel demand on national woodfuel resources," the first of four priority axes identified by the environment sector round-table, organized by the Interim Cooperation Framework (*Cadre de Coopération Intérimaire, CCI*).

The first part of the final document describes the current household energy situation, based on the outcome of complementary surveys jointly carried out by the Ministry of Environment, the Bureau of Mines and Energy (BME) and the ESMAP team. In the second part, the strategy brings forward some recommendations aimed at alleviating the pressure of energy requirements on national wood resources. The strategy comprises the following five components, of which the first one provides the basis for the whole document:

- Update and apply rules and regulations, and set up an institutional coordination mechanism in order to support the proposed courses of action. This framework should especially promote: 1) improved land management by farmers; 2) efficient use of woodfuels; 3) imports and/or local manufacturing of more efficient stoves; 4) a mechanism to supply imported substitution fuels; and 5) manufacturing and/or imports of equipment required for producing substitution fuels from agricultural origin, such as briquettes;

- Reducing woodfuel demand, in particular by promoting more efficient stoves and by reviving the production of the "Mirak" model. This program will comprise the following actions: 1) a promotion campaign aimed at converting 80 percent of Port-au-Prince households; 2) a training program for artisans to manufacture improved stoves; and 3) the setting up of a quality and energy efficiency labeling system. This component aims at increasing efficiency by at least 20 percent, in order to reduce the charcoal demand by 50,000 ton/year or more, which would amount to reducing the national demand by 10 or 15 percent;
- Promote alternative fuel imports with 200,000 ton/year charcoal substitution potential. Those fuels are: Liquefied Petroleum Gas (LPG), kerosene and coal. It is hereby proposed to: 1) promote potholders (*porte marmite*) and the supply of LPG in small quantities, to facilitate wider access to LPG for a greater number of households; and 2) launch a program for imported coal briquettes;
- Foster local options to substitute charcoal and firewood. It is, therefore, proposed to revive the currently abandoned production of briquettes using charcoal fines, with a potential 35,000 ton/year, as well as using carbonized agricultural waste, principally bagasse, with 30,000 ton/year potential;
- Boosting supply by promoting: 1) an upgrading of professional standards in the charcoal chains, which could almost double the occasional producers' supply levels using wood; 2) the integration of firewood within the programs for rural development, such as watershed management areas, and forestry development; and 3) the promotion of a more effective and efficient management of forestry areas, through local community-based management systems, and through the introduction of a tax promoting "Sustainable Charcoal Production;"
- The cost of implementing this strategy over a five-year period is estimated to be around US$20 million, with more than half of which could be covered by the private sector, with the following distribution of costs: demand-side management 14 percent, substitution 42 percent, production of substitutes 6 percent, supply-side management 33 percent, and regulatory framework 5 percent. The participation of the public sector amounts to about 47 percent, and focuses essentially on wood supply management 33 percent, demand-side management 6.2 percent, regulatory framework 5 percent and substitution fuels 2.5 percent.

- The expected results are as follows:
  - The overall charcoal consumption would decrease by at least 20 percent over a 10-year period;
  - The consumption of coal, and of charcoal, would level after a 10-year period, LPG and kerosene consumption would at least grow twofold in 10 years; and
  - The indicated actions jointly developed allow us to anticipate a substantial reduction in charcoal consumption without social repercussions; however, after 11 or 12 years, the levels of consumption are likely to rise again as a result of demographic growth.

- The strategy's impact can be summarized as follows:
  - Higher profits in fuel consumption: over a five-year period, the Net Present Value (NPV) could reach US$76.1 million as compared to the US$24.3 million costs NPV over the same period. Over a 20-year period, the referred amounts would be: US$593 million (profits) and US$90 million (costs). The profits do not include environment- and health-related aspects; and
  - The Internal Rate of Return (IRR) is expected to remain fairly elevated, at 89 percent over a five-year period, and 109 percent over a 20-year period.
- Benefits in terms of environment and health.

Over five years time, the reduction of CO_2 emissions would reach 3,200,000 tons and 99,400,000 tons over 20 years. The value of CO_2 has been calculated as US$10/ton. Therefore, the environmental benefits represent 4 percent of the consumption profits over five years (or 2 percent over 20 years). The level of environmental benefits, which could thus be reached, would nearly allow covering the costs of energy control.

The positive effects on health should be equally underlined: reduction of smoke in the households, lower incidence of fire risks and, consequently, reduced risk of contracting diseases for the family members. The health-related benefits would raise the consumption profits by 11 percent over five years, or 7 percent over 20 years.

1. Introduction

Had the 80s projections materialized, the last Haitian tree would have been cut down a few years ago. As not all trees have yet disappeared in Haiti, such alarmist forecasts should be taken with some precautions. No doubt, except for a few exceptions, today our natural forests have practically vanished; however, firewood and charcoal – both entirely derived from trees – are still available in the market, at relatively affordable prices, as compared to other types of fuel. All seem to indicate that isolated trees (growing in the fields and along the roads, etc.,) are currently providing a substantial part of the firewood supply. No other plausible explanation can be put forward, in the absence of a detailed inventory of woodfuel resources, taking into account the isolated trees, outside of the remaining forests.

But, even if results of said inventory were available, the approach aiming at managing the household energy sector would probably not be substantially different. One might calculate more accurately when the last tree will be cut down from the forest, but no prediction can be made regarding isolated trees. It would be difficult to envisage an intervention at the forest level, given the large investments required for obtaining significant results. Firewood and charcoal are, therefore, likely to be used for many more years, or even decades. However, no one can tell exactly how long such types of fuel will be available, given the existence of some species such as the coppicing species Bayonde, which can be harvested over relatively short periods (three years). This vision, therefore, calls for immediate measures aimed at readdressing the current situation. The anticipated solution comprises several simultaneous approaches, in order to balance supply and demand for wood energy through a progressive use of substitute sources of energy: an increased return on the use of charcoal and a large scale planting of trees.

The present study aims at updating the Household Energy Strategy (HES) in Haiti, elaborated in the early 90s, through a diagnosis of the experience and new data currently available. This review examines the supply and demand for woodfuels, in order to identify the components of a comprehensive and sustainable energy solution. Such an activity is part of the section "alleviating the pressure of energy needs on national woodfuel resources," the

first of four priority axes identified by the sector environment table set up by the CCI. This activity strengthens the capacity of the BME to assist the Haitian Government in updating its household energy action plan.

In order to identify the changes which occurred in the Haitian energy situation since the 90s, five complementary surveys were carried out[2] as a basis for a number of technical notes. These notes cover the following topics:

- Forest resources and their contribution to wood supply (firewood, charcoal);
- Description of the charcoal distribution chain, its organization, actors, production sites and sustainability elements (the impact of charcoal production on production sites and forestry resources);
- Household energy consumption, urban and rural;
- Substitution fuels, if any; and
- The regulatory, institutional and fiscal frameworks and their positive or negative impact on wood resources, the charcoal exploitation and the production of other types of fuel used by households and small enterprises in Haiti (comparing, whenever possible, the impact of said elements on each of the types of fuel analyzed).

The present document describes the current household energy status, incorporating the results of complementary surveys as well as other data provided to the team, and brings forward recommendations to solve the current household energy problems.

[2] *(i) group interviews and discussions with women in order to identify energy consumption issues; (ii) charcoal chain description; (iii) evaluation of incoming charcoal shipments in Port-au-Prince over a one-week period; (iv) assessment of the briquettes production potential capacity; and (v) evaluation of a burner conversion program among SMEs.*

2. Evolution of Haiti's Energy Situation

Current Status

In spite of the evident natural environment degradation, the country keeps covering, year after year, about 72 percent of its energy demand with the local resources, principally composed of firewood and charcoal (66 percent), as well as bagasse and hydro energy (4 percent and 2 percent respectively). The main difficulty related to wood energy is that existing resources have not been assessed but are heavily overexploited, thus aggravating the chronic woodfuel resources deficit. How long can such a situation last? Promotion of charcoal substitutes, which has been recommended multiple times, is not yet implemented, mainly due to a lack of political stability, an appropriate regulatory framework and funding, etc.

Oil products cover the remaining 25 percent of the yearly energy demand, weighing heavy on the country's commercial budget. The annual LPG consumption has considerably risen over the past few years, from 900 tons in 1991 to over 12,000 tons in 2004. LPG infrastructure has been developed and several companies (Sodigaz, Total Haïti and Ecogaz) currently import and distribute butane and/or propane gas. Ecogaz is supplied from the Dominican Republic, whose consumption is 60 times greater than Haiti's and achieving significant economies of scale. Sodigaz and Total Haïti have established two storage centers. In spite of a minor price decrease, the LPG retail price remains beyond the population's means, which explains why the use of LPG is limited to the well-off strata. Although many households consider LPG an ideal type of fuel, charcoal remains the only choice for them.

Kerosene is mainly used for lighting in rural and suburban areas, and occasionally for daily cooking. Its annual consumption is 150,000 tons, a relatively low figure compared to the overall oil products imports.

Table 2.1 indicates the energy consumption details by sector in 2003 (latest available data).

Table 2.1: Secondary Energy Consumption, ktoe, 2003

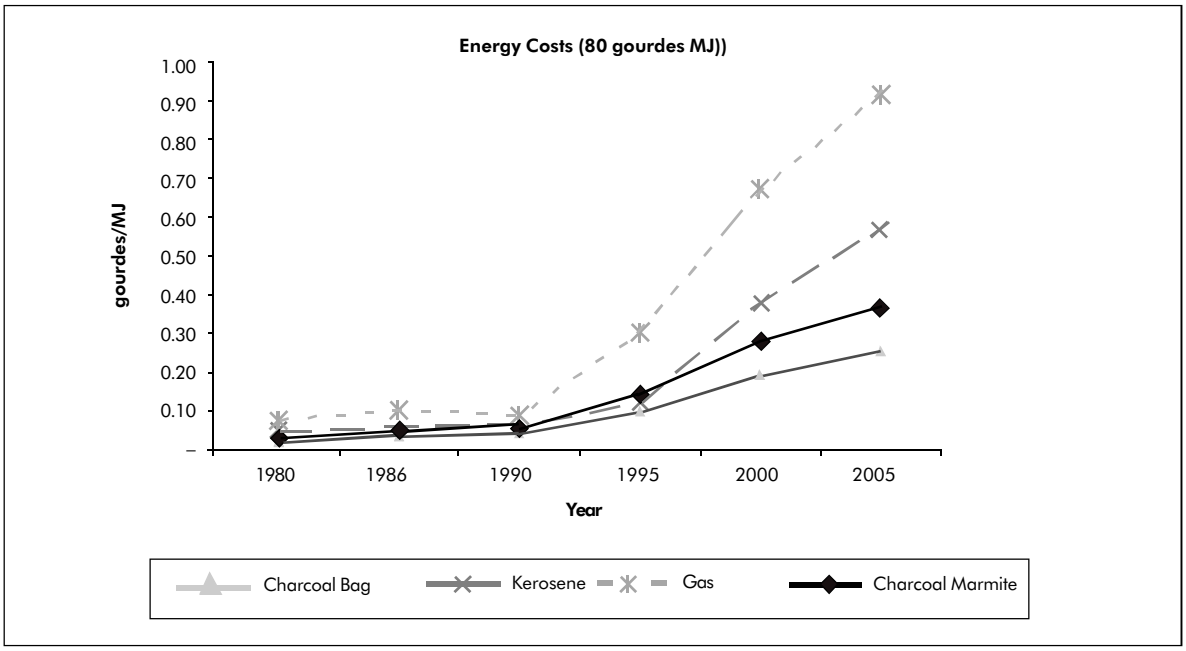
	Rural Households	*Urban Households*	*Trade & Services*	*Transportation*	*Industry*	*Total*	
Firewood	862	17	35	113	112	991	55%
Charcoal		161		170		196	11%
Bagasse					66	66	4%
LPG		28			9	37	2%
Petrol						113	6%
Kerosene		57			122	349	19%
Diesel			12		19	19	1%
Fuel Oil		16			12	40	2%
Electricity						1,811	
Total	**862** **48%**	**279** **15%**	**47** **3%**	**283** **16%**	**340** **19%**	**1,811** **100%**	**100%**

Source: BME.

Energy Prices

Figure 2.1 shows the evolution of energy prices. LPG remains the most expensive source of energy, and charcoal (in bags), the cheapest. By the late 80s, kerosene was cheaper than charcoal bought by marmite. However, the current sale price is US$300/ton for charcoal, US$750/ton for kerosene and US$1,050/ton for gas.

Figure 2.1: Price of Fuels (in gourdes)



Sources: ESMAP and BME.

The charcoal price does not directly reflect the exhaustion of this primary resource caused by the overexploitation of trees in the Haitian territory. The rise in charcoal prices follows the rise of prices of other fuels.

3. Energy Consumption

Energy in Haiti is used in four main sectors: domestic (comprising households, the traditional industry – SMEs, trade and services), electricity, industrial (modern industry-large companies) and transportation (road, maritime and air).

Domestic Sector

This sector comprises rural households (60 percent), urban households in Port-au-Prince (25 percent) and other urban areas (15 percent), as well as the traditional industry in the commercial and services sectors (laundry, bakery, road restaurant, guildive, *vétiver*, etc.). The latter are small enterprises mainly depending on the same energy sources as households, firewood and charcoal.

The domestic sector is by far the most important in terms of overall energy consumption. Its average share in the overall consumption is 70 percent, principally coming from biomass (wood, charcoal and agro-industrial waste). However, this sector has a very low energy efficiency use rate, particularly among the most destitute households. Such a low output mainly results from the lack of financial means to invest in more performing equipment, or in modern types of fuel.

Cooking Habits and Meals

As shown by the complementary surveys, consumption habits have barely changed since the 90s. The poorest households still depend on firewood and agricultural waste to cover their energy needs. As poverty worsens, the poorest households can no longer afford having three warm meals a day. Due to various types of constraints, women tend ever more to buy ready-made meals outside the home (if they leave early in the morning, or if they spend many hours away from home, working in small businesses such as the "ti machann," or small trade) and have no domestic help to do the cooking for them, or when they lack the

financial means to buy all the items required for preparing a meal. Mothers with infants try as much as possible to cook at least one warm home-made meal a day. In many cases, breakfast and supper are frequently reserved for children alone, given the lack of money to cook a meal for the entire family. The principal meal is generally lunch (taken at noon), or supper in the evening. In most cases, it is the only meal taken during the day, which is cooked at home, and shared by all members of the family.

Cooking habits have hardly changed over the past years. People cook the same types of food, using the same cooking techniques. Breakfast generally includes eggs, boiled plantain or spaghetti. The main meal at noon usually comprises beans (dry beans), rice or maize, and meat with vegetables or salad. In the evening, supper usually consists of boiled grains (rice, cornflour, *manioc* flour, oat) or bananas. While breakfast or supper need fairly short cooking time, the midday meal requires a longer cooking time, particularly in the case of mashed dry peas (*sos pwa*). Other preparations take a longer time to prepare, such as meat stew, braised vegetables and braised "leaves" with meat.

Due to economic and time constraints, housewives tend to prepare less elaborated meals, requiring less cooking time (rice and green, fresh peas, white rice, no meat, no mashed dry peas). It should be further noted that imported chicken, introduced in the Haitian market a few years ago, is currently largely consumed as it is much tenderer than the local chicken and its cooking time is much shorter. Haitian traditional cuisine is rich in recipes demanding longer cooking time.

Used Fuels and Equipment

The data available clearly show that charcoal remains the most used type of fuel. Among 70 women met during the survey, mostly from modest urban origin, only three do not use charcoal at present. The other fuels are, by order of importance, kerosene and propane. Wood and agricultural residues are generally used in rural and semi-rural areas.

Charcoal is practically the only fuel available in towns, where people use it to address different types of needs. On the contrary, whenever it is used together with propane or kerosene, charcoal is frequently used to prepare time-consuming meals,[3] principally mashed dry peas, or boiled meat. For women mainly using gas, it is important to have a permanent reserve of charcoal, in case LPG is unavailable. The oil products embargo remains vivid in many Haitians' memory.

[3] *This is explained by the energy costs: for each useful Mega Joule (MJ), charcoal is cheaper than LPG or kerosene.*

Moreover, charcoal has the great advantage of requiring very low-cost equipment: an ordinary stove can be purchased with as little as 30 gourdes, and an improved burner, such as the "Mirak," for 150-200 gourdes, whereas a kerosene burner costs some 300 gourdes or more. According to the model, an "eco LPG" burner costs 1,500 gourdes and a propane stove 20,000 gourdes. "Mirak" burners cannot be found at moderate prices for several reasons, especially because it is increasingly difficult for artisans to find low-cost metal, the basic material.

Charcoal can be found almost everywhere, in all types of quantities, and at any given time. Besides, it does not require a special space to be used: if one does not possess an oven, the charcoal stove can be used outdoors as well as indoors, and it is easily stored and transported. Additionally, people consider it safer to manipulate charcoal than kerosene or gas. On the other hand, charcoal is seen as a "dirty" fuel: it blackens cooking pots, generates ashes which spread all around, and stains the cooking area. Another drawback is the fact that combustion cannot be controlled.

Although wood can be obtained free of cost, it has a negative image, due to the nuisances caused during its use. It has a lachrymator effect, its caustic and suffocating smoke affects the eyes, its unpleasant smell impregnates food, and one has to constantly maintain its combustion. Finally, if there is no appropriate stove, wood has to be burnt outdoors which is not feasible on rainy days.

Kerosene's main advantage is that it allows fast cooking. Kerosene stoves are much cheaper than propane stoves and burners. Besides, kerosene is sold on a retail basis: at the time the surveys were conducted, it was being sold by gallons, liters and even in small 16 oz/ 476 ml quantities, at 14 gourdes. Yet, kerosene has several impediments: if incorrectly adjusted, its flame blackens cooking utensils, its smell impregnates food, the wick has to be constantly monitored and stoves quickly malfunction. Beyond everything else, one should also mention accidents, explosions and burn risks.

The wealthiest households use propane LPG to prepare light meals, breakfast and supper when they are running short of time. In fact, propane serves as a second solution to charcoal use for economic reasons (to make LPG last longer). Wood also plays the same role as charcoal for time-consuming cooking, for the poorest households.

LPG is easy to use: whether day or night, one just has to turn a switch. It reduces cooking time, does not stain cooking utensils or kitchen space. The temperature of stoves and burners can be controlled at will. However, various factors limit its use by the Haitian population. LPG's first drawback is an economic one: it is not sold on a retail basis. Transporting LPG

cylinders weighing 25, 50 or 100 Pounds (lb) is rather difficult. Additionally, given the frequency of accidents caused by improper use, it generates distrust and fear among many persons. The other very important issue is the high cost of propane stoves.

Small and Medium Enterprises and Services

Various surveys carried out in the 90s indicated that, same as households, most SMEs use wood and charcoal, representing about 15 percent of domestic consumption. Those are mainly family enterprises, such as bakeries, laundries, dry cleaners, distilleries, guildives, mills, street restaurants, etc. SMEs generally lack the financial means to improve their energy equipment.

The use of bagasse is constantly rising among distilleries; wood supply problems and cost motivate consumers to use it as a substitution fuel. The number of sugarcane transformation workshops throughout the country is an estimated 5,612. About 130 bagasse production mills and some 200 distilleries are found in the Leogane plain alone. According to industrial professionals met during the survey, currently more than 75 percent of Leogane distilleries only use bagasse. Such a transformation has begun to expand slowly throughout the country.

Haiti's bakery industry is expanding fast, as demographic growth generates a strong demand for bread, a basic food item. A study carried out by CARE (an international humanitarian NGO), Peter Young calculated that 1,300 bakeries operate throughout the country, with a consumption amounting to 156,000 to 208,000 tons of wood. The study revealed the very low profit-yielding capacity of such enterprises (3 to10 percent). Many large bakeries (such as those producing the "épi d'or" brand) possess imported ovens using LPG and/or electricity. It is important to mention the irreversibility of a bakery's conversion, which hampers spontaneous conversions.

As per data gathered in 2001, 170 laundries were operating throughout the country, with a total consumption of 23,000-26,000 tons of wood per year. Some of the larger ones use diesel burners. Unlike bakeries, the conversion of laundries does not imply deep modifications in the functioning system. The only requirement is to have a diesel burner to generate the temperature level needed by the boiler, in substitution of wood.

The street restaurants – "manje kwit" – proliferate in Port-au-Prince town. An increasing number of people can no longer eat lunch at home and look for suitable alternatives. The referred survey interviewed several street restaurant owners, selling on an average 150 to 200 meals per week each. They are not equipped (as they would like to be) with

ameliorated large boilers because their consumption level is about five-seven charcoal bags per week. The few street restaurant owners who opted for kerosene or LPG are satisfied and declare having made appreciable savings.

Energy Consumption and Costs

Based on observations made by a nonstatistically representative group which served as a basis for one of the surveys, housewives consume on an average two to three *marmites*[4] of charcoal per day, at an average cost of 50 gourdes. One charcoal bag costs some 400 gourdes in Port-au-Prince (less in the province), and lasts almost two weeks. One kerosene gallon costs 100 gourdes, and may last two to three days. A 25-lb propane cylinder costs 425 to 450 gourdes and lasts 10 to 15 days. Table 3.1 gives a summary of units used and annual costs for each fuel-type. It also indicates the fuels' costs per unit, consumption in energy indicators and annual costs per type of fuel (to prepare the same type of meal). The table includes paper briquettes, recently introduced in a Port-au-Prince neighborhood.

Table 3.1: Characteristics of Fuels

	Unit	*INIT/14 days*	*Gdes/14 days*	*Gdes/kg or liter*	*kg or liter/d*	*MJ/d*	*MJ eff/d*	*Gourdes/ yr*
Charcoal	kg	11	210	1.8	8.1	114.0	22.8	5
Briquettes	marmite	2-3/d 14 days	700	18.4	2.7	81.4	22.8	18
Charcoal	bag	1 in 14 days	400	10.5	2.7	81.4	22.8	10
Kerosene	gallon	5 in 14 days	407	21.4	1.4	47.5	21.4	10
LPG	cylinder 25 lb	1 in 14 days	435	38.4	0.7	34.0	22.1	11

Source: *Complementary investigation (ESMAP/BME 2005).*

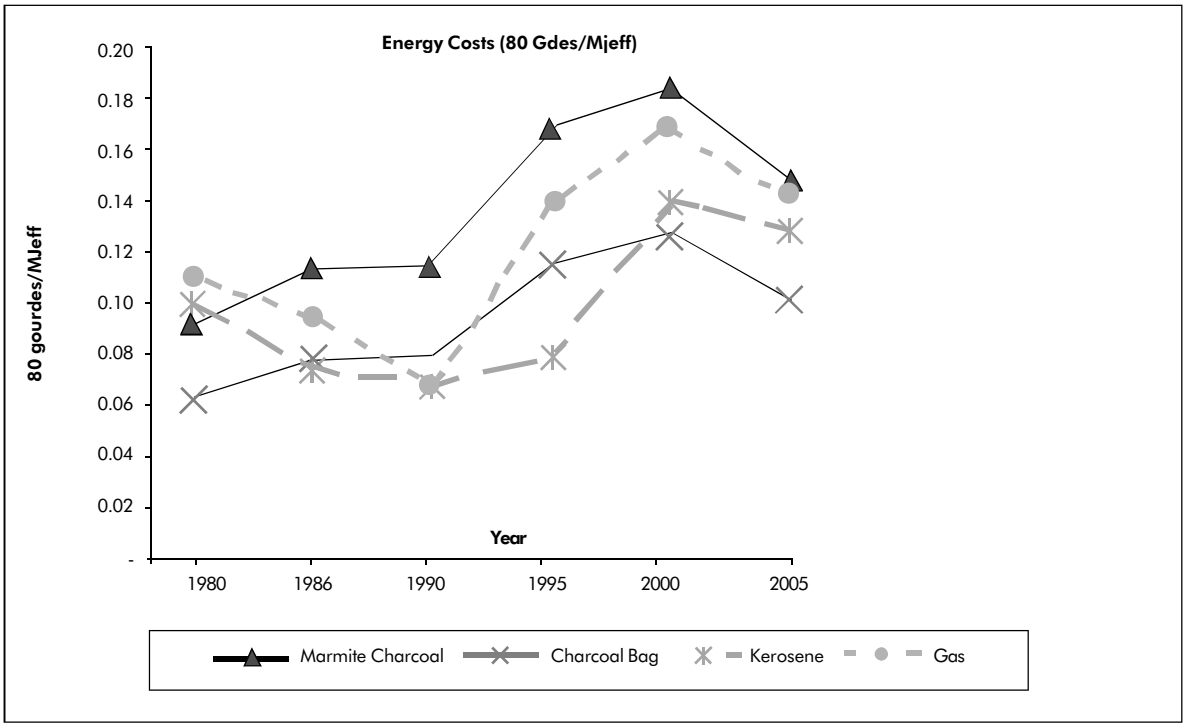
All women interviewed during the survey consider that fuels are expensive. Over recent years, prices have increased substantially, and this rise is probably related with the general high cost of living, the rise in fuel prices and the State's inaction. In terms of cost-effectiveness and fuels' durability, kerosene comes up as the cheapest fuel. Pricewise, charcoal and propane are practically the same.

[4] *This is the quantity which the poorest households buy; and it is often sold in prepacked heaps or piles. Wealthier households buy charcoal in bags.*

Charcoal purchased in *marmites* is the costliest energy. It is also used by the majority of households; this observation is valid for all countries, poor households pay a higher price for energy than rich households. If poor households were in a position to buy charcoal in bags instead of in *marmite*, they could reduce their energy expenditure by almost half. However, their daily income does not allow them to accumulate the required sum to buy a whole bag.

In Figure 3.1, the lower curves indicate fuels costs, corrected in function of inflation. We may note (i) that the cost of cooking with charcoal in bags is the lowest; the cost of using charcoal in *marmites* is higher; and (ii) kerosene and LPG are slightly more expensive. It is normal that LPG and kerosene are slightly more expensive than charcoal, in view of the latter's lesser efficiency and comfort. However, kerosene cooking was cheaper between 1995 and 2004. We further note that charcoal cooking cost has increased since the 80s (in constant 1980 terms), except during the recent past years, and that it rose even more than oil products.

Figure 3.1: Costs of Cooking Fuels (1980 gourdes)



Sources: ESMAP and BME.

Electricity Sector

Although it is important in terms of public investment and national petroleum consumption (about 20 percent per year), the electricity sector only represents 2.6 percent of the national

energy balance. In fact, it represents one of the main factors hampering economic and social development in Haiti, given the following elements: poor performance (over 50 percent of nontechnical losses are due to fraud, nonpayment and illegal connections), low coverage rate (less than 10 percent of households)[5] and low installed capacity (an average 30 Watts (W) per inhabitant, versus 346 W per inhabitant in the Caribbean region).

Electricity does not provide solutions against deforestation; very few persons use electric power for cooking, and there is no indication that this could change soon. For this reason, the electricity sector is not incorporated in the strategy for household energy, which focuses on cooking fuels.

Industrial Sector

The industrial sector's share in the country's overall energy consumption is 15 to 20 percent. In 1989, it contributed 14.77 percent to the Gross Domestic Product (GDP); one must however note that the State subsidizes electric power, which mainly benefits the industry. Given the crucial role energy plays in the sector's functioning, it is imperative to maintain and increase energy supply to prevent any disruption.

The traditional industry consumes some 160,000 to 200,000 tons of firewood every year.[6] But use of wood generates problems, as it takes place without renewing the resource. Neither consumers nor relevant institutions have given a thought to the need to establish a program for rational firewood production, to help compensate for the large volumes collected and used each year. For this reason, firewood used by industry represents one of the causes of deforestation in Haiti (Moran *et al*., 1989).

Transportation Sector

Several factors generate an ever-increasing energy demand (around 60 percent of the total volume of imported oil products) in the transportation sector, and must, therefore, be controlled. This demand not only emanates from the number of motorized vehicles, estimated to be over 100,000, all categories included. For a great part, the demand results from lack of control of motorized vehicles, roads' poor conditions, huge traffic jams in towns, as well as inefficient traffic control in urban centers.

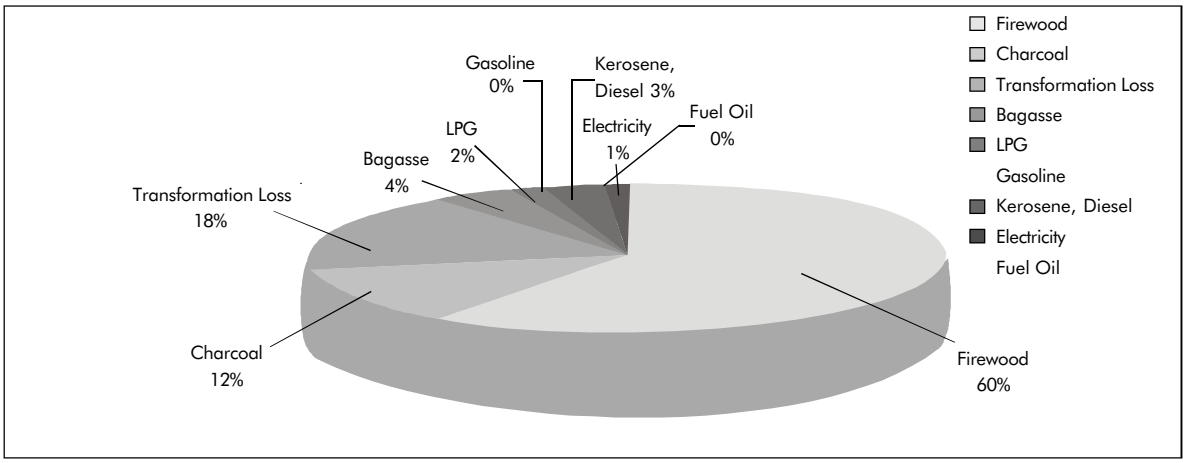
[5] The average power consumption in Haiti is 32.70 Kilo Watt (s) Per Hour (kWh)/inhabitant, which is clearly lower than the Caribbean region's average of 1,180 kWh/inhabitant (SIEE/OLADE, 1994).

[6] In 1985, a total of 473 guildives and mill-guildives were counted, principally in the south-west peninsula. Some of them use bagasse as fuel, the more modern ones use diesel; but most of them use thick wood. Such is the case with 31 essential oil workshops (vétiver, lime, bois chandelle, etc.), where more than half use firewood for extracting oils (ESMAP, 1991).

4. Energy Sources

Haiti's estimated household energy consumption is: biomass 79 percent, oil 17.6 percent, electricity 2.6 percent and LPG 0.6 percent (Figure 4.1).

Figure 4.1: National Household Energy Consumption (%) 2003



Source: BME.

In the capital, Port-au-Prince, the charcoal market's value is between US$110 and US$150 million; the figures for kerosene and LPG at national level are US$120 million and US$15 million respectively. Some 30 percent of the charcoal market's value are redistributed in the rural areas, and, therefore, represent a nonnegligible source of income.

Firewood

In order to cover woodfuel needs, Haitian peasants fell some 30 million trees each year to satisfy a consumption amounting to about 3.4 to 3.7 tons of firewood (750-1,600 Thousand Tons of Oil Equivalent[ktoe], in 1995). In 2003, this consumption probably passed the level of 4 million tons of wood, 33 percent of which are transformed into charcoal. Wood is

consumed in rural areas, where a large part is gathered by the households as dead wood, small wood, twigs, etc.[7] In order to satisfy the urban demand for firewood, the population generally uses green wood, which implies the cutting of live trees; a commercial chain handles the distribution of firewood. Although wood consumption is higher than charcoal consumption, the latter is considered to have more negative impact due to its economic importance and its effect on forest resources, as it is produced from live wood harvested for this purpose.

Charcoal

Consumption Level

It should be noted that the observations made on household consumption per unit date back to 1990 and 1998, at which time the BME carried out several surveys. To verify such trends, the Ministry of Environment and ESMAP (2005) jointly conducted complementary surveys which show that consumption not only did not slow down but probably increased.

In May 2005, the Environment Ministry carried out a flux survey during one week in Port-au-Prince. The methodology was simple, and consisted of posting a certain number of investigators over a seven-day period in some key spots[8] around the town to assess the arrivals: number of bags, transportation means used, source of charcoal. Additionally, observations in three strategic locations monitored the charcoal traffic during night hours.[9]

It should also be noted that the observed charcoal flows only concern Port-au-Prince and that the brief observation period permitted by the logistical and financial constraints is far from being sufficient to allow making projections on one-month or one-year scale. The figures put forward represent orders of magnitude which ought to be treated with prudence. The total volume of deliveries in Port-au-Prince during that week was 5,300 tons of charcoal, of which some 20 percent entered by night. More than 85 percent were 45-50 kg "large bags" and the rest were 35 kg bags and smaller bags of less than 20 kg. A summary of the results is shown in Table 4.1.

[7] *Energy balance in 2003.*
[8] *Carrefour Shada (northern entrance), Rond Point de la Croix des Bouquets Police Station for charcoal coming from the Plateau Central and from the border zone. Gressier (southern entrance), Cité Soleil wharf, Jérémy wharf, La Rochelle wharf, Mariani wharf, the Croix des Bouquets market.*
[9] *Carrefour Shada, Croix des Bouquets and Gressier.*

Table 4.1: Quantities of Charcoal Observed in Port-au-Prince during One Week

Bag (Size)	*Large*	*Medium*	*Small*	*t/Week*	
Night-time					
Shada	13,890		200		
Crx Bouquets	1,340	2,970	3,810		
Gressier	5,321	82	1,423		
Total Tons	**20,551 925**	**3,052 107**	**5,433 109**	**1,140**	**22%**
Daytime					
Shada	13,948	47			
Rp Crx Bouquets	16,060	3,275	1,663		
Marché Crx Bouquets	8,608	895			
Gressier	13,604	2,031	348		
Wharf jeremie	21,579		5,487		
Wharf cite soleil					
Wharf rochelle	4,560	1,185	1,440		
Wharf tuff	2,566		3,920		
Total Tons	**80,925 3,642**	**7,433 260**	**12,858 257**	**4,159**	**78%**
Grand Total	**4,567 86%**	**367 7%**	**366 7%**	**5,299**	

Sources: Haitian Environment Ministry and ESMAP.

If the doubts regarding the reliability of the investigation's results concerning the observed fluxes through the six main accesses over one week (observation in wharf Cité du Soleil had to be abandoned due to insurmountable security problems) can be put aside, and if the found volume is multiplied by 52 in order to estimate the annual consumption of Port-au-Prince, we obtain a volume of 300,000 tons/year. Although this figure is higher than expected, it may well be correct: it reflects a consumption of 0.4 kg/day/person for 100 percent of the current population in Port-au-Prince. If one assumes that charcoal demand grows proportionally with the urban population in Haiti, the level of national demand for charcoal would have been some 370,000 tons or 390,000 tons in 2004.

Yet, the figures produced by this survey cannot easily be extrapolated; they confirm that charcoal continues to be the first choice of fuel in urban areas. The last reliable consumption numbers date back to 1993 and are shown in Table 4.2. The charcoal's share in the total consumption (as wood used for producing charcoal) has grown substantially, not only as a result of the considerable current increase in charcoal consumption, but also because the carbonization return is lower than the estimates made in the past.[10]

Table 4.2: Firewood Consumption Estimates, 1993

Consumption Sectors	*Quantity (tons)*	*(In Thousands) (cubic meters)*	*%*	*Origin*
Firewood	**2,655.0**	**3,865.0**	**65.5**	
• Households				
– Rural	2,250.0	3,275.0		Dead Wood, Twigs,
– Urban	68.0	100.0		Greenwood
• Bakeries, Dry-cleanings Lime Ovens	103.0	150.0		Felling, Trimming, Large Trees,
• Rural Industries (Mills, Guildives, Essential Oils)	234.0	340.0		Fruit Trees
Charcoal	**1,400.0**	**2,038.0**	**34.5**	Greenwood from
• Urban Households	1,150.0	1,674.0		clean-up operations
• Informal Sector, Others	250.0	364.0		fallowing or fragile ecosystems, mangroves
Total	**4,055.0**	**5,903.0**	**100.0**	

Use of charcoal: 0.42 kg/person/day (Matly, Medina 1990) Use of firewood: 1.5 kg/person/day. Informal sector (ESMAP/BME 1991) Bakeries and "Dry-cleanings" (Grosenick, Kooi).

Charcoal Production

Where does charcoal come from, or, more precisely, where are trees located that are cut down to produce all that charcoal? The forest cover is in constant reduction and hardly represents 1 to 2 percent of the national territory; no doubt, the remaining forests supply part of the charcoal, but to a much smaller degree. As a theoretical estimate, with the presently available data on forestry resources (covered in the next chapter), the volume of charcoal which could be produced in a sustainable manner is around 70,000 tons/year, or less than one-quarter of the overall consumption.[11]

[10] *Fifteen percent output is not realistic; a 10 percent to 12 percent output is more likely to be correct, in view of the type of charcoal producers, the species of wood used and the procedures followed.*

[11] *With 37,000,000 cubic meters of living wood and a 2 percent annual growth rate, it would be possible to produce 474,000 tons of wood, or 71,000 tons of charcoal, provided wood is not transformed into other products.*

The complementary surveys[12] specifically sought to answer the question of the charcoal origin. In short, there are several sources of supply:

- Part comes from forests and contributes substantially to deforestation;
- Part is made of trees cut and sold by peasants to be used as construction wood, as well as cut wood to be transformed into charcoal; selling wood is an economic activity and as long as it represents a viable income, peasants will continue doing it;
- Part comes from discarded portions of fast growing species found in several areas of Haiti, such as the "Bayahonda" (*Prosopis*), resistant to drought, poor soils, frequent cuts, etc., whose hard wood is very suitable for charcoal production. Despite too frequent cuts (every two years), this production mode might well continue; and
- Part comes from the Dominican Republic.[13]

Charcoal is nowadays produced all over the country. The main production areas apparently are Grande-Anse, Belle-Anse, Aquin, the south coast, the Plateau Central, the north-west region. In the Plateau Central, the main communes are: Maïssade, Thomonde, Thomassique, Pignon, Cerca-Cavajal, Hinche, Mirebalais, Boucan Carré, Saut d'Eau and Lascahobas.

Some "professional charcoal producers" work exclusively in charcoal production and sale. They spend all their time looking for raw material, filling their ovens and burning, and in transporting and selling charcoal. There are some 30 charcoal producers, in the three communal sections near Maïssade, a small town. In rural areas, all are occasional charcoal producers: the rural producer becomes a coalman, whenever he has enough wood to fill an oven or whenever emergencies or economic constraints force him to do so.

Charcoal producers are generally not organized. Their working relationship is based more within the family or with friends. They frequently agree to transport their merchandise to Port-au-Prince together. Problems may arise when they want to buy a tree or a "rac" (piece of land with dry soils covered with various tree species, near Maïssade). Severe conflicts may arise when some charcoal producers offer, unbeknown to others, a higher purchase for a tree or for a stock of wood.

[12] *Complementary surveys were conducted in the high plateau: three axes from the Southern peninsula: Jacmel-Belle-Anse; Aquin-Cotes de Fer; Jérémie-Corail-Pestel; and in the Malpasse-Fonds Parisien axis to assess cross-border fluxes.*

[13] *Lake and the mountain slopes between Haiti and the Dominican Republic are the main crossing points for Haitians trying to enter clandestinely from the Jimani area into the Dominican Republic. The same circuits are also used by charcoal producers and traders to transport charcoal produced in the Jimani area, namely in Bocachon, Lobotar, Lemorne and Narac. Each year, some 50,000 tons of charcoal transit through Malpasse-Fonds Parisien axis to enter Port-au-Prince.*

Raw material costs may vary greatly, according to the type of wood. People buy stocks ready to be carbonized, or pay for the rights to exploit land covered with trees, bushes or even lianas, and parts of trees discarded in the fabrication of planks and beams.

In the Plateau Central, exploiting *racs* or *bouquets* has become a habit. Charcoal producers pay rac owners a given sum of money to get the right to clear a plot of land. This amount varies according to the surface of the plot, as well as the density and importance of the trees it contains. The sum is paid in exchange of the right to exploit all woodfuel resources. In such cases, there is no selection, and the entire standing stock is cut.

As cutting is not selective, sparing neither young trees nor bushes, one can find many plots in the Plateau Central where the vegetation has literally been razed. Regrowth possibilities for bushes and lianas are scarce, and practically nil for many trees.

According to several conversations held with local experts, both *racs* exploitation and nonselective cutting prevail throughout the country.

The species most frequently used for charcoal production are: Bayahonde, Candelon, Tchatcha, Madeleine, Gommier, and increasingly Mahogany and Mangrove.

Observed Quantities

The complementary surveys registered the following quantities (data extrapolated on a one-year basis, without distinction by bag size – Table 4.3).

The supply coming from all visited areas could cover almost 50 percent of the demand. As the surveys did not aim at providing quantitative data, their results are of no assistance to better understand the charcoal chain. The results show that charcoal is produced all over Haiti; the greater part comes from peasants' fields, from trees growing outside forests, and from the Dominican Republic. Part of this supply is or might be sustainable, especially the one coming from peasants' plots and from species producing high amounts of residue. What would an acceptable exploitation volume be? No answer can be provided in the absence of a more in-depth study.

Table 4.3: Results of Complementary Surveys

Origin	*Bags/Year*	*Tons/Year*
DR	182,500	5,475
Plateau Central	137,037	74,000
Jeremie	20,000	10,800
Corrail	36,800	19,872
Pestel	24,000	12,960
Bonbon	9,600	5,184
Cote fer, aquin	14,000	7,560
Jacmel, b.anse	10,000	5,400
Total	**433,937**	**141,251**

Charcoal's Economic Contribution

Charcoal is generally commercialized in the local markets, although most of the production is sold off on the Port-au-Prince market. According to estimates, over 80 percent of the charcoal produced in Haiti is consumed in the capital.

Professional charcoal producers produce charcoal in their own mud ovens, extract the charcoal, and generally package it in large bags they sell on-the-spot directly to wholesalers, or transport it to Port-au-Prince where they sell it. They often buy and gather charcoal occasionally produced by peasants or less important charcoal producers, who cannot transport it themselves. Professional charcoal producers thus sell goods they did not produce, with substantial profit margins in Port-au-Prince. The technical yield is low, rarely higher than 10-15 percent.

Most charcoal producers use traditional grindstones, which only produce 10-15 kg of charcoal per 100 kg of (dry) wood. This represents a loss of resources: households using firewood for cooking use fewer trees than those using charcoal. If he used an improved grindstone, a coalman could almost double his production, and, therefore, his income.

In Maïssade, charcoal producers sell charcoal in 10 bags portions, at 1,000 gourdes/portion, that is, 100 gourdes/bag, for which consumers pay 400 gourdes in Port-au-Prince. The transportation cost for 10 bags portion is 500 gourdes (50 gourdes/bag), from any production area in the Plateau Central, to which 50 gourdes must be added for handling charges, so that the total cost of forwarding 10 charcoal bags portion to Port-au-Prince is 550 gourdes.

The main parties intervening in this chain are:

- Producers: professional or occasional charcoal producers;
- Speculators: at the local or regional level, who gather the product on-the-spot and resell it in the department markets;
- Port-au-Prince wholesalers: buyers coming from the capital, commercially related with speculators or local gatherers, who organize transportation from the regrouping areas to Port-au-Prince, where they sell the charcoal to other wholesalers or retailers;
- Truck drivers, who carry out the charcoal transportation up to the capital and main towns; and
- Retailers, who sell the charcoal to consumers in the urban districts.

The retailer's margin on 10 charcoal bag lots apparently is far more important than the one made by other operators. In fact, retailers generally buy about 10 bags, and then resell by bags or by marmites, at a relatively slow pace. Whereas wholesalers handle tens of 10 bags lots they quickly resell in Port-au-Prince, and multiply the frequency of such operations, so that their actual commercial margins on their entire stock become very important, justifying their frequent trips, as well as the risks incurred during transportation. This is precisely what motivates professional charcoal producers to gradually withdraw from production and ever more frequently reconvert into wholesalers, to collect charcoal from small charcoal producers or occasional producers, transport and commercialize it in Port-au-Prince; given that the producer's margin is equally fairly high, charcoal production is a very important economic activity in rural areas.

As a great part of rural area inhabitants work in the charcoal chain, this product's contribution to the rural economy is important. As shown in Table 4.4, about 20 percent of the selling price remains in the rural economy, which amounts, for a 370 Thousand Ton (kT)/year production, to some 656,000,000 gourdes (equivalent to US$16 million).

Table 4.4: Charcoal's Price Structure

Production Component	*Cost (gourdes/10 bags)*	*% of Total*
Raw Material's Cost	200	5%
Felling Charges	70	2%
Charcoal Production-related Expenditure (four hrs/day)	140	4%
Bagging + Bags Cost	100	3%
Producer's Margin	490	12%
Production Cost	**1,000**	**25%**

Production Component	*Cost (gourdes/10 bags)*	*% of Total*
(Wholesaler's Purchase Price)		
Gathering Charges	50	1%
Transportation Costs	500	13%
Handling	50	1%
Wholesaler's Margin	400	10%
Wholesale Price in Port-au-Prince	**2,000**	**50%**
(Retailer's Purchase Price)		
Storage Charges	250	6%
Handling	200	5%
Retailer's Margin	1,550	39%
Consumer's Price	**4,000**	**100%**

Source: Complementary Surveys/ESMAP.

Charcoal's Economic Costs

As shown in Table 4.2, for every charcoal bag, there is a contribution for wood – the raw material – of 20 gourdes per bag. This is almost equal to US$1.7 per ton of wood, which does not clearly reflect the wood's current value. Wood production costs are some US$20 to US$30 per ton, depending on the species and plantation-type. For living trees, one should add between US$20 to US$30 per ton of wood to the charcoal price structure, which brings the price per large bag between 600 and 780 gourdes. At that price, charcoal would no longer be affordable for the majority of households.

Bagasse

Since modern sugar mills disappeared, bagasse consumption has greatly dropped in Haiti. However, this local energy resource has a very high potential. It is estimated that about 140,000 tons of bagasse are available in the mills and guildives[14] every year.

[14] *A 1985 census indicated there were 461 mills and guildives spread all over the national territory. Before the sugar mills closed down, sugarcane production, which varies each year between 1.3 and 2.0 millions tons depending on the harvest, was utilized as follows: 40 percent by sugarcane mills, 50 percent by mills-guildives and 10 percent directly consumed by man (canne de bouche). Bagasse constitutes 30 percent of the ground sugarcane's weight.*

Small sugar mills producing syrup use bagasse exclusively, whereas most small distilleries or guildives, producing "agricultural alcohol" or clairin from syrup, use firewood as fuel, and some of them have by now converted to other types of fuel. The energy potential of the bagasse Haitian distilleries produce oscillates between 37,000 and 56,000 Ton Equivalent of Oil (toe).

As part of the complementary surveys, visits were conducted to two mills in May 2005, to assess bagasse's potential as substitution product. Both mills have a production capacity of 1,000-1,500 drums of *clairin* per year. Each of them consumes between 20 and 30 bagasse trucks, 40 percent of which is destined for energy use. Therefore, each mill could produce every year 65 tons of briquettes (carbonized and compressed bagasse), or up to 30,000 tons had the number of small mills not increased when the large sugar mills closed down.

Hydro Energy

Electricity production from hydraulic resources began in 1971, when the Péligre Hydroelectric Plant entered in service, with a 47.1 Mega Watt (s) (10^6 Watt) (MW) installed capacity. This plant ordinarily produces 220 to 320 Giga Watt (s) Per Hour (GWh), depending on the Artibonite river's flow. Later on, Electricity of Haiti (Électricité d' Haïti) (EdH) elaborated and implemented a development program for mini plants, with a total of 7-8 MW capacity, distributed in seven sites, all located in the province. Those are small plants with an installed capacity ranging from 0.30 MW to 2.25 MW (see Table 4.2 for details).

This developed hydroelectric potential has rendered an important service to the Haitian community as it became operational, particularly in the difficult moments when EdH experienced oil fuel supply problems.

In 1973, hydroelectric energy met more than 94 percent of the national electricity supply. Over the years, this proportion has decreased and now represents 40 percent of the supply. Forecasts for the next coming years reflect this decreasing trend.

It is evident that electricity will not be the only answer to solve wood shortage issues. In view of the current problems in the electricity sector, this energy source is not included within the potential solutions.

Oil Products

Oil products importation is constantly on the rise; from 13 percent of the national energy balance in 1973 (969,000 Barrels [bbl]), to 20 percent in 1995 (2,006,312 [bbl]); in 1990,

a record 2.6 million bbl was reached. This increase in the energy demand, which may reach 150 percent in given years, has no repercussions on the Haitian economy. Between 1986 and 1989, the economic growth was negative, while the overall energy consumption grew by almost 8 percent. In 2003, imports amounted to 518 ktoe, that is, more than 4 million bbl.

The rise in oil products consumption is for a great part due to the increased demand from transportation and industry sectors. The former is responsible for 60 percent of the increase in oil fuels. The household energy sector accounts for some 8 percent only. Additionally, 30 to 50 percent of the country's foreign currency is spent each year on exports, in order to cover the oil products imports. For modern industry, self-generation with generators is now an indispensable tool, given EdH's service level.

As an alternative in case of unavailability of charcoal in the market, kerosene might be considered as a substitute. If the overall charcoal consumption was entirely substituted by kerosene, the quantity of kerosene required would double the present consumption level, and would account for an 8 percent increase in the total oil product consumption.

5. Potential Energy Resources and Perspectives

It is difficult to count on local energy resources to improve the supply and demand energy balance in Haiti. The existing resources cannot be used in their present form, or they are too scattered and their gathering too expensive, to ensure a real and less costly contribution to the charcoal problem. The present chapter reviews the potential of local resources.

Turning to account the high potential of renewable sources of energy, principally solar and wind, different types of waste, either in their present form (vegetable waste such as bagasse) or in biogas form (animal waste and urban garbage), it is possible to change Haiti's current energy practice. Unfortunately, no effort has been made to date to promote the development of such abundantly available resources.

Potential Forest Resources

The volumes of firewood annually gathered exceed the trees' natural regeneration capability. This phenomenon causes a deficit reflected in the vegetation cover's progressive decrease, which went from 60 percent in 1923 to 18 percent in 1952 and 1.44 percent in 1989. (Source: Environmental Country Monitoring Unit (ECMU)/United Nation's Development Programme (UNDP 1996). The present vegetation cover is estimated to be 1-2 percent.

Table 5.1: Haiti's Woodfuel Resources Evaluation in 1989

Occupational Category[1]	*Estimated Surface (in 1,000 ha)*	*Standing Trees (in 1,000 m^3)*
Leafy Tree Forests	144.0	7,800.0
Pine Forests	68.0	2,320.0
Sylvan/Pasture Formations	290.0	5,155.0

[1] *In the different areas, productivity in Cubic Meters Per Hectare (s) (m^3/ha) oscillates between 1 and 25. For example, it is 6 m^3/ha for herbaceous cultures, 16 m^3/ha for clear wooded cultures, 30 m^3/ha for dense wooded cultures and 150 m^3/ha for dense leafy tree and pine forests. In very clear pine forests, it may drop to 13 m^3/ha.*

Occupational Category[1]	*Estimated Surface (in 1,000 ha)*	*Standing Trees (in 1,000 m³)*
Mangroves	15.0	525.0
Dense Wooded Cultures	170.0	5,100.0
Clear Wooded Cultures	400.0	6,400.0
Others (Herbaceous Cultures, etc.)	1,683.0	10,093.0
Total	**2,770.0**	**37,393.0**

[1] *In the different areas, productivity in cubic meters per Hectare (ha) oscillates between 1 and 25. For example, it is 6 m³/ha for herbaceous cultures, 16 m³/ha for clear wooded cultures, 30 m³/ha for dense wooded cultures and 150 m³/ha for dense leafy tree and pine forests. In very clear pine forests, it may drop to 13 m³/ha.*

Source: Association Internationale de Développement. Gestion des Ressources Naturelles en vue d'un Développement Durable en Haiti. No.1786-HA Ministère de l'Économie et des Finances. BDPA/SCET AGRI. 1989, 2 Vol.

Statistics at hand reveal a fairly pessimistic situation: Table 5.2 shows that Haiti lost 44 percent of its forests between 1990 and 2000. According to Earth Trends, the overall productivity of forests in Haiti is estimated to be 6.3 million cubic meters for energy purposes. As indicated before, these figures ought to be used with great prudence, as long as an in-depth survey has not been carried out.

Table 5.2: Forest Statistics

Forest Area and Change	*Haiti*	*Central America & Caribbean*	*World*
Total Forest Area, 2,000 (000 ha)	88	78,737	3,869,455
Natural Forest Area, 2,000 (000 ha)	68	76,556	3,682,722
Plantations Area, 2,000 (000 ha)	20	1,295	186,733
Total Dry Land Area, 1950-1981 (000 ha) {a}	70	138,063	5,059,984
Change in Forest Area:	- 44%		
Total, 1990-2000	- 53%	-11%	-2%
Natural, 1990-2000	5%	-11%	-4%
Plantations, 1990-2000		0%	3%
Original Forest {b} as a percent of Total Land Area {c} Forest Area in 2000 as a percent of Total Land Area {c}	93% 3%	67% 29%	48% 29%

Forest Area and Change	*Haiti*	*Central America & Caribbean*	*World*
Forest Area by Crown Cover (000 ha), 2000 *Note:* Crown cover data are gathered using different methodologies than the forest area calculated above. The two estimates may differ substantially.			
Area of Forest with Crown Cover:			
Greater than 10%	2,251	175,478	6,537,209
Greater than 25%	1,196	134,045	4,84,071
Greater than 50%	225	72,537	3,143,720
Greater than 75%	85	38,012	1,945,916
Ecosystem Areas by Type			
Total Land Area	2,775	271,325	13,328,979
Percent of Total Land Area Covered by:			
Forests	12%	34%	24%
Shrub Lands, Savanna and Grasslands	29%	41%	37%
Crop Land and Crop/Natural Vegetation Mosaic	42%	22%	20%
Urban and Built-up areas	0.1%	0.1%	0.2%
Sparse or Barren Vegetation Snow and Ice	0%	1%	16%
Wetlands and Water Bodies	16%	3%	3%

Source: Earth Trends.

The estimated 37.4 million m^3 total reserves for 1989 represent six years of production, given the country's global wood demand at the time (firewood and timber). The fear of an accumulated deficit in the country's wood production has been often expressed during the past decades. However, although 18 years have passed, we do not register any slowing down of energy wood supply.

Chapter 4 (under the heading "Charcoal") provides a partial explanation: today, charcoal producers resort to individual trees which can grow relatively fast. In other words, part of the charcoal supply presently comes from woodfuel resources located outside of the forests. As no one knows the sensitivity of such a production system, it is impossible to assess its durability prospects.

Potential in Other Resources from Biomass[15]

In Haiti, one may find several types of biomass residues from coffee, cotton, grains and essential oils extraction. Such types of waste could be used for energy purposes; however, due to their wide dispersion, they cannot easily be used in the locations where they are generated. Additionally, specific techniques are required for each of them, according to their specific characteristics. Farm waste (dung produced by hen, cows, pigs, kids, equines, etc.,) as well as domestic garbage[16] can easily be transformed into ready-to-use biogas. But the gathering issue needs to be solved, principally concerning the urban waste and the open air rearing waste. Moreover, the cost-effectiveness question remains: is biogas cheaper[17] than the presently used energy source?

Agro-industrial and agricultural waste or residues are another type of potential local energy. Table 5.3 lists some agricultural products generating great amounts of waste.[18] Bagasse, a residue produced by sugar mills, is available in great quantities, although its use is currently increasing. The existing waste could be transformed into briquettes, to replace firewood or charcoal. If statistics are correct, the (theoretical) maximum production of carbonized bagasse briquettes might reach 80,000 tons/year, which is equivalent to one-fourth of the current charcoal consumption. Agricultural waste generated by Haitian farms could be converted into biogas (methane gas). Not only does biogas have the advantage of being a modern energy source (methane), but it can be used as manure to increase agricultural productivity. At the farm level, a disadvantage of briquettes is that they cause the disappearance of residues used by peasants to enrich their soils, much needed in Haiti.

Table 5.3: Production of Selected Agricultural Products

Haiti Production (Mt)	*Year*				
	2000	*2001*	*2002*	*2003*	*2004*
Coconuts	27,000	24,000	25,000	25,500	25,500
Coffee, Green	30,000	28,000	28,500	29,000	29,000
Groundnuts in Shell	21,000	21,000	21,500	22,000	22,000
Rice, Paddy	130,000	103,000	104,000	105,000	105,000
Seed Cotton	1,500	1,200	1,500	1,500	1,500

Source: Food and Agriculture Organization (FAO).

[15] *Energy wood and bagasse belong to the bio energy resources category; however, given their importance in the energy balance, they are treated separately here.*
[16] *Taking into account the organic matter percentage in domestic waste, as well as the amounts generated, it could be used to produce annually 35,688 tons equivalent petrol in the form of biogas.*
[17] *Large scale use of biogas is not likely, in view of the elevated costs implied: at the household level the cost of a biogas system is some US$1,000.*
[18] *According to the type of product, between 20 and 40 percent of the main product is available as residue.*

Hydro Energy Potential

Haiti's total energy potential of nondeveloped hydroelectric sites is estimated to be 153.58 MW.[19] Of this total, 85 percent (130.7 MW) correspond to four large plants between 22 and 45 MW, the remaining 15 percent (22.58 MW) corresponding to 27 small plants between 0.10 and 2.57 MW, with falling heights of 2.1 to 111.0 meters. Those are small or mini plants which can use the two types of turbines most frequently used worldwide: action turbines and reaction turbines.

At this stage, electricity does not provide a solution to the firewood and charcoal problem.

Coal Potential

There is a lignite deposit in Maïssade. It is a low quality one, with proven reserves of about 13,000,000 tons.[20] The reason for its low quality is due to a high humidity rate, and its high content in sulfur and ashes: its calorific power only reaches 10-12 Mega Joule (MJ) per kg, which is inferior to wood's calorific power (15-16 MJ/kg). Other lignite deposits exist in Azile and Camp Perrin, but the potential reserves are unknown; in compensation, they have a better quality than the Maïssade deposit, due to low sulfur and ashes content.

In 1986, some surveys and a technical and financial feasibility study were jointly carried out by the Research Center on Energy and Environment *(Centre de Recherche sur l'Energie et l'Environnement)* of North Dakota University (UNDEERC), the Oak Ridge National Laboratory (ORNL), the US Energy Department and United States Agency for International Development (USAID), with the Bureau des Mines et de l'Energie's participation. They showed that, at that time, out of 77,500 tons of lignite from Maïssade at 5,200 British Thermal Unit (BTU)/lb, it was possible to produce 50,000 tons of charcoal briquettes per year, as well generate 8.7 MW of power (that is, 63 GWh/year). The conclusion was that some open questions remain concerning the resource's exact quantity and quality, as well as what kind of lignite transformation technology would be acceptable for the population. Given the low profitability rate at the time, it was decided to import good quality coal. An answer to these questions is usually ignored

[19] This total amount includes the 45 MW Dos Bocas binational dam could provide to the Haitian government, with a 90 MW total capacity.

[20] In 1977, Sofrelec-Sofremines had defined a 590 ha exploitable area containing 13.4 million tons of lignite. In 1982, a more punctual and detailed study made by BGR (Germany) defined a 221 ha exploitable area containing 6.13 million tons (B. Bourgueil, in reference 16).

these days, but it is important to note that, at present, the cost of imported mineral coal is much lower than in 1986, and that the cost of charcoal (in large bags) has risen from 18 gourdes in 1986 to 400 gourdes in 2005.

Potential in Other Durable Energy Sources

Solar energy has traditionally been used in Haiti in a direct form, for drying laundry, or agricultural and fishing products. It started being used for generating power only recently. This trend has amplified since the embargo period, with a massive importation of photovoltaic (PV) modules, principally for the domestic sector, to compensate for longlasting brownouts in the grid system. Located just north of the Equator line (20° latitude), Haiti benefits from a good insulation regime throughout the year (five to six hour/day).

Wind energy potential in Haiti is essentially concentrated in the north-west, mainly on the northern slope of Île de la Tortue, where the average wind speed is 5-7 meters per second, which would allow the use of wind generators for power generation, and for pumping underground water.

These types of energy will, however, not represent a solution to Haiti's wood and charcoal problem.

6. Energy and Environment

Local Environment

Haiti's rural environment is in a process of accelerated degradation, the most immediate results being deforestation and erosion. The substantial direct impact is reflected in a decrease in the agricultural productivity, deteriorating health conditions and a greater impact of natural disasters. The level of agricultural production is very low when compared with the populations' accelerated growth rate. The felling of trees and land clearing in marginal plots carried out by the local population has stripped 25 out of 30 catchment basins of vegetation, and soils are now heavily affected by erosion.[21] As Haiti is a mountainous land, with two-third of rural areas containing slopes of more than 20 percent, the very serious erosion results in an estimated annual loss of soil of 3 cm. As a consequence, agricultural productivity dropped by 0.5-1.2 percent annually during the last 10 years. There are various reasons for such an environmental deterioration, namely unsuitable and environmentally detrimental exploitation techniques used by peasants, lack of education, demographic pressure, use of firewood as a main source of energy, a complex land tenure system which is not favorable to soil conservation or tree planting, institutional inefficiency and the absence of investment promotion policies in rural areas.

Traditional energy practices have a particular impact on the environment. Some effects are immediate and are already visible; others will become visible in the middle and long terms. Deforestation figures are alarming and clearly reflect the woodfuel crisis. The country's overall forest cover has decreased by 37 percent between 1956 and 1978, and at present is estimated to represent a mere 1.44 percent of the national territory (27,500 Square Kilometer (s) [km^2]). The intense deforestation accelerates the slopes' erosion and derives from the necessity to satisfy the energy and food needs of an ever more numerous population. *"Forests play a decisive role in protecting the environment, principally in tropical countries*

[21] *The World Bank, Etude Sectorielle Rurale (in draft stage): Développement local et gestion des bassins versants.*

with fragile ecosystems, where they should represent 50 to 60 percent of space occupancy. As Haiti is a mountainous country presenting the referred characteristics, its natural forests of pine and broadleaf trees are mere relics, hardly covering 1.4 percent of the territory."[22]

According to some calculations, the total soil loss is estimated to be 36.6 million tons, that is, 1,353 tons/km²/year. This corresponds to 2,000 ha of eroded soils over a 1.2 m layer of soil.[23] *Based on an evaluation of the agricultural production on 1 km² of cultivation in 33 plots located in different areas, and considering their distribution per type of slope, it has been possible to quantify the annual soil loss due to erosion in the agricultural land by planning area, as US$2,350,000 (BDPA-SCETAGRI, October 1990, page 57),* that is, a total of US$77.55 million. These are fairly conservative figures, given the difficulty to find detailed statistical data to reduce the margin of error.

Despite abundant legislation on the protection of forest resources and environment,[24] the official policy on woody resources management is not sufficiently clear. Several efforts have been developed, principally by international institutions and Non Governmental Organizations (NGOs) to palliate this situation. But the lack of official guidelines rendered such efforts fruitless, and even inoperative.

The explanation of failures in environment rehabilitation should be sought in Haitian culture itself. People deforest out of ignorance, to generate energy, to increase the agricultural surface, to supply construction requirements, and, finally, for military and political reasons.[25]

Global Environment

All systems for producing, transforming and using energy produce negative consequences on the local and world environment. Biomass and fossil fuels, which are the basis of Haiti's energy structure, have various repercussions on the environment, according to the volume and the methods used in the different stages of the process. Frequently, the inefficient methods for transforming biomass do not permit a sustainable exploitation and, therefore, contribute to the emission problem. Systematic felling of trees, and reclaiming of wooded areas to

[22] *According to studies carried out by the Haitian Agriculture Ministry, the Macaya Peak was covered by 6,250 ha of virgin forest only 30 years ago. In 1977, only 750 ha were left and in 1985, the total forest cover had shrunk to 225 ha. Thus, in three decades, one of the principal Haitian forests had been almost destroyed. These studies further revealed that Grande-Anse had replaced the north-west region as the principal charcoal production area.*

[23] *Environnement et Développement MPCE, August 1991, page 83.*

[24] *More than a hundred laws and related texts have been counted during the past years.*

[25] *Such as in the Péligre basin, and the entire border area with the Dominican Republic and the north-east area during the '60s, as well as the Grand Goave and Leogane basins.*

produce woodfuel, contribute to deforestation and lead to desertification, ponds becoming marshy, landslides and floods, thus aggravating fuel shortages. All these actions have repercussions on the emission of global warming gases, such as CO_2, CH_4 and N_2O.

Pollution risks associated with the use of fossil fuels are especially prevalent in urban districts, where the majority of heavy energy consuming industries are concentrated, as well as the greater number of motorized vehicles. In the latter case, the seriousness of the situation calls for regulatory measures without delay. The type and level of pollutants emanating from car exhausts are a serious source of preoccupation. Knowing that the pollutant levels generated by transport and industries (CO_2, CO, SOx, NOx, and other particles) are not regulated, and taking into account the density of covered distances and the population density per km^2 in some districts of Port-au-Prince, one cannot but deduct that air pollution risks are serious, as well as their effects on the population.

Environment and Health

Three-stone stoves and open cooking stoves without chimney, used to burn firewood, generate pollution which may have serious potential consequences. The health impact of biomass combustion is well known. The effects of exposure to pollutants on the inhabitants of rural dwellings and in the urban and suburban areas are more serious than the effects of passive nicotine poisoning in industrial countries. They result in respiratory diseases and low weight at birth.

7. Legal and Regulatory Framework

The legal and regulatory framework comprises all environment-related laws and regulations. Laws are voted by the legislative body. Regulations are a set of dispositions taken by Haitian authorities: decrees, orders, circulars, communiqués, guidelines, etc. The regulatory framework is difficult to apprehend, at least for two reasons:

- Bad record-keeping, and poor archives; and
- Haitian executive authorities exercise a limited regulatory power which is, in principle, placed under the jurisdiction of the central government, town government and territorial organizations.

Concerning environment in general, we registered some 10 decrees and about a hundred laws, apart from the land tenure law, which is also covered by some hundred laws.

Land Law

Land tenure laws are different, but just as important as environment legislation. The land tenure concept in Haiti is yet to be qualified: 23 percent of terrains having one legal owner were jointly inherited with other heirs, but remain undivided. About 40 percent of the owners have neither legal title nor any other purchase certificate. About 60-65 percent of inherited plots lack such important documentation. This explains why agro-forestry projects in Haiti have not been more successful.[26] As long as there is no clear ownership of trees and land, no one will engage in planting or protecting trees.

[26] *Rural governance and local institutions in Haiti: Constraints and opportunities for development, Willy Egset (2004), the World Bank, ESW RD Haiti.*

Evolution of Environment Laws in Haiti

Before tackling the essential aspects of Haitian environment legislation, it is important to understand the evolution of the environment legal framework. We can identify four main periods in the history of environment and trees legislation:

First period: 1804-80

At that time, Haiti had great forests under intense exploitation. Precious species such as mahogany, oak tree and campêche were being exported in exchange for an export tax. Tax revenue was important enough to allow, for example, paying the independence debt.

Second period: 1880-1950

Resources started to dry up. Consequently, legislators became concerned about controlling deforestation, and introduced the following measures:

- Obligation to seek an authorization for cutting;
- A tax on cutting;
- Specification of locations where tree cutting is authorized;
- Specification of species which can be cut down; and
- Restrictions regarding pine trees.

Concerning taxes, one must note the taxes on tree felling and charcoal transportation. By the end of that period, in 1950, Haiti still maintained its food balance. Exports outweigh imports, in spite of very low technological standards.

Third period: 1950-95

Decadence begins. Legislators consider deforestation control did not give positive results and that reforestation should be taken up. The Reforestation Day, then the Reforestation Week is instituted, and a component on reforestation is introduced in most public projects. Meanwhile, taxes are no longer collected. Fiscal fences are tacitly eliminated, without modification of laws.

Fourth period: from 1995 to nowadays

Natural disasters become more frequent. Reforestation is unsuccessful. The country enters

a new dynamic: humanitarian work. A new discipline is born. "Risks and Disasters Management" is in. Several organisms or mechanisms are established in this perspective:

- OPDES (Office Post-Désastres et de Secours);
- Service of the Civil Protection (Service de la Protection Civile) (SPC);
- Plan National de Gestion des Risques et Désastres; and
- Projets de Gestion des Risques et Désastres.

Interventions generally take place in three stages:

First stage: Immediate response to a disaster.
Second stage: Humanitarian action.
Third stage: Rehabilitation or reconstruction.

Promotion of and subsidy on improved burners is a new concern. And what if that had been done sooner? Along the four periods, one finds that damage is always noticed after the event occurred, and that disaster management takes place subsequently: prevention is neglected.

Legislation in Vigor

In Haiti, environment legislation is quite abundant, practices deficient and habits relatively unknown. "Law is neither applicable, nor applied," according to *Jean André Victor* in his article: Le Droit de l'Environnement en Haïti, published in *ECONET* special edition, May 1998.

The main reasons explaining the laws' nonapplication and lack of efficiency are:

- Population's lack of education;
- Lack of political will;
- Civil servants' corruption; and
- Little knowledge of laws.

In general terms, Haitian legislation appears to be fairly abundant concerning trees and protected areas, but remains rather poor regarding soils, water, rural or urban environment, or energy resources, and it is practically nonexistent regarding pollution, nuisances or

biodiversity. In the recent years, the progress made by national environment legislation is more a result of the international conventions signed by Haiti, than of legislator's autonomous action. Among the most important conventions ratified by the Haitian Republic, we may quote the following:

- The 1982 United Nations Convention on the Law of the Sea;
- The 1992 UN Convention on Biologic Diversity;
- The UN Framework Convention on Climatic Changes;
- The UN 1994 Convention on Desertification; and
- The Rio Conventions elaborated in the UN Conference on Environment and Development (Rio 1992).

Haitian legislation, per se, can be considered as fairly rich, as it comprises about a hundred laws concerning environment, currently in force. We shall, however, recall some essential legal dispositions of the last century:

- Between 1920 and 1938, the Borno and Vincent governments were very concerned about anarchic tree felling. New laws establish the first forest reserves and establish a national day of the tree, la "Fête de l'Arbre;"
- Between 1938 and 1962, legal dispositions declare as reserved zones some areas of the country, among which Fond-Verettes, Baudarie, la Gonave, la Tortue. The February 1945 and September 1955 laws forbid the exportation of nonmanufactured woody materials, and regulate wood's cultivation, felling, transportation and trade;
- Since 1962, François Duvalier's Code Rural governs the majority of legal dispositions concerning forests and reserved areas. It promotes the protection of trees and reforestation works, in particular; and
- During Jean-Claude Duvalier's rule, several decrees and decisions strengthened earlier dispositions concerning the unruly felling of trees.
- Up to now, two law texts elaborated in 1987 are the most frequently mentioned juridical references concerning environment law:

The 1987 Constitution

The 1987 Constitution, presently in force, defines in Articles 253 to 258 Haitian government's preoccupation in relation to environment (forest reserves, types of energy to be promoted, waste…). Those Articles also stipulate that some environment-related issues must be governed by laws. Such laws are yet to be voted by the Haitian legislative body.

The July 7, 1987 Decree

This Decree regulates the use of energy wood in Haiti, establishes the procedures for seeking tree-cutting authorization, imposes the obligation to create wooded areas in rural inhabited zones, stipulates control measures for firewood and charcoal transportation and establishes sanctions and penalties to prevent infractions.

Although Haitian environmental laws contain all necessary elements to regulate wood felling and use, including the resource's renewal, one must admit that such laws are not applied. They are obsolete, and the Haitian Government seems to have neither the authority, nor the will to make them respected.

Moreover, the sector shows a certain degree of inertia, since no initiative for new laws has been taken either by the legislative body nor by the citizens. It is evident that a better collective management of environment is desirable, as well as the modernization of Haiti's environment legislation, as per the main lines defined in the *Plan d'Action de l'Environment* (PAE – Environment Action Plan).

8. Analysis of Haiti's Energy System

Compared to the Latin America and Caribbean regions, Haiti's total energy consumption is 10 times smaller and its per capita consumption is four times smaller, than the average consumption for the region. Such a contrast is still more obvious if we compare urban and rural consumption. In Haiti, a citizen consumes 13 times more energy than a peasant, with 0.51 toe/person against 0.04 toe/person, respectively.

The energy sector's poor performance is mainly due to inefficient management, as well as a total absence of related policies. It is, therefore, not surprising that the consequences of this situation are felt by all sectors of national life, as energy is a crucial driving force for development. The general characteristics observed in Haiti's energy system derive from the continuing underdevelopment and energy insecurity. One can find the elements of dependence in relation to the outside world, disarticulated local situation, both in terms of supply and of uses, inadequate response to essential needs and degradation of the natural environment.

In Haiti, the oil, power and firewood subsystems evolved autonomously, without a comprehensive energy strategy or policy, resulting in various forms of incoherence and efficiency loss. Moreover, the country has so far not been able to benefit from the advantages which might result from enhanced performances in the use of traditional energy, as well as from the results which could be obtained by resorting to sustainable energy, in the future.

The attitude adopted by interested parties and actors reveals their ignorance of the advantages of an efficient demand and a strategy promoting more rational use of energy sources. Even in this respect, options generally were left up to productive enterprises, whose natural tendency is to improve their own system's efficiency rather than the efficiency of the overall energy system. Substitution options between various resources have not yet been taken into consideration; likewise, some easy solutions were neglected, such as turning to Renewable Energy (RE) (solar thermal, solar PV, microhydraulic, wind, etc.) to cover needs in marginal and isolated areas.

As seen previously, energy dealers as well as distributors and salesmen (who all depend entirely on the income generated by this activity) suffer the dire consequences of this resources' scarcity. As far as charcoal consumers are concerned, the poorest ones living in poor urban areas are the most seriously affected, as they are obliged to buy at ever higher cost a resource in constant rarefaction, out of more and more limited financial means. Intensive exploitation of the woody biomass resource covers ever wider surfaces, in order to attend to a growing demand for charcoal in the various towns and the metropolitan area around Port-au-Prince. In areas very depleted of woody resources,[27] overexploitation generates a desertification process which goes beyond the wood supply issue. Deforestation and associated problems are a matter of concern for the population as well as the authorities in Haiti. This is why they have decided to act on the problem's root causes, which were identified as being, for one part, the need to satisfy energy requirements of urban agglomerations, and on another part, underemployment in rural areas, and the need to find supplementary sources of income impelling peasants to diversify their productive activities.

Given this state of affairs, the energy strategy will not succeed in satisfying the full demand and will have to focus on priority sectors and activities. Given that 70 percent of the energy demand – woodfuels used in the domestic sector by almost 100 percent of Haitians – are covered by the private sector without any government support, that no efficient regulatory framework exists, and that this entails serious consequences on environment, the solutions required must take all those weaknesses into account. Although electricity is a priority for the country's development, in the present circumstances electric light and information are a secondary priority compared to the daily need to cook food for surviving. A serious risk exists that fuels still available to the population at present might no longer be found in the future. Most destitute sectors of the population in rural areas depend on wood transformation activities (such as charcoaling), while other groups in urban areas depend on the availability of such supply. It is consequently proposed to opt for a HES focusing on a balance between supply and demand, so that traditional, low-cost energy remains available for those who need it, and continues to contribute to rural development.

[27] *The very same areas are at the same time the greater charcoal suppliers.*

9. Updated Strategy for Household Energy

Worried by the ecological, economic and human consequences of the growing wood energy demand, the Haitian Environment Ministry – whose main concern is to fight environment deterioration – and the *Bureau des Mines et de l'Énergie* – which is responsible for promoting an efficient, low cost and safe energy use, want to take all possible measures to correct the situation. This document proposes a strategy for household energy whose options incorporate the preoccupations arising from all parts: government, producers, consumers and distributors of energy wood, according to their priorities and motivations.

In order to ensure a long-term balance between energy wood supply and demand, three types of intervention can be envisaged:

- Reduce the woodfuel demand by using efficient equipment and substitution fuels;
- Increase the woodfuel supply by promoting a more effective and efficient management of forest resources, the planting of additional trees, improved carbonization methods and the production of briquettes and other substitution fuels; and
- Elaborate an improved regulatory framework in support of constructive solutions.

It should be noted that there is no panacea for balancing wood supply and demand for ever and fast: but there are various types of activities and interventions which, together, could assist in reducing the gap progressively. In this context, the design and definition of the proposed strategy for household energy is based on the following components:

- The updating and application of the regulatory framework and the introduction of an institutional coordination mechanism to support the proposed actions. The regulatory framework should specifically promote: 1) a better land management by Haitian peasants; 2) an efficient and effective use of woodfuels; 3) the manufacturing and/or importation of more efficient stoves; 4) a supply system for imported substitution fuels; and 5) the mass production and/or importation of

equipment required for producing substitution fuels of agricultural origin, such as briquettes, ethanol, etc;

- The reduction of wood energy demand, namely by promoting more efficient stoves and by relaunching the production of "Mirak" stoves. This program should be supported by: 1) a publicity campaign to convince at least 80 percent of households in Port-au-Prince of shifting toward more efficient stoves; 2) a training program for artisans to produce these stoves; and 3) the introduction and application of a quality and energy efficiency label. This component pursues a 20 percent gain on efficiency at least, in order to decrease the charcoal demand up to 50,000 tons/year or more, which would signify a 10 to 15 percent reduction of the overall demand;
- The promotion of imported substitution fuels, with a potential to reduce charcoal consumption by 200,000 tons/year. These fuels are: gas, kerosene and mineral coal. It is proposed to: 1) promote the *porte marmite* and LPG supply in small quantities, which would facilitate households a greater access to LPG; and 2) launch a program for producing briquettes from imported coal;
- The production of local alternatives to replace charcoal and firewood. It is thus proposed to produce briquettes using charcoal fines (currently abandoned in urban areas) with a 35,000 tons/year potential, as well as carbonized agricultural waste, particularly bagasse, with a 30,000 tons/year potential; and
- Strengthening the supply of woodfuels by promoting: 1) better forest management practices, by organizing their control at the local level, including the introduction of a sustainable charcoal production tax; 2) the improvement of the charcoal production chain by a professionalization of its actors, which could almost double the productivity compared to occasional producers; and 3) integrating wood energy in programs for rural development, watershed basin protection and agro-forestry.

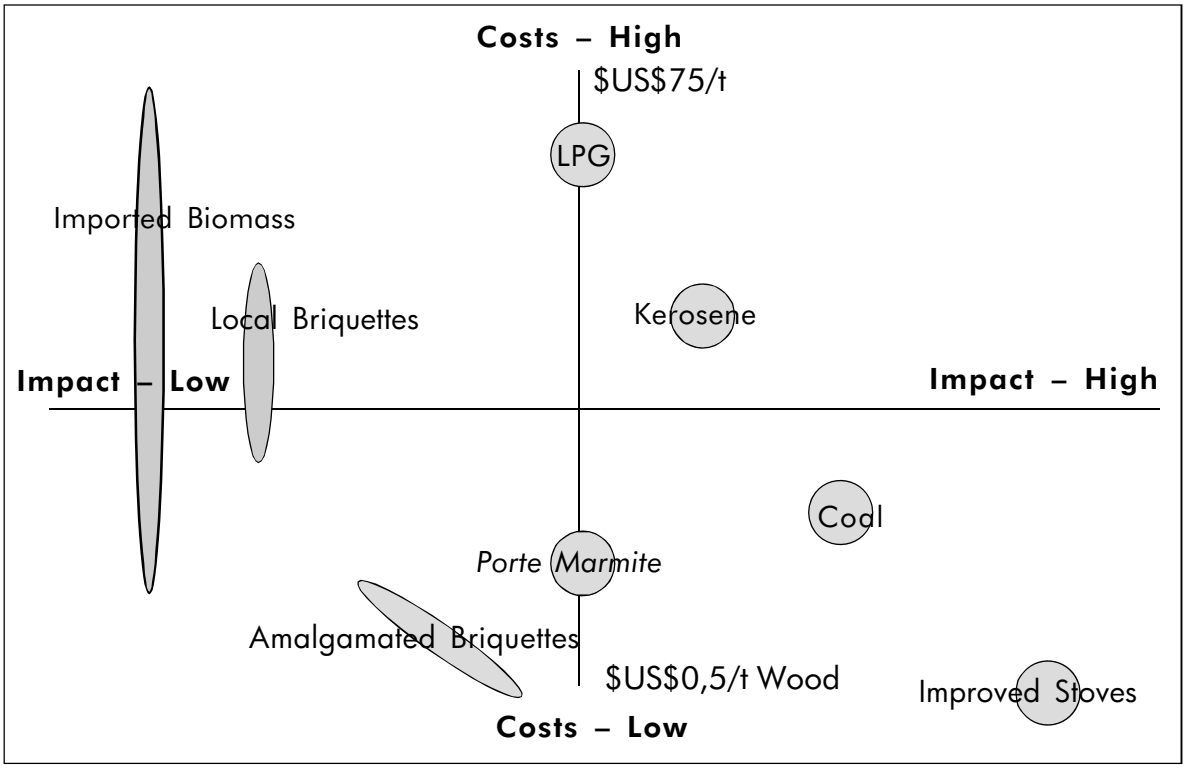
It should be noted that these options are, in fact, interdependent; for example, if one wants to successfully produce and sell a new type of fuel in Haiti, it is necessary to have adapted burners. Activities related to reforestation (energy plantations) and better forest management would be carried out by the local population, in cooperation with services provided by the Environment and Agriculture Ministries, through various projects supported by international donors. Reforestation activities are not covered in detail in the present document. The strategy to alleviate the pressure on natural resources focuses on the most serious environmental damages caused by charcoal supply (production) and consumption (demand). Parameters such as price evolution and current woodfuel availability dictate that some of the components should be applied in a particularly rigorous manner. Table 9.1 lists the different options, as well as some details concerning the intervention schedule and their impact on the economy, poverty and environment. Figure 9.1 shows a "cost-impact" figure for the principal options.

Table 9.1: Evaluation of Strategic Options

Strategy Element	*Cost of Results (US$ per t of Energy Wood)*	*Intervention Schedule*	*Economic Impact*	*Poverty Impact*	*Environment Impact*
Substitution Fuels					
• Top Quality (Gas)	US$30-50 /t	2-15 years	+/-	+/-	-
• Low Quality (Charcoal)	US$20-30 /t	1-5 years	+	+	-
Demand-side Management					
• Stoves	US$0.5-3 /t	1-3 years	++	++	++
• SMEs	US$5-15 /t	2-5 years	+	+	++
Production of Alternatives					
• Compressed Residues	US$ 5-10 /t	1-2 years	+	++	+
• Briquettes	US$40-70 /t	2-5 years	+	+	+
Supply-side Strengthening	US$10-50 /t	5-15 years	+/-	+	++
Regulatory Framework	N.A.	Immediate	++	++	++

Source: ESMAP team.

Figure 9.1: Summary of Options



Substitution Fuels

This intervention aims at promoting the use of imported substitution fuels. The potential savings of charcoal are about 200,000 tons/year after a 10-year period. Reaching this level is a *sine qua non* condition for obtaining a true impact on deforestation. The private sector will obviously be called to play a key role, not only in terms of the investment required to develop importation and distribution chains, but also for the promotion and sensitization of Haitian households.

This activity aims at identifying which fuel(s) are more suitable for the Haitian population as a whole or part of it, with a view to reducing charcoal consumption substantially. Some conditions have to be met, not only regarding expenditures (fuels' quantity and price) and investments (boilers, furnaces, LPG cylinders, cooking stoves), but also in terms of comfort (fire prevention, wick regulation, smoke, etc). Various options might meet such conditions, hereby listed according to their user-friendly characteristics and price per MJ:

- Propane and butane gas;
- Kerosene;
- Coal; and
- Biomass (firewood, charcoal, bio-diesel, ethanol, etc).

Some imported woodfuels are not listed here: past experience with importation from various countries (Canada in 1987-88, France in 1999, and the United States in 2003) does not permit proactive support; even if these fuels were cost-free in the foreign production sites, the handling charges in the countries of origin and transportation costs up to Port-au-Prince would be prohibitive and would not be competitive either with charcoal produced in Haiti, nor other imported fuels. Apart from that, punctual wood supplies would not represent a durable solution.

Below are listed the conditions required for carrying out the various support actions intended to increase the use of these fuels in the future.

Gas

LPG is a solution in the long term and a large part of the population is likely to use it during the forthcoming decades. The initial objective is to double consumption in 10 years. This aims at reducing the current constraints which make households hesitant

to use LPG on a small-scale basis. Once households discover the comfort of using gas, they will most probably tend to increase their consumption. The constraints are threefold: high cost of LPG, the fact that it is sold per LPG cylinders only, and the relatively elevated cost of LPG stoves. Clearly, the government would not be in a position to invest in this sector, as that normally is the role of private operators, but it could launch pilot actions to convince LPG companies to modify their habits.

In order to take maximum advantage of scale savings, the Haitian LPG market should be larger. Notwithstanding an appreciable evolution of LPG market, from 900 tons in 1981 to nearly 12,000 tons in 2004, this product is still much less used than charcoal. The 1988 Shell promotion campaign, and the arrival of several LPG companies in the market, met with a certain degree of success. Efforts so far have not yet allowed consumers to benefit from substantial reductions resulting from much cheaper importation and transportation costs from the loading location. In order to encourage investments required for solving these problems, the government should be open to discuss various improvement modalities with the main actors.

LPG prices, the obligation to fill a whole cylinder, and the high cost of stoves reduce its access possibilities for a large part of the population. Like they do with charcoal, people prefer to buy frequently in small quantities rather than infrequently in a large quantity. There are five options to make LPG more accessible:

- Introduce small size cylinders (3 kg, 6 kg), as per successful experiences made in several African countries, namely Senegal, where the introduction of subsidized small LPG cylinders allowed a substantial and sustainable increase in consumption;
- Apply a cross-subsidy program for small cylinders, to help increase consumption levels: the wealthiest households will not use too cumbersome small cylinders, but will continue to use large ones; the price difference between the two would thus be used to enable low-income households to also use LPG;
- Support the modality of partial filling of cylinders. In some Asian countries, LPG companies sell LPG per Kilogram (s) (kg); households carry their cylinders to a filling center in town, and buy LPG for the amount they choose;
- Introduce the *porte marmite*. This model is already being produced and sold by Ecogaz at low prices, but they are still considered as too expensive by households who wish to become LPG consumers; other low-cost burners exist in other countries,[28] such as the *porte marmite* manufactured by informal sector metal workers, with a burner directly fitted onto the cylinder. It is hereby recommended to conduct tests, in

[28] *For example, the Bip Tjéri in Senegal, with various models, for 3 and 6 kg cylinders.*

order to identify the households' reaction, and conclude to which extent this measure might contribute to increase LPG use; and

- Encourage the sale of those burners through a preferential tax and importation regime. The above options could enhance LPG use, and it is hereby recommended to conduct tests in order to assess the economic impact.

Kerosene

Cooking costs with kerosene and charcoal (in bags) are practically identical; in spite of current world prices (Figure 3.1). Indeed, cooking with charcoal sold in *marmite*s is more expensive than cooking with kerosene. Although kerosene is very frequently used for lighting, it is rarely used as a cooking fuel. Its distribution network is already in place. The objective is to extend its use to a minimum 50,000 households within 10 years. There is a lack of kerosene stoves which are acceptable by the population. Some companies have started research in this direction, but without reaching appreciable results so far. It is hereby recommended to encourage them, through a sensitization campaign, promoting both kerosene as a cooking fuel and kerosene stoves. Moreover, the government could encourage the sale of such stoves through a preferential tax and importation regime.

Mineral Charcoal (Coal)

Coal is a fuel which resembles charcoal; in addition, it can be found worldwide as well as in the subregion, at quite low prices, which are usually not linked to petroleum prices. Coal might be an option to replace charcoal among the most destitute households lacking financial capacity to buy LPG or kerosene. Coal is certainly far from being an ideal fuel in environment terms (sulfur and ashes), yet the impact of charcoal production on deforestation is still far more serious and preoccupying. It is precisely the comparison between those two impacts which justifies coal as a temporary solution. The initial objective is to replace charcoal among 50,000 households at least in 10 years.

There are two options: One is to use coal as mined, as is done in countries such as South Africa, Botswana, Mongolia and Russia. The requirements are: good quality of coal, and availability of specifically adapted burners. Cooking costs might be far lower than that of charcoal. The other option is to transform coal into coal briquettes. The advantage would be lower pollution levels, but the disadvantage a slightly higher cost price. In 2005, Biomasse-Haiti proposed a project for "briquettes of imported coal," comprising two phases: a pilot phase, aimed at testing acceptability conditions among consumers, and a production phase on a medium scale, including (i) production of coal briquettes between 50,000 and 100,000 tons/year; (ii) promote intensive *manioc*

crops by agricultural producers, to produce sufficient binding agents; and (iii) production of residual electric power at a 10-20 MW level. It is hereby recommended to review the support mechanisms to allow the private sector to develop such a plant.The quality of this type of briquettes is far better than that of raw coal, for combustion purposes. Briquettes production is an interesting alternative to reduce charcoal consumption. In addition, power production itself is also interesting; given the difficulties EdH currently experiences to meet electric power demand.

Demand-side Management

One of the principal axes of intervention is the introduction of measures to reduce the demand for woodfuels. The projected potential charcoal savings are some 100,000 tons/year in 10 years.

Demand-side management is subdivided into four main components:

- Improved stoves or burners using charcoal and firewood;
- Propane and butane cooking stoves;
- Ovens and burners in the informal sector, school canteens; and
- Other options such as solar stoves or boilers using solar energy, or ethanol, or biogas, etc.

Improved Stoves

The "Mirak" improved stoves have been successfully implemented in Haiti. Yet, the success story was not a longlasting one, as the stoves almost disappeared from the market after the end of the sensitization and promotion phase. However, some households still remember the stove and ask about it. This is regrettable, as more than 20,000 units were sold at the time, and the obtained savings per unit were shown to be 25-30 percent. The reasons for this model no longer being manufactured or sold are: (i) it was more expensive than traditional stoves, because of the small production scale; (ii) the advertisement and promotion campaigns ended after less than two years; and (iii) quality problems caused by pirated versions manufactured by unqualified artisans.

It is hereby recommended to start a new massive promotion campaign for the "Mirak" model, principally aimed at replacing as many traditional stoves as possible. Rather than popularizing once again 20,000 or 30,000 stoves, it would be preferable to try and directly replace traditional stoves with improved ones, thus reaching a 20-30 percent savings

potential of the overall consumption. The private sector has already expressed its willingness to facilitate such activity, provided a revolving fund is created to buy the necessary raw materials. For example, Haiti Métal is reportedly prepared to manufacture these ameliorated stoves on a massive scale and at a limited cost, and Biomasse Haiti would ensure the distribution to commercialization centers.

Stoves using Kerosene or LPG

As indicated earlier, it would be convenient to promote performing kerosene stoves. Kerosene has good chances of replacing, in the very short term, charcoal as domestic fuel, because both types of fuel have quasi-identical cooking costs. It is further proposed to promote the use of LPG stoves, particularly low-cost models such as the *porte marmite* with fixed burners.

"Eco" Quality Label

In general terms, there is also a need to promote an "energy saving" or "green energy" label ("Eco" label). This label could be introduced to promote the entire set of options (improved stoves, substitution stoves, ovens for SMEs, briquettes production, etc). Rather than promoting specific improved burners or stoves, the key idea to promote would be a generic energy-saving label. Also, the quality label would significantly increase the visibility of the options available to the people. BME could be called to implement this idea, ensure an adequate monitoring of private operators responsible for specific tasks (training, follow-up, advertising, quality control, etc.); BME could also be responsible for granting the label to qualified equipment and actors. The relevant tests (quality control, output control) should be under the responsibility of an authorized laboratory, to identify producers and suitable products. We consider that a sustainable market could thus develop; helping users to better understand performing equipment and easily identify them.

Energy Use in the Services Sector

SMEs consume relatively important quantities of woodfuels. Most of them are bakeries, laundries, guildives, mills, etc. Given their often fairly high income levels, the SMEs could shift to other types of fuel, without greatly affecting their profitability. It is hereby recommended to promote and encourage conversions, to curb woodfuel demand:

- Bakeries, laundries, etc.: conversion to diesel, LPG or briquettes, pursuing an almost total conversion rate;

- Mills, *rapadou* producers or guildives, sugar refineries: conversion to bagasse or briquettes, pursuing an almost total conversion rate; and
- Street restaurants, school canteens: conversion to large-size improved stoves, or to substitution fuels.

The "Eco" label could be used as a working tool; a support fund could help cover equipment costs (ovens or burners).

Others

Other options exist, such as solar stoves, ethanol stoves, biogas, etc. Those solutions would certainly be interesting for users, yet, they will not significantly help solve the energy wood problem. They have a scarce probability of being accepted on a large scale, due to factors such as high costs, social acceptability, or other. Consequently, it is proposed not to support them actively.

Alternative Fuels Production

One of the main intervention axes will be the production of alternative fuels in Haiti, from still unused biomass waste or residue. Residue transformation is interesting because it generates added value and rural employment in the plants with easy access to this type of resource. The other advantage is the availability of a low-cost fuel which could replace woodfuels in the plant's surroundings.

There are several options to produce a local substitution fuel as an alternative to firewood or to charcoal:

- Instead of charcoal, households and small street restaurants could use:
  - Briquettes made with charcoal fines; and
  - Agricultural carbonized and agglomerated residue;
- Instead of firewood, SMEs and destitute households could use:
  - Raw agricultural residues (such as bagasse);
  - Briquettes made with raw agricultural residues; and
  - Briquettes made with amalgamated waste and used paper.

It is recommended to implement a program for promoting the production and use of such alternative fuels in Haiti. The private sector should carry out the relevant investments, but the government could encourage the alternative fuels' commercialization through a preferential

tax and imports regime for the equipment required. A label system should also be envisaged for briquettes production.

Briquettes made from charcoal fines

Ten percent of the charcoal volume is normally transformed into powder or charcoal fines. On the basis of a 350,000 tons consumption of charcoal in Port-au-Prince, 35,000 tons of briquettes could, in principle, be produced in one year, with 250,000 tons of wood potential reduction in tree felling in one year. At present, these fines are abandoned and generate significant maritime pollution, or clog drainage ditches or trenches in Port-au-Prince, aggravating the road network's deterioration. The advantage of briquettes is that their combustion lasts longer than that of charcoal. Although they are more difficult to ignite, they are cheaper than ordinary charcoal, and would contribute in protecting Haitian trees. In Kenya, a private operator has been producing such briquettes for six-seven years. The Biomasse Haïti Company also has a positive experience in producing them on a pilot scale. It is, hereby, recommended to continue the production of briquettes made from charcoal fines.

Briquettes made from carbonized agricultural residues

Table 9.1 shows the agricultural products' potential: theoretically, 20-30 percent of the crops of each product would be transformed into residue, part of which is already being used at present. The production of briquettes made from carbonized agricultural residues raises an economic question: would their production cost be competitive with charcoal? Instead of disposing bagasse, it would be possible to produce large quantities of briquettes, and such fuel production would represent an interesting economic complement for the plants producing such residues.

Agricultural surplus residues

Bagasse transformation could be an alternative solution to charcoal, or to firewood in some industries. Bagasse frequently obstructs the streams near feeding mills, particularly in the Leogane plain, unless it is simply burnt to prevent accumulation.[29] Wherever

[29] *140,000 tons, according to the latest estimates.*

it is not found in large amounts, it is possible to use simple and low-cost techniques (whose prototypes can be found in Haiti) to carbonize it and then transform it into briquettes. If necessary, raw coal could be sold and processed in a larger briquette-producing plant.

If rice cultivation ever increased in the Artibonite or other areas of Haiti, it would be possible to envisage producing briquettes from rice straw and rice husks.

Briquettes made from used paper and other municipal residues

Part of the agricultural and woody waste and/or residues which exist in Port-au-Prince could be recuperated and agglomerated with used paper or cardboard, to produce small logs or briquettes. The end product could be used to cook food or to boil water in dry cleaners or laundries, or to bake bread in bakeries, or to be used in some industries (guildives). A survey on household residues, funded by the World Health Organization (WHO)-PAHO Haiti and carried out by the *Faculté des Sciences de l'Université d'Etat d Haïti*, registered about 1,000 waste piles in the Port-au-Prince metropolitan area, and estimated that, in 1997, the capital was producing 1,500 tons of waste daily, 3 percent of which were papers and cardboard; therefore, 45 tons could be produced daily for domestic use, that is, 15,000 tons and above.

Ethanol

This type of fuel is used in other countries for cooking, either in liquid or gel fuel form (Zimbabwe, Ethiopia). Ethanol is produced from molasses, currently no longer available in Haiti. It is recommended to study extent to which imported ethanol could be used as a reliable alternative to charcoal in Haiti. This type of fuel has not yet been introduced in Haiti, and we ignore how households would react; yet, this has been done successfully in other countries.

Strengthening the Supply

The search for solutions to strengthen energy wood supply is an important axis of action. Several options exist, all of them with often very high specific costs. Protection of standing trees is essential, and less costly than planting additional trees. It would be unrealistic to envisage large State-owned tree plantations: the cost would be prohibitive, given the number of hectares (ha) required to produce a genuine impact on the wood energy balance. Therefore, the supply-side options should essentially integrate woodfuel supply issues in forestry and environmental activities. Programs for protection of catchment areas and rural

development should include activities to promote sustainable woodfuel production issues and the development of an energy wood market. The main stumbling block continues to be land tenure law uncertainty; as long as people do not possess land titles, no one will venture into investing in any plot of land, or in any improvements to them. Given such constraints, the options for the energy wood production program are:

- Management of the still existing natural resources;
- Improvement of carbonization techniques;
- Agro-forestry;
- Promotion of private plantations and of income-generating crops, as an alternative to firewood gathering; and
- Reorganization of wood trade by modernizing distribution chains.

Based on the referred principles, production and support activities are foreseen. Concerning the former, it is recommended to:

- Undertake an economic assessment which will identify the benefits and costs of improved wood cutting management in forest areas and organize the supervision of this management by the neighboring population level. Those activities should be an integral part of support programs for local communities, and for conservation of natural resources within parks and drainage basins;
- To launch a campaign for sensitizing local businessmen to firewood's ecological and economic issues, and, on the basis of program-contracts, place government-owned vacant lands at the use of energy wood producers;
- To launch an operation for enhancing professional standards in the charcoal chain, with professional groups who produce charcoal out of wood purchased from peasants. With a better familiarity and control of the carbonization process, those charcoal producers could almost double their return and output. This activity's greater impact will be principally noticeable during the initial years: under the joint impact of the said interventions, woodcutting for charcoal production should, in principle, decrease considerably. However, it would be important to involve charcoal producers in the pursuit of solutions to wood energy. Such a charcoal production modality is sustainable, in as much as it does not cause deforestation. A sustainable charcoal label will be introduced and implemented; and
- To implement a pilot program for energy wood plantation, including the regeneration of species particularly demanded for producing coal in dry and degraded areas, as an integral part of agro-forestry, drainage basins protection, rural development and/or decentralization.

In spite of wood's importance in the national energy structure and the country's environment deterioration state, no proper "energy and environment" program has yet been adopted by the authorities, or supported by the international donor community. The alternative consists of adjusting the ongoing programs for agro-forestry and catchment area protection, so that they incorporate woodfuel issues.

Regulatory Framework

For one part, the national legislation on energy, forestry and natural resources has strong points which deserve to be pointed out:

- It is simple and contains several texts; yet, it is not applied. It has assigned a variety of mandates and functions to different institutions which could unfortunately, not always adequately, fulfill their roles;
- This legislation's objectives in relation to considerations contained in the relevant texts are noble and pursue the conservation of natural resources and the upgrading of our energy resources; and
- The ratification of international conventions on global warming and maritime law has permitted to modernize, to a certain extent, the national legislation on some energy resources.

On the other hand, the national legislation shows several weaknesses, some more important than others:

- The absence of a true energy policy does not allow a framework law which embraces the entire sector's reality;
- The absence of decrees to apply forest policy aspects;
- The absence of a clear land tenure law allowing land owners to plant more trees;
- The missing elements are evident and refer to pollution, sustainable energy and the absence of measures to encourage energy efficiency and wood and charcoal substitution programs; for example, they lack encouragement mechanisms for purchase of stoves (and/or spare parts), ovens, efficient burners, through a preferential tax and importation regime and/or a cross-subsidy system. The charcoal chain functions totally outside the fiscal framework, yet, it could likely self-finance a large part of the strategy through fiscal measures which, at the same time, could be a management tool for the chain's actors;
- The legislation reflects the incoherencies and contradictions of the national energy system, which was never conceived as a whole, as a system. The coordination

mechanisms required for a complex horizontal sector, such as the energy sector, are rarely provided for in the laws. No application decree stipulates which dispositions should be adopted by those in charge of applying the law; and
- The national energy legislation is, in fact, made of several scattered and dispersed laws which do not convey this sector's exceptional importance.

It is thus, necessary, to formulate a new legal and regulatory framework for the energy sector, which would be connected with the overall national energy system's reality, and with the relevant energy policy's context, so as to harmonize relationships between the various forms of energy, on one hand, and the different institutions concerned with energy issues, on the other hand.

An adequate regulatory framework should, as a matter of principle, promote:

- Planting of trees and better land management, by all peasants;
- An efficient use of woodfuels, SMEs included;
- Manufacturing and/or importation, under a preferential regime, of stoves and relevant spare parts for households, and of ovens and burners for SMEs, to allow the use of substitution fuels;
- Manufacturing and/or importation, under a preferential regime, of equipment needed to produce substitution fuels, such as briquettes;
- A support or safeguard mechanism for the most destitute households, such as small LPG cylinders at reduced prices, given that LPG price per kg in that format is cheaper than that of large cylinders (cross-subsidies, etc.); and
- A financial support mechanism for investing in high efficiency equipment.

In more concrete terms, action is specifically called for in the following spheres:

- Analyze and improve the forest and land legislation to promote spontaneous tree planting (natural regeneration);
- Review the legislation and taxation of charcoal chains to enhance their efficiency and contribute to the intervention's self-financing. A transportation tax could be envisaged, to be collected at trees owners' level, great part of which should directly benefit those who exercise a correct tree management. The objective of this tax would be twofold: first, it would represent a management tool allowing a better handling of various aspects of the charcoal chain; second, it would help generate funds which could be used to finance specific activities. This option is a valid one, but requires more in-depth analysis prior to making decisions, given the present foreign currency flight;

- Review legislation and taxation covering the importation of spare parts, ovens and burners, in order to increase the availability of high-yield and low-cost stoves and boilers; and
- Review legislation and taxation of modern fuels, to facilitate solutions for the benefit of poorest households.

Expected Results

The anticipated results of such a strategy would be:

- A reduction in primary energy consumption produced by replacing traditional stoves by improved ones and use of more efficient fuels; a 20 percent plus reduction in the overall charcoal consumption would be achieved over a 10-year period;
- A substantial increase in substitution fuels, and more particularly in charcoal; coal and charcoal consumption would level after a 10-year period; LPG and kerosene consumption would double or more, in the forthcoming 10 years;
- As a result of the whole set of actions to be carried out, a strong reduction in charcoal consumption is anticipated to take place without social repercussions; and
- Past a certain time (11-12 years), consumption is expected to increase again, due to demographic growth.

In 2015, the number of charcoal-using households would decrease by one-third, and almost all of them would use improved stoves. Nearly half of the households would use substitution fuels (see Figure 9.2).

Figure 9.2 depicts the fuels' distribution in the household energy demand, and Figure 9.3 the fuels' use evolution.

Figure 9.2: Household Energy Demand (MJ/yr)

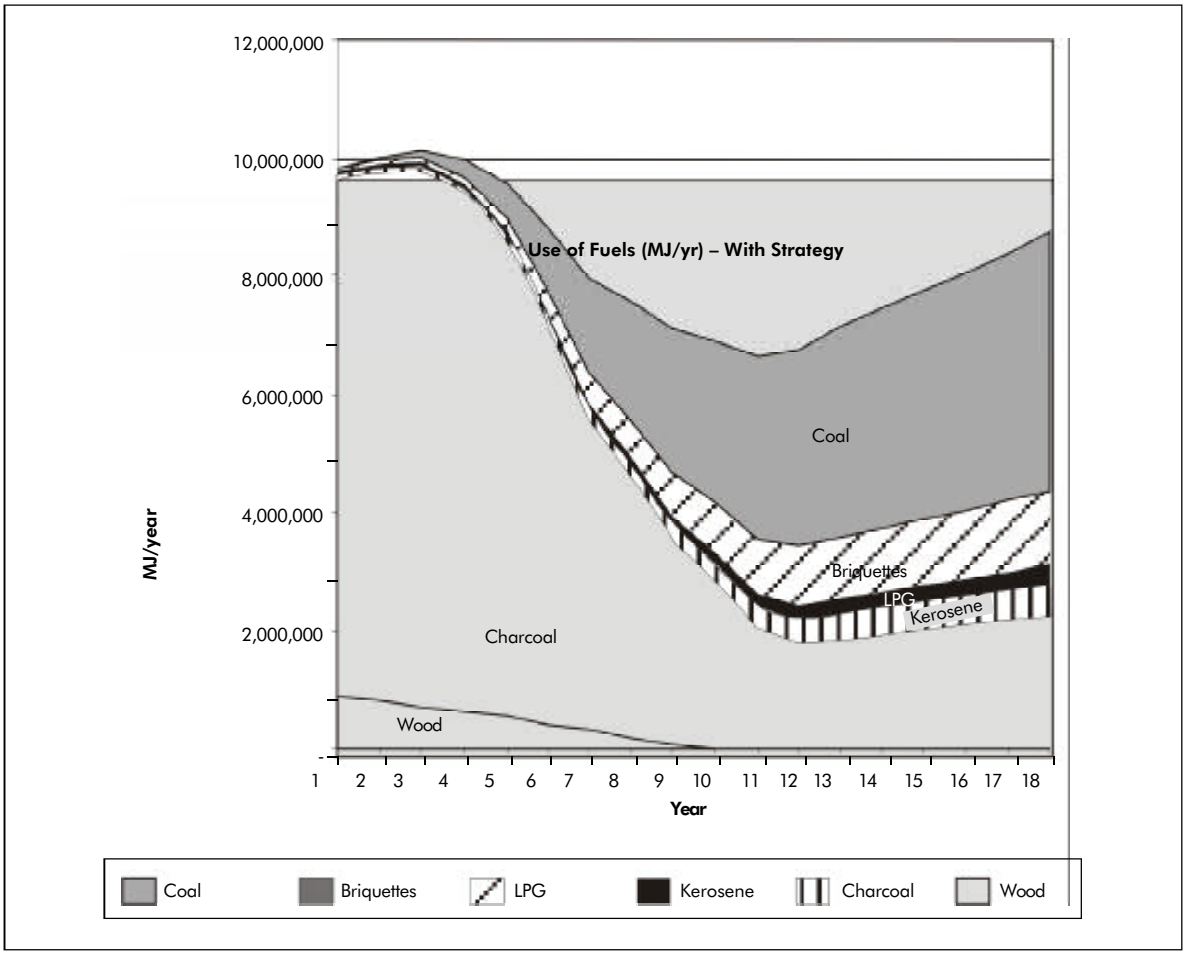
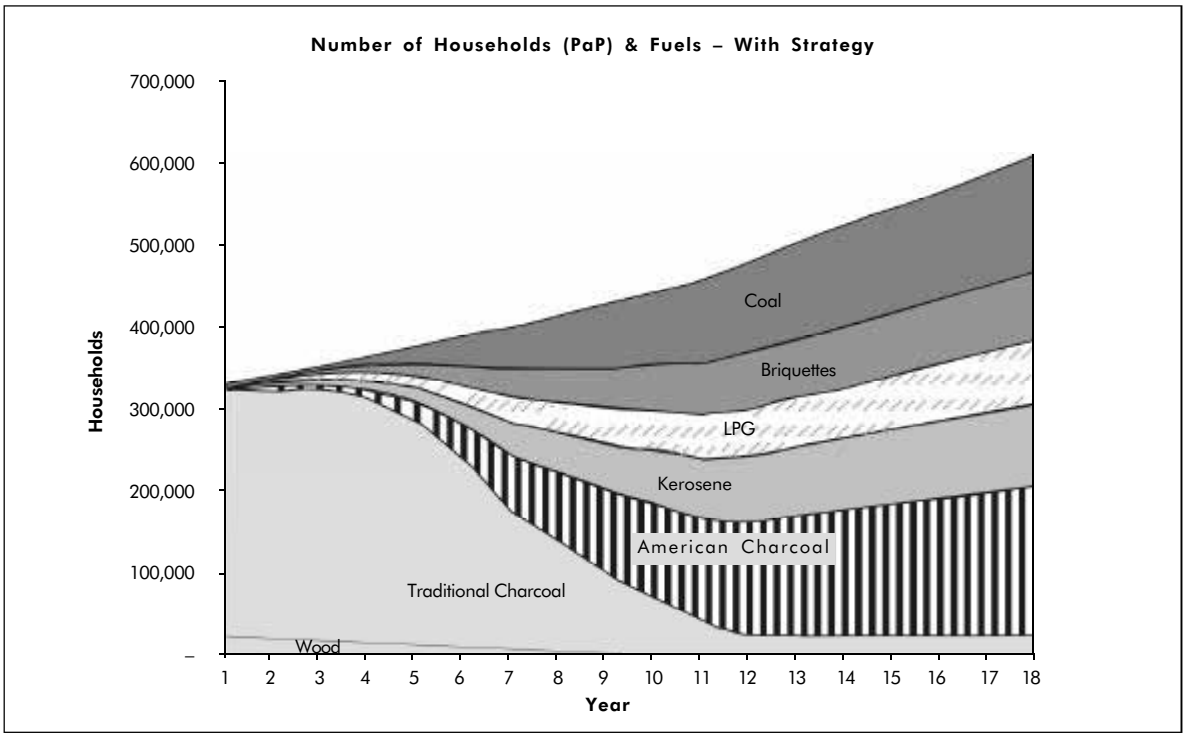


Figure 9.3: Evolution of Fuels



No one knows whether demand and supply can be balanced in 10 years' time. This question could only be answered if the data concerning supply were more precise. However, in light of the anticipated outcomes, a strong reduction in energy woodcutting could take place, generated by the "substitution" and "demand-side management" components, and the supply durability could increase, as a result of the "strengthening" and "fuels production" components.

Strategy Costs

The costs of strategy implementation over five years are estimated to be around US$20,000,000, more than 50 percent of which have to be funded by the private sector. Table 9.2 provides a summary of costs.[30]

[30] *These are estimated costs; we need to analyze in greater detail the activities to develop.*

Table 9.2: Distribution of Costs by Components, in US$000

	Public	*Private*	*Total*	
• Demand Control				
• Charcoal Improved Stoves ("Eco" Label)	550	1,000	1,550	
• Kerosene, Propane and Butane Stoves	340	400	740	
• Informal Sector, School Canteens	500	400	1,000	
• Other	60	0	60	
	1,450	*1,900*	*3,350*	14%
Substitution				
• Propane LPG and Butane LPG	130	1,000	1,130	
• Kerosene	0	500	500	
• Ethanol	110	0	110	
• Coal	0	8,000	8,000	
	240	*9,500*	*9,740*	42%
Substitution Fuels Production				
• **To Replace Charcoal**				
– Charcoal Fines Briquettes	20	250	270	
– Carbonized, Compressed Agric. Residues	50	250	300	
	70	*500*	*570*	2%
• **To Replace Firewood**				
– Raw Agricultural Residues (Bagasse)	200	0	200	
– Briquettes from Raw Agric. Residues	50	0	50	
– Briquettes from Amalgamated Waste and Used Paper	250	400	650	
	500	*400*	*900*	4%
Wood Supply Management				
• Natural Resources Management	1,100	0	1,100	
• Carbonization Techniques' Improvement	500	0	500	
• Agro-forestry	3,400	0	3,400	
• Promotion of Private Plantations and Cash Cultivations	2,400	0	2,400	

	Public	*Private*	*Total*	
• Distribution Chains Improvement	300 *7,700*	0 *0*	300 *7,700*	33%
Regulatory Framework				
• Forest and Land Legislation	50	0	50	
• Woodfuels' Efficient Use	30	0	30	
• Support to Importation (stoves and spare parts, ovens and burners)	30	0	30	
• Support to Importation (fuels production equipment)	30	0	30	
• Support Mechanism for Poor Persons	1,000 *1,140*	0 *0*	1,000 *1,140*	5%
Grand Total	11,100 47%	12,300 53%	23,400	

Infrastructure investments and alternative fuel supply will be reserved for private funding, except activities to strengthen the woodfuel supply, which will be reserved for public funding. All users will have to pay for their equipment, but a financing mechanism could be established to help them purchase efficient equipment. Concerning the production of substitution fuels, such as briquettes, training and sensitizing activities are foreseen among potential producers. As for the regulatory framework, the activity will consist of reviewing extent to which the government could apply existing laws to minimize the impact of fiscal measures.

The HES costs should be compared with a nonintervention situation: in the worst of cases, that is, the current scenario (business as usual), charcoal consumption would eventually be replaced by imported kerosene, at an annual cost of US$150,000,000 or more. Kerosene is a cheaper fuel than LPG, which would certainly be used by the population in case there was no more charcoal available. If the overall charcoal consumption was entirely replaced by kerosene, the quantity of kerosene required would double the current consumption levels; this theoretical quantity implies the obligation to increase the overall use of oil products by some 8 percent.

Implementation Mechanisms

The present study does not propose an ideal institutional structure to implement the

strategy for solving the wood energy problem. The most important part of that effort should be carried out by private actors, within the framework of a regulation to be applied by the government. Only the Haitian Government is competent for designating the best coordination and management mechanisms, to carry out all foreseen activities within the frame of this strategy. However, some thoughts might contribute to better identify and address the institutional issues.

Although the strategy comprises several activities which could be conducted separately, all of them should ideally be carried out in a concerted and integrated manner. Given that the strategy concerns several sectors of the Haitian economy simultaneously, such as environment, energy, natural resources, rural development and funding, the relevant ministries must necessarily be involved in its implementation, to grant the best possible synergy.

A coordination committee or commission should, therefore, be envisaged, either within a ministry having strategic importance in the implementation, or at inter-ministerial level. An efficient modality observed in some countries is the setting up of a coordination unit, or an autonomous agency for household energy and environment. The unit could depend on a key ministry and could assume the responsibility for managing the overall strategy. Alternatively, such a responsibility could be entrusted to an independent agency, operating under the auspices of a Board of Directors (BoDs), where all relevant ministries as well as the private and civilian sectors would be represented.

The most appropriate mechanism in the Haitian context should be the object of a detailed study.

10. Economic Analysis

With less than 2 percent of forest cover, Haiti cannot maintain, either ecologically or sociopolitically, its current dependence on local wood resources to satisfy some 80 percent of the national energy demand. The alternative, for the HES, to alleviate the pressure on natural resources – the present trend – would consist of doing nothing and let the household energy situation evolve by itself. There is a serious risk that deforestation will continue aggravating, until the day when charcoal supply will drastically decrease, reach prohibitive prices, or even disappear entirely. In anticipation of an uncertain future, Haiti must find substitution fuels for charcoal. There is no time left to develop the best alternatives and, consequently, imported kerosene will most likely be the most realistic option. But such a scenario has huge implications, not only on rural life – there would be no more trees left, no more energy – but also on society as a whole: reduced agricultural production, catastrophic erosion levels and the need to import all required fuels. The economic costs of such a scenario are higher than those of the proposed strategy.

A Strategy for Household Energy was developed in the early 90s, with a scenario aimed at solving the wood energy problem. Of the total number of recommendations, only two were pursued with success: LPG promotion and small-scale energy control in SMEs. Several LPG companies exist today and this resource's consumption has evolved significantly, but is still insufficient to produce a real impact. Some SME have changed fuel, or improved their ovens and burners. The last tree has fortunately not yet been felled, contrary to forecasts for the beginning of 21st century. It is important to intervene resolutely and without delay. Some trees can still be found in/and out of the forests, which could be managed in a sustainable manner, **but this situation will certainly not persist if the high levels of charcoal demand remain unchanged, with no promotion of alternative fuels and efficient equipment**.

Table 10.1 shows a summary of the HES costs and benefits over two periods: a five-year period (during which public funding is available), and a 20-year period (the necessary time span to obtain and see project results). Energy wood consumption could decrease by

25 percent after five years, 4 percent of this decrease being due to improvement in carbonization techniques; after 20 years, this decrease could reach 56 percent .

Table 10.1: Summary of Costs and Benefits

	Over 5 yrs, i=10%	*Over 20 yrs, i=10%*
NPV Costs	US$24,317,035	US$89,800,994
NPV Benefits	US$76,186,434	US$593,124,608
Tri	89%	109%
Consumption Reduction		
• Demand (Overall)	21%	54%
• Carbonization	4%	3%
• Total	25%	56%
Benefits CO_2		
NPV Benefits	US$2,142,911	US$32,777,264
Total CO_2 Reduction	3,233,782	99,416,499
Health Benefits		
• Beneficiary Households	422,228	1,281,468
• NPV Health Benefits	US$8,326,634	US$43,402,732

Note: NPV: net present value; IRR: internal rate of return; Discount Rate =10 percent.

Table 10.1 summarizes the types of intervention contemplated within the HES framework, as well as their anticipated results to better balance energy wood supply and demand:

- Demand-side management (improved stoves, energy savings) 20-30 percent;
- Imported substitution fuels (kerosene, LPG, coal) 20-30 percent;
- Briquettes made from locally available products (charcoal fines, bagasse) 10-20 percent; and
- Strengthening of local wood supply 10-40 percent.

The first intervention priority will be a wide-scale diffusion of improved stoves and substitution stoves. This is a sensitization and training activity which does not entail high levels of expenditure, and which would have a great impact on the economy, the environment and living conditions. But is it imperative to replace practically all of the traditional stoves with the "Mirak" improved model, well accepted by the population in the past. BME and CARE activities at the end of the 1990s had already indicated how to develop a "Mirak" market. With a US$3 million cost over five years, the annual charcoal savings obtained would reach US$50 million or above, and US$150 million after 10 years.

The second intervention priority would be the production or import of substitution fuels. These are not only LPG and kerosene, already available in the market, but also fossil coal. Although the latter is not yet present in the market, it ought to be: the price in Port-au-Prince would be US$50/ton, compared to US$300/ton for charcoal (in bags). So, upon some improvements to clean up coal (such as removing sulfur, for example), there is still a sufficient margin to sell coal cheaper than charcoal. This intervention has slightly lower economic benefits, due to fuel importation costs and the investments required to construct the coal cleaning and briqueting center. But, with benefits exceeding US$10 million per year, costs over five years under US$10 million are fully justified. As far as LPG and kerosene are concerned, demonstration and test activities are foreseen, to show users and industrialists that some market development portions remain untouched. Moreover, this type of intervention would have a positive effect on the payments balance at the macroeconomic level.

The third intervention priority would be the production of briquettes made from charcoal fines, from bagasse and from amalgamated used paper and other waste. Investments required to create several production units are not very substantial. At a cost of US$1.5 million over five years, annual savings could reach or exceed US$5 million after five years, or US$16 million after 10 years.

The fourth intervention priority would be the strengthening of energy wood demand. There would be several benefits from more trees and better management of existing natural resources – there would be a sustainable charcoal supply and, at the same time, less deforestation, less soil deterioration, higher incomes for peasants, etc. This intervention's minimal costs reach US$7.7 million over five years. Although not calculated with precision, the economic benefits would, by far, exceed US$10 million per year. However, as demonstrated by past reforestation experiences, in the absence of concrete changes in the land tenure legislation, this solution will not produce significant results and, therefore, demands a joint intervention on both aspects.

The fifth intervention priority comprises a series of transversal actions to allow an adequate launching of the four tangible intervention priorities. It aims at developing importation modalities of equipment and fuels, under a special regime, a tax system as a management tool for the energy wood chain, and the application of forest and land laws, as well as the setting up of a financial support system to promote investments.

Fuel Consumption Benefits

As shown in Table 10.1, an evaluation of all the overall benefits indicates that the Net Present Value (NPV) over five years reaches US$76.1 million, compared to a US$24.3

million NPV of costs over the same period. Over a 20-year period, those amounts are: US$593 million for benefits, and US$90 million for costs. The benefits do not include environment and health-related aspects.

The IRR is relatively high, 89 percent for a five-period and 109 percent for 20 years. The justification elements for the investments required to carry out the HES are very strong. In addition, this analysis only covers the costs and benefits associated with fuel consumption. To that, we should add the economic benefits associated with environment and health.

Environment Benefits

The environment-related benefits have been assessed. Those are principally CO_2 emissions, which would considerably decrease as a result of the HES. It is through energy savings (more performing equipment) and the use of modern substitution fuels that such emissions will be reduced. Over five years, the expected reduction is 3.2 million tons of CO_2, and 99.4 million tons of CO_2 over 20 years.[31] The price of CO_2 has been calculated as US$10/ton. The environment-related benefits, therefore, represent 4 percent of the consumption benefits (over five years), or 2 percent (over 20 years). Such a relatively low contribution for this kind of projects can be explained by the use of coal.

With the environment benefits obtained, it would almost be possible to cover the cost of the energy control intervention.

Health Benefits

The benefits on health are relatively important and are estimated to be as follows: a household using improved stoves or modern fuels enjoys better health conditions. There is less smoke in the house; the risks of contracting illnesses are smaller for the family members, and, consequently, less need for medical consultations. The analysis estimated the number of households which could start using an improved stove as a

[31] *In evaluating the environment benefits, it was estimated that 25 percent of the charcoal production is sustainable and does not contribute to deforestation; concerning firewood, 60 percent of the production is sustainable.*

result of the HES. The benefits in terms of reduced medical costs were evaluated as US$10 per year and per household.

After five years, the estimated number of new beneficiaries would be 422,000 households, and some 13,000,000 after 20 years. The health benefits would add 11 percent to the consumption benefits over five years, and 7 percent over 20 years.

11. Conclusions

The HES aimed at alleviating the pressure on woody resources is justified at various levels. First, it shows high performance from an economic point of view. Then, in terms of health benefits, its main positive impact is a reduced pollution level inside dwellings. In terms of rural development, alternative fuel production activities, improvement of the charcoal chain, and better tree management and planting, are decisive elements in favor of carrying out the HES and have a substantial positive local development impact. Moreover, global environment aspects, which are not a priority in Haiti's current social and political situation, might attract donations to fund some interventions, namely within the Clean Development Mechanism (CDM) framework.

Past experiences have irrefutably demonstrated that the Strategy's implementation depends fundamentally on political will. In order to prevent problems ansing from political inertia, most activities would be implemented by the private sector. However, the government has a crucial role to play, not only in sensitizing actors and households in relation to the measures to be taken, but also in establishing the rules of the game for all parties. In order to ensure that Haitians still have low-cost cooking fuel five or 10 years from now, we need to carry out the entire set of proposed interventions, articulating simultaneous actions on supply and demand. Isolated activities would not be useful, for the issues at stake go beyond the energy sector as such, and Haiti could be forced, in the worst cases scenario, to import the majority of its food requirements, and even its drinking water.

List of Technical Reports

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	SUB-SAHARAN AFRICA (AFR)		
Africa	Power Trade in Nile Basin Initiative Phase II (CD Only): Part I: Minutes of the High-level Power Experts Meeting; and Part II: Minutes of the First Meeting of the Nile Basin Ministers Responsible for Electricity	04/05	067/05
	Introducing Low-cost Methods in Electricity Distribution Networks	10/06	104/06
Cameroon	Decentralized Rural Electrification Project in Cameroon	01/05	087/05
Chad	Revenue Management Seminar. Oslo, June 25-26, 2003. (CD Only)	06/05	075/05
Côte d'Ivoire	Workshop on Rural Energy and Sustainable Development, January 30-31, 2002. *(Atelier sur l'Energie en régions rurales et le Développement durable 30-31, janvier 2002)*	04/05	068/05
Ethiopia	Phase-Out of Leaded Gasoline in Oil Importing Countries of Sub-Saharan Africa: The Case of Ethiopia - Action Plan	12/03	038/03
	Sub-Saharan Petroleum Products Transportation Corridor: Analysis and Case Studies	03/03	033/03
	Phase-Out of Leaded Gasoline in Sub-Saharan Africa	04/02	028/02
	Energy and Poverty: How can Modern Energy Services Contribute to Poverty Reduction	03/03	032/03
East Africa	Sub-Regional Conference on the Phase-out Leaded Gasoline in East Africa. June 5-7, 2002	11/03	044/03
Ghana	Poverty and Social Impact Analysis of Electricity Tariffs	12/05	088/05
	Women Enterprise Study: Developing a Model for Mainstreaming Gender into Modern Energy Service Delivery	03/06	096/06
	Sector Reform and the Poor: Energy Use and Supply in Ghana	03/06	097/06
Kenya	Field Performance Evaluation of Amorphous Silicon (a-Si) Photovoltaic Systems in Kenya: Methods and Measurement in Support of a Sustainable Commercial Solar Energy Industry	08/00	005/00
	The Kenya Portable Battery Pack Experience: Test Marketing an Alternative for Low-Income Rural Household Electrification	12/01	05/01
Malawi	Rural Energy and Institutional Development	04/05	069/05
Mali	Phase-Out of Leaded Gasoline in Oil Importing Countries of Sub-Saharan Africa: The Case of Mali - Action Plan *(Elimination progressive de l'essence au plomb dans les pays importateurs de pétrole en Afrique subsaharienne Le cas du Mali — Mali Plan d'action)*	12/03	041/03
Mauritania	Phase-Out of Leaded Gasoline in Oil Importing Countries of Sub-Saharan Africa: The Case of Mauritania - Action Plan *(Elimination progressive de l'essence au plomb dans les pays importateurs de pétrole en Afrique subsaharienne Le cas de la Mauritanie – Plan d'action.)*	12/03	040/03

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Nigeria	Phase-Out of Leaded Gasoline in Nigeria	11/02	029/02
	Nigerian LP Gas Sector Improvement Study	03/04	056/04
	Taxation and State Participation in Nigeria's Oil and Gas Sector	08/04	057/04
Regional	Second Steering Committee: The Road Ahead. Clean Air Initiative In Sub-Saharan African Cities. Paris, March 13-14, 2003	12/03	045/03
	Lead Elimination from Gasoline in Sub-Saharan Africa. Sub-regional Conference of the West-Africa group. Dakar, Senegal March 26-27, 2002 *(Deuxième comité directeur : La route à suivre - L'initiative sur l'assainissement de l'air. Paris, le 13-14 mars 2003)*	12/03	046/03
	1998-2002 Progress Report. The World Bank Clean Air Initiative in Sub-Saharan African Cities. Working Paper #10 (Clean Air Initiative/ESMAP)	02/02	048/04
	Landfill Gas Capture Opportunity in Sub Saharan Africa	06/05	074/05
	The Evolution of Enterprise Reform in Africa: From State-owned Enterprises to Private Participation in Infrastructure-and Back?	11/05	084/05
Senegal	Regional Conference on the Phase-Out of Leaded Gasoline in Sub-Saharan Africa *(Elimination du plomb dans l'essence en Afrique subsaharienne Conference sous regionales du Groupe Afrique de l'Ouest Dakar, Sénégal. March 26-27, 2002.)*	03/02	022/02
	Alleviating Fuel Adulteration Practices in the Downstream Oil Sector in Senegal	12/03	046/03
	Maximisation des Retombées de l'Electricité en Zones Rurales, Application au Cas du Sénégal	09/05 03/07	079/05
South Africa	South Africa Workshop: People's Power Workshop.	12/04	064/04
Swaziland	Solar Electrification Program 2001 2010: Phase 1: 2001 2002 (Solar Energy in the Pilot Area)	12/01	019/01
Tanzania	Mini Hydropower Development Case Studies on the Malagarasi, Muhuwesi, and Kikuletwa Rivers Volumes I, II, and III	04/02	024/02
	Phase-Out of Leaded Gasoline in Oil Importing Countries of Sub-Saharan Africa: The Case of Tanzania - Action Plan	12/03	039/03
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China	Assessing Markets for Renewable Energy in Rural Areas of Northwestern China	08/00	003/00
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	Technology Assessment of Clean Coal Technologies for China Volume II-Environmental and Energy Efficiency Improvements for Non-power Uses of Coal	05/01	011/01
	Technology Assessment of Clean Coal Technologies for China Volume III-Environmental Compliance in the Energy Sector: Methodological Approach and Least-Cost Strategies	12/01	011/01
	Policy Advice on Implementation of Clean Coal Technology	09/06	104/06
	Scoping Study for Voluntary Green Electricity Schemes in Beijing and Shanghai	09/06	105/06
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Philippines	Rural Electrification Regulation Framework. (CD Only)	10/05	080/05
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Poland	Poland (URE): Assistance for the Implementation of the New Tariff Regulatory System: Volume I, Economic Report, Volume II, Legal Report	03/06	101/06
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Morocco	Amélioration de d´Efficacité Energie: Environnement de la Zone Industrielle de Sidi Bernoussi, Casablanca	12/05	085/05
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	How do Peri-Urban Poor Meet their Energy Needs: A Case Study of Caju Shantytown, Rio de Janeiro	02/06	094/06
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	Bolivia: National Biomass Program. Report on Operational Activities	05/07	115/07
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	Population, Energy and Environment Program (PEA) Comparative Analysis on the Distribution of Oil Rents (English and Spanish)	02/02	020/02
	Estudio Comparativo sobre la Distribución de la Renta Petrolera Estudio de Casos: Bolivia, Colombia, Ecuador y Perú	03/02	023/02
	Latin American and Caribbean Refinery Sector Development Report - Volumes I and II	08/02	026/02
	The Population, Energy and Environmental Program (EAP) (English and Spanish)	08/02	027/02
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	Knowledge Exchange: Online Consultation and Project Profile from South Asia Practitioners Workshop. Colombo, Sri Lanka,	12/03	043/03

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	Petroleum Revenue Management Workshop	03/04	051/04
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	Gender in Sustainable Energy Regional Workshop Series: Mesoamerican Network on Gender in Sustainable Energy (GENES) Winrock and ESMAP	12/04	062/04
	Women in Mining Voices for a Change Conference (CD Only)	12/04	063/04
	Renewable Energy Potential in Selected Countries: Volume I: North Africa, Central Europe, and the Former Soviet Union, Volume II: Latin America	04/05	070/05
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