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Project Phase 2 – Report about energy planning in Jamaica and proposals to upgrade it

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Executive Summary

Jamaica, with an area of 10,990 km2 and a population of approximately 2.67 million inhabitants is the largest English speaking island in the Caribbean. About a third of Jamaica's population lives near the capital, in the greater Kingston area.

Over the past two decades, Jamaica has implemented a programme of economic liberalization, stabilization and structural reform that has made it more open to trade and financial flows. The liberalization programme covered trade, exchange controls, the removal of subsidies and price controls. The liberalization measures were also applied to the energy sector.

The main sectors of Jamaica's economy are tourism, mining, manufacturing, agriculture and financial and insurance services. In the mining industry, by far the main product is bauxite, followed by limestone. Food and beverage (particularly rum), tobacco, cement and flour are the most important manufactured products in the island. Among the main agricultural products of Jamaica, sugar is the most expressive; banana, coffee, spices and coconut follow suit.

Energy imports, which cost the country US$ 2.7 billion in 2008, exceed the export earnings. This imbalance does not tear apart the country's finances only because forty percent of the payment of oil imports from Venezuela are treated as a loan over a 25-year period at one percent rate of interest.

The petroleum sector has been deregulated since 1993, when the market was liberalised and price controls were removed.

Within the petroleum industry, there are several players: one refinery, Petrojam, which is state-owned, the marketing companies and the gas retailers.

There are approximately eleven marketing companies, of which more than half are local. Three of them are multinational companies: Chevron-Texaco, Total and Cool Petroleum.

The state also participates in the local gas retailers market by way of the Petroleum Company of Jamaica (PETCOM).

While some marketing companies participate in the retail market, the market is largely comprised of individual operators under the umbrella of the Jamaica Gas Retailers Association (JGRA). There are approximately 300 retail stations in Jamaica.

Jamaica only has a downstream segment of the market. It is hoped that through current exploration activities, a commercially viable upstream segment will also be developed.

The electricity sector was privatised in 2001 by way of sale of the Jamaica Public Service Company Limited (JPSCo) to Mirant Corporation, an international firm.

The generation segment was further liberalised in 2004, although some terms and conditions are governed by the All Island Electricity license granted to the JPSCo in 2001.

Along with the JPSCo, there are four independent power providers, Jamaica Energy Partners (JEP), Jamaica Alumina Company (JAMALCO) and Jamaica Private Power Company (JPPC) and Wigton Windfarm Limited. They sell electricity to the grid under power purchase agreements with JPSCo, which is also the sole distributor of electricity to the public.

The renewable sector does not currently have any defined economic feature like the petroleum and electricity industries.

The Petrojam refinery is the only importer of crude oil. The refinery, marketing companies and the bauxite companies import finished petroleum products.

Crude oil is imported from Venezuela under the new PetroCaribe Agreement replacing Caracas Accord. Crude oil is also imported from Mexico under the San Jose Pact, Ecuador and Nigeria. Refined products are mainly imported from Trinidad and Tobago, Venezuela and the United States.

Petroleum consumption is dominated by the transport sector, the electricity generation sector and the bauxite and alumina sector. These sectors account for over 90 percent of consumption. The remainder is shared among cooking and lighting, manufacturing and the petroleum refinery activities.

In November 2004 the governments of Jamaica and Trinidad and Tobago signed a Memorandum of Understanding on the annual supply of 1.15 million tonnes of liquefied natural gas (LNG) under preferential pricing terms over a 20-year period.

In September 2009, the negotiations, led by the Minister of Energy and Mining, were still seeking to secure long-term supply of LNG from providers, determine the best import re-gasification solution for Jamaica, and identify partners for the supply of technology, capital and management for a local liquefied natural gas industry.

Electricity is provided to consumers by JPSCo. There are, also, self-producers, highly concentrated in the bauxite/alumina and sugar industries.

Total generating capacity in Jamaica was approximately 818 MW in 2006, which includes 217 MW capacity provided by independent power producers. Total electricity output was estimated at 4,046 GWh at that year, of which some 33% was provided by non-JPSCo sources, up from 28% in 2005. Residential use accounted for approximately 35% of annual consumption (GWh) while large scale users (rates 40 and 50) accounted for 41%.

About 40% of the generation capacity is over 30 years old and need to be replaced. The proportion of diesel oil based generation capacity in the total generation capacity mix (34%) is high and requires expensive fuel (Ministry of Energy and Mining, 2009).

System losses in transmission and distribution represented 23% of total output in 2006 (as estimated by the Office of Utilities Regulation), of which approximately 12.5% is represented by non-technical losses, including theft (The Energy Sector Task Force, 2007).

Renewable energy sources contributed 5.32 percent to gross electricity generation in 2005. It is the government's aim that this contribution will increase to 10 percent by 2010 and 15 percent by 2020.

It is the intention of the government to facilitate universal access to electricity. Approximately 92% of households island-wide now have access to electricity.

In 2006, the energy supply in Jamaica was of 31,734,070 barrels of oil equivalent (boe). From this total, 91.8% were imports and 7.8% were local production.

Jamaica produced 2,474,180 boe of primary energy in 2006. Fuelwood was responsible for 51.7% of this energy, sugarcane products for 41.7% and hydropower for 5.2%. The country imported 7,629,640 boe of primary energy in that year, from which 98.2% were of petroleum.

The secondary energy production in Jamaica in 2006 was 12,069,610 boe and the main energy carriers were: electricity (38.4%), fuel oil (33.2%), Diesel Oil (14.0%) and gasoline/alcohol (7.8%). The imports of secondary energy in that year – 21,616,790 – were mainly of fuel oil (58.4%), diesel oil (18.7) and gasoline (13.7%).

There are public service power stations and selfproducers in Jamaica. The former generated 2,454,550 boe, or 53.1% of the electricity produced in the country in 2006 –

4,629,990 boe. The large share of selfproduction is mostly concentrated in the production of bauxite and alumina and, to a lesser extent, in the sugar industry.

In 2007, 4,078,770 MWh were produced for the public grid. Jamaica Public Service Company (JPSCo) Limited, the only electricity utility in the country, generated 41.0% of this total in steam cycle thermal power plants, 23.8% in power stations which follow the Brayton, or the Combined cycles, and 3.9% in hydro power stations; the remaining power (31.4%), JPSCo bought from independent power producers (IPP's).

The sectors which consume more energy in Jamaica are mining/agriculture/fishing and transport.

The most consumed oil products in 2008 were fuel oil, representing 59.9% of the total, gasoline (15.6% of the total), diesel oil (14.3% of the total) and turbo fuel (5.8% of the total).

Jamaica is an oil importing developing country. Over 90 percent of petroleum demands are satisfied by imported oil. This has placed Jamaica in a vulnerable position with respect to the movement of oil prices on the world scene.

The main characteristics of energy and its relationship with the Jamaican economy can be summarized as follows:

- excessive dependence on imported primary energy;
- low energy supply self-sufficiency due to a lack of indigenous energy resources, and low utilization of available sources, namely wind, hydro, solar and biomass;
- high petroleum consumption, that is concentrated in the alumina production, power generation and transport activities;
- rising share of oil products in the import energy supply mix relative to crude oil;
- low levels of the refinery utilization; and
- high system losses in the electricity industry, which has been deteriorating since 2001 and reached 22.1% in 2007.

There are now seven areas of focus for the new energy policy in Jamaica: ensuring the security of Jamaica's energy supply; developing a modernised energy infrastructure; encouraging Jamaicans to adopt conservation measures; inclusion of renewable energy sources in Jamaica's energy mix; ensuring that Jamaica has a well-defined governance framework for the energy sector; the Government leading by example in energy conservation practices; and industries embracing the green economy and eco-efficiencies.

From the seven areas of focus in the White Paper, the development of a comprehensive governance and regulatory framework should be given the highest priority, right now, since the accomplishment of this is essential for the eventual success of the other policies.

The analysis of the short-term energy policies and actions taken by the Jamaican government in the last years reveals that most of the initiatives and investment have been expected from the private sector, given some government guidelines and, in some cases, financial incentives. Several of these expectations, however, did not materialize. Besides, despite of the privatisation of JPSCo and the existence of some private independent power producers in the power sector and private marketing companies in the oil industry, the Jamaican government is still the owner of some sugar mills and alcohol dehydration

facilities, which can produce bioethanol, and, particularly, it controls the apparently well organized Petroleum Corporation of Jamaica (PCJ).

Therefore, the Government should clearly define, during the elaboration of the short, medium and long-term plans accruing from the White Paper policies, which investments can actually be carried out by the private sector and with what incentives, which investments will be made just by state-owned companies, such as PCJ or its subsidiaries, and when partnerships between private and state-owned companies will need to be worked out to support the planned investments.

Energy policies and programmes directed to energy conservation can provide substantial energy savings already in the short-term, as pointed out in the Energy Conservation and Efficiency Policy (ECEP), and should be given high priority.

Jamaica has good potentials for the development of some renewable energy resources. Bioethanol, solar water heating and wind power seem to be the most attractive in the short and medium terms; biodiesel and energy from waste follow suit.

The country's current problem with the balance of payments due to oil imports will not be solved just with the help of good policies and practices concerning energy conservation and a more widespread use of renewable energy resources. Substituting LNG for oil products certainly is a good policy for the short term. The high volatility of LNG's prices, particularly in recent years, the strong correlation they have with oil prices, and the recent moves to form an association of the major natural gas producers in the world do not assure stable and affordable supplies of this energy source much far in the future.

Imported coal and nuclear power, the last one perhaps in a collaborative work with other countries in the Caribbean region, should be carefully evaluated as likely cheaper solutions than LNG for generating electricity in Jamaica, in the medium and long terms, respectively.

Interactions among the stakeholders about the plan assumptions and targets are as important as their opinions about the energy policies that originate the plan.

The first barrier that should be overcome to improve the current least cost plan for the electric power sector is to pass a new electricity act in the Jamaican Parliament that empowers the Ministry of Energy and Mining with the tasks of elaborating this plan, preparing tenders, inviting bids and evaluating the bids for new generation capacity, instead of JSPCo. Other issues that should be addressed in this new act are the setting-up of a regulated third party access to the transmission and distribution grids, as happens today in many countries all over the world, and an independent and transparent system for merit order dispatch. The mature WASP model could continue to be used as an optimisation tool for the least cost plan under the Ministry responsibility, since it is perfectly able to simulate the basic characteristics of the Jamaican mainly thermal power system.

Possible future discoveries of oil and natural gas in Jamaican territory, the strong increase of market share envisaged for the renewable energy resources in the White Paper on National Energy Policy, and the need to plan the future availability and expected cost of the energy inputs to the existing and new power stations in the country recommend the opening of the, medium-term, least cost expansion plan to include, also, the expansion planning of fossil fuels' and renewable energy's facilities.

The long-term expansion plan is purely indicative and provides guidelines and insights for government policies and their eventual targets and for companies' corporate strategies.

In the other hand, the more detailed medium-term plan can be mandatory for the first years of the planning period, since the results of the plan can determine, as in Brazil, which power stations, or plant types, the Ministry should prepare tenders and invite bids, including their commissioning dates. This can also be applied for tenders concerning areas for the exploitation and exploration of petroleum and natural gas.

1. Introduction

This report presents, initially, the main features of the Jamaican economy, the local energy supply industry and the main energy markets of that country.

The most relevant features of energy demand and supply in Jamaica are discussed then, with the help of recent statistics taken from OLADE's data basis and complemented with some additional information provided by the Energy Division of the Ministry of Energy and Mining.

Analysis of the current energy policies, planning and regulation of the energy markets follows suit, before the final conclusions and recommendations.

Two visits were scheduled to Jamaica, to help gather the information and data required for this report's evaluations and proposals. The first one actually happened in November 2008 and contemplated some meetings in the Energy Economics and Planning Unit of the Ministry of Energy and Mining, then called Ministry of Energy, Mines and Telecommunications. The Ministry is formally responsible for energy policy and energy planning in Jamaica.

The second one should have occurred in February 2009, involving, this time, representatives of other stakeholders in the Jamaican energy industry, such as regulators, utilities, other energy supply companies, large consumers, etc. The responsibility to organize this visit was given by OLADE's representative in Jamaica to the director of the Ministry's Energy Economics and Planning Unit – Ms. Yvonne Barrett-Edwards, who, without giving any explanation, did not carry out this task. A questionnaire was sent by this consultant to this person to indicate the main missing points that would be desirable to explore in this second visit and to make easier the choice of the right people to discuss these points. The people responsible for this project in OLADE's headquarters in Quito also intervened and proposed a video conference, instead of the visit, with a smaller group of stakeholders, in the middle of this year. Unfortunately, none of these initiatives succeeded.

Nevertheless, the data obtained in the first visit and some reports gathered then, added to new information obtained recently through searches via Internet provided a sufficient background to write a comprehensive and useful report.

2. Population, economy and main economic sectors in Jamaica

Jamaica, with an area of 10,990 km2 and a population of approximately 2.67 million inhabitants is the largest English speaking island in the Caribbean. About a third of Jamaica's population lives near the capital, in the greater Kingston area.

Over 90% of Jamaica's population is of African descent, but it also includes people of European, East Indian, Chinese, Middle Eastern and Jewish descent.

Jamaican economy's Gross Domestic Product (GDP) growth rates have been quite modest in the first years of the current decade: 2001 – 1.7%; 2002 – 1.1%; 2003 – 2.3%;

and 2004 – 1.2%, partly due to natural disasters. In 2007, this growth rate was 2.5%. The GDP per capita in 2003 was estimated at US$ 2,728 (Ministry of Energy, Mining and Telecommunications, 2006).

The White Paper on National Energy Policy forecasts negative growth rates for the Jamaican GDP in 2008 (-0.6%) and 2009 (-2.3%) and a very low positive growth in 2010 (0.1%) (Ministry of Energy and Mining, 2009).

Inflation rates have been recently two digit: 16 - 19% per annum.

Over the past two decades, Jamaica has implemented a programme of economic liberalization, stabilization and structural reform that has made it more open to trade and financial flows. The liberalization programme covered trade, exchange controls, the removal of subsidies and price controls. The liberalization measures were also applied to the energy sector.

The main sectors of Jamaica's economy are tourism, mining, manufacturing, agriculture and financial and insurance services. In the mining industry, by far the main product is bauxite, followed by limestone. Food and beverage (particularly rum), tobacco, cement and flour are the most important manufactured products in the island. Among the main agricultural products of Jamaica, sugar is the most expressive; banana, coffee, spices and coconut follow suit.

3. Local energy sector – petroleum, electricity and renewable energy sources

The local energy sector can be characterised by three sub sectors: petroleum, electrical power and renewables.

3.1 The petroleum industry

The petroleum sector has been deregulated since 1993, when the market was liberalised and price controls were removed.

Within the petroleum industry, there are several players: one refinery, Petrojam, which is state-owned, the marketing companies and the gas retailers.

There are approximately eleven marketing companies, of which more than half are local. Three of them are multinational companies: Chevron-Texaco, Total and Cool Petroleum.

The state also participates in the local gas retailers market by way of the Petroleum Company of Jamaica (PETCOM).

While some marketing companies participate in the retail market, the market is largely comprised of individual operators under the umbrella of the Jamaica Gas Retailers Association (JGRA). There are approximately 300 retail stations in Jamaica.

Jamaica only has a downstream segment of the market. It is hoped that through current exploration activities, a commercially viable upstream segment will also be developed.

The refinery began an expansion programme, in a joint venture with Petroleos de Venezuela SA, the state-owned oil company of Venezuela. It is expected to improve the production capacity of the crude unit from 35,000 barrels per day to 50,000 barrels per day, and also increase the capacity of the gasoline production unit. As part of an upgrade process, facilities will be installed to produce a much lower level of sulphur in the diesel oil

current; the recovered sulphur will be used, locally, to produce sulphuric acid, which, in turn, can be employed to manufacture fertilizers. Deep conversion technologies, especially the Delayed Coker Unit, will convert heavy fuel oil into higher valued products and a new by-product, petcoke, which will be used to produce electricity and heat in the Petcoke Cogeneration Power Project, a partnership between the Petroleum Corporation of Jamaica (PCJ), Petrojam, and the Jamaica Public Service Company (JPSCo). This plant will increase the installed generating capacity by 100 – 120 MW (www.men.gov.jm, consulted in September 2009).

Petrojam Ltd., Petrojam Ethanol Ltd. and PETCOM are subsidiaries of the Petroleum Corporation of Jamaica (PCJ), which is a sort of an agency linked to the Ministry of Energy and Mining.

3.2 The electric power sector

The electricity sector was privatised in 2001 by way of sale of the Jamaica Public Service Company Limited (JPSCo) to Mirant Corporation, an international firm. The government is planning to divest its remaining 20 percent share in the power company.

The generation segment was further liberalised in 2004, although some terms and conditions are governed by the All Island Electricity license granted to the JPSCo in 2001.

Along with the JPSCo, there are four independent power providers, Jamaica Energy Partners (JEP), Jamaica Alumina Company (JAMALCO) and Jamaica Private Power Company (JPPC) and Wigton Windfarm Limited. They sell electricity to the grid under power purchase agreements with JPSCo, which is also the sole distributor of electricity to the public.

3.3 Renewable energy

The renewable sector does not currently have any defined economic feature like the petroleum and electricity industries, but there is more interest and participation in the development of renewable energy.

3.3.1 Hydropower

Previously, for a long time, hydropower was used to generate electricity. Government rehabilitated six mini-hydro plants, which were privatized to JPSCo, and now account for 22 MW of capacity to the system. New hydropower plants could be economical in Jamaica in 2005 if generation costs did not exceed 6 US-cents per kWh (Loy and Coviello, 2005). The Energy Division (ED) of the Ministry of Energy, Mining and Telecommunications (MEMT) estimated, in 2008, a hydropower generation of 160 GWh, or 99,000 boe, in Jamaica, the year before.

A major additional contribution from hydropower is not to be expected within the next decade due to limited resources and competing water uses, which tend to reduce the river flows. All new hydropower investment would have to come from independent producers, since JPSCo shows no interest in operating any small-scale plants beyond the existing facilities (Loy and Coviello, 2005).

3.3.2 Wind power

The most recent technology to come on stream is wind-powered electricity. The Wigton Windfarm, in Manchester, was commissioned in May 2004 to deliver electricity to the grid under a power purchase agreement with JPSCo. It has the capacity to deliver power output of up to 20 MW and is expected to generate, on average, 7MW. According to an ED/MEMT datum, wind power generation in Jamaica was 52 GWh, or 32,000 boe, in 2007.

This windfarm is being expanded by 18 MW to bring its total generating capacity to 38.7 MW by the end of 2010 (www.men.gov.jm, consulted in September, 2009).

According to preliminary assessments there is further wind potential on Jamaica. Limits are mainly set by the availability of land (unless off-shore sites can be assessed), the topographic conditions as well as road and grid access. Loy and Coviello (2005) estimate that within the next years three more wind farms of about 20 MW each could be erected.

3.3.3 Solar energy

It should be noted that warm water is not an essential requirement in Jamaica, with many households having no heating system at all. Yet, the growing numbers of electric heating devices are contributing significantly to the daily evening load peaks in the public electricity system.

Nevertheless, solar technology is becoming increasingly popular, particularly in the use of water heating. The average solar radiation in Jamaica is high – 4.8 kWh/m^2 per day, i.e. about 1,800 kWh per annum.

In 2005, solar water heaters covered only about 1% of the domestic market (private houses). The total number of solar water heaters was estimated to be around 7,000, mainly in the form of small-scale passive thermosyphon systems with integrated water storage tanks directly attached to and above the glazed flat-plate collector; only a few large scale applications are active systems using a collector circulation pump and a remote storage tank.

Higher oil prices and subsequent electricity price increases offer new opportunities for solar water heaters mainly in the domestic sector as well as for hotels restaurants and hospitals. Primarily new housing schemes could cost-efficiently be equipped with solar heaters.

Potentials for solar water heating exist in particular in medium- and high-income households and in the tourism sector. The hotel industry alone provides for about 14,000 rooms with 30,000 beds across the island and has an occupancy rate of well above 50%, indicating that there is a hot water need throughout most of the year. In this specific case solar water heating has to compete against LPG, since this is the common energy source for hot water generation in hotels. Other niche market potentials can be found in the industrial sector, mainly in food-processing, and for sporting facilities.

The company Solar Dynamics Ltd. has done some market research, showing that about 45,000 residential customers of JPSCo have an electricity demand of above 600 kWh/month. Most of those customers are expected to have an electric heater and spend about one third of their electricity bills for hot water generation. Therefore, about 75 to 100 GWh of electricity could be saved annually, if those consumers would install collector systems with an area of 3 to 4 m^2 each to cover almost all their hot water needs (Loy and Coviello, 2005).

The government recently boosted the use of solar technology by enacting the National Housing Trust (NHT) to provide loans to contributors to purchase and install solar water heaters.

Two demonstration photovoltaic schemes supplying non-grid electricity to 45 homes in deep rural Jamaica have been established; these communities are Middle Bonnet in St. Catherine and Ballymony in St. Ann (Ministry of Energy, Mining and Telecommunications, 2006).

Existing photovoltaic applications for rural electrification have shown rather negative results due to a lack of continued monitoring and maintenance as well as the absence of funding for spare parts and rehabilitation. New solar electric installations for remote houses will need to be established within an improved long-term financing and operation scheme (Loy and Coviello, 2005).

3.3.4 Production of ethanol and electricity from sugar cane

Jamaica is a traditional producer of sugar from sugar cane and has some experience with ethanol, even though this is limited to the dehydration of imported wine ethanol from the European Union (EU), which was sold in public tenders far below costs, and more recently cane ethanol from Brazil. Since the cessation of the EU wine ethanol export to the Caribbean countries in mid 2004, due to the development of a bio-fuels market in the EU, the Jamaican dehydration plants have turned to Brazil for a new source of ethanol feedstock supply (Loy and Coviello, 2005).

Several countries in the Caribbean region, including Jamaica, built dehydration facilities to produce anhydrous ethanol in order to benefit from the 1983 Caribbean Basin Initiative (CBI) trade protocol, which permitted exports of alcohol to the US, processed or dehydrated in the region.

The Brazilian firm Coimex, a large sugar trading company, rehabilitated the Petrojam Ethanol Limited (PEL) plant. This has facilitated the production and export of ethanol to the United States (US). The operations began in September 2005. In 2008, the Petroleum Corporation of Jamaica assumed total ownership of PEL.

With the intention of diversifying and revitalizing the Jamaican sugar sector, the planting of sugar cane is being extended and this raw material is being used as a feedstock for an indigenous ethanol production, mainly for the fuel supply to the national transport sector. On November 1, 2008, the Government introduced, on a phased basis, 10% ethanol in gasoline (E10) for the transport sector. Mandatory use of the ethanol blend was programmed for April 1, 2009.

Over 100 service stations have been certified by the Ministry of Energy and Mines, and the Bureau of Standards Jamaica (BSJ), to dispense E10. With 62 stations on-line in December 2008, the demand of E10 was 8,000 barrels per week (www.men.gov.jm, consulted in September 2009)

One of the largest renewable energy potentials for electricity in Jamaica is to be found in the sugar processing industry.

All Jamaican sugar mills are equipped with cogeneration units of low efficiency[1] for self-supply of heat and power by burning bagasse, while at certain times even additional oil and electricity has to be purchased from outside, or electricity is produced in own diesel

[1] System efficiencies of less than 10%.

plants. Typically, the boilers were designed to have an efficiency of less than 50%, as to maximize the amount of bagasse being fired. Excess bagasse was not desired when the plants were built and selling electricity to the grid was not an option.

With the installation of new high-pressure boilers and improvements in the energy efficiency of the sugar plants, more than 220 GWh/year of excess electricity could be supplied to the public grid, based on cane production in 2004. At least 300 GWh would be available, if the cane plantation is extended to former volumes for the (additional) production of bioethanol (Loy and Coviello, 2005).

Due to the harvest of period of only about 185 days per year and in order to secure firm capacity at the highest availability possible, additional fuelwood and/or coal or other biomass resources need to be fed into the boilers during the rest of the year. The necessary feedstock for most of the demand could come from dedicated energy plantations.

Recent field test have demonstrated that dedicated fuelwood plantations could provide more than 90 tonnes of wood per hectare and year, based on a five year crop cycle. Such fuelwood could be used to operate the sugar plant boilers during off-harvest periods, in order to secure firm capacity throughout the year (with subsequent higher sales prices for electricity supply). Other options could be to use pelleted and stored bagasse or fossil fuels as supplementary feedstock (Loy and Coviello, 2005).

3.3.5 Energy from waste

It is estimated that approximately 950,000 tonnes of waste are generated annually from households, industries, the commercial sector and other entities across Jamaica.

Of this amount, 72%, or 680,000 tonnes are collected by the regional waste managements (public service) in the island and contain a large proportion of organic matter (65%). Under anaerobic conditions as on landfill sites, this biodegradable material can produce more than 180 m^3 methane per tonne of waste over a time span of 50 to 100 years. About 50 to 80% of this gas can be captured by wells and drains and used in cogeneration facilities for heat and electricity production. Landfill gas extraction and use is one of the cheapest measures to tap renewable energy sources and offers good opportunities for additional financing within the flexible mechanisms of the Kyoto protocol (Clean Development Mechanism).

Apart from solid waste, liquid remains (such as wastewater and effluents with a high organic content from human settlements, industrial facilities and farms) can also provide a basis for biogas production as part of the anaerobic treatment of such wastes. Under tropical conditions, as in Jamaica, and with appropriate technologies, such biodigestion will always result in a surplus of energy, since the required temperature of the process does not have to be maintained by external heating.

Currently only about 30% of the domestic wastewater is handled by the central sewage system, which provides hardly any treatment and disposes most of the sewage with high organic loads into the open sea, or into the landscape. This is even truer for the remaining 70% of the non-collected sewage. About 150 private and public wastewater treatment facilities operate in the country. The majority of those central sewage treatment facilities has been constructed in the 1960s and is reported to be in bad condition. It is estimated that less than half of those installations are in workable conditions (Loy and Coviello, 2005).

Biogas from animal manure and sewage sludge can provide limited contributions to the overall energy consumption in Jamaica, but can have a significant impact in individual cases, like in the food processing industry, in connection with organic waste treatment. Sewage treatment plants can be operated on a stand-alone basis if biogas is used for oxygen supply and electricity needs (Loy and Coviello, 2005).

3.3.6 The Clean Development Mechanism

The Clean Development Mechanism (CDM) is an instrument within the Kyoto Protocol to which Jamaica is a signatory. Under the CDM, developed countries are encouraged to fund alternative energy projects (in developing countries and economies in transition) that will contribute to the reduction of greenhouse gas (GHG) emissions.

Financing through the sale of emission certificates within the Clean Development Mechanism can facilitate the implementation of renewable energy projects. Such could "earn" 0.4 US-cents/kWh and more in 2005.

Of particular interest for Jamaica could be small-scale projects of up to 15 MW capacity, which are subject to a fast-track procedure with reduced application requirements and lower transaction costs (Loy and Coviello, 2005).

Landfill gas projects can be of particular interest for CDM financing, since they can generate emission credits both, for methane abatement and for displacing fossil fuel based electricity.

4. Petroleum – supply, prices and demand

The refinery is the only importer of crude oil. The refinery, marketing companies and the bauxite companies import finished petroleum products.

Crude oil is imported from Venezuela under the new PetroCaribe Agreement replacing Caracas Accord. Crude oil is also imported from Mexico under the San Jose Pact, Ecuador and Nigeria. Refined products are mainly imported from Trinidad and Tobago, Venezuela and the United States.

Although from 2003 to 2007 the volume of imports has risen by only 10.5 per cent, the value of imports grew 146.9 per cent during this period (see Table 1). In 2007, the oil import bill surpassed the US$2 billion mark.

Jamaica has relatively low gasoline prices and tax rates for a non-oil producing country (The Energy Sector Task Force, 2007).

Petroleum consumption is dominated by the transport sector, the electricity generation sector and the bauxite and alumina sector. These sectors account for over 90 percent of consumption. The remainder is shared among cooking and lighting, manufacturing and the petroleum refinery activities.

Jamaica has entered into a bilateral arrangement with Venezuela under the PetroCaribe Agreement. The PetroCaribe Agreement, which was signed on 23rd June 2005, replaced the Caracas Agreement of 2001.

Under this new arrangement, Jamaica can purchase 23,500 barrels of crude oil and petroleum products per day from Venezuela.

The agreement also covers the following:

- Jamaica pays the full market price for the products provided. Forty percent of the payment due are treated as a loan over a 25-year period at one percent rate of interest.
- The loan funds should be used for social and economic programmes to improve the life of the poor.
- The Petrojam refinery will be upgraded to increase its output from 36,000 barrels per day to 50,000 barrels per day.
- The Refinery will also be configured to process heavier grades of crude oil

5. Supply of liquefied natural gas

In November 2004 the governments of Jamaica and Trinidad and Tobago signed a Memorandum of Understanding on the annual supply of 1.15 million tonnes of liquefied natural gas (LNG) under preferential pricing terms over a 20-year period.

The delivery was envisaged to start in 2008 and would mainly contribute to the supply of two new combined cycle power plants, the growing energy demand of the bauxite and alumina industry, the subsequent replacement of oil in other power plants and the requirements of other industrial, commercial and residential final consumers.

Private investors were sought to participate in the setting up of the infrastructure needed to unload, store, regasify and distribute LNG. In 2004 the purchase price was expected to be below 3.90 US$/million BTU, equalling prices paid by large-scale customers in Trinidad and Tobago, when the world market price was around 4.30 US$/million BTU (Loy and Coviello, 2005).

In September 2009, the negotiations, led by the Minister of Energy and Mining, were still seeking to secure long-term supply of LNG from providers, determine the best import re-gasification solution for Jamaica, and identify partners for the supply of technology, capital and management for a local liquefied natural gas industry (www.men.gov.jm, assessed in September 2009).

According to a Ministry' spokesman: "A switch from oil to LNG would *revolutionize* Jamaica's industrial sector, particularly within the bauxite and alumina sector, and go for a far way in *resuscitating the country*".

6. Electricity – supply, demand, losses, costs and rates

Electricity is provided to consumers by JPSCo. There are, also, self-producers, highly concentrated in the bauxite/alumina and sugar industries.

Total generating capacity in Jamaica was approximately 818 MW in 2006, which includes 217 MW capacity provided by independent power producers. Total electricity output was estimated at 4,046 GWh at that year, of which some 33% was provided by non-JPSCo sources, up from 28% in 2005. Residential use accounted for approximately 35% of annual consumption (GWh) while large scale users (rates 40 and 50) accounted for 41%.

About 40% of the generation capacity is over 30 years old and need to be replaced. The proportion of diesel oil based generation capacity in the total generation capacity mix (34%) is high and requires expensive fuel (Ministry of Energy and Mining, 2009).

System losses in transmission and distribution represented 23% of total output in 2006 (as estimated by the Office of Utilities Regulation), of which approximately 12.5% is represented by non-technical losses, including theft (The Energy Sector Task Force, 2007).

Renewable energy sources contributed 5.32 percent to gross electricity generation in 2005. It is the government's aim that this contribution will increase to 10 percent by 2010 and 15 percent by 2020.

Government rehabilitated six of the mini-hydro plants, which were privatized to the JPSCo and now account for 22 MW of capacity to the system. A 20.7 MW publicly owned wind farm was commissioned in 2004 at Wigton, Manchester costing US$26 million. Wind and hydropower are used for baseload generation.

A total of 23.2 MW of cogeneration capacity was brought on stream of which 12.2 MW was produced by Jamaica Broilers and 11 MW by Jamalco. Subsequently, the Jamaica Broiler's production was suspended and Jamalco reduced its available export capacity to approximately 6 MW as a result of the expansion in production capacity of 250,000 tons.

The average operation costs of the public supply power stations in Jamaica were estimated to be around 7 US-cents per kWh in 2005, with 4 cents originating from fuel costs and 3 cents from other operation and maintenance costs. The electricity supplies of two independent power producers, JPPC and JEP, in 2005 were expected to cost 11.5 US-cents/kWh and 11.0 US-cents/kWh. A new plant, expected to be commissioned by JEP at the end of 2005, was expected to supply electricity under the same unfavourable (while expensive) pricing terms[2]. Even under optimistic fuel price conditions, average generation costs will not significantly decrease in the coming years, taking into account the installation of a new combined cycle plant based on liquified natural gas (LNG) with preferential energy supply prices and on further plants based on oil. The high generation costs of the current inefficient plant stock (which needs to stay in operation) will prevail (Loy and Coviello, 2005).

The average price of electricity in Jamaica was estimated by the Office of Utilities Regulation (OUR) at US$0.23 per kWh in 2006, with a generation cost of US$0.16 per kWh. Bulk electricity prices to energy-intensive industrial users in Jamaica were in the range of US$0.18-0.21 per kWh at that year, significantly higher than bulk electricity prices in Trinidad, which range as low as US$0.02-0.03 per kWh (The Energy Sector Task Force, 2007).

Electricity rates vary according to group. There are five different groups: residential, streetlight, general service, power service and large power.

In 2005, the highest annual average rate of electricity was J$14.23 per kWh and this was for the general service category. The second highest was the residential category, with a rate of J$14.04 per kWh.

Electricity prices now reflect true cost. However, Government's policy continues to provide a lifeline rate, which benefits monthly consumers of less than 100 kWh per month. This cross-subsidy is provided by those consumers using more than 101 kWh per month (Ministry of Energy, Mining and Telecommunications, 2006).

7. Universal access to electricity

[2] At least until cheaper liquefied natural gas (LNG) is made available.

In 1995 the state-owned company Rural Electrification Programme Ltd. was established as a non-profit company to ensure that rural communities that lie outside of the grid network would be provided with electricity. Since beginning, 7,000 km of low voltage distribution lines were constructed at state costs (with support of international donors like the Caribbean Development Fund and KfW) and later handed over to JPSCo, and approximately 70,000 rural homes were electrified (Loy and Coviello, 2005; Ministry of Energy, Mining and Telecommunications, 2006).

Since then, the mandate has been extended to provide electricity to certain marginalized groups under the Urban Electrification Programme.

It is the intention of the government to facilitate universal access to electricity. Approximately 92% of households island-wide now have access to electricity.

It is estimated that about 20,000 houses remain for electrification, of which roughly 6,000 houses do not meet the required density standards for grid extension and would therefore be targets for stand-alone generation systems, which could include the use of renewable energy sources (Loy and Coviello, 2005).

8. Energy conservation programmes

The demand side management and energy efficiency programme introduced in 1996 has had some positive impact on the residential lighting market. A study commissioned by the World Bank in 2005 to determine the impact of the demand management side programme shows an estimated 28 MWh/year reduction in demand for electricity, eliminating the need for 6 to 8 MW of peak capacity.

The installation of several hundred solar water heating (SWH) units was stimulated by activities under the Demand Side Management (DSM) demonstration project operated by JPSCo in the period 1998 – 2001, by the introduction of a tax reduction for imported systems in the range of 5 to 30% and the total exemption from CGT[3] payment for imported products since 1994. The promotion activities within the DSM programme targeted the residential as well as the commercial and service sector. Both parts were financed by a grant and a revolving loan with assistance from the World Bank. More than 300 units have been installed in the residential sector after the solar water heating units were selected on the basis of an international bidding. Measurements have shown that, on average, an annual 1,825 kWh of electricity could be saved in households (Loy and Coviello, 2005).

The commercial part of the DSM programme combined energy audits and the installation of SWH units on selected properties. Such units were integrated into the hot water supply of 10 hotels and two student residences at the University of West Indies in Kingston. As a consequence of those activities, the market got off the ground and more than 1,000 units were installed in 2000 alone (Loy and Coviello, 2005).

A draft Energy Building Code to guide energy efficiency and conservation in building designs has been prepared and will now be subjected to review by the relevant stakeholders before promulgation.

[3] A type of value-added tax.

Government approved an initial allocation of US$10 million to establish an energy fund to finance energy conservation and efficiency projects (Ministry of Energy, Mining and Telecommunications, 2006).

The Ministry of Finance and the Public Service and the Inter-American Development Bank (IDB) signed, on August 2009, an agreement for a grant to fund an Energy Efficiency and Conservation Technical Assistance programme valued at US$ 437,500. The objective of the programme is to support the Government efforts to improve energy efficiency in the public sector, and provide the technical assistance to prepare a potential energy efficiency loan programme. The country's energy costs for last year totalled approximately US$ 2.7 billion, with public sector consumption accounting for 20% of that amount. Earlier this year, the Jamaican Prime Minister gave the directive that the public sector should cut its energy consumption by 15% (www.men.gov.jm, consulted in September 2009).

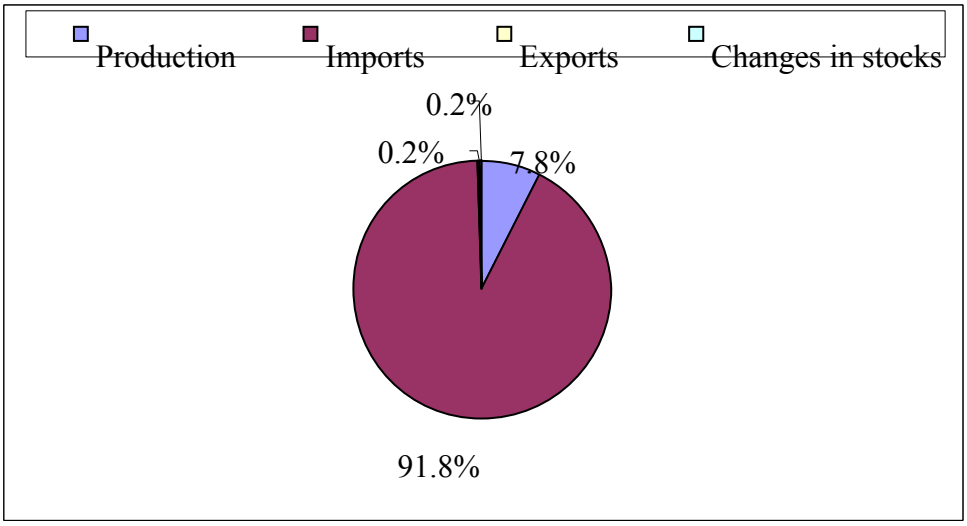
The Energy Efficiency and Conservation Technical Assistance programme has five components: evaluation of energy consumption patterns for public sector buildings; cost assessment of public sector energy consumption; cost benefit analysis of retrofitting public sector buildings with energy efficient equipment; investment plant for energy efficient equipment installation; and definition of a term of reference for an energy services company.

9. Some energy statistics for Jamaica

The energy statistics for Jamaica presented in this section of the report are divided in two categories: energy supply statistics and energy demand statistics. The main sources for them are the last issue of OLADE's Energy – Economics Information System - SIEE (OLADE, 2008) and the Jamaican Ministry of Energy and Mining. OLADE repeated for 2007 the Jamaican Energy Balance of 2006 (OLADE, 2008).

9.1 Energy supply

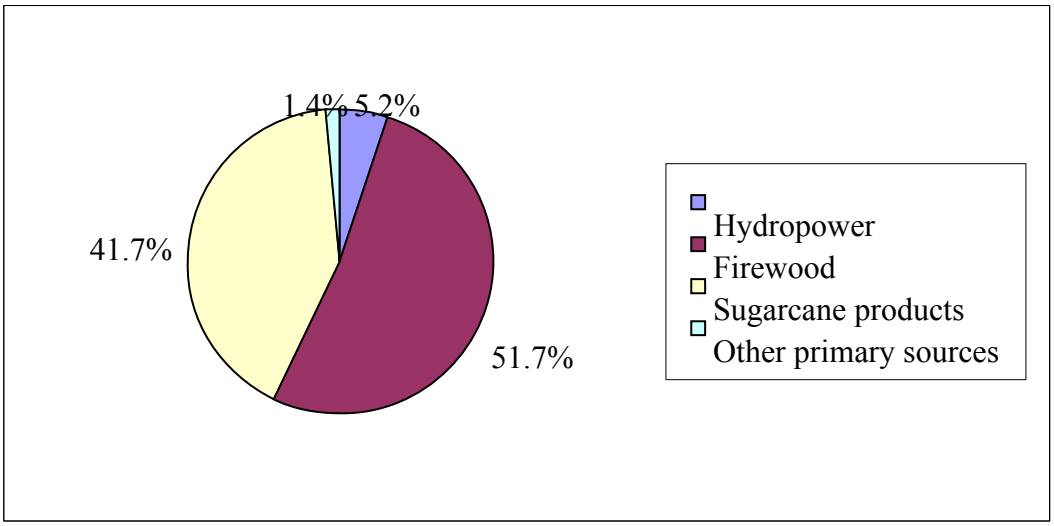
In 2006, the energy supply in Jamaica was of 31,734,070 barrels of oil equivalent (boe). From this total, 91.8% were imports and 7.8% were local production (Figure 1).



Source of data: (OLADE, 2008)

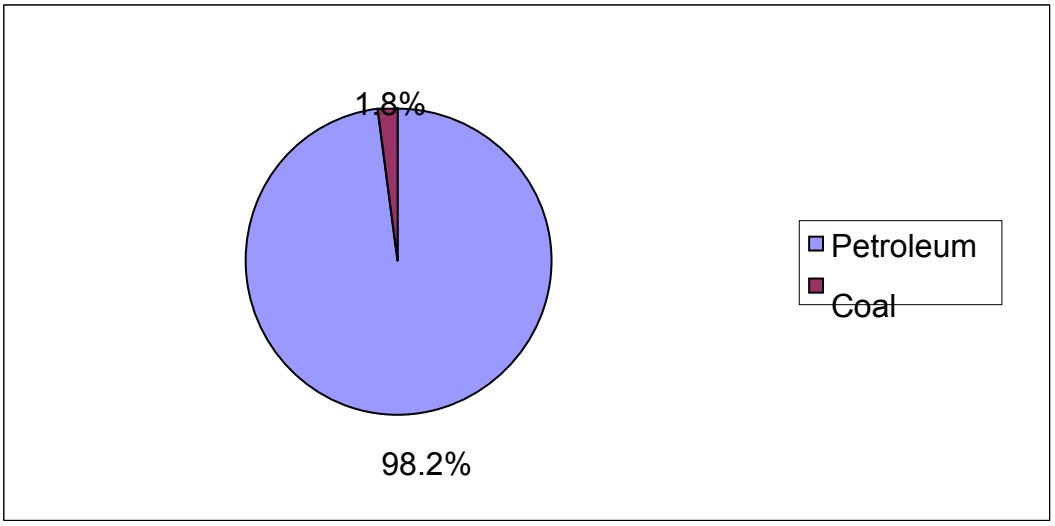
Figure 1 The shares of local production, imports, exports and changes in stocks in the energy supply of Jamaica in 2006

Jamaica produced 2,474,180 boe of primary energy in 2006. As shown in Figure 2, firewood was responsible for 51.7% of this energy, sugarcane products for 41.7% and hydropower for 5.2%. The country imported 7,629,640 boe of primary energy in that year, from which 98.2% were of petroleum (Figure 3).



Source of data: (OLADE, 2008)

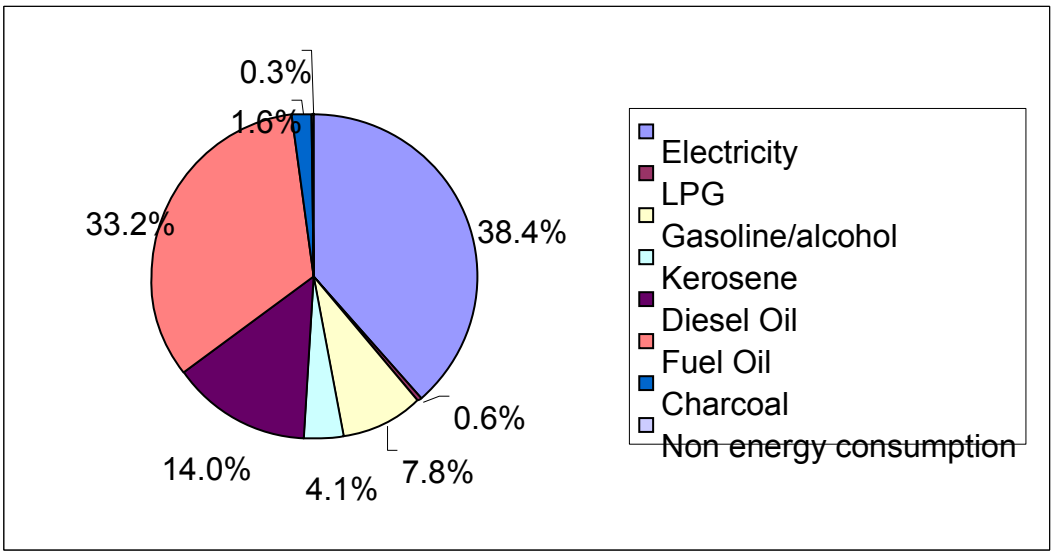
Figure 2 The shares of firewood, sugarcane products, hydropower and other primary sources in the total primary energy production of Jamaica in 2006



Source of data: (OLADE, 2008)

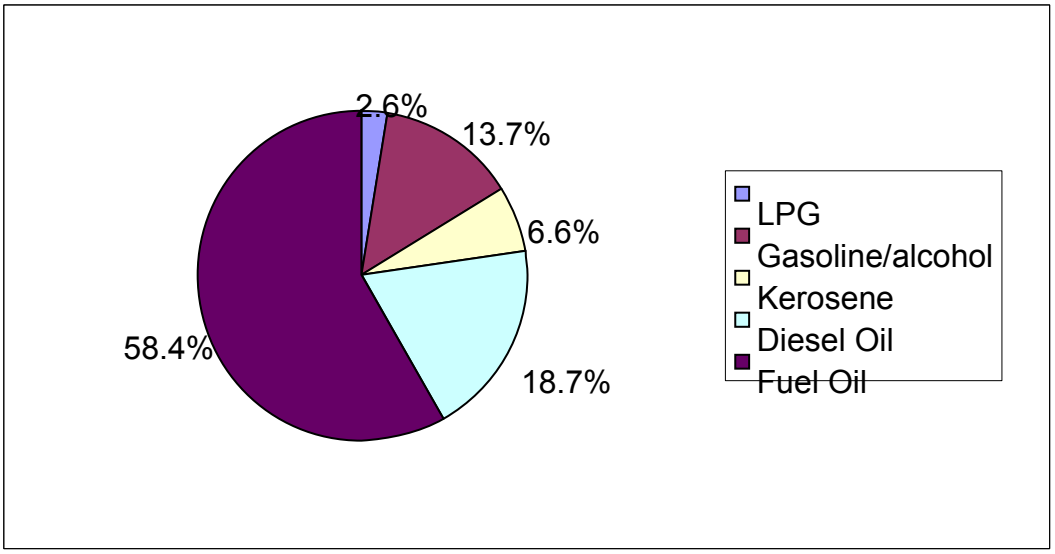
Figure 3 The shares of petroleum and coal in the total primary energy imports of Jamaica in 2006

The secondary energy production in Jamaica in 2006 was 12,069,610 boe and the main energy carriers, according to Figure 4, were: electricity (38.4%), fuel oil (33.2%), Diesel Oil (14.0%) and gasoline/alcohol (7.8%). The imports of secondary energy in that year – 21,616,790 – were mainly of fuel oil (58.4%), diesel oil (18.7) and gasoline (13.7%) (Figure 5).



Source of data: (OLADE, 2008)

Figure 4 The shares of the several energy carriers in the total production of secondary energy in Jamaica in the year 2006



Source of data: (OLADE, 2008)

Figure 5 The shares of the several energy carriers in the total imports of secondary energy in Jamaica in the year 2006

Figures 1 to 5 reveal the strong dependence of Jamaica on imports of both petroleum and petroleum products and that the largest part of the country's supply of petroleum products comes from imports; the rest is produced locally in one state-owned refinery, Petrojam.

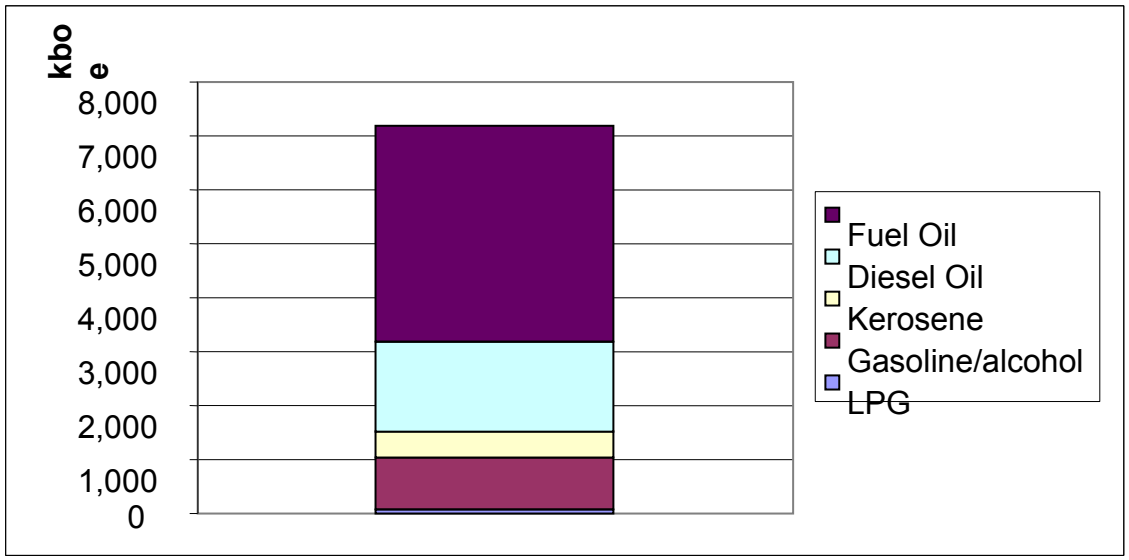
Table 1 shows both the volume, in barrels (Bls.), and the value, in US$, of crude oil and petroleum products imports in Jamaica during the period 2004 – 2008, carried out by Petrojam, the bauxite companies and the marketing companies. This table highlights the increasing burden of oil imports in the Jamaican balance of payments.

Table 1 Jamaican imports of crude oil and petroleum products from 2004 to 2008

Refinery		2004	2005	2006	2007	2008p
Crude & spikes	*Volume (Bls)*	5,514,746	3,292,141	7,479,715	8,361,103	8,259,071
	Value (US$)	189,752,122	182,747,141	447,072,431	515,413,276	771,264,734
Refined products	*Volume (Bls)*	8,991,119	12,711,590	9,994,857	9,511,142	9,299,676
	Value (US$)	399,055,762	691,270,995	620,729,000	699,359,616	911,504,239
Sub- total	*Volume (Bls)*	14,505,865	16,003,731	17,474,572	17,872,246	17,558,746
	Value (US$)	588,807,884	874,018,136	1,067,801,431	1,214,772,892	1,682,768,973
Bauxite companies						
Bunker C	*Volume (Bls)*	7,015,657	6,958,345	7,344,159	6,569,111	6,908,380
	Value (US$)	170,168,701	240,049,993	343,339,011	343,834,169	512,568,667
Low vanadium	*Volume (Bls)*	2,110,179	2,351,020	2,282,260	2,056,526	2,110,982
	Value (US$)	52,068,788	80,955,467	103,097,899	101,064,780	162,362,061
Sub - total	*Volume (Bls)*	9,125,836	9,309,365	9,626,419	8,625,637	9,019,362
	Value (US$)	222,237,489	321,005,460	446,436,910	444,898,949	674,930,728
Marketing companies						
Refined products	*Volume (Bls)*	2,550,836	2,448,538	3,669,410	3,358,512	2,516,459
	Value (US$)	133,935,058	192,846,491	307,542,425	332,112,427	335,377,369
Lubricants	*Volume (Bls)*	88,017	56,335	89,797	73,754	37,161
	Value (US$)	9,457,001	9,388,370	15,721,104	16,017,072	8,630,700
Sub - total	*Volume (Bls)*	2,638,853	2,504,873	3,759,207	3,432,266	2,553,621
	Value (US$)	143,392,059	202,234,861	323,263,529	348,129,499	344,008,069
Non - bauxite total	*Volume (Bls)*	17,144,718	18,508,604	21,233,779	21,304,512	20,112,367
	Value (US$)	732,199,943	1,076,252,997	1,391,064,960	1,562,902,391	2,026,777,042
Grand total	*Volume (Bls)*	26,270,554	27,817,969	30,860,198	29,930,149	29,131,729
	Value (US$)	954,437,432	1,397,258,457	1,837,501,870	2,007,801,340	2,701,707,770

Note: p – preliminary
Sources: Petrojam Ltd, Marketing Companies and Bauxite/Alumina Companies.
Prepared by the Energy Economics and Planning Unit, Ministry of Energy and Mining, 2009

The Petrojam refinery processed 7,420,360 boe of crude oil in 2006 to produce 7,240,930 boe of petroleum products and 41,700 boe of non-energy raw material. As shown in Figure 6, the main yields of the refinery were fuel oil, diesel oil and gasoline, in this order.



Source of data: (OLADE, 2008)

Figure 6 Yields of oil products, in kboe, in the Petrojam refinery in 2006

Jamaica consumed 783,290 boe of wood in 2006 to produce 198,690 boe of charcoal, i.e., the losses in this process were very high: 584,590 boe (OLADE, 2008).

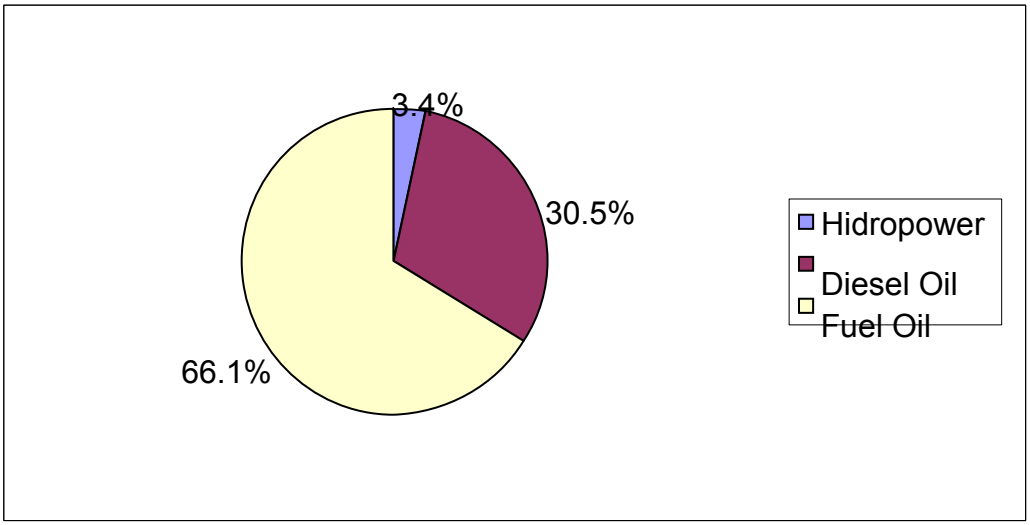
There are public service power stations and selfproducers in Jamaica. The former generated 2,454,550 boe, or 53.1% of the electricity produced in the country in 2006 – 4,629,990 boe (Figure 7). The large share of selfproduction is mostly concentrated in the production of bauxite and alumina and, to a lesser extent, in the sugar industry.

Source of data: (OLADE, 2008)

Figure 7 Generation of electricity in Jamaica, in boe, in public service power stations and by selfproducers in 2006

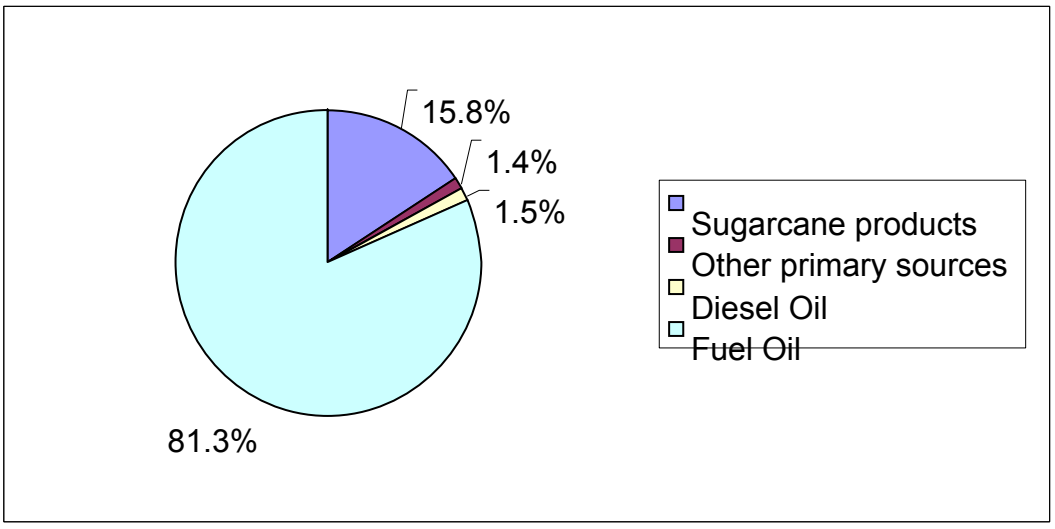
As shown in Figure 8, 66.1% of the electricity generated in the public service power plants in that year consumed fuel oil and 30.5% diesel oil; the rest was produced in hydro

power stations. Fuel oil also is the main energy source in the selfproducers' plants – 81.3%, followed by sugarcane products – 15.8% and much less by diesel oil – 1.5% and other primary sources – 1.4% (Figure 9).



Source of data: (OLADE, 2008)

Figure 8 Jamaica: Distribution, in %, of the energy sources used in the production of electricity for the public grid in 2006

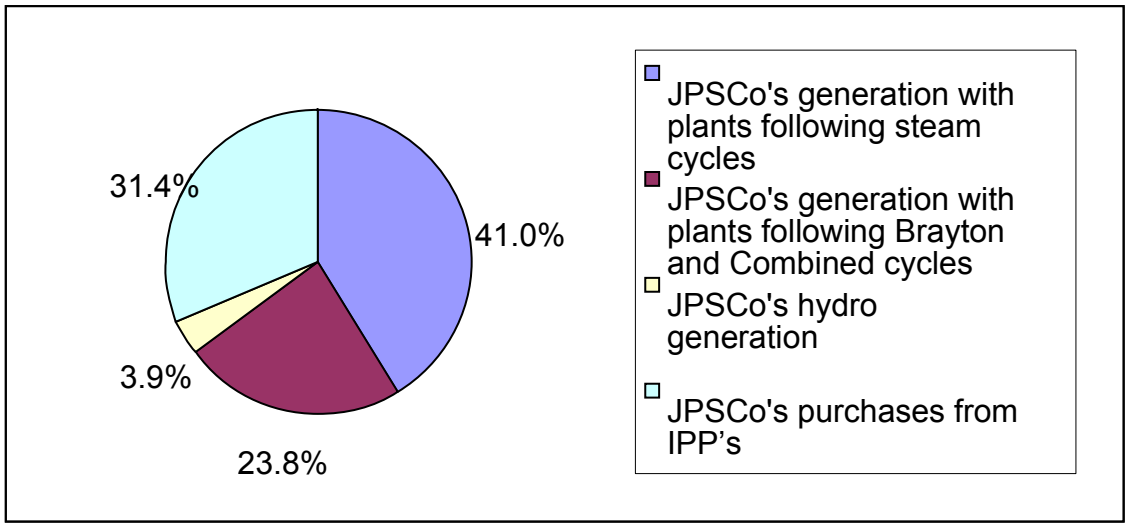


Source of data: (OLADE, 2008)

Figure 9 Jamaica: Fuel shares in the generation of electricity in the selfproducer's plants in 2006

In 2007, 4,078,770 MWh were produced for the public grid. Jamaica Public Service Company (JPSCo) Limited, the only electricity utility in the country, generated 41.0% of

this total in steam cycle thermal power plants, 23.8% in power stations which follow the Brayton, or the Combined cycles, and 3.9% in hydro power stations (Figure 10); the remaining power (31.4%), JPSCo bought from independent power producers (IPP's).



Source of data: JPSCo statistics, collected by the Energy Division, Ministry of Energy, Mines and Communications in 2008

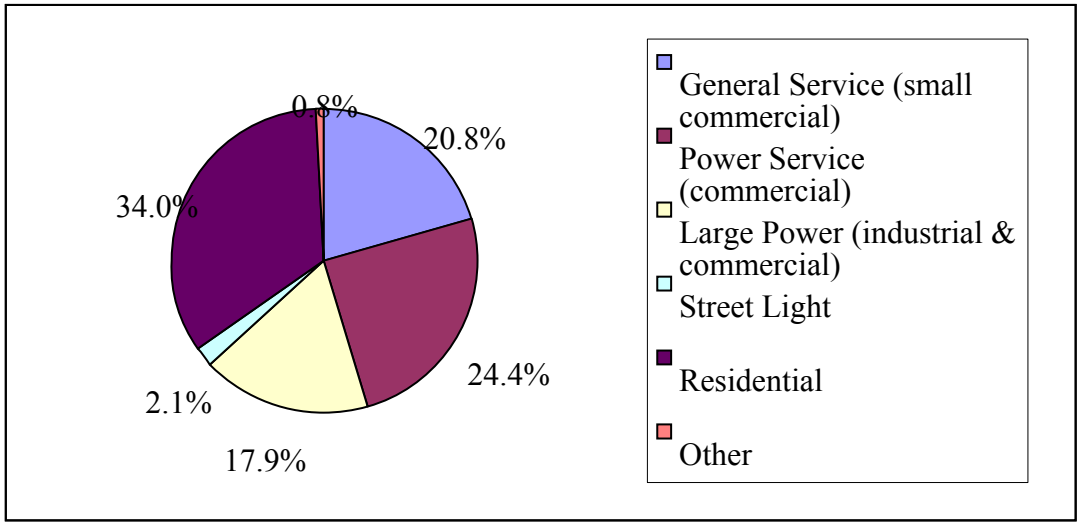
Figure 10 Electricity production for the public grid in Jamaica in 2007: distribution, in %, among JPSCo's power plant types and purchases from IPP's

Electricity losses in the transmission and distribution grids in Jamaica represented 22.15% of total generation in 2007, according to JPSCo statistics, collected by the Energy Division, Ministry of Energy, Mines and Communications. These losses decreased substantially from 2006 (34,81%), but are still very high, in terms of international practice.

In 2007, 3,164,022 MWh were sold in Jamaica by JPSCo and the per cent distribution of this amount among the rate classes referred to in section 5 of this report is illustrated in Figure 11. It can be seen, in this figure, that the households represent the largest consumer class, followed by the Power Service class (commercial consumers), the General Service category (small trade) and the Large Power class (industry and large trade), in this sequence. So, the households and the trade/services sector were responsible for the largest share of JPSCo's sales. It is important, however, to have in mind that the electricity needs of the producers of bauxite/alumina and sugar, within the industrial sector, are largely met by selfproduction.

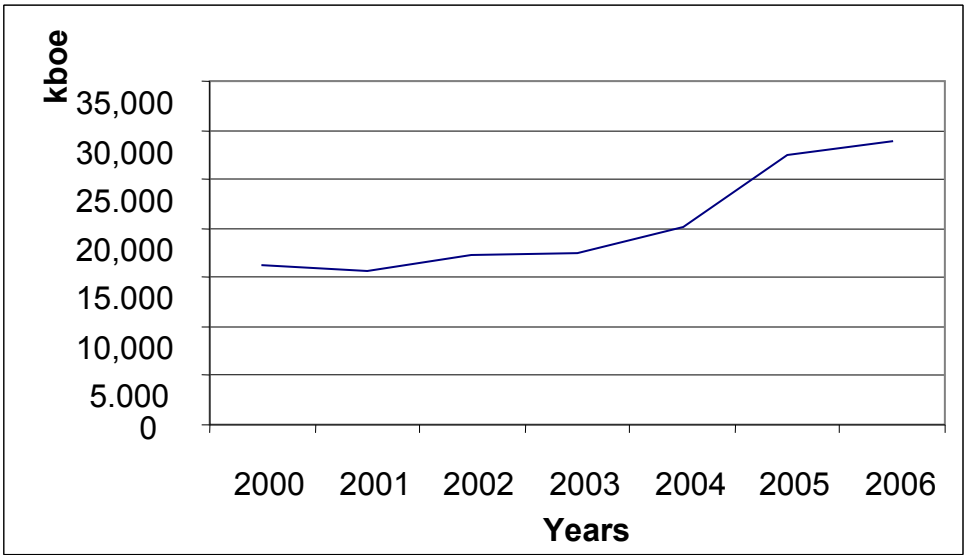
9.2 Energy demand

The total consumption of energy in the Jamaican economy from 2000 to 2006 is depicted in Figure 12. The value for 2006 was 28,801,390 boe. It should be highlighted, in Figure 12, the upward trend since 2001 and the strong consumption growth in 2005.



Source of data: JPSCo statistics, collected by the Energy Division, Ministry of Energy, Mines and Communications in 2008

Figure 11 Electricity sales of JPSCo in Jamaica in 2007: distribution, in %, among rate classes

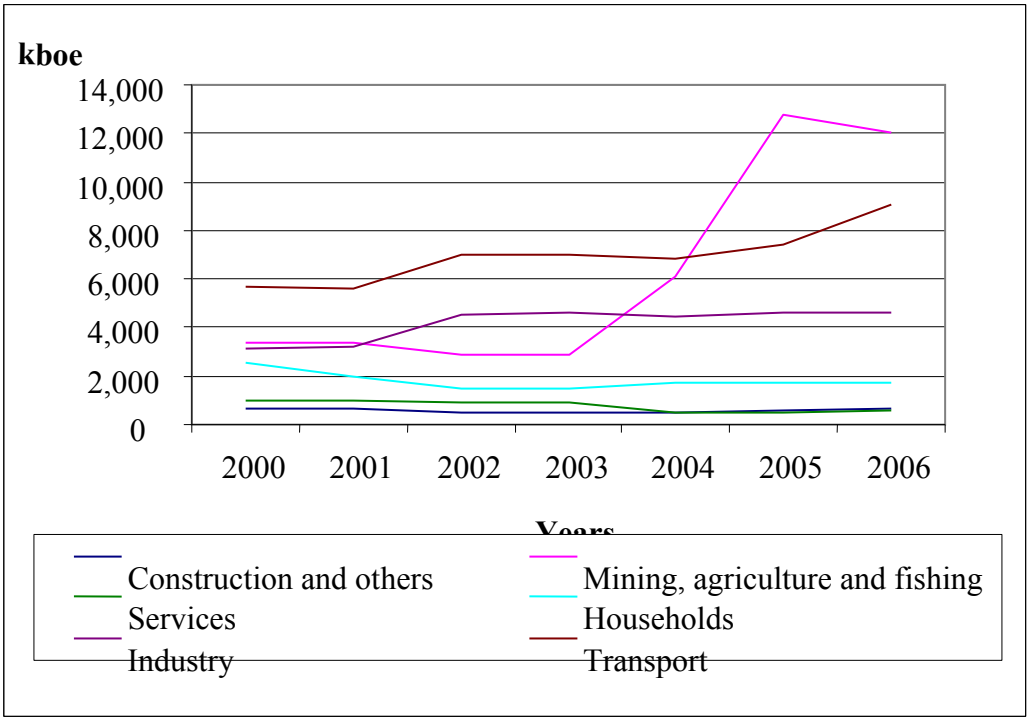


Source of data: (OLADE, 2008)

Figure 12 Total consumption of energy in Jamaica from 2000 to 2006

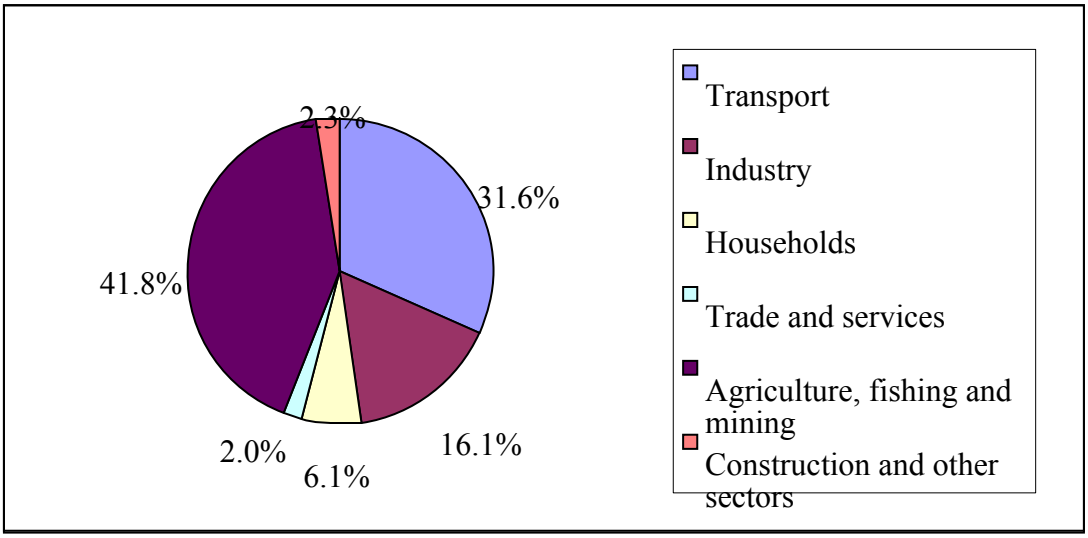
The evolution, from 2000 to 2006, of the total energy consumption in the Jamaican economy sectors is shown in Figure 13. Figures 13 and 14 reveal that the sectors which consume more energy in Jamaica are mining/agriculture/fishing[4] and transport. The energy consumption of the former experienced a larger than threefold jump upwards from 2003 to 2005. The energy consumption of the other sectors did not grow after 2002.

[4] Actually, mining much more than agriculture and fishing.



Source of data: (OLADE, 2008)

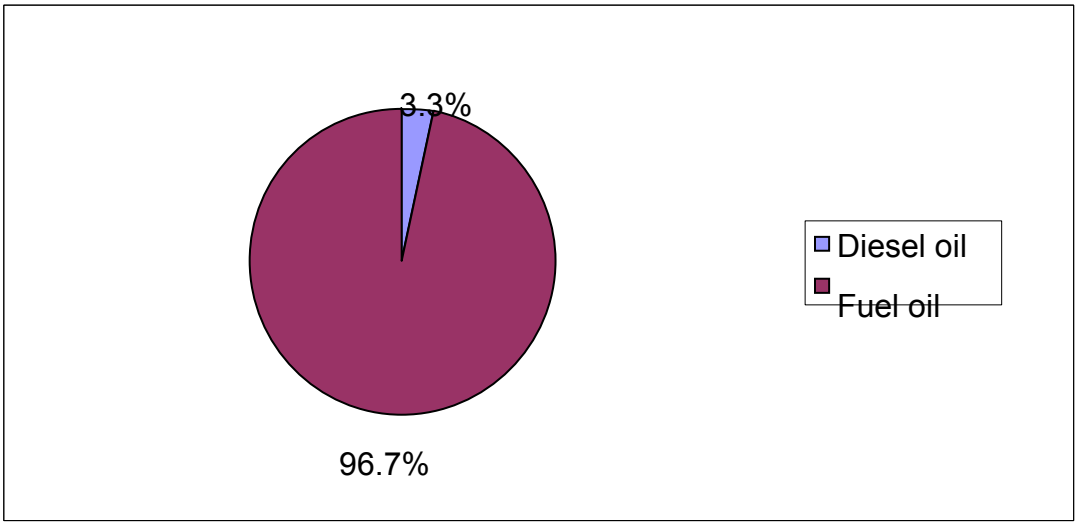
Figure 13 Total energy consumption, in kboe, in the Jamaican economy sectors, from 2000 to 2006



Source of data: (OLADE, 2008)

Figure 14 Distribution, in %, of the total energy consumption of Jamaica in 2006 among the sectors of the economy

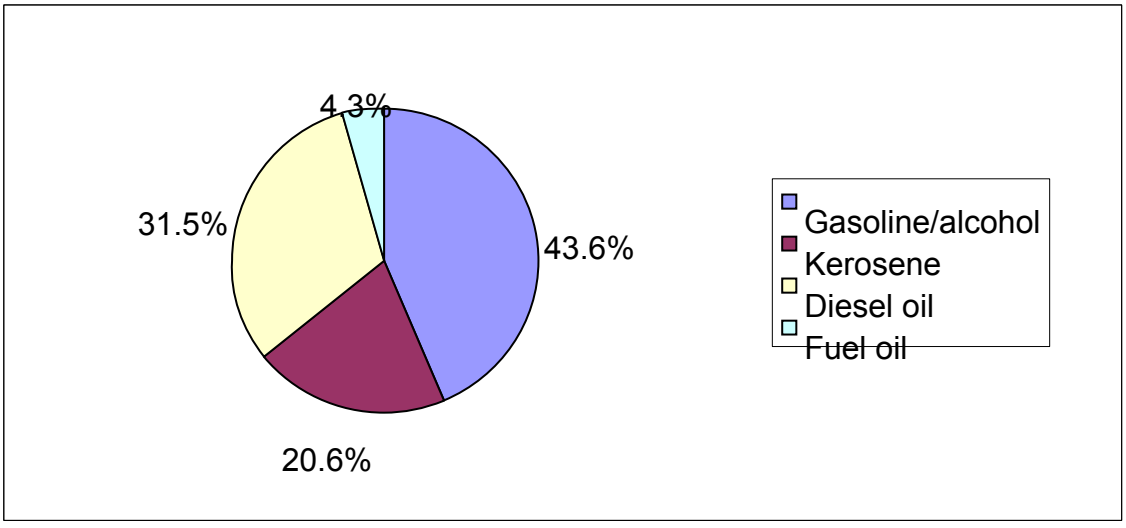
The mining/agriculture/fishing sector in Jamaica consumed 12,049,500 boe of fuels in 2006, 96.7% of this total as fuel oil and the rest as diesel oil (Figure 15). Part of these fuels, particularly of fuel oil, was used to generate electricity in selfproducer plants.



Source of data: (OLADE, 2008)

Figure 14 Market shares of fuel oil and diesel oil, in %, in the total consumption of fuels in the mining/agriculture/fishing sector of Jamaica in 2006

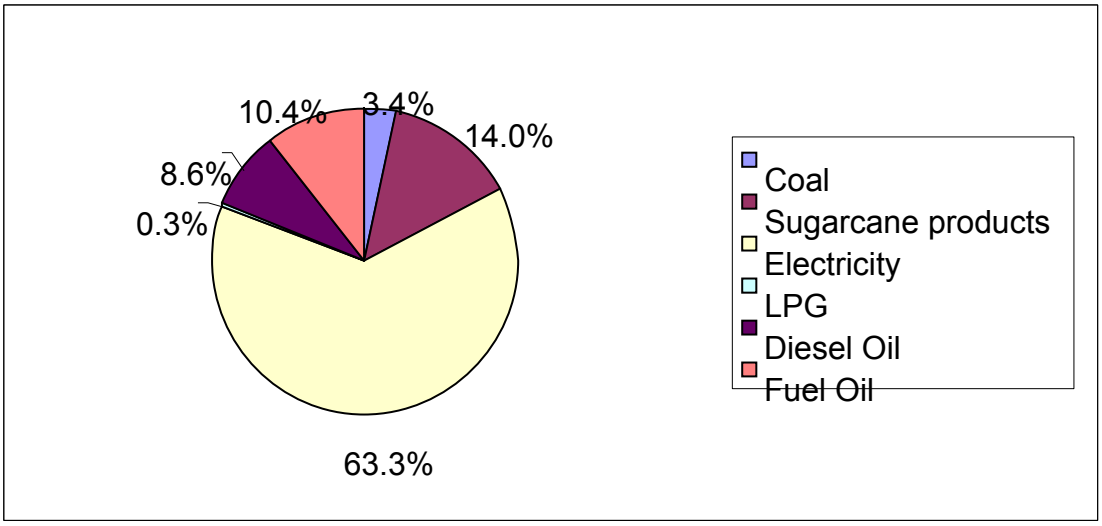
Transport activities in Jamaica demanded 9,094,950 boe of fuels in 2006. The market shares of each of these fuels are indicated in Figure 15, which shows that gasoline, diesel oil and kerosene, in this sequence, were the main fuels consumed in this sector.



Source of data: (OLADE, 2008)

Figure 15 Market shares, in %, of the fuels consumed for transport activities in Jamaica in 2006

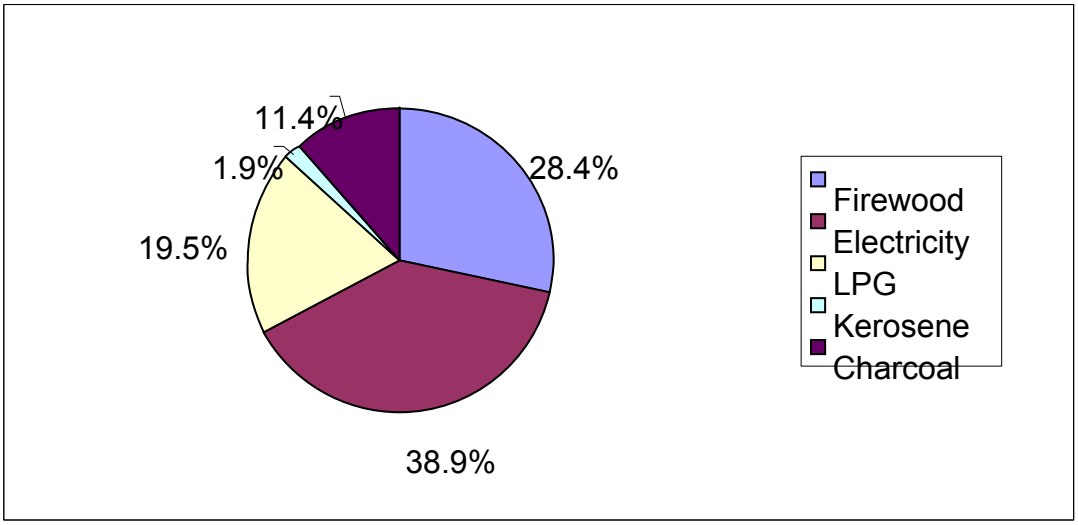
Electricity was, by far, the main energy carrier consumed in the industrial sector of Jamaica in 2006 (63.3%), followed, well behind, by sugarcane products (14.0%), fuel oil (10.4%) and other less demanded fuels (Figure 16). The total energy consumption of this sector in 2006 was 4,651,280 boe.



Source of data: (OLADE, 2008)

Figure 16 Market shares, in %, of the energy carriers consumed in the industrial sector of Jamaica in 2006

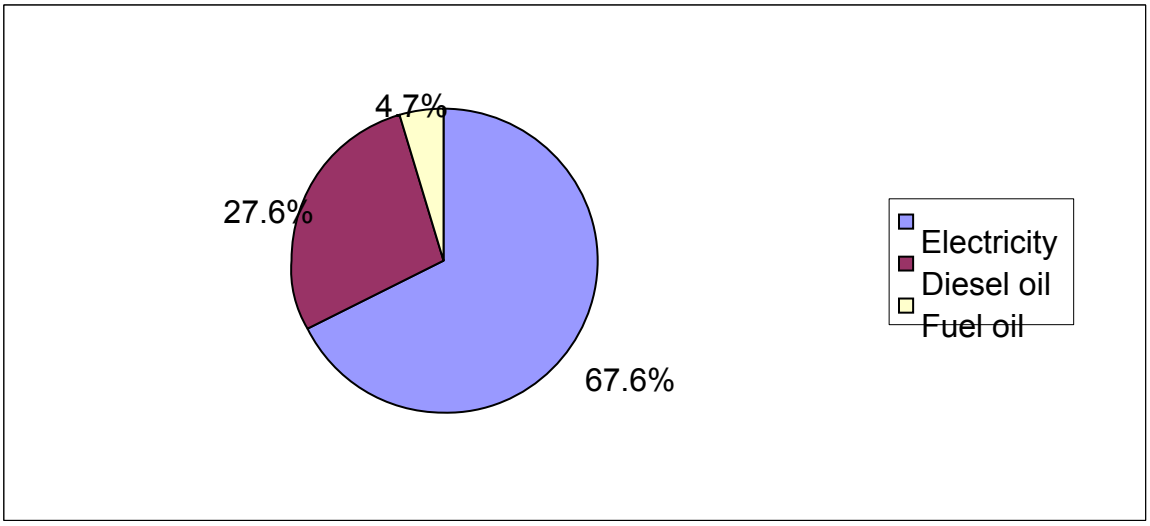
Electricity was, also, the main energy carrier consumed in Jamaican households in 2006. It was responsible for 38.9% of the 1,747,610 boe of energy demanded by these consumers in that year. As shown in Figure 17, traditional fuels, as firewood and charcoal, still accounted for nearly half of the total energy consumption of this sector in 2006.



Source of data: (OLADE, 2008)

Figure 17 Market shares, in %, of the energy carriers consumed by the Jamaican households in 2006

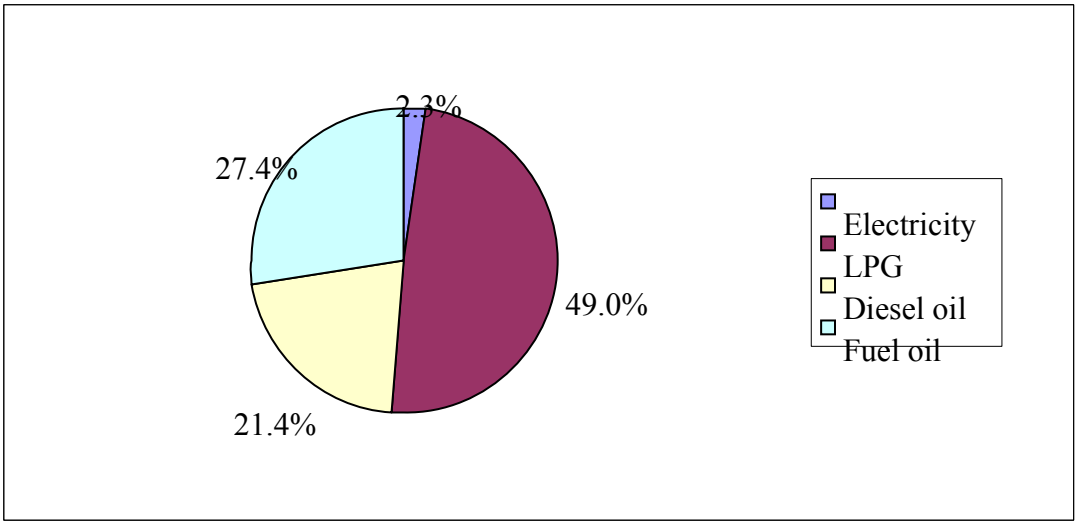
Trade and services in Jamaica demanded 589.620 boe of energy in 2006. Electricity led the basket of energy carriers consumed in that sector, with 67.6% of the total, followed by diesel oil, with 27.6%, and, then, by fuel oil, with 4.7% (Figure 18).



Source of data: (OLADE, 2008)

Figure 18 Market shares, in %, of the energy carriers consumed in trade and services in Jamaica in 2006

Finally, construction and other sectors of the Jamaican economy consumed 540,190 boe of energy in 2006, with LPG responding for 49.0% of this total, fuel oil for 27.4%, diesel oil for 21.4% and electricity for only 2.3% (Figure 19).



Source of data: (OLADE, 2008)

Figure 19 Market shares, in %, of the energy carriers consumed in construction and other sectors of the Jamaican economy in 2006

The consumption of petroleum products in Jamaica increased 6.4% from 2004 to 2008 (Table 2). The most consumed products in 2008 were fuel oil, representing 59.9% of the total, gasoline (15.6% of the total), diesel oil (14.3% of the total) and turbo fuel (5.8% of the total).

Table 2 Consumption of petroleum products in Jamaica, in barrels, from 2004 to 2008

Product	*2004*	*2005*	*2006*	*2007*	*2008p*
Aviation gasoline	3,110	5,700	-	-	-
Turbo fuel	1,789,865	1,571,738	1,983,596	1,931,222	1,598,706
Unleaded gasoline 87	2,828,599	3,149,273	3,330,554	3,232,175	3,194,939
Unleaded gasoline 90	1,569,397	1,433,463	1,174,201	1,068,783	1,069,595
E10	-	-	-	-	30,374
Kerosene	38,650	39,059	34,273	10,691	17,565
Auto diesel oil	3,978,967	4,537,938	4,004,230	3,827,121	3,661,327
Auto diesel oil Bunker	150,929	249,045	342,390	234,026	247,330
Fuel oil (Bunker - C)	11,969,553	13,133,964	14,805,667	15,463,354	14,249,852
Fuel oil (Low Vanadium)	2,116,349	2,153,727	2,226,127	2,055,242	2,122,071
LPG	864,289	885,671	929,258	902,979	925,288
Lubricants	87,995	88,885	104,529	89,420	55,027
Asphalt	254,753	129,413	192,771	150,660	137,755
Other	2,947	2,194	2,100	4,637	1,027
Total	25,655,403	27,380,070	29,129,696	28,970,310	27,310,856

Notes: (1) p - preliminary
(2) Information in this table does not include Petrojam's consumption
(3) For the refinery consumption see Table 3
(4) E10 was introduced in the Jamaican market in November 2008

Sources: Bauxite/Alumina Companies, Caribbean Cement Company, Jamaica Public Service Company, Independent Private Power Companies, Petrojam Ltd, Marketing Companies

Prepared by the Energy Economics and Planning Unit, Ministry of Energy and Mining, 2009

Table 3 presents the consumption of petroleum (the Petrojam refinery) and of petroleum products in Jamaica, during the period 2004 – 2008, by economic activity. According to the data of Table 3 for 2008, the activities which consume more of such products are bauxite/alumina processing, electricity generation, road and rail transport, shipping, and aviation, in this order.

10. Energy and the economy

Jamaica is an oil importing developing country. Over 90 percent of petroleum demands are satisfied by imported oil. This has placed Jamaica in a vulnerable position with respect to the movement of oil prices on the world scene.

Table 3 Consumption of petroleum, or petroleum products in Jamaica, from 2004 to 2008, by activity

Activity	*2004*	*2005*	*2006*	*2007*	*2008p*
Road & rail transport	6,075,623	6,247,835	6,373,380	6,079,884	5,803,724
Shipping	368,356	1,636,028	3,239,911	3,972,826	2,805,615
Aviation	1,792,975	1,577,438	1,983,596	1,931,222	1,598,706
Cement manufacture	104,791	37,066	14,338	28,477	26,004
Electricity generation	6,225,912	6,555,261	6,390,163	6,654,238	6,274,571
Bauxite/alumina processing	9,444,053	9,799,121	9,551,792	8,810,650	9,392,039
Sugar manufacturing	75,993	40,283	50,055	61,491	52,926
Cooking & lighting	902,939	924,730	963,531	912,116	931,853
Other manufacturing	135,991	163,261	181,695	198,995	128,678
Other	186,022	180,749	83,935	80,332	73,537
Total	25,312,655	27,161,772	28,832,396	28,730,231	27,087,653
Petroleum refinery	223,266	164,247	331,788	362,947	355,076
Grand total	25,535,921	27,326,019	29,164,184	29,093,178	27,442,729

Notes: (1) p - preliminary
(2) In 2005, Petrojam entered into an agreement to supply bunker fuels for vessels outside of the Kingston area to AGEAN Marine Petroleum SA Ltd., of Greece, through its subsidiary AGEAN Bunkering Jamaica Ltd.
(3) Totals do not include figures for lubricants and asphalts, which are non energy products

Sources: Bauxite/Alumina Companies, Caribbean Cement Company, Jamaica Public Service Company, Independent Private Power Companies, Petrojam Ltd, Marketing Companies

Prepared by the Energy Economics and Planning Unit, Ministry of Energy and Mining, 2009

The country pays for oil in foreign exchange. Whenever the local refinery is importing crude, it places a high demand on the foreign exchange market. This affects the price of foreign currency in the local exchange market.

Despite the rapid increase in world oil prices over the recent years and the record levels attained, Jamaica's energy consumption continues to increase at a much faster pace than the expansion of the economy. Over the period 2000 - 2006 the average increase in non-bauxite oil import**s** was 5.5%.

Jamaica has one of the highest energy intensity rates in Latin America and the Caribbean. This is largely due to the high energy use of the bauxite and alumina sector. In 2007, it took 3.51 barrels of oil equivalent (boe) to generate US$ 1000 of Gross Domestic Product (GDP), for US$ of 2000. In that same year, the per capita final energy consumption in Jamaica was 10.63 boe (OLADE, 2008).

Jamaica has no oil or natural gas reserves and the ratio between net exports of energy[5] and total supply of energy was – 0.92 in 2007 (OLADE, 2008).

The main characteristics of energy and its relationship with the Jamaican economy can be summarized as follows (Ministry of Energy, Mining and Telecommunications, 2006):

- excessive dependence on imported primary energy;
- low energy supply self-sufficiency due to a lack of indigenous energy resources, and low utilization of available sources, namely wind, hydro, solar and biomass;
- high petroleum consumption, that is concentrated in the alumina production, power generation and transport activities;
- rising share of oil products in the import energy supply mix relative to crude oil (the latter share has fallen from 42.5% in 1990 to 38.8% in 2007 (OLADE, 2008));
- low levels of the refinery utilization; and
- high system losses in the electricity industry, which has been deteriorating since 2001 and reached 22.1% in 2007 (OLADE, 2008).

11. Energy policies in Jamaica

In February 2006, the Jamaican government, through its Ministry of Energy, Mining and Telecommunications (MEMT), published, for public consultation, a National Energy Policy Green Paper for the period 2006 – 2020. A White Paper[6], however, did not follow suit.

The Minister of Energy and Mining said, in 2008, that the Green Paper referred to above has been in the Jamaican Parliament since 2006, with no action taken. He noted also that views gathered during extensive public consultations were not factored into the document and, as such, the Government felt that this policy document did not sufficiently respond to the country's energy development needs. Consequently, a five-member team was established and mandated to revamp the draft energy policy, in light of current and projected global and local realities (www.men.gov.jm, assessed in September 2009).

There are now seven areas of focus for the new energy policy: ensuring the security of Jamaica's energy supply; developing a modernised energy infrastructure; encouraging Jamaicans to adopt conservation measures; inclusion of renewable energy sources in Jamaica's energy mix; ensuring that Jamaica has a well-defined governance framework for the energy sector; the Government leading by example in energy conservation practices; and industries embracing the green economy and eco-efficiencies.

The new version of the Energy Policy Green Paper was tabled in the Jamaican Parliament in November 2008 (www.men.gov.jm, assessed in September 2009). It finally became a White Paper (Ministry of Energy and Mining, 2009), i.e. an official public policy document, after approval in the Parliament, in 2009.

[5] Exports minus imports of energy.

[6] According to British tradition, now adopted by several other countries and the European Union, the Government issues "Green Papers" to publicize and collect opinions and criticism from stakeholders about new public policies. Some time later, the Government uses this information to improve the policy proposals, which are, then, published, in their final form, in "White Papers".

The Ministry of Energy and Mining will have the dual responsibilities of articulating the policy and coordinating the monitoring of its implementation. The first role will require it to set out clear guidelines to its departments and agencies and other sister ministries and their departments and agencies.

According to the White Paper, there will be strategic plans and action plans developed for each of the goals set out in the Paper and aligned to the energy sector plan and the action plan developed under Vision 2030 Jamaica – National Development Plan. It is expected that each strategic plan will be developed for three years and will be further aligned and find expression with the Corporate Plan and budget of the Ministry.

The White Paper proposes a set of indicators for monitoring the evolution of the Jamaican energy sector and defines targets for some of them for the years 2012, 2015 and 2030. The indicators with targets associated are: energy intensity, percentage of renewable energy resources in the energy mix, percentage of total households with electricity, and greenhouse gas emissions per annum (Ministry of Energy and Mining, 2009).

In order to ensure that the desired outcomes of the National Energy Policy are being achieved, the effectiveness of the policy will be periodically assessed to identify when a complete review or alteration is appropriate (Ministry of Energy and Mining, 2009).

The long list of specific and vaguely defined energy policy measures present in the White Paper is not much different from the corresponding list in the 2006 Green Paper.

The most relevant policies of both the 2006 Green Paper and the current White Paper are presented below, together with some other complementary policy documents and information.

11.1 Diversifying energy sources and supplies

The Government's foreign trade policy seeks to strengthen bilateral relationships with energy supplying countries within and external to the region and especially with Venezuela, Mexico, Trinidad and Tobago, Ecuador and Brazil, as well as with North/West Africa and Middle East producing countries, and to preserve benefits negotiated under various bilateral energy agreements.

The Green Paper stated that the Government would revise existing regulations to make provisions that would ensure adequate inventory levels exist to cushion any short-term disruption in supply.

The current White Paper states that energy diversification will involve moving from an almost total dependence on petroleum to other sources, including natural gas, coal, petcoke, nuclear, and renewable energy such as solar, wind, and biofuels. In the short to medium term, natural gas would be the fuel of choice for generation of electricity and the production of alumina. In the longer term more sustainable and cheaper fuel options must be identified and developed (Ministry of Energy and Mining, 2009).

In 2008 Jamaica's supply mix consisted of 95% petroleum and 5% renewable energy sources. The White Paper expects that the supply mix will have marked changes by 2012, with petroleum representing 67% of the mix, natural gas 15%, petcoke/coal 5% and renewable sources 12.5%. By 2030, the share of petroleum in the supply mix is expected to be only 30%, with natural gas accounting for as much as 42% of the mix and renewable sources 20%. No Paper, however, provides no details about the assumptions and forecasts that support these estimates.

11.2 Oil and gas

The Jamaican government decided, few years ago, to re-evaluate oil and gas exploration data gathered over the last 20-30 years from various locations in Jamaica. From this analysis, indications arose that Jamaica could have some commercial quantities of oil and gas reserves. Accordingly, the Government has been encouraging companies to undertake further exploration work.

There are concerns about the abuse of dominant positions by some players of the Jamaican petroleum industry. The resulting tension between marketing companies and retailers often causes disruption of supplies for the domestic market, which adversely affects normal economic activity. Efforts to correct these weaknesses through moral persuasion and within the existing regulatory framework have not yielded sustained results. The Government has resisted the promulgation of regulation over the years hoping that self-regulation and good business practice would be adequate. So, the Green Paper recommends that the Government should use all the necessary instruments of policy, legislation, regulation and licensing to maintain a competitive and deregulated petroleum industry and to facilitate peace and industrial harmony.

The provisions in existing legislation that governs trading in, and handling of kerosene and LPG need revision.

Jamaica is prone to natural disasters, especially hurricanes that create dislocations in energy supplies. Thus, in cases of such disasters, according to the Green Paper, the Government should be empowered to intervene in the energy sector, if necessary, for a specified time, to bring order and ensure that national priorities are met.

Mergers and acquisitions in small economies such as Jamaica could undermine competition. Other jurisdictions legislate against anti-trust practices. So another policy recommendation is that the government should promulgate legislation and establish protocols to safeguard against mergers and acquisitions which could be anti-competitive.

The state-owned refinery, which operates in a fully liberalized and deregulated market, contributes 2% to gross domestic product. The government is committed to preserve the value-added benefits from the refinery. There is need, however, to increase capacity and modernize the refinery, to improve its efficiency. The proposal is that the Government should invite a broader participation in the ownership of an upgraded refinery.

Taxes on gasoline and LPG are low in Jamaica and are not differentiated for the other oil products. The Green Paper recommends that the Government should undertake studies and conduct consultations with stakeholders on taxation levels for petroleum products, with a view to instituting a system designed to enhance efficiency and conservation. Still according to the paper, the tax rate on LPG should remain low, as an important strategy to encourage its use as a convenient household fuel and to reduce the harvesting of fuelwood.

Still on the issue of fuel taxation, the Green Paper states that the Government should undertake studies and conduct consultation with a view to the possible introduction of an *ad valorem* tax on transportation fuels and the dedication of 80% of this increased revenue to the Road Maintenance Fund and 20% provided to the National Energy Fund to support conservation, efficiency and renewable energy projects.

11.3 Electricity

In 2007, the electricity sector responded for 23.2% of petroleum products consumed in Jamaica (see Table 3). It is therefore crucial to have high levels of efficiency in generation; fuel cost is "passed through" in the price cap regulation of electricity tariffs in Jamaica and underpins the competitiveness of the productive sector. Generation efficiency levels in the country have been under 30% during the nineties. The newer generation plants have higher heat rates and therefore as new generation capacity is added, the more efficient plants should be dispatched first. The Green Paper proposes two new policies concerning this subject: (i) the Government should establish efficiency standards for each generating unit with a schedule for phased replacement of inefficient plants; and (ii) the Government should make provision in a new electricity act for an independent and transparent system for merit order dispatch.

There is a need to reduce the current level of technical and non-technical losses in transmission and distribution of electricity. Since privatization, there has been an increase in total losses from 16.3% in 2001 to 20% in 2004 (Ministry of Energy, Mining and Telecommunications, 2006). According to the Green Paper, the Government should establish standards, to be rigorously enforced, for technical losses in transmission and distribution of electricity, as well as quality of service standards. Also, a new electricity act should make appropriate provisions for penalties for illegal tapping of power lines.

In 2006, approximately 16,000 rural households remained to be electrified. The Rural Electrification Programme, run by the Jamaican government, has the goal of facilitating universal access to electricity and in keeping with established standards.

11.4 Renewable energy sources

The Government of Jamaica expects to have renewable energy sources contributing more significantly to the local electric power system. To enable the development of this market, barriers to entry for energy from such sources and from cogeneration should be minimized. Among the key issues to be addressed are: appropriate protocols within which contractual arrangements are governed; wheeling, or third party access to the transmission and distribution grids; and net metering. The following policies addressing renewable energy resources are put forward in the Green Paper (Ministry of Energy, Mining and Telecommunications, 2006):

- Contribution from renewable sources to the electricity sector should be increased from the level of 6% in 2006 up to 10% by 2010 and 15% by 2020.
- Tax policies should be designed to encourage the development of the renewable energy sector.
- The Government should encourage the development of a domestic industry for the production of solar systems and biogas technologies.
- The Government should establish a centre of excellence, to bring focus to the development of the renewable energy sector.
- The Petroleum Corporation of Jamaica and other public sector agencies should actively stimulate the development of, and promote investments in this sector.
- The Government should seek to create a competitive market for solar water heating systems. It already has proposed that the National Housing Trust (NHT) provide loan financing for solar water heating systems to NHT beneficiaries.

According to the recently approved White Paper on National Energy Policy, renewable energy resources are expected to represent no less than 20% of the energy mix in Jamaica by 2030 (Ministry of Energy and Mining, 2009).

In April 2001, the government of Jamaica made it mandatory for public buildings requiring hot water to utilize solar energy for that purpose.

The DBJ-PetroCaribe SME Energy Fund is a line of credit, created in 2008 for small and medium-sized enterprises, to develop alternative renewable energy initiatives. The Development Bank of Jamaica will commit US$ 1 billion to this fund. Approved financial institutions will carry out the lending operations to the interested companies (www.men.gov.jm, assessed in September 2009).

Coming on the heels of the successful implementation of E10, the Ministry of Energy and Mining is moving to introduce a blend of motorgrade diesel fuel from locally grown plants such as castor beans and jatropha. A Biofuels Task Force was created for this purpose in March 2009, involving staff from the Ministries of Energy and Mining, and Agriculture and incorporates several industry stakeholders as well as multilateral agencies, including the Organization of the American States (OAS), World Bank, and Food and Agriculture Organization (FAO) (www.men.gov.jm, consulted in September 2009).

According to the draft of a new electricity policy, suppliers (currently only JPSCo) will be mandated to provide a certain percentage of renewable energy electricity annually, either through own generation or purchase from external providers. Non-compliance is thought to be fined (Loy and Coviello, 2005).

To smooth administrative procedures and attract foreign investment, the establishment of a one-stop agency as central contact point is proposed by Loy and Coviello (2005). This agency would act as a node between the investor and the Government, coordinate actions with all public entities involved and promote the integration of sustainable energy approaches into the main economic policies. The achievement of the renewable energy goals set by the Jamaican government will not only depend on external factors, but also on a strong and competent administrative structure with clear responsibilities and sufficient and well informed personal capacity.

Financial and fiscal incentives like income tax rebates or reduced duty taxes could lower the threshold for investments with high up-front costs, as is the case of renewable energy technologies. For larger projects the accessibility of low-interest long-term credits and an adequate risk management is essential. State guarantees can support and facilitate bank lending. An additional financing source could be the proposed Energy Efficiency Fund with an extension for renewable energy projects (Loy and Coviello, 2005).

Tendering procedures for renewable energy projects in the electricity sector make only sense if they are related to specific sites and technologies. A competition among different technologies and across various external conditions will hardly deliver the expected results and could even be counter-productive (Loy and Coviello, 2005).

11.5 Energy conservation

The Green Paper also proposes some policies for energy conservation in the domestic economy (Ministry of Energy, Mining and Telecommunications, 2006):

- The Government should implement a sustained energy efficiency programme to reduce motor vehicle use and electricity consumption in the public

sector, with emphasis on major users as the National Water Commission in the case of electricity.

- It should be a requirement for all ministries and public sector entities, specified energy-intensive firms, as well as publicly listed firms, to publish prescribed energy statistics.
- Companies with gross revenue of over US $ 3 million should be encouraged to include prescribed energy statistics with their annual reports.
- The Government should establish equipment standards to encourage energy efficiency.
- Government funded educational institutions should be required to include energy courses in their programmes.
- The Government should promulgate energy efficiency building codes, including passive solar design and solar technologies.
- The Government should establish a revolving energy fund to finance certain energy conservation projects such as retrofitting of buildings, to improve energy efficiency, that do not qualify for funding through traditional development bank facilities.

As an addendum to the Draft Energy Green Paper 2006-2020, the Government has mandated the development of an Energy Conservation and Efficiency Policy, to engage all sectors of the economy and all persons in the society in a coordinated and aggressive drive towards significantly reducing national energy consumption (Ministry of Energy, 2008).

Past efforts at energy conservation programmes have not been sustained. The proposed Energy Conservation and Efficiency Policy (ECEP) identifies strategies to overcome the barriers to the implementation of energy conservation initiatives. In this regard, the ECEP recommends that a targeted approach be taken with emphasis on public awareness, provision of financing and the establishment of an appropriate institutional framework. The Government intends to lead by example, ensuring that the public sector implements energy conservation initiatives as a matter of urgency. The private sector will be engaged and encouraged to participate in this national drive.

Electricity generation and the transport sector will be the major focus for the ECEP. For the whole economy, this policy sets targets in the range of 1.4 – 2% reduction per year, relative to the business-as-usual scenario (a conservative assumption of 2.8% growth in the energy demand). A target of 1.4% yields 292,231 barrels of oil savings per year and is based on plant/equipment efficiency upgrade only. A 2.0% reduction seemed as a reasonable target for the Ministry when all the other initiatives are taken into account (Ministry of Energy, 2008).

The recommendations of ECEP for the several sectors of the economy are:

- Public sector
  - Advancing energy conservation efforts towards a 10 – 15% reduction in use. Energy budgeting is strongly recommended;
  - Mandating that new buildings fulfill the requirements of the building code and have solar water heaters and photovoltaic devices installed where applicable;
  - Focusing on National Water Commission as the single largest consumer in the public sector, with intensification of loss reduction, improvement in pumping efficiency and introduction of a distributed storage programme, which will facilitate better management of pumping operations;

- Targeting street lighting for efficiency improvement;
- Expediting the implementation of energy efficiency measures in hospitals and other areas of the public sector, based on the findings of various earlier studies; and
- Establishing energy conservation protocols for the operation of public sector facilities, including the appointment of an energy coordinator for each facility.

➢ Private sector

- Expanding the financing facility for householders to access solar water heaters, photovoltaic home systems and other devices that increase energy efficiency at low interest rates;
- Replacing incandescent lamps with compact fluorescent lamps in homes and businesses;
- Encouraging the National Housing Trust and other financing agencies to introduce energy conservation initiatives as a condition of home improvement loans at preferential interest rates;
- Providing financial and technical support for the implementation of energy conservation programmes for the commercial and industrial sectors; and
- Establishing targets for energy use reduction for large commercial and industrial enterprises. Some facilities will be deemed energy management facilities and will be required to appoint an energy manager, have an updated energy audit, and implement a system of tracking and reporting.

➢ Electricity sector

- Encouraging the JPSCo to make significant contributions to an improved energy efficiency of the Jamaican economy effort by intensification of its loss reduction effort, heat rate improvement strategies, implementing a customer power factor improvement programme and reintroduction of a load research programme; and
- Implementation of a full scale demand side management programme is contemplated, with a target peak reduction of 30 MW.

➢ Transport sector

- Advancing and significantly expanding efforts under the National Transport Policy towards improved energy efficiency from better traffic management in urban centres by utilizing a range of strategies which include but are not limited to: park-and –ride and car pooling.
- Establishing and implementing minimum fuel efficiency standards for imported vehicles;
- Re-establishing the rail transportation system or conversion of the rail corridor into a mass transit road way; and
- Exploring the use of water transportation for moving cargo and persons around the island.

The inter-sector strategies proposed in ECEP are:

➢ Energy conservation market

- Stimulating an energy conservation market by encouraging the establishment of small energy services and products enterprises such as designers, installers and after-sales service providers;
- Increasing the availability of technological solutions for improving energy efficiency by removing duties on energy-efficient equipment and devices.

- Institutional framework
  - Establishing specialized units within the portfolio Ministry to:
    - Develop key indicators to measure the impact of energy conservation measures
    - Assess and monitor the effectiveness of approved energy conservation measures for periodic policy review
    - Design and promote timely public awareness messages according to energy consumption trends; and
    - Undertake economic analysis, modeling and forecasting energy demand for the transport and electricity sectors.
  - Expanding the role of the Energy Efficiency Unit (EEU) within the Petroleum Corporation of Jamaica (PCJ) to provide technical assistance for energy conservation initiatives in the public and private sectors.
- Codes, standards and labeling
  - Promulgating the energy efficiency component of the recently revised and updated national building code as mandatory standards in Jamaica;
  - Implementing a system of mandatory efficiency labeling of selected appliances, e.g. refrigerators, air-conditioners, washers;
  - Establishing minimum standards for air-conditioners and other end use devices.
- Environment
  - Apart from the energy cost savings to be derived from the implementation of energy conservation measures, there are the benefits to the environment of reduction of gaseous emissions;
  - The implementation of energy conservation programmes also poses an environmental challenge in terms of disposal of materials and equipment which may contain materials which could be harmful to health. Measures to ensure the safe disposal of used products will be devised in support of ECEP.

As one result of ECEP, the Jamaican government already suspended the common external tariff (GCT) to incentive imports of several energy-efficient items.

11.6 Fuel consumption in transport

A White Paper entitled "National Transport Policy" was presented to Cabinet in October 2005. The document contains some proposed policy positions that affect fuel consumption in this sector (Ministry of Energy, Mining and Telecommunications, 2006):

- The Government should maintain a lower level of import duty on vehicles with smaller engines than on vehicles with larger engine sizes.
- The Government should implement a lower tax on diesel-powered engines such that this will serve to increase the proportion of diesel-powered engines to reach a target of 30% of the annual imports within 10 years.
- Ethanol should be introduced as an octane enhancer to replace MTBE. Initially this should be at 10%, to be increased, incrementally, within five years, to 15%.

- The Government should promote a wider use of hybrid[7] and flexi[8] vehicles, through a discriminatory tax regime that favours fuel diversification and fuel efficient vehicles.
- Private mode of transportation is inefficient and demands significant investments for upgrading and maintaining road networks and the provision of expensive urban land for parking. So, a "balancing" between the public and transportation modes is an important step to improve energy efficiency in the transport sector.

12. Energy planning in Jamaica

12.1 The least cost expansion plan for the electric power sector

Under the present licence, the JPSCo is empowered to be responsible for the preparation of a least cost expansion plan (LCEP). The JPSCo also has authority to prepare tenders, invite bids and evaluate the bids for new generation capacity. Potential bidders for generation capacity have expressed concern with this arrangement, since there is a potential conflict of interest as JPSCo can also bid. The moral hazards associated with this arrangement are high since bidders would have revealed confidential financial and technical information, which could compromise their negotiating position with JPSCo.

While the Government has authority to approve the LCEP, administratively this has proven to be quite difficult (Ministry of Energy, Mining and Telecommunications, 2006). Therefore, the green paper recommends that a system for the proper planning and timely approval of a least cost expansion plan for electricity should be instituted consistent with a harmonized legislation.

According to a Jamaican government's energy sector long-term draft plan, expansions of the generating plant carried out in recent years have not represented least-cost solutions, and have involved turbines using high-cost fuels (The Energy Task Force, 2007).

The Least Cost Expansion Plan of November 2004, with addendum of March 2005, for the public electric sector assumes an optimistic average growth rate of 4.57% per annum for the peak load and a reserve margin of at least 25% until 2027. The planning period covers the whole time-span of the envisaged LNG import from Trinidad and Tobago (Loy and Coviello, 2005).

The LCEP assumes that the peak demand will more than double from 641.9 MW in 2005 to 1439.3 MW by 2027. Significant expansion in generation capacity will be required to meet this increased long-term demand, including replacement of existing plant with more efficient generators, increase in supply by private producers, and increased use of renewable energy sources. There are a number of projects to expand and improve electricity production including petcoke, coal and biomass projects. Another option in the medium term is the installation of a new combined cycle gas turbine generating plant based on the proposed supply of natural gas to Jamaica from external sources, which would require the installation of new import terminal facilities for natural gas.

[7] A hybrid vehicle integrates a gas engine and an electric motor to provide power.
[8] Flexi vehicles use gasoline and biofuels, such as ethanol, in various proportions.

The WASP model is employed to guide the Jamaica Public Service Company Ltd. (JPSCo) in the task of setting up the Least Cost Expansion Plan, and helps JPSCo's regulator – the Office of Utilities Regulation (OUR) in checking the results obtained.

WASP - "Wien Automatic System Planning" is a model widely used, since the seventies, in several countries for the expansion planning of mainly thermal power systems. It decomposes the original problem into two sub-problems and employs dynamic programming in the solution of the investment planning sub-problem and probabilistic simulation for solving the power scheduling sub-problem (Covarrubias, 1979).

12.2 Long-term energy plan

In 2006, the Government of Jamaica (GOJ) mandated the Planning Institute of Jamaica (PIOJ) to lead the preparation of a comprehensive long-term National Development Plan (NDP), called Vision 2030 Jamaica, which will seek to place Jamaica in a position to achieve developed country status by 2030.

Development of the Plan began in January 2007 and twenty-seven Task Forces (TFs) including the Energy Task Force were established thereafter. The TFs represent sectors and areas critical to the achievement of the national goals and have been charged with responsibility for developing the relevant long-term sector plans (www.pioj.gov.jm, consulted in September 2009).

The Energy Task Force commenced the plan preparation exercise in April 2007, leading to the completion and submission of a 1st draft report for the long-term development of the energy sector in Jamaica (The Energy Task Force, 2007).

This first draft of the Energy Sector Plan considers imperative to undertake a comprehensive upgrading of the island's electricity generation system to reduce production costs and the average price of electricity to consumers, and to pave the way for the long-term competitiveness of Jamaican industry.

According to this draft, Jamaica's future energy options may even include nuclear energy in the form of small pebble-bed nuclear reactors (small tennis ball sized helium-cooled reactors consisting of only 9 grams of uranium per pebble to provide a low power density reactor in the size range of 70-200 MW) which are expected to become commercially available in the time window 2020 - 2025 (Wright, 2007).

The bulk of energy consumption in Jamaica occurs in three areas: transport sector, bauxite and alumina, and electricity generation. The long-term planning for the energy sector therefore must be focused on these main areas, in order to achieve meaningful improvements. Reduction in the cost of electricity and other energy supplies must be a clear priority in the medium and long term (The Energy Task Force, 2007).

This draft of the Energy Sector Plan brings no energy demand and supply forecasts, as well as no quantitative targets concerning the goals pursued in the Plan, due, likely, to a combination of lack of modelling capacity and enough input data, with missing, or changing energy policies for the long-term.

Two institutions were helping the Ministry in November 2008 to carry out the modelling required for this long-term energy plan. The Argonne Laboratory was providing consultancy in the use of a demand-supply balance model licensed by the Laboratory, and a representative from the International Energy Agency (IAEA) was giving guidance on the utilization of the models MAED and MESSAGE, developed by the Agency for use in all member-countries and places where IAEA collaborates with the local energy planning staff.

An economist from the Ministry's Energy Economics Division was trained on-the-job on how to use these models, while he was trying to gather the input information and data for them, concerning the Jamaican economy and energy sector.

MAED is a demand forecasting model that follows the end-use demand forecasting steps typical for an engineering-economy model. It relies on the systematic development of consistent scenarios for the demand forecasts where the socio-economic and technological factors are explicitly taken into consideration. Through scenarios, the model specifically captures possible structural changes and evolution in the end-use demand markets. For competing forms of energies, the demand is first calculated in useful energy form and the final demand is derived taking market penetration and end-use efficiency into consideration. The model does not use pricing and elasticity information for the inter-fuel substitution as is common in the econometric tradition. This is a deliberate decision of the model developers as the long-term price evolution is uncertain, the elasticity estimates vary widely and because energy policies of the governments tend to influence demand significantly.

The energy demand is aggregated into four sectors: industry, transport, households and services. The industrial demand includes agriculture, mining, manufacturing and construction activities (or sub-sector). The demand is essentially determined by relating the activity level of an economic activity to the energy intensity. However, the demand is determined separately for non-substitutable energy forms (electricity, motor fuels, etc.) and substitutable forms (thermal energies). The need for feedstock or other specific needs can also be considered. The demand is first determined at the disaggregated level and then added up using a consistent accounting framework to arrive at the overall final demand. The model focuses only on the final demand and does not cover the energy used in the energy conversion sector (Bhattacharyya and Timilsina, 2008).

Message is a mixed: linear-integer programming model developed to optimize the expansion of an energy system. The objective function is the minimization of the total cost of the expansion path chosen. The problem formulation takes into account maximum amounts for the available energy sources, reserve margins, environmental constraints and operational rules (Sales and Bajay, 2006).

The model was designed to formulate and evaluate future alternatives strategies to supply energy, constrained by limits on investment levels, availability and prices of fuels, environmental regulations and diffusion rates, in the market, of new technologies. Information in the model are organized in the form of variables (flows, production capacities and stocks) and constraints (energy balances, physical limits on flows and capacities, financial constraints, etc.).

Useful energy forecasts from MAED are inputs to Message, together with assumptions about energy prices and technical, economic and environmental constraints associated to each energy source considered. Final energy forecasts for each source result from the interaction of these two models (Sales and Bajay, 2006).

Apparently this modelling effort is not progressing fast, since in the beginning of September 2009 a working session was held at the Ministry of Energy and Mining, with a senior programme manager from the International Science and Technology Centre (ISTC), *still to determine how well the MAED model will work when data from the Jamaican energy sector is applied* (www.men.gov.jm, consulted in September 2009).

12.3 Data availability

Data collection concerning demand and supply of energy in Jamaica is carried out, in a non-coordinated way, by the following institutions:

- Ministry of Energy and Mining;
- Statistical Institute of Jamaica;
- Planning Institute of Jamaica; and
- Bank of Jamaica (Central Bank).

There are now significant delays in accessing reliable information on various aspects of the energy sector. This has adverse effects on the ability to plan and take decisions on informed judgement (Ministry of Energy, Mining and Telecommunications, 2006). The relevant ministries and state agencies need to be empowered to collect reliable information, and on a timely basis to inform the decision making process.

13. Energy regulation in Jamaica

The Office of Utilities Regulation (OUR) was established in 1997 as a multi-sector regulator for electricity and other utilities (telecommunications, water resources, cable TV, etc.). The petroleum sector is regulated by the portfolio ministry; there is no independent regulator.

In the 1990s price controls were removed on fuel prices, and new marketing companies were allowed to access petroleum products at the refinery's Industry Loading Rack. The stamp duties were removed, making it easier for new traders to enter the market to import petroleum products into the country. There is, however, just one, state-owned, refinery, which imports all the petroleum processed in the country.

The JPSCo was privatized and operates under the All Island Electricity Licence 2001, which expires in 2021. In keeping with the provisions of the licence, the power generation side was liberalized in 2004 and some independent power producers now supply electricity to the national grid. JPSCo retains the exclusivity for transmission, distribution and retailing, which are regulated by the OUR under a price cap incentive regime; so, the utility acts as a single buyer for the electricity delivered by the independent producers. The provisions of the JPSCo's licence now set the framework for the regulation of the electricity sector (Loy and Coviello, 2005, Ministry of Energy, Mining and Telecommunications, 2006).

The different factors which determine the end-user electricity tariffs represent a price-cap scheme, allowing JPSCo to benefit from improvements (e.g. by reducing the heat-rate below the target levels) and accept financial disadvantages if the performance objectives and standards are not met.

Tariffs contain a basic connection and electricity charge (non-fuel base rate), and a variable fuel and independent power producer (IPP) charge. The fuel charge is adjusted monthly according to international fuel price changes, inflation and exchange rate of the Jamaican dollar. Fuel price variations are therefore directly transferred on to the consumers. The IPP charge is also monthly adjusted and reflects variations of the non-fuel costs of IPP's. Due to fuel price increases and the devaluation of the Jamaican dollar, generation costs and tariffs have moved upward considerably in recent years (Loy and Coviello, 2005).

The National Environment and Planning Agency (NEPA) has implemented emission standards and is the regulatory agency responsible for monitoring emission levels.

Jamaica has phased out lead from gasoline since 1999. This has contributed to the reduction in greenhouse gas (GHG) emissions.

The Green Paper of 2006 states that the Government should rationalize the institutional arrangement for the regulation and monitoring of the energy sector, with the objective of establishing an effective and efficient system.

14. Conclusions and recommendations

Already vulnerable for food security, Jamaica can not continue to be also highly energy dependent, which leaves it even more vulnerable.

Energy imports, which cost the country US$ 2.7 billion in 2008, exceed the export earnings. This imbalance does not tear apart the country's finances only because forty percent of the payment of oil imports from Venezuela are treated as a loan over a 25-year period at one percent rate of interest.

So, it is no surprise that energy diversification is a priority for the current Minister of Energy and Mining in Jamaica (www.men.gov.jm, assessed in September 2009).

Due to this critical situation, the government of Jamaica has been receiving, for already some years, technical and financial support from several countries and multilateral international agencies, some of them referred to in this report, to set up energy policies, to elaborate an adequate planning and to start actions aiming to solve the detected problems in the local energy sector.

As a result, there is now a quite elaborate and precise evaluation of where the main problems are and, also, some guidelines about the possibilities of how to sort them out.

The White Paper on National Energy Policy, approved recently in the Jamaican parliament after about three years dragging around, represents a clear advance over the Green Paper tabled on Parliament in 2006 not only because it has more focus on the main policies that should be adopted and it is related to the country's ongoing long-term National Development Plan, but also because it recognizes the complex interactions that the implementation of the proposed policies will require from several government bodies and private sector stakeholders, and it calls for concerted actions from now. The White Paper also indicates the key implementing institutions or companies (both government and private ones) for each of the policy goals set out in the document.

The next step is to define short, medium and long-term actions, as part of feasible and sustainable detailed targets and programmes and, for this purpose, planning and modelling is essential.

From the seven areas of focus in the White Paper, the development of a comprehensive governance and regulatory framework should be given the highest priority, right now, since the accomplishment of this is essential for the eventual success of the other policies. The barriers this consultant found when tried to meet the main players of the Jamaican energy sector, the weaknesses of the current least cost expansion plan for the electric power sector and the lack of long-term plans for the oil and gas industries and renewable energy resources illustrates well how serious this problem is.

The analysis of the short-term energy policies and actions taken by the Jamaican government in the last years reveals that most of the initiatives and investment have been

expected from the private sector, given some government guidelines and, in some cases, financial incentives. Several of these expectations, however, did not materialize. Besides, despite of the privatisation of JPSCo and the existence of some private independent power producers in the power sector and private marketing companies in the oil industry, the Jamaican government is still the owner of some sugar mills and alcohol dehydration facilities, which can produce bioethanol, and, particularly, it controls the apparently well organized Petroleum Corporation of Jamaica (PCJ).

Therefore, the Government should clearly define, during the elaboration of the short, medium and long-term plans accruing from the White Paper policies, which investments can actually be carried out by the private sector and with what incentives, which investments will be made just by state-owned companies, such as PCJ or its subsidiaries, and when partnerships between private and state-owned companies will need to be worked out to support the planned investments.

Energy policies and programmes directed to energy conservation can provide substantial energy savings already in the short-term, as pointed out in the Energy Conservation and Efficiency Policy (ECEP), and should be given high priority. Also, Government institutions should be models/leaders in energy conservation and environmental stewardship in Jamaica (Goal 6 in the White Paper on National Energy Policy).

Jamaica has good potentials for the development of some renewable energy resources, as discussed in this report. Bioethanol, solar water heating and wind power seem to be the most attractive in the short and medium terms; biodiesel and energy from waste follow suit.

The country's current problem with the balance of payments due to oil imports will not be solved just with the help of good policies and practices concerning energy conservation and a more widespread use of renewable energy resources. Substituting LNG for oil products certainly is a good policy for the short term. The high volatility of LNG's prices, particularly in recent years, the strong correlation they have with oil prices, and the recent moves to form an association of the major natural gas producers in the world do not assure stable and affordable supplies of this energy source much far in the future.

Imported coal and nuclear power, the last one perhaps in a collaborative work with other countries in the Caribbean region, should be carefully evaluated as likely cheaper solutions than LNG for generating electricity in Jamaica, in the medium and long terms, respectively. Some policies, programmes and background work, however, should be started soon, in order to have these options actually available in the future at reasonable costs and acceptable environmental impacts.

A more advanced draft of the Energy Sector Plan should be made available soon, in order to provide detailed targets and guide the first actions accruing from the White Paper on National Energy Policy. It is hard to understand why, even with the support given, since nearly two years ago, by the Argonne Laboratory and IAEA/ISTC consultants in the use of appropriate modelling tools, the first long-term energy demand and supply forecasts were not disclosed for public discussion[9]. Lack of reliable input data for the models and/or lack of agreement, among the main players of the Jamaican energy sector, about specific new projects, or targets to be achieved in the plan are possible explanations for this fact.

[9] Some long-term energy demand forecasts, however, for three alternative scenarios, contemplating business-as-usual, energy conservation measures and fuel diversification, are presented in the White Paper on National Energy Policy (Ministry of Energy and Mining, 2009).

Interactions among the stakeholders about the plan assumptions and targets are as important as their opinions about the energy policies that originate the plan. Any kind of government planning nowadays in democratic regimes, particularly when involves substantially the private sector, requires a high level of public consultation.

The models currently adopted by the Energy Economics and Planning Unit, of the Ministry of Energy and Mining to help in the elaboration of the Energy Sector Plan seem adequate for this task. Refining the modelling details is sometimes required and often is possible, depending on the availability of reliable input data. What matters, however, right now, is to speed-up the current learning-while-doing process.

The first barrier that should be overcome to improve the current least cost plan for the electric power sector is to pass a new electricity act in the Jamaican Parliament that empowers the Ministry of Energy and Mining with the tasks of elaborating this plan, preparing tenders, inviting bids and evaluating the bids for new generation capacity, instead of JSPCo. Other issues that should be addressed in this new act are the setting-up of a regulated third party access to the transmission and distribution grids, as happens today in many countries all over the world, and an independent and transparent system for merit order dispatch. The mature WASP model could continue to be used as an optimisation tool for the least cost plan under the Ministry responsibility, since it is perfectly able to simulate the basic characteristics of the Jamaican mainly thermal power system.

Possible future discoveries of oil and natural gas in Jamaican territory, the strong increase of market share envisaged for the renewable energy resources in the White Paper on National Energy Policy, and the need to plan the future availability and expected cost of the energy inputs to the existing and new power stations in the country recommend the opening of the, medium-term, least cost expansion plan to include, also, the expansion planning of fossil fuels' and renewable energy's facilities. In this case, other modelling tools should be added to the WASP model. This type of change occurred recently in Brazil (Bajay, 2009).

The long-term expansion plan is purely indicative and provides guidelines and insights for government policies and their eventual targets and for companies' corporate strategies.

In the other hand, the more detailed medium-term plan can be mandatory for the first years of the planning period, since the results of the plan can determine, as in Brazil (Bajay, 2009), which power stations, or plant types, the Ministry should prepare tenders and invite bids, including their commissioning dates. This can also be applied for tenders concerning areas for the exploitation and exploration of petroleum and natural gas.

Nine persons were responsible, in November 2008, for carrying out the core aspects of energy policy and planning in the Jamaican Ministry of Energy and Mining; the total staff was made up by 25 people. Twenty three new positions were expected for 2009. It is important to bear in mind, however, that, while more people can face more tasks, their qualification is essential in this kind of job.

No opportunities should be missed in the building up of a qualified team on energy policy making and planning in the Ministry of Energy and Mining, and all initiatives should be integrate whenever possible, in order to benefit from possible synergies among them.

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