CLEAN ENERGY – THE RENEWABLES OPTION[1]

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Abstract

Although deficient in fossil fuels Jamaica has alternative sources of energy in the form of such renewables as wind, solar, hydropower, biomass, biofuels and ocean energy. These should be developed with alacrity to the maximal extent that is economically possible. The renewable energy industry is now growing, looking to markets more than to governments. Once there is a narrowing of the gap between government goals and private sector expectations, and clarity about government objectives, commitment, and the decision-making process; private investment, both domestic and foreign, will follow. The global energy market is strong, growing, attracting private capital, and shows positive indicators for the future. It will bode well for renewables when domestic capital markets in Jamaica become stronger and more mature. Coupled with a thrust towards energy efficiency, the increase in renewables in the Jamaican Energy Mix will be an important pillar in Jamaica's Energy Future.

Introduction

The French writer Antoine de Saint-Exupéry suggested that "As for the future, your task is not to foresee it, but to enable it." The world now faces a problem of a conflict between energy and food supply. Presently, the world's population is just over 6 billion persons. By 2050 there will be 9 billion people. The problem is that the amount of arable land suitable for agriculture and food production will be halved by 2050 so we will have significantly less land and resources to feed more people. The situation is similarly exacerbated in the energy sector where the available oil is now at a peak or near the peaking point and oil and gas resources will continue to decline over time. There is probably approximately 60 years of oil reserves left, 80 years of natural gas but up to 150 years of coal. However, coal is not yet a clean fuel and its use will continue to adversely affect climate change.

Climate Change is one of the greatest threats to humanity. The response of the energy sector will be to see much more use of nuclear energy in the future because nuclear energy has little deleterious effect on climate change. It will also

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see a rise in the use of renewables such as wind, solar, hydropower, biomass, biofuels and ocean energy.

Role and Scope of Renewable Energy

Renewable Energy in most cases is coincident with clean energy. Renewables, as part of a cleaner energy mix is rising in importance.

Jamaica, a country deficient in fossil fuels should maximize the use of renewables as it plans its energy future

The use of renewables in the energy mix of Jamaica will be driven in part by public policy as well as the participation of the private sector in developing renewable energy sources as a business and in a partnership between government and civil society in creating a paradigm shift in culture to develop and use energy resources rationally.

Renewable energy technologies will reduce fuel import cost as well as emissions.

The goal is to increase the percentage of renewables in Jamaica on an annual basis towards a reachable target of 10% by 2015 and 15% by 2020.

In a stepwise progression towards a renewable energy strategy the following are important.:

1. Promulgation of a national energy policy emphasizing the use of all economically viable renewable resources.
2. Encouragement of the use of renewable energy through tax incentives and the promotion of energy efficiency and conservation.
3. The setting of reachable targets, obligatory or non-obligatory, for the development of renewable energy in the nations energy mix.
4. The utilization of carbon trading as a vehicle to encourage the development of renewables.
5. Promotion of conservation and efficiency measures to slow or reduce the growth in electricity demand.

Human capital will be an important component of renewable energy implementation, as will the organizational and regulatory arrangements to achieve significant progress in this area. Agencies in Jamaica will be mandated to be the driving force that will generate positive action.

It appears that there will be a gradual transition towards a hydrogen economy based in large measure, on fuel cell technology. Renewables will be an important source of hydrogen as fuel cell technology becomes mature.

Some relevant Renewable Energy Technologies to Jamaica

Wind and hydropower are the most competitive renewable energy sources when compared to fossil fuels such as oil, natural gas and coal. Solar energy is available virtually everywhere on the island and can be used for security lighting and hot water heating. Solar is not yet cost competitive with fossil fuels for electricity generation on a large commercial scale.

Bioethanol and biodiesel may become important components of the transport fuel mix with ethanol production sustaining a renewed sugar cane industry. Biodiesel with caster beans as a feedstock can be produced from marginal lands including mined out bauxite lands. If it proves to be cost competitive with conventional diesel, it will provide the additional benefit of being significantly cleaner and reduced dependence on the imported crude oil.

Other relevant renewable energy sources include Ocean Thermal Energy Conversion (OTEC), Wave Power, Geothermal Energy and Waste-to-Energy. The Geothermal Energy potential in Jamaica is limited. With the only approach being drilling deep into hot dry rock and introducing water, which will produce steam that can be used to drive a turbine. This technology, although theoretically possible, may not be economically practicable in the context of Jamaica.

Ocean Energy is presently not competitive with fossil fuels or with the more efficient renewable energy technologies such as wind and hydropower.

Wind

Wind energy has the advantage of being abundant and sustainable. No heat, air or water pollution is produced when wind power is converted to energy. In contrast to thermal plants (coal, nuclear, fuel oil), it does not require water for the production of electricity. Its disadvantages are the low density of the energy and the variability of the wind. Wind is free, but the capture of that energy is not free.

The initial cost of wind turbines is relatively high. If on-site storage is needed, then the initial cost can nearly double. The progress in the development of wind energy over the last ten years gives assurance that a gradual shift to alternative energy will be feasible. Wind power has developed rapidly both in terms of cost-effectiveness and technical performance.

Presently, there is a 20.7 MW wind farm at Wigton not far from Newport, Manchester. The windfarm uses twenty-three 900kW wind turbines.

The Wigton windfarm will be expanded by 18 MW at a cost of approximately US$50 million.

Jamaica has the potential for at least another 60MW of wind energy onshore in two or more windfarm sites. Such sites may exist at locations in Manchester, St. Catherine and Portland, amongst others.

The great valley, south of Wigton is capable of accommodating a 30-40 MW windfarm. The area immediately north of Wigton windfarm could be the site for another 10-15 MW of wind generation. There are other sites in the area of Spur Tree Hill and north of Kirkvine in north west Manchester. However, it is left to be seen whether these sites will have the required 7.7 meters per second or more average wind speeds that will be economic for new windfarms.

If wind fulfils its promise, it could provide as much as five per cent of the world's electricity by the year 2035.

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Whilst traditional energy costs have been rising, wind energy costs have been declining. Larger and more efficient manufacturing, advances in technology and improved experience with wind turbines have contributed to this trend. Meanwhile, as the number of systems in operation has grown, the cost of maintaining them has fallen significantly.

However, international demand for wind turbines and the cost of increased cost of steel have driven up prices over the past two years. Wind technology is already the least costly source of renewable energy, ahead of photovoltaics and solar thermal, and is now the most economic new source of electricity, except for large scale hydropower. When located at appropriate sites, the costs of wind power are now competitive with the full cost of power from conventional sources such as coal and oil.

Wind energy provides other economic and social benefits such as greatly reduced environmental impact, reduced dependence on fossil fuels, and flexibility in electric-power planning as a result of the simplicity and modularity of wind turbines. These factors allow more options to be considered in layout and expansion on suitable sites.

Another socioeconomic benefit is its compatibility with other land uses such as animal rearing and agriculture. Wind power also has one of the lowest environmental and other external costs. Policy makers are realizing that these benefits have value and should be considered when calculating energy costs. Energy technologies should be selected based on societal benefits and costs, because there are more risks and greater impacts on society than just the cost per kilowatt-hour charged by the utility company.

A wind turbine is economically feasible only if its overall earnings exceed its overall costs within a given time period. The time taken to reach the point at which earnings equal costs is called the payback period. The relatively large initial cost of installation means that this period could be over a number of years. Of course, a short payback is preferable and a payback of five to seven years is acceptable. Longer payback periods should be viewed with caution by investors.

The most favourable sites would have average wind speeds of 8 metres or more/second, and a rate of return on investment of 20 per cent. About 70 per cent of the capital cost is dedicated to the cost of the turbine.

Winds are generated by changes in atmospheric pressure induced by changes in earth and atmospheric temperature. They are further affected by the earth's rotation and by frictional encounters with topographic features such as mountain ranges and are thus not uniformly distributed.

Wind resources are classified according to wind-power density, ranging from class 1 (the lowest) to class 7 (the highest). Good wind resources of class 4 and above, with an average wind speed of at least 21 kilometres per hour (13 mph), are obtained in many parts of the Caribbean

Wind turbines capture energy from the wind with a rotor which usually consists of two or three blades mounted on a shaft. The spinning blades rotate a generator to produce electricity. The turbines are mounted on towers to optimise the capture of the wind's energy because wind speed is generally slower and the wind more turbulent closer to the ground.

Although various configurations and designs exist, wind turbines are generally of two types: vertical-axis wind turbines which resemble an upright eggbeater, in which the axis of rotation is roughly perpendicular to the wind stream; and horizontal-axis wind turbines which resemble a traditional windmill, in which the axis of rotation is nearly parallel to the wind stream .

A blade or rotor converts the wind to rotational shaft energy which produces electricity through a gearbox and generator. The blades can have variable or fixed pitch, twist or other airfoils.

For units connected to the utility grid the generators can be synchronous, induction, variable frequency alternator or direct current with an inverter. Although wind turbines can be sited individually or as stand-alone systems, there are operating advantages to siting the turbines in an array to form a wind farm connected to the power grid.

Because the energy in the wind increases as the cube of the wind speed, all wind turbines must be able to release (dump) power at high wind speeds. The ways of doing so include:

1. Changing the aerodynamic efficiency of the blades (rotor) by variable pitch, spoilers, or operation at constant rpm.
2. Changing the intercept area by changing the rotor geometry and yawing the rotor out of the wind.
3. Applying brakes, whether mechanical, hydraulic, air or electrical.

Annual average wind speeds greater than 18 kilometres per hour (11 mph) or 5 metres per second are required for small wind turbines. Less wind is required for mechanical applications such as water pumping.

Solar

Led by Barbados the Caribbean has become a world leader in the use of Solar Water Heaters (SWH). Barbados presently has approximately 60,000 solar water heaters installed in a population of 270,000. By contrast, Jamaica has approximately 55,000 SWH in a population of 2.7 million. This massive penetration was driven by fiscal incentives primarily relating to income tax which was instituted more than two decades ago.

In respect of photovoltaics solar energy is now used extensively for security lighting and street lighting in a number of Caribbean countries including Jamaica, Cuba, Haiti, and the Dominican Republic. There is over 80 security lighting or street lighting systems in Jamaica. Photovoltaics are also used widely as back up electricity systems for computer installations as well as for marine buoys. **The use of photovoltaic generation in homes will increase significantly in Jamaica when the utility company allows the application of net metering.**

Energy from the sun travels to the earth in the form of electromagnetic radiation similar to radio waves, but in a different frequency range. Available solar energy is often expressed in units of energy per time per unit area, such as watts per square metre (W/m2). The amount of energy available from the sun outside the Earth's atmosphere is approximately 1367 W/m2; that's nearly the same as a high power hair drier for every square meter of sunlight! Some of the solar energy is absorbed as it passes through the Earth's atmosphere. As a result, on a clear day the amount of solar energy available at the Earth's surface in the direction of the sun is typically 1000 W/m2. At any particular time, the available solar energy is primarily dependent upon how high the sun is in the sky and current cloud conditions. On a monthly or annual basis, the amount of solar energy available also depends upon the location. Furthermore, useable solar energy is dependent upon available solar energy, other weather conditions, the technology used, and the application.

There are many ways that solar energy can be used effectively. Applications of solar energy use can be grouped into three primary categories: heating/cooling, electricity production, and chemical processes.

The most widely used applications are for water and space heating. Ventilation solar air heating is also growing in popularity. Uptake of electricity producing solar technologies is increasing for the applications photovoltaics (primarily) and concentrating solar thermal-electric technologies. Due to recent advances in solar detoxification technologies for cleaning water and air, these applications hold promise to be competitive with conventional technologies.

Solar energy has the following advantages over conventional energy:

- The energy from the sun is virtually free after the initial cost has been recovered.
- Depending on the utilization of energy, paybacks can be very short when compared to the cost of common energy sources used.
- Solar and other renewable energy systems can be stand-alone; thereby not requiring connection to a power or natural gas grid.
- The sun provides a virtually unlimited supply of solar energy.
- The use of solar energy displaces conventional energy; which usually results in a proportional decrease in green house gas emissions.
- The use of solar energy is an untapped market.

Not only are there many different ways that solar energy can be applied, but there are also many different methods for collecting the solar energy from incident radiation. Below is a listing of some of the more popular types of solar collectors.

- Glazed flat-plate solar collectors

- Unglazed flat-plate solar collectors
- Unglazed perforated plate collectors
- Back-pass solar collectors
- Concentrating solar collectors
- Air based solar collectors
- Batch solar collectors
- Solar cookers
- Liquid-based solar collectors
- Parabolic dish systems
- Parabolic trough systems
- Power tower systems
- Stationary concentrating solar collectors
- Vacuum tube solar collectors

The photovoltaic (PV) process converts radiant sunlight into direct current (dc) electricity through the use of semi-conducting materials. Solar photovoltaic systems are an important part of the move towards greater use of renewable energy in the first part of this century. It is the only technology that does not convert renewable resource energy into mechanical energy in order to generate electricity.

A photovoltaic system is a complete set of interconnected components that convert sunlight into electricity, including modules, array, inverters, storage batteries and the electric load.

Solar Thermal systems collect the thermal energy in solar radiation for use in low to high temperature thermal application. Several types of collection systems (parabolic trough, central receiver and parabolic dish) may be used to concentrate and convert the solar resource.

The leading solar thermal technology is the parabolic trough, which focuses the sunlight on a tube which carries a heat-absorbing fluid, usually oil. The fluid is circulated through the line focus tubes of the parabolic trough collectors, reaching temperatures up to 391°C, and is used to boil water to steam which is then routed to a high-pressure turbine to generate electricity. Turbine efficiency is almost 38 per cent..

Solar water heating systems are the primary solar application in the Jamaica. Solar water-heating technology is reliable and the equipment is relatively simple to manufacture and install. Further, most installations have a payback period of four to five years. Although hot water may be considered a luxury in the Jamaica, there is still a large demand in households and, in particular, in the tourist industry. Solar water heaters should be used for preheating water in all hotels before raising the temperature by electrical methods.

The potential for solar crop drying has not been fully realised although it is a means of preventing spoilage which affects as much as thirty per cent of crop production in tropical countries. Crops such as bananas, papaya, sorrel, sweet potato, yam, ginger, nutmeg, pimento, grasses and leaves can be dried by solar dryers which range from the simple wire basket dryer of approximately two square metres to roof solar collectors.

Solar distillation units produce relatively small volumes at a rate of about 3-6 litres per square metre per day.

Hydropower

Because hydropower plants do not burn fuel to produce electricity, their costs are not subject to the inflation resulting from rising fossil fuel prices.

Conventional hydropower plants are of three types: storage, run-of-river, and diversion. The geographic and hydrologic characteristics of particular sites dictate the appropriate type of hydroelectric development.

Storage facilities make good baseload and peaking plants. They have a high capital cost but low operating costs and these characteristics make them more cost-effective when used continuously.

Run-of-river plants use natural streamflow for power generation, although a small dam is often used to augment the head in such projects.

Diversion plants involve a man-made channel, or aqueduct, of sufficient slope to make enough head to drive the turbine. Most of these structures are built solely for hydroelectric power, although many diversion projects are sited at existing irrigation or water supply conduits.

Various types of turbines are used to produce hydraulic power. They include the Pelton, Kaplan, and Francis designs, and variations thereof.

Jamaica lacks the potential for large-scale hydroelectricity generation. Only some 23.8MW of power is presently installed with potential for a maximum of another 80 MW.

HYDROELECTRIC STATIONS CURRENTLY OPERATED BY JPSCo.

Plant Location	Years Put in Service	Installed Capacity
Upper White River	1945	3.8
Lower White River	1952	4.9
Roaring River	1949	3.8
Rio Bueno A	1949	2.5
Maggotty Falls	1966	6.3
Constant Spring	1989	0.8
Rams Horn	1989	0.6
Rio Bueno River	1989	1.1
TOTAL		23.8

POTENTIAL NEW HYDROPOWER PROJECTS

Hydroelectric Scheme	Potential Capacity (MW)
Black Rio Grande (BRG)	3.9
BRG Upper(Incremental)	48.0
Dry River	0.8
Great River	8.0
Green River	1.4
Laughlands Great River	1.2
Martha Brae River	5.4
Morgans River	2.3
Negro River 3	1.0
Negro River 2	0.9
Rio Cobre	1.0
Rio Grande	3.9
Spanish River (Alternative I)	3.98
Spanish River (Alternative II)	2.6
Wild Cane River	2.5
Yallahs River	2.6

The hydropower project that is now essentially ready for implementation is a small 2MW hydropower plant on the Laughlands Great River in St. Ann. This project will be situated in a nature park and would reflect the harmonization of energy and environment. The project would cost approximately US$4 million to implement.

Ocean Thermal Energy Conversion (OTEC)

Ocean Thermal Energy Conversion (OTEC) is a relatively new technology which is currently being tested for commercial use as a renewable energy source. The OTEC energy generation system is dependent on the temperature difference that exists between warm surface waters and cold deep ocean waters. A temperature difference of at least 20°C is a prerequisite for a viable OTEC operation. This requirement is likely to be more available in tropical and sub-tropical seas.

In the tropics there is a significant temperature difference between surface and deep water, the latter being rich in nutrients such as nitrates and phosphates. If the warm and cold water (20°C difference) are brought together, a turbine can be operated to generate electricity by Ocean Thermal Energy Conversion.

The technology, though feasible from an engineering standpoint has not seen any large scale commercial applications as yet.

OTEC should be regarded as a technology on the threshold of commercial application. Although it cannot compete economically with present day fossil fuelled electricity generation, it promises to be an important energy source for Caribbean island states 2020.

Wave Energy

Waves are a powerful source of energy. The problem is that it is not easy to harness this energy and convert it into electricity in large amounts. Thus, wave power stations are rare

At a wave power station, the waves arriving cause the water in the chamber to rise and fall, which means that air is forced in and out of the hole in the top of the chamber. We place a turbine in this hole, which is turned by the air rushing in and out. The turbine turns a generator.

There are pilot wave power projects in the Orkneys, west of Scotland, Cornwall in southern England (20MW) and a 3 MW plant has been designed for offshore Portugal. These plants are using a polanis system of flexible pipes, 3 metres in diameter and 100-150 metres long.

Biomass

Biomass has major potential in the context of Jamaica. The first are Waste-to-Energy projects involving amongst others biogas, the burning of solid waste and the use of effluence from industries such as sugar manufacturing. Presently the greatest effort is in regard to the production of ethanol is from sugar cane.

Biofuels such as ethanol and biodiesel have become the center of attention particularly over the past decade. Key policy issues relating to biofuels in the transport sector, include concerns about the reliability of petroleum supplies, low incomes in the agricultural sector and environmental concerns relating to climate change. Biofuels are compatible with existing petroleum systems in respect of blending and marketing. Ethanol is usually used in a 10% mix with gasoline (E10) or up to 85% (E85). 100% ethanol is also used as a fuel, particularly in Brazil. E10 will be introduced into Jamaican gasoline starting in November 2008. By April 2009, all gasoline sold in Jamaica should have 10% ethanol as the Octane enhancer.

The five government owned sugar factories will be privatised early in the fourth quarter 2008. A new company (Newco) has been formed whose major partner is Infiniti BioEnergy of Brazil with a 75% stake and the Government of Jamaica with 25%. Petrojam Ethanol Limited will now form part of that company. It is expected that some of these sugar factories will produce local feedstock for ethanol production and so replace some of the wet alcohol feedstock from Brazil that is being used in Jamaican ethanol plants such as that at the Petrojam Ethanol and at Port Esquivel (Jamaica Broilers). Ethanol production could assist in sustaining a sugar cane industry in Jamaica which will become multipurpose. The ethanol industry based on sugar cane will also provide the cogeneration of bagasse. The other two sugar factories, Appleton and Worthy Park will be involved in the production of sugar, molasses and rum.

Waste to Energy

This includes biogas using animal waste in a programme now fostered by the Scientific Research Council (SRC). There is also potential to use liquid effluence as well as to burn solid waste in order to produce energy either as ethanol, biodiesel or gasification to produce a fuel that will be used to generate electricity. To this end, proposals have been invited from companies to develop such waste to energy projects.

A non-renewable energy source whose time is coming - Nuclear Energy

Although nuclear power is not a renewable resource it is considered to be a source of clean energy. Not withstanding potential problems of radioactive waste disposal. A new generation of fission energy is predicated on the commercial arrival of small pebble-bed nuclear reactors. These are helium-cooled reactors that contain an array of small tennis ball-sized 'pebbles', with just 9 grams of uranium per pebble, which gives a low power density reactor.

Pebble bed reactors are expected to become available at some point between 2020- 2025. They would be economically viable in the size range of 70-200 MW and would be suitable as a least cost economic option for many developing countries, including Jamaica.

There would be serious issues with regard to safety engineering and the disposal of waste. However, these may be resolved by 2025, so countries such as Jamaica could look seriously at the role of nuclear power in a future energy mix.

Methods of Financing Renewables

Traditionally, financing for energy projects have come from five sources:

1. multilateral and bilateral agencies
2. large international commercial banks and investment houses
3. internal funds generated from internal operations
4. borrowing from local banks and financial houses
5. government contributions through cash and guarantees

Typically, funds from domestic sources are in local currency and generally cover the local cost of the energy project. Externally sourced funds come as foreign exchange and cover the cost of engineering consultancies, contracts and equipment. Loans from multilateral and bilateral sources are usually accessed by government, and require a government guarantee.

The new trend is for state entities to go to private capital markets (both local and foreign) to borrow money, not requiring a government guarantee. They borrow on their own account or with the proposed project as collateral. Private companies entering the market often provide equity funds by borrowing from private banks and other lenders. The participation of insurance and pension funds as well as bond markets, are newly emerging. In international capital markets commercial and investment banks continue to be active. So are venture capital funds. Now even the multilateral and bilateral agencies are introducing facilities to fund private ventures, and to lend without a government guarantee in some instances. The International Finance Corporation (IFC) and OPIC are examples.

Energy Efficiency

Energy efficiency is required in every aspect of energy use including households, commercial activities, hotels and the hospitality industry, manufacturing, and the transportation sector.

In households, the first step is to use compact fluorescent lamps for lighting and as a replacement for all incandescent units. This replacement would save the need for somewhere between 30 and 40 megawatts of electricity if it was done in totality. Reasonable market penetration will result in a saving of about 22 MW. Other household efficiencies include purchasing, the most energy efficient equipment such as refrigerators, freezers, microwave ovens and air-conditioning units. Attention should be paid to the use of electric irons as infrequently as can be accommodated and a reduction in the electric current used by "vampires" such as cable boxes and television sets which should be plugged out when not in use. Where hot water is a requirement, solar water heaters should be the *modus operandi*. In order to effect energy efficiency in the home the National Housing Trust will now give loans of up to Ja$1.12 million to modify, upgrade and install energy efficient equipment and design features. Where two parties are involved with a loan, the amount can be doubled to Ja $2. 4 million. This sum (Ja $2. 4 million) is actually sufficient to install a solar photovoltaic system, that will provide most of the energy required for the average Jamaican three bedroom household.

In the commercial and the educational sector significant savings can be made in electricity use by motion sensors in rooms. In fact, all commercial infrastructure should be the subject of energy audits and suitable energy management systems put in place. One would like to see a situation where when applying for a loan at a bank, the bank would require an energy audit report to show that the facility is as energy efficient as it could be.

Further, our architects should be trained and stimulated by demand to use passive energy efficient design in order to reduce the demand for energy in a building. This includes, amongst others, orientation so that the sun does not hit windows directly, shading of windows and insulation in walls as well as energy efficient roofing materials. .

In the hotel and hospitality sector the use of solar hot water heaters should be pervasive. In addition one recommends the implementation of an electronic card which opens the door to a guest room being also used to turn on and off the airconditioning and lighting in the room on the entrance and exit of the guest.

The manufacturing sector presents some problems. The cost of electricity to this sector in Jamaica is now nearly 30cents per kWh. Compare this to the 4.5US cents per kWh charged for electricity in Trinidad and Tobago. In order to be competitive, Jamaican manufacturers have to be more sensitive to the use of electricity in the most efficient manner. Japan is a model that is worth visiting in that it has relatively high electricity cost but conducts the most efficient use of energy in its manufacturing sector.

Transportation requires significant attention. It is important to discourage the use of high powered engined vehicles which are quite unnecessary given the Jamaican road system and travel destinations. Thus today we should see an import tariff structure that favours engines less than 200cc as well as high bred vehicles, diesel engined vehicles and ultimately flexi vehicles that can run on essentially 100% ethanol. In the public transportation sector, consideration should be given to modifying the Jamaican taxi vehicles in order for them to use LPG as the fuel. Some 90% of the taxis in Australia, run on LPG and 65% of those in Canada do so. Vehicles operating on LPG run cleaner and their engines require less maintenance. However, there is an initial conversion cost of approximately US$3,000.

Supporting these measures in the transport sector will be the rationalization and improvement of urban transportation the addition of a railway system for the movement of heavy goods and people as well as the consideration of flexi time to avoid the gridlock that obtains on urban roads such as those of the Kingston Metropolitan area during morning and afternoon peak traffic. High fuel prices will dictate a change in our driving habits and lifestyle in respect to travel arrangements. We will now need to become accustomed to reducing driving speeds in order to save fuel, switching lanes less often, driving with windows closed on the highway to avoid wind drag and eliminating quick stop and starts in city traffic. Furthermore we will need to plan our travel needs more carefully in terms of routes to be taken as well as unnecessary trips for domestic errands and other purposes. Car pooling should be an option to be accommodated where possible.

Government has to lead by example in respect to energy efficiency. For this reason, solar water heaters should be used in Government buildings such as hospitals wherever and whenever the need for hot water arises. It is important to note that the National Water Commission accounts for approximately 47% of the total energy used by the public sector. Steps have to be taken to make water pumping more efficient because this is an additional cost to the already burdened consumer utility bills

Conclusion

It is likely that a diversified portfolio of energy resources will be needed in order to provide sustainability, security and economic stability.

It is also important to note that unforeseen advances also could come from new 'disruptive' technological innovations. These are major innovations that have the potential to significantly alter the entire pattern of energy production, distribution and use. This might include, for example, the development of nano-technology and advanced materials that can be used for superconducting 'smart grids' to greatly improve electricity transmission, reducing weight while maintaining or increasing vehicle safety, or for reducing friction and improving energy efficiency for both land and air transportation.

Jamaica's challenge will be to find the optimal economic mix of technologies that will assure a secure and clean energy future. It will require strategic planning, innovation and collaboration, as well as a drive towards conservation and the more efficient use of energy.

With concerted action from the government, private sector, the academic community, donors and civil society, there is still time to find a cleaner and more sustainable course.

Jamaica needs to see a shift in the culture of energy use with strong motivation from civil society, commerce and industry, to develop domestic sources of energy and to use energy resources efficiently. Some other energy deficient countries have become major economic successes. Japan and Singapore are examples.

NGOs, academics, researchers, policy makers, decision makers, and implementers, can all make a contribution to a major thrust that will fortify the will of the Jamaican people to cope with our present energy predicament with new initiatives and successful outcomes.