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# Renewable Energy and Energy Efficiency in Small States

*David Barrett*

## Introduction

It has long been recognised that the sustainable supply of energy services is an imperative which delineates the viable developmental options which any sovereign island nation can select as it provides for current and future generations. Energy services – *the appropriate use of energy to achieve desired productive outputs* – play a crucial role in facilitating the implementation of nation-specific options for all small island developing state regions.

Implicit in the sustainable development of SIDS are global economic issues which give rise to special vulnerabilities, as identified in the 1994 Barbados Programme of Action. Strategies for economic survival and success include: the production of value added products as a competitive alternative to high volumes and low prices; niche marketing as a competitive strategy; producing an educated, skilled and trainable workforce to attract higher paying jobs and technologically driven markets; efficiency, productivity and energy conservation to maximise foreign exchange earning and retention while improving self-reliance; import substitution; and improving energy security.[1] The development of viable industries is also a critical component of sustainable economic development. All these strategies are energy dependent.

Sustainable social targets are also energy driven to a large degree. Strategies for improving the quality of life include modern, convenient and safe energy supplies, less labour intensive tasks, modern transportation services, up-to-date effective health services, improved life expectancy, effective education, reduction of poverty, improvement of national security, increasing food supplies and providing recreational or inspirational settings conducive to emotional health. These are are all energy reliant.

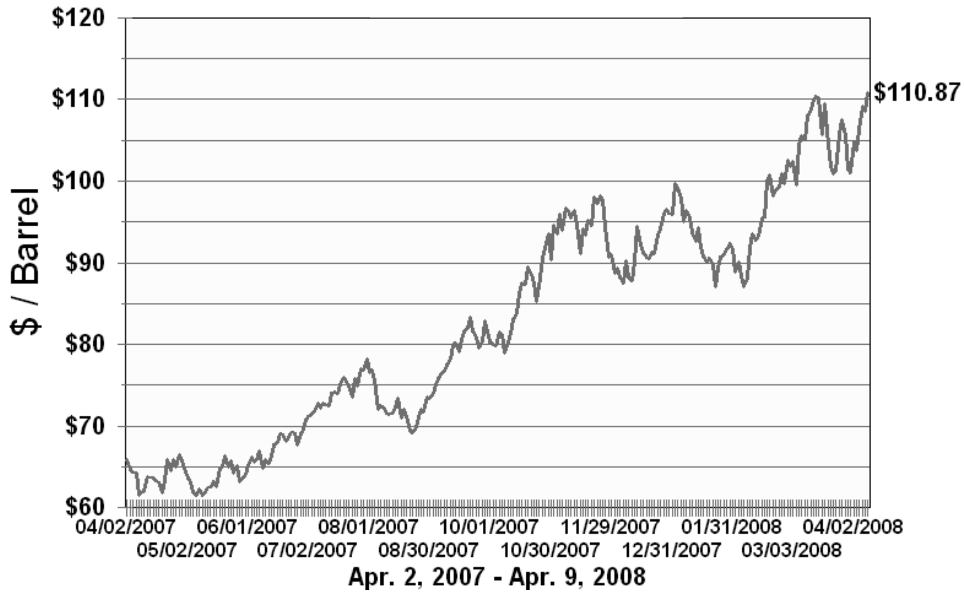
Environmental health depends on sustainable and cost-competitive energy options, careful selection of mechanisation for sustainable livelihoods, energy resources with fewer environmental aspects, lower and reversible impacts, and a reduced need for end-of-pipe treatment. In addition, energy options used for addressing environmental impacts should produce economic, energetic and productive collaterals.

Critically, the global phenomenon of climate change, to which SIDS are particularly vulnerable, is energy derived and exogenous. Collaboration in global energy strategies by SIDS is a proactive stance which addresses this concern.

## Driving forces for implementing non-conventional energy options

The growing need for adequate energy services has been somewhat stymied as the conventional fossil fuels on which SIDS have depended are rapidly failing in volume of supply, stability of affordable prices and reliability of supplies.

**Figure 5.1. NYMEX crude oil futures close (front month)**




Source: WTRG Economics, www.wtrg.com

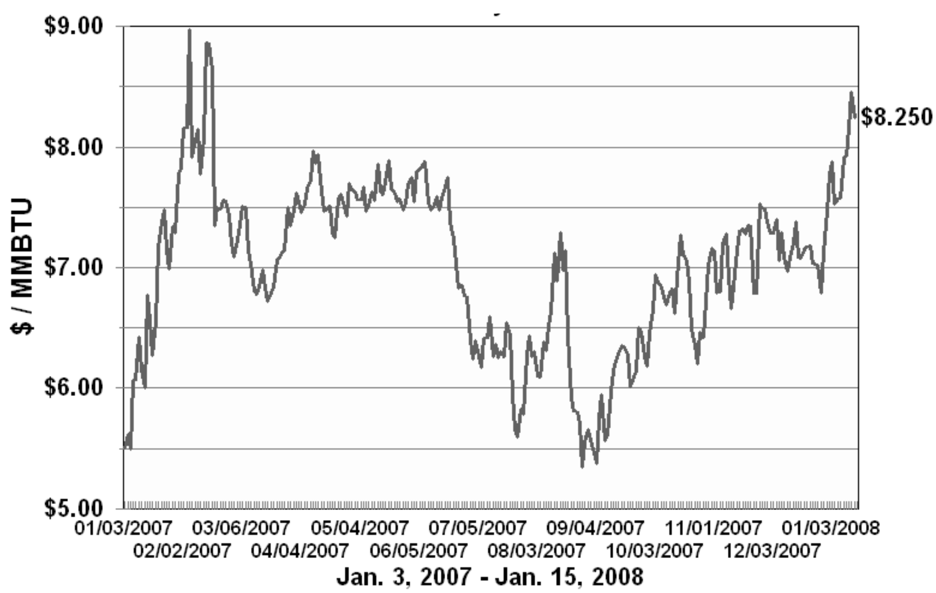
On the supply side, the energy security of SIDS is affected by the global scenario. World forecasts[2] project a demand of 87.5 million barrels per day (bpd) with supplies of only 86.4 million bpd (Standard Bank, 2005). This represents a 1.5 million bpd supply cushion or 2 per cent of 2005 global demand, which could easily be absorbed by the average global demand growth of approximately 2 per cent. We now live in the reality of the oil peak,[3] where the rate of new discoveries and production lags behind the rate of consumption of fossil fuels. Supply issues are aggravated by:

- Diminishing spare capacity of the Organisation of Petroleum Exporting Countries (OPEC);
- Pressure on lighter sweet crude, such as West Texas Intermediate (WTI) and Brent benchmarks for higher environmental and performance specifications, as proportionately more heavy and medium-sour crude is found;
- Decline of major non-OPEC production areas, such as the North Sea, US Gulf of Mexico and Alaska;

- Disruption of supplies by volatile geopolitical conditions and unpredictable weather incidents;
- Rapid economic growth of developing and industrialised nations;
- Aged infrastructure and decline in new exploration and refinery investments.

These factors have not only caused oil prices to break old price thresholds, but also created a new threshold of US$100/barrel (bbl) and sustained new price floors of US$30–35/bbl.[4] Now, more than ever, SIDS are reminded that 'energy dependence is a major source of economic vulnerability'.[5] Volatile fossil fuel prices have significantly challenged national development planning and economic strategies. In Jamaica, for instance, approximately 90 per cent of the energy mix comes from imported energy. Jamaica's current ability to meet developmental targets is severely hampered by the consumption of 65–70 per cent of its export foreign exchange earnings, or more than 15 per cent of its GDP, to import over 25.7 million barrels of petroleum products. Similarly, up to 40 per cent of national budgets, and 46 per cent of total national revenues, of Pacific islands are spent on the import of fossil fuels.

**Figure 5.2. Natural Gas Spot: Henry Hub**




Source: WTRG Economics, www.wtrg.com

Natural gas, a more price stable product over the long term, has surrendered to the vicissitudes of price movements. Though more steady in the market, coal prices have also risen dramatically. Continued dependence on fossil fuels is therefore contrary to energy security, not only because of price fluctuations, but because of other factors, not the least of which is climate change.

International efforts to stem global warming by reducing the use of fossil fuels have raised the demand for renewable energy, non-petroleum fuels and fuel blends, including biofuels. Stand-alone or distributed generation systems have also become a preferred option, because they are cleaner, less impacting and more viable.

In this context, the strategic sustainable development of SIDS lies firstly in the concurrent and strategic actions of:

1. Reducing the rate of growth of energy consumption (energy conservation); and
2. Producing more high value outputs from less energy (energy efficiency).

This is a near-term and sustainable solution for achieving full energy security, global competitiveness and rapid social and economic development against the backdrop of global energy events. Finance could initially be focused on making early large energy savings on the supply side to large-scale commercial and industrial sectors which skew national energy demand, e.g. heat and power demands by hotels, sugar cane processing and minerals, followed by transportation and domestic consumers. The proportion of energy costs relative to total production costs in the cement industry, for example, is approximately 55 per cent. However, the potential energy savings could be 10–50 per cent depending on energy efficiency and conservation application (Wright, 2003). In Jamaica, where the cement industry is responsible for coal imports equivalent to 1.2 per cent of national energy consumption, energy efficiency provides an opportunity for significant savings; bauxite/alumina processing consumes over 36 per cent of petroleum imports and has been responsible for a 50 per cent increase in energy intensity. Transportation, and commercial and residential buildings may consume in the order of 20 per cent and 30 per cent, respectively, of the energy used in island economies.

Secondly, the strategic sustainable development of SIDS should involve near-term application of renewable energy technologies (RET) (e.g. cogeneration and biofuels) to provide the additional energy required to close the gap between the current energy baseline demand and future demand. In the near- to long-term, renewables should also be used as a strategic option to replace fossil fuel when old systems are to be decommissioned and in meeting graduated fuel switching, especially in industry and transportation. The application of concepts of import substitution (Bruton, 1998) to energy security suggests that SIDS must protect their economies from harmful dependence on imported energy by harnessing an array of indigenous energy options to replace what they would otherwise import. The emphasis should be on increased energy self-reliance, as opposed to the exclusion of imports, as energy demand and supply must be met for development to be continuous.

Intra-regional collaboration and effective national policies are also crucial in accelerating implementation across SIDS in any given region.

## Energy status of SIDS

With few exceptions, SIDS from the Caribbean to the Pacific are predominantly energy (petroleum) importers and therefore energy insecure. Islands approaching 'sustainable energy island' status may include Faroe Island, Denmark, where wind supplies 100 per cent of electricity; Yakushima, Japan, where over 80 per cent of electricity comes from renewable energy technologies, especially hydro (56 MW); Dominican Republic with 45 per cent hydro (220 MW); and Guadeloupe, which utilises its wind (2 MW) and geothermal (5 MW) potential. On a smaller scale, Dominica's hydro resources (7.6 MW) provide more than 50 per cent of the total energy supplied to the national grid; in the French Overseas Departments, 45 per cent of fuel imports are from fossil fuels, and the balance comes from renewable energy technologies, including wind and hydropower.

More typical, though, is a low level of energy security predicated on fossil fuel imports. In CARICOM, hydrocarbons accounted for around 95 per cent of total primary energy supply, with renewables accounting for approximately 5 per cent (Detlef and Coviello, 2005; CARICOM Energy Policy, 2007). The US Virgin Islands depend on imported energy for 99 per cent of their needs and in some Pacific islands petroleum products account for almost 80 per cent of primary commercial energy consumption, while renewable energy technologies – mostly hydro – contribute less than 10 per cent of energy use (SPREP, 2006). The economic costs of failing to use indigenous renewable energy are inflationary prices induced by imported energy costs and reduced price competitiveness in global markets. The social cost is stagnation in health services, education and security, as debt repayments consume a greater portion of government national spending. The environmental challenge is failure to arrest natural resource damage induced by the transportation, storage and use of fossil fuels.

SIDS such as Jamaica and Grenada hope to improve energy security rapidly from potential oil and gas finds; others, such as Trinidad, Cuba and Barbados, hope to augment their current petroleum resources through exploration within their territories. However, these options are highly risky and expensive; prospects are assumed to be minor and cannot easily attract investment from oil and gas companies with the requisite financial and technical resources to make this a present reality. Although the option of new finds should not be excluded, energy efficiency and conservation, together with renewable energy technologies, remains the sure near-future option for SIDS. Energy security should therefore include utilising localised wind, geothermal and biomass options, proven for industrial, commercial and domestic uses, and petroleum for existing infrastructure. Solar and hydro will also be critical resources in meeting domestic and commercial demand.

## Energy efficiency and conservation – the first line of defence

Energy efficiency plus conservation is an immediate to long-term strategy for SIDS to improve their market competitiveness. As energy prices increase, there is an external opportunity for energy efficient sectors within SIDS to maintain or increase production levels and profitability against less efficient counterparts (Wright, 2003). Efficient operations also lead to less environmental impacts, as pollution prevention and reduction techniques are successfully applied. Appropriate technologies and best practices for energy efficiency and conservation can often be implemented in one or two years, as opposed to some large scale renewable energy technology projects, which may require between two and four years from feasibility study to operation. Energy efficiency and conservation not only reduces expenditure (making monies available for other key areas of national development such as education, health and social services), but allows for productivity levels that meet international benchmarks. EE&C gains can be most dramatic for SIDS with high energy costs (the Caribbean mean average cost is US$0.17/kWh) (Escalante, 2003), high industrial energy demands and vulnerability to oil price shocks.

Replacement of the EU/ACP sugar protocol from 1 January 2008 may impact on Caribbean sugar production, an important sector with high heat and power demands, with 'sudden' 37 per cent price cuts, market uncertainties and heightened competition from the entry into the EU market of new lower-cost ACP producers. In response, on-site cogeneration[6] and trigeneration in the sugar cane industry could be a potential internal strength to increase overall factory efficiencies by up to 80 per cent, reduce costs, provide additional income streams and, at a minimum, maintain market share. Incentives for EE&C in the CARICOM cane industry alone could mean the saving of over 125,000 jobs and income of approximately US$300 million per annum.

The hotel industry is also a major foreign exchange earner for SIDS. Energy accounts for over 70 per cent of the total utility costs at typical hotels, with equipment, appliances, air-conditioning and lighting being significant contributors (Escalante, 2003). With simple inexpensive devices and practices, such as monitoring energy use, insulation, use of natural ventilation and lighting, occupancy sensors, compact fluorescent lighting (CFL) lamps, maintenance and weather-stripping, hotels can reduce electricity consumption per guest night by 10–24 per cent, and save up to 19 per cent of their total electricity use. These savings can occur in just 18 months, and some payback periods are as short as four months, depending on the intervention.

Potential savings for industrial and commercial consumers are easily achieved through energy monitoring (10 per cent), corrective and preventive maintenance (15–20 per cent), awareness (10 per cent), reduced air infiltration into conditioned spaces (10 per cent) and energy efficient lighting and retrofits (40 per cent) (Eaton Haughton, 2003). For utilities, savings can be made from the supply side by reducing generation and transmission losses (16–20 per cent in the Caribbean). The main consumers of electricity should be targeted for special programmes.

With sectors such as transportation consuming as much as a quarter of imported fossil fuels, interventions must transform cultural barriers over time. Air transportation may impact on SIDS less than ground transportation, as fuel supplies are distributed over various international ports of call; costs of fuel are borne mainly by international carriers and in some SIDS the percentage consumption is relatively low (approximately 6 per cent of the total in Jamaica, compared with 24 per cent for road and rail). More significantly, the association of mass transport with a lower quality of life, and large engine private vehicles as the converse, presents challenges. In this context, attempts at improving mass transit efficiencies (e.g. fuel switching to natural gas), introducing car-pooling and vehicle fleet shifts towards electric, hybrid or flexi fuel vehicles may be unsuccessful. Other measures, such as linking duties with engine sizes and rated fuel mileage, lower toll/road charges for utilising optimal seating capacities and congestion charges in cities may induce EE&C practices for motorists.

Very important in cost savings for implementing EE&C is an 'upstream' approach, by incorporating these aspects into building design. Energy Efficiency Building Codes (EEBC) (e.g. EEBC-94 finalised and approved as a voluntary standard in Jamaica with funding from the World Bank and the Canadian International Development Agency (CIDA)) or the Leadership in Energy Efficiency Design (LEED) protocol are important tools for facilitating opportunities and rewards for the building industry and private sector entities. Such tools are said to be able to reduce energy consumption by 30–36 per cent per annum and shave electricity peak demand by 24–29 per cent with only an initial 5 per cent increase in building costs.

Another upstream approach is the creation of a demand for energy saving through the engagement of more energy services companies (ESCOs) and energy auditors. ESCOs are driven by performance contracts to generate quantifiable energy or other savings for their client. Hilton hotel chains within Barbados, the Bahamas, St Lucia and Puerto Rico have benefited from energy management interventions. Retrofit markets can also have a fast uptake (e.g. CFL lamps, water savers and motion sensors), where tax and other incentives are applied and public education is dynamic.

With the current cost of money, competition for development funds and reducing unit cost of production in a global market, regional collaboration among SIDS has become critical in order to efficiently and cost effectively fast track energy efficiency. This has been recognised both in the Pacific (by the Pacific Energy Ministers Meeting held in the Cook Islands in 2007) and the Caribbean. A CARICOM Charter on Energy Efficiency has been promulgated and member states have agreed to promote high-efficiency power generation technologies (including combined cycle and cogeneration) and best practice industry standards, with the aim of reducing system losses in generation, transmission and distribution (CARICOM Energy Policy, 2007). Among other initiatives, the Pacific Islands Energy for Sustainable Development (PIESD) programme is targeting the power utilities of 14 south Pacific ACP members in an attempt to decrease costs and fuel consumption and improve the efficiency of power production, transmission and distribution, with a target of 30 per cent reduction in losses using supply-side management projects (Fairbaim, 2004).

## Status and potential for renewable energy technology use in SIDS

Globally, renewable energy investments continue to increase significantly, amounting to over US$38 billion in 2005.[7] In the context of this favourable global growth rate, the potential for harnessing and renewable energy technologies in island states have to be carefully examined against the background of available natural resources. Most SIDS have varied but limited endowments of renewable resources and may not have the potential to harness more than 25–30 per cent of renewable energy technologies for their national energy mix. It is important that when RET are considered, energy efficiency and conservation outcomes are fully integrated, or they cannot be considered truly sustainable and could be potentially as damaging to economies and the environment as non-renewable resources.

Renewable energy technologies for SIDS, such as solar, biogas, biomass and wind, when implemented with EE&C considerations, allow for the avoidance or removal of greenhouse gases (GHG), as well as effluents and solid wastes.

Possibly the most prolific application of RET, and a competitive strength for tropical SIDS, is solar energy.[8] With falling photovoltaic (PV) module costs (approximately 30 per cent – 60 per cent of total system costs), at prices around US$5.50 per peak watt (DBEDT, 2006), there are no restrictions on the application of PV systems in Pacific, Caribbean, African and Indian SIDS, sited on the roofs of buildings or on the ground. In Hawaii, 309 kW has been installed on the Ford Island's navy building in Oahu; 25 public schools have rooftop PV systems (in Oahu, Maui and Hawaii's Big Island); and 209 kW has been installed at the Parker Ranch. All the systems are grid tied (*Star Bulletin*, 2007; Power Technology.com, 2007), in addition to several thousands which are in remote subdivisions not serviced by the utility grid. It has been projected that solar panels will be installed in several thousand new homes in Hawaii over the next few years, totalling 6MW and a commercial 167 kW generation plant is to be installed on the roof of the Hawaiian Electronic Company's Archer sub-station, servicing up to 200 homes (*Star Bulletin*, 2007). The ADMIRE (Actions for the Development of Marshall Islands Renewable Energy) programme has a target of over 2,000 PV installations, with some currently installed on Wothoo and Wodmej. These installations have already improved academic performance in schools and the productivity of fisherfolk (GSEII, 2007). Solar PV is a proven solution to the challenge of bringing electricity to remote rural areas.

Solar thermal, the most widely used RET application in the Caribbean (especially for solar water heaters (SWH)), is one of the best commercial opportunities for SIDS. Barbados has developed its SWH industry, encouraging manufacturers (e.g. Solar Dynamics, SunPower and AquaSol), distributors and retailers. Over 40,000 solar water heaters have been installed in homes, commercial businesses and hotels in Barbados. For hospitals needing large volumes of hot water and power, and in islands such as Jamaica, Barbados, Mauritius and Seychelles where the tourism industry is significant, economies of scale generate the most meaningful cost savings and cut fuel imports. Hotels and bed and breakfast accommodation, depending on size and season, may spend approximately 20–30 per cent of their electricity costs on water heating (EHMS, 2003). Domestic payback periods may be around 3–4 years, but for commercial utilisation they can be only 2–3 years, especially when electric heating is replaced.

Islands with large land masses, highly varied topography and elevations, and limited karst rocks tend to have some hydropower resources. Cuba (57 MW), Dominican Republic (220 MW), Dominica (7.6 MW) and Fiji Islands (90 MW), by virtue of their topography, geology and land mass, have adequate rainfall and can utilise dams and run-of-the-river-type mini-hydropower systems. The theoretical potential of these islands (e.g. Dominica (25 MW), Jamaica (82 MW), Fiji Islands (400 MW), Cuba (650 MW) and Dominican Republic (1,800 MW)) is constrained in practice by competing social uses, ecological water demands and insufficient technical information for analysis of potential.

Some Caribbean SIDS (Jamaica, Curaçao, Bonaire, St Lucia and St Vincent) are geographically positioned to take advantage of localised wind sources (e.g. sea and land breezes, and mountain and valley winds) and the prevailing trade winds, blowing from east to west. Others, such as Cape Verde and some Pacific Islands, are also able to utilise their wind potential. Hawaii's mountainous topography and strategic location within the northern Pacific trade wind belt creates an excellent wind resource; several megawatts of wind power have been installed at Kahuku, Lalamilo and South Point on Hawaii Island (Kaya, 1999).

Geothermal is an important heat and power source for industrial applications and therefore may be significant in displacing fossil fuels for heat and power generation. Commercial and industrial geothermal potential is restricted mainly to SIDS on the volcanic ridges of an archipelago (e.g. Guadeloupe (5 MW)) where tectonic plates are spreading or colliding. Puna, on Hawaii Island at the edge of the Kilauea volcano, is said to have one of the most significant geothermal resources at 676°F (358°C). Nevis estimates its geothermal potential at 900 MW and will soon construct a 50 MW plant, 35 MW of which will be exported to its neighbours (Isaacs, 2008).

Commercial biomass fuel plantations (e.g. cane, corn and sorghum for bioethanol; Jatropa and coconuts for biodiesel; trees for fuelwood) are mostly suitable for larger SIDS (e.g. Mauritius, Cuba and Dominican Republic), as they require contiguous land space to minimise transportation costs and obtain economies of scale for production and maintenance. Smaller SIDS also face dwindling land space, with competition from housing, landfills and the need for open space. Pre-existing competence in large scale mono-crop production with power generation (e.g. sugar cane in Mauritius and Fiji Islands) is also important in the application of biomass fuels. In the case of cane, some capital infrastructural costs have been written off or reduced over years of operation, potentially reducing the cost of biomass power generation. Cellulosic feedstocks (as opposed to edible crops) grown on marginal lands, with increased $CO^2$ sequestration and lower fertiliser costs, can increase ethanol production. In conjunction with newer conversion technologies, cellulosic feed stocks such as switchgrass, miscanthus or sorghum may yield a total of 2,000 gallons per acre (assuming 20 tons harvested per acre), while edible corns may yield about 900 gallons of ethanol per acre (*Green Chip Review*, 2007).

Biogas, though an proven technology for heat and power generation, is not a significant option for the national energy mix as centralised effluent flows are typically small and often do not justify the capital costs. Larger projects, such as the Soapberry Wastewater project (Jamaica), will treat over 20,000 imperial gallons of wastewater per day, using state-of-the-art biological aerobic technology (Kelly, 2007).

In considering the sustainability of biofuels, therefore, it is important to take into account other issues such as opportunity costs, especially for export crops, reduction of food crops and the energy needed for production.

Advanced technologies such as Ocean Thermal Energy Conversion (OTEC)[9] may be considered by SIDS with steep island shelves and sufficient water temperature differentials near shore. Open cycle OTEC has been demonstrated in Cuba, and closed and open cycle OTEC in Hawaii (52 kW and 210 kW at Keahole Point). Possibly such cutting edge technologies, which are not yet convincingly proven, should be reserved until proven and less expensive technologies have been utilised.

From this menu of indigenous energy resources, RET applications should be customised to take into account local issues. It seems that commercial power generation and transportation offer the greatest potential for RET applications in the next decade. Domestic and commercial use of solar water heating could also be important, together with small amounts of PV. In the meantime, some SIDS are aggressively exploring their petroleum potential to achieve greater energy security and reduce energy imports, as part of a holistic and viable solution.

## Overcoming barriers to the implementation of RET and EE&C

Several issues negatively affect the implementation and proliferation of RET and EE&C. They include:

- Inadequate policy support
- Absence of a dedicated and empowered champion for RET and EE&C
- Absence of appropriate financing and accounting practices
- Inadequate expertise in resource mobilisation
- Cross-sectoral issues
- Public education and public awareness
- Influence of utilities
- Competition for scarce resources
- Scale of resources.

### Energy policy support

In the last 3–5 years there has been a concerted effort to develop (or document) local renewable energy policies or policies which have committed sections for RET and energy efficiency. Examples of such efforts include:

- Jamaica – revising the Jamaica Energy Sector Policy 2006 and completing a study, *Renewable Energies Potential in Jamaica* (UNECLAC, 2005);

- Cuba – Law of the Environment with encouragement for renewable energy and an 'energy revolution';
- Barbados – comprehensive energy policy with recent updates; and
- Regional efforts that have produced, for example, a draft CARICOM Energy Policy.

From these initiatives, conclusions can be drawn about the elements that effective energy policies promoting RET and EE&C might usefully include, such as:

- Planning and evaluation tools, such as energy forecasting and balancing;
- Clear legislative and regulatory directives;
- Various financial incentives and special financing mechanisms for RET & EE&C in all sectors, including equity with existing incentives (such as subsidies) to existing users of conventional fuel, and differential taxation based on energy efficiency, availability and appropriateness;
- Contractually linked or binding specific targets for RET and EE&C applications, especially for the heat and power sector, including cogeneration and combined cycle technologies;
- Power generation incentives, including feed-in tariffs, capital subsidies, grants or rebates, special duties and tax concessions or credits;
- Net metering and net billing options for small distributed generation applications;
- Reduced or weighted influence of utilities in bid evaluation and selection for new generation;
- Public education, including development of a trained and skilled workforce;
- The development of market mechanisms for GHG emission reductions;
- Stimulation of upstream RET and EE&C demands (e.g. EEBC as a regulatory standard);
- Updated and appropriate emissions and fuel quality standards for all sectors;
- Use of RET for rural electrification;
- Development of appropriate models for energy sector liberalisation, decentralisation and privatisation;
- Use of full cost accounting and benefit cost to evaluate proposed new installations – accounting should consider all aspects of sustainability.

The result of clear policies and political will be the proliferation of RET and EE&C nationwide, as can be seen in Cuba and Japan. The Cuban energy revolution (a government policy) facilitated savings of approximately US$1 billion per year from RET, including 1,000 MW of wind, solar and hydro power (James, 2007).

### A dedicated and empowered champion of RET and EE

The strategy of an 'internal catalyst'[10] (i.e. internal to the sovereign state) is a proven means of achieving RET and EE&C policy targets, and sustainable consumption and production targets. Without a sustained (over 10 years) agency, 'genetically linked' to the governments of SIDS to drive the objectives, a surge in implementation and cultural shift will not be achieved. Commitment and dedication must be endogenous factors for sustainability. While the private sector grapples with inherent conflicts between profit objectives and environmental and social responsibilities, central government is driven towards the development of social, environmental and political agendas with limited economic resources. NGOs and civil society do not have sufficient political and legislative influence or funding to achieve a sustained outcome. The profile of the champion or internal catalyst should therefore be a hybrid, drawing on the strengths of these three groups. With its origin in government, it needs private sector decision-making power and financing, and the liberty to lobby. This internal catalyst must have a clear transforming vision to catalyse sustainable consumption and production imperatives.

In the case of Jamaica, the champion was the Petroleum Corporation of Jamaica (PCJ). In Japan it was the New Energy and Industrial Technology Development Organisation (NEDO) and in the French Overseas Departments (Guadeloupe, Martinique, Réunion Island and French Guiana) it was Agence de l'environnement et de la maîtrise de l'énergie (ADEME).

The PCJ has a legal mandate for implementing the national energy policy, owns the nation's petroleum refinery (Petrojam Ltd) and petroleum marketing subsidiary (Petcom), both of which compete with private sector entities. It also regulates the current campaigns for oil and gas exploration. It lobbies for a reduction of Jamaica's high energy intensity, improvement in energy security and utilisation of supply and demand-side management techniques to increase energy self-reliance. In the French Overseas Departments ADEME, a public agency under three ministries, is committed to energy, research and the environment. It collaborates closely with public sector partners on research, with the European Commission on market incentives and with various councils for local implementation. Where there is no internal catalyst or champion for RET and EE&C, the successes demonstrated by these institutions in promoting RET and EE&C are not as likely to occur or be sustained.

### Appropriate energy financing and the use of traditional accounting methods

The cost of renewables cannot be measured by monetised values alone, but must also incorporate the emergent negative and positive externalities. Whereas the capital outlay for RET options may be considered more expensive than that for traditional fossil fuels, full cost accounting methods (considering associated fuel generation, transport, storage, use and disposal issues) can show that renewables are competitive over the full lifecycle of the fuel. In this context, Jamaica's 20.7 MW wind farm, which received a grant of US$7 million to achieve energy costs of 5.6 cents/kWh, plus an estimated income of US$3.1 million between 2004 and 2012 for certified emission reductions, is competitive with a fossil option. Interestingly, the typical threshold of 5–7 cents/kWh for the acceptance of some power generation projects using fossil fuels does not reflect the electricity prices of 20–35 cents/kWh experienced in many SIDS.

Biomass, using fuel cane, bagasse cogeneration and bio-ethanol production, will be critical in improving the US$300 million earnings and saving 125,000 cane industry jobs in CARICOM. Currently in Jamaica, wet ethanol is imported for the production and export of 100 million gallons of fuel grade anhydrous bioethanol (60 million gallons from Jamaica Broilers Group Ltd, a private sector agro-industry company). Local production of feedstock is the route to optimise social and economic gains. Prices are increasing from 85 cents/gallon in Brazil to $1.9/gallon in the USA and $2.8 /gallon in Hawaii (with production incentives and tax credits equal to about 4 cents per gallon),[11] making bioethanol more lucrative as a fuel.

Special low-cost loan facilities should be made available for RET and EE&C applications, recognising the cost savings in externalities and import substitution, and the potential for economic gains such as certified emission reductions (CERs) and employment benefits. ESCOs could also be utilised to create value-added linkages between improved efficiencies and investment dollars. The French Overseas Departments have made use of innovative fiscal incentives to proliferate wind and solar technologies. Long-term domestic loan facilities could be made available to residential users (e.g. in Jamaica, the National Housing Trust offers low interest long-term loans for solar water heating). As a tool to encourage serious EE&C applications, banks could consider energy audits before granting loans to business operations. Fiscal support should also be considered for local industries, including concessions, duty free import of SWH materials and partial or full tax deductions to consumers for the cost of heaters (UNDESA, 2000). With such support, Barbados has now become the largest CARICOM producer of solar water heaters, and has the biggest number of installed units per capita (1 unit per 18 households). Energy funds on a revolving basis can assist in providing capacity building in energy efficiency technologies, support small projects and drive market development. Special financiers such as E+Co can provide equity, loans, security and lines of credit from start-up through to implementation. Funds are available to ESCOs, financiers and end-users.

Whereas SIDS are often funded from external sources, it is important to ensure that national priorities and drivers are given sufficient weighting in selecting projects and providing fiscal incentives. The agreement on a Caribbean Single Market and Economy, growing support for PetroCaribe and a suspension of the common external tariff in the Caribbean Region are opportunities to explore the bundling of clean development mechanism projects under the Kyoto Protocol, so as to attain a critical mass of CERs which will enable projects from small states to enter the commodities market.

## Adequate expertise for resource mobilisation

The application process for funding of €200 million through the EU Energy Initiative was so complex that only 10 per cent of SIDS were able to apply and those that did so needed European consultancies (GSII, 2007). Available funding without simplified procedures for proposal preparation or special assistance as part of the funding offer presents a barrier to the proliferation of RET.

Capacity building is also needed to develop engineering designs and modelling for project proposals, feasibility studies and business plans which are specifically suited for the peculiarities of SIDS. Historically, the economies of SIDS were managed on an expense budget as the offshore interests of empires, instead of on a 'zero' budget basis, and this may have reduced innovations in sourcing funds. Many SIDS are trailing behind European and North American states in their ability to mobilise resources. On the other hand, some SIDS have developed the competence and expertise to access clean development mechanism (CDM) financing for projects. Pacific Hydro negotiated CER carbon credits from the Netherlands-based ABN-Ambro for its Wainikasou and Vaturu (Fiji Islands) hydro projects; the Wigton Windfarm (Jamaica) also successfully negotiated financing from the Dutch Government (Dutch Development and Environment Related Export Transactions Programme) via an Oret/Miliev grant. Where experience has been gained, countries should make their expertise available to member SIDS as a gesture of goodwill, and also to attract further funding for their region by developing a positive investment climate for developed and industrial nations seeking locations for projects.

## Harnessing cross-sectoral initiatives

Traditionally, synergies were not created between the sectors that generated and those that consumed energy. For example, cogeneration developed as a method of disposing of bagasse as solid waste. This should be be made efficient so that the sugar cane industry can produce ethanol and power from cogeneration for the power, spirits and transportation sectors, creating employment in each sector. Similarly, waste disposal in landfills should be transformed into a source of energy. New technology has made it possible to produce ethanol from cellulosic wood mass in a second generation biomass-to-liquids technology, thereby utilising waste biomass from forestry and agricultural processes, and the furniture industry (James, 2007). Similarly, the production of biodiesel (using Jatropa curca) in Dominican Republic, or over 100,000 gallons of coconut based biodiesel from the Tobolar coconut industry (GSII, 2007), can provide fuel for transportation, reducing imported diesel fuel and sulphur emissions, while creating employment opportunities in agriculture, processing and exports. Hydropower can provide irrigation, domestic water and power (as, for example, in the proposed Blue Mountain Multipurpose Scheme).

## Public education and awareness

Staff awareness of EE&C technologies and practices in the hotel industry can generate a 10 per cent savings in energy costs. Awareness at every level, from the board room to

Parliament, will help to capture opportunities and benefits in using RET and EE&C for a number of reasons:

- In many cases the shift to RET and EE&C is a cultural one – cultural shifts may occur in the short term, but for them to be sustained, behaviour must be reinforced continuously;
- Advantages gained for conventional fuels (lower prices or the addition of new fuels to the energy mix, such as natural gas) may detract from renewables and EE&C;
- Creating awareness among the younger generation is essential to the creation of a sustainable cultural pattern;
- Technologies are changing rapidly and the benefits should be grasped to maximise new opportunities;
- On the expiry of the useful life of equipment that generates power from existing fossil fuel technologies, opportunities will emerge for new investments. Both local and foreign investors should have the appropriate knowledge to make decisions which yield optimal results (including social, economic and environmental benefits).

Public education should include a range of informal to formal educational options and deliver both information and competence for sustainability.

### Influence of utility companies

Another barrier faced by RET is the influence of power generation and transmission companies. While there have been various degrees of privatisation, unbundling of monopolies and deregulation of the power sector in many SIDS, utilities continue to hold licences for large blocks of electricity supply and usually for all transmission. A small state's total power demand is often insufficient to make generation commercially viable for more than one generator, and dividing transmission would be unwieldy. This exerts an unusual influence on regulators and energy ministries to provide special consideration for the technical and fuel preferences of the operators over large blocks of generation using 'familiar' conventional fuel technologies. In some cases, the utility company is a deciding member of bodies that select new generation proposals. Energy efficiency may be seen by some to be contrary to the core business of energy supply and often EE&C is valuable in periods when expansion is not economically feasible and buffer capacity is approaching a critical low. While recognising the limits of competition in SIDS, it is also important that government interventions lead the way to national benefits, with the utilities acting in a supportive role.

### Competition for scarce resources

The demand for renewable fuel sources often competes with other social, economic or environmental demands and may naturally limit which RET can be implemented. The diffused nature of renewable energy sources such as solar and wind, as compared with the more energy-dense fossil fuels, also means that RET typically need to concentrate the energy source (using large volumes of water, hectares of space or multiples of turbines) before it can be applied in commercial settings. Competition for resources is therefore heightened and sometimes conventional energy-dense fuels are selected over RET. For example, hydropower considerations must now reserve 'environmental' and 'social' water demands (i.e. the minimum flows needed to maintain healthy ecosystem functions, social use or recreational benefits), as stipulated by water resources management agencies. This can affect projections of the economic viability of projects. Biomass plantations may compete with high-value crops for land and wind farm sites may compete with aesthetic features, especially in coastal areas.

### The challenge of scale

With small populations and limited land space and surface water, the resources available for renewable options are often small compared with those in industrialised nations. For centralised power generation, waste-to-energy and other technologies, small populations may not provide adequate economies of scale to make investment attractive. Numerous feasibility assessments of the potential for using Jamaica's 900,000 annual tonnes of waste have determined that this is too small to fuel commercially attractive generation systems. Technologically advanced smaller modular systems can now utilise as little as 250,000 tons per year with an investment of US$1,967/ kW to warrant waste-to-energy power generation.

### National benefits

Finally, in considering whether to make use of RET and EE&C, the potential gains should take into account national benefits. For example, SWH incentives in Barbados brought about a reduction in fossil fuel imports of 33,000 tonnes of fuel per year, a saving of about US$6.5 million (assuming an oil price of US$25/bbl and a population of 260,000). For the English-speaking Caribbean this would be an annual saving of US$125 million (assuming a population of 5 million) (INFORSE, 2007). A solar water heater of 100 litres has the capability to prevent the emission of 1.5 tonnes of carbon dioxide per year and 1,000 such units can shave 1 MW off peak loading: the Wigton Windfarm is estimated to save 52,540 metric tonnes of $CO^2$ equivalent per annum. The local environment and the utilities (private and public) would benefit from the installation of additional peak load capacity (Government of India, 2007), where RET are used.

## Conclusion

Various regional and international accords have captured the challenges and plights of SIDS, and also provided useful frameworks for sustainable development. To fast-track the development of SIDS to the level of equitable partners on a global platform, increasing wealth, improving the quality of life and sustaining vulnerable environments, while avoiding the mistakes of the past, SIDS must be selective in their strategies for achieving energy security and independence. Full appraisal and development of local resources is paramount in gradually replacing the imported energy used for long-term investments in heat, light and power generation. An emphasis could be placed on valuable local sectors which can experience transformation in the short term for the preservation of key economic earners, cultural heritage and the environment. Energy options which facilitate early shifts in the national energy mix towards dependence on sustainable indigenous energy resources should be pursued with alacrity.

The litmus test of energy efficiency and conservation should be applied to energy options which can be administered within a paradigm shift towards achieving and subsequently raising the benchmark for energy use. Achieving energy efficiency and conservation must therefore be the first objective in reducing the energy appetite of SIDS in order to enable them to achieve optimal gains from energy security advances.

Renewable energy options in small states are diverse, though there are limitations in any one approach, depending on the surface and subsurface features of the environment, geographic location and resource mobilisation opportunities. The optimal combination and proportion in the energy mix of sovereign states are best identified by the application of rigorous economic, social and environmental considerations and comparison of conventional options on the same platform, taking into account externalities and social, economic and environmental impacts. Tested and proven appropriate technologies should be a priority relative to new and cutting edge technologies, in order to avoid spending time and funds on unsuccessful attempts.

After a longstanding use of conventional energy resources, full cost accounting methods and access to special project funding are critical for levelling the conditions for the application of EE&C and RET. Building competencies for resource mobilisation and project development will be important, and collaboration between experienced nations and their neighbours will accelerate the transition.

National policies should be crafted and communicated to achieve these ends, with support from regional policies to encourage collaboration among sovereign states in achieving their transformational targets. Strategic buy-in by corporate ‘citizens’, special interest groups and the population at large is important for successful change, and is therefore an important part of the state communication process. Without a dedicated and empowered champion for RET and EE&C, efforts towards transformation may be weak and diffused at best, or costly and unsuccessful. However, there may be enough examples among the Caribbean, Asian, Pacific and other SIDS to facilitate transformation within each. Awareness and knowledge has grown, but methods for informing the public and decision-makers should be continuous, deliberately designed, implemented and sustained if they are to have a transforming and lasting impact.

Location, geology, climate and the global efforts to reduce GHG are internal strengths which can help SIDS to develop RET-based projects that can attract special funding. However, for most SIDS the historical barriers discussed above and limited resources of land and water have proved a challenge. Clear policy directives and planning tools can lead to the solutions that are needed. In the near future, some SIDS will decide if their cane industry can survive under favourable market terms with bioethanol and cogeneration as sweeteners; others will attempt to make biofuels and cogeneration the determining factor.

The future for the sustainable development of SIDS using RET and EE&C as platforms is favourable, but it will require clear vision, early action and a tenacious determination to succeed.

## Notes

1 Energy security means the appropriate blend of energy forms, in adequate quantities and at affordable competitive cost, in a timely manner, meeting quality and functionality requirements, from a strategic blend of suppliers (supply buffer). More recently, the dimension of reducing unacceptable or irreversible environmental impacts over the long term has been added to address sustainable development requirements.
2 November 2005 EIA Forecast, 4Q05. EIA, IEA and OPEC projects 86.8 mbpd for 2007 (*Energy Economist*, 2007).
3 Colin Campbell indicated that an oil peak would be evidenced in the years 2006–2015.
4 NYMEX WTI for December 2007; Graph from *Energy Economics News Letter*, 2007.
5 Mauritius Strategy, para. 41.
6 Simultaneous production, usually of heat and power, from a single energy input; trigeneration is similar with heat, mechanical and power as the outputs.
7 REN21 – 2006 Update Renewables Global Status Report.
8 Experts Meeting on Capacity Building for Renewable Energy and EE in SIDS, Matavai Resort, Niue, 2003.
9 OTEC is a technology that generates electricity by using temperature differentials between deep and shallow waters in order to run an engine.
10 David Barrett, 'Catalyst Model for Sustainable Consumption and Production', Second International Experts Meeting on Sustainable Consumption and Production in Latin American Countries, Costa Rica, 5–8 September 2005.
11 William Maloney, Pacific West Energy LLC, 2006.

## References


Barrett, D. (2005). 'Catalyst Model for Sustainable Consumption and Production', Second International Experts Meeting on Sustainable Consumption and Production in Latin American Countries, Costa Rica, 5–8 September, 2005.

Bruton, H.J. (1998). 'A Reconsideration of Import Substitution', *Journal of Economic Literature*, XXXVI: 903–36.

CARICOM (2007). CARICOM Energy Policy, January 2007.

Centre for Renewable Energy and Sustainable Technology (2006). Renewable Energy Policy Outside the United States. Part 6: Japan – The World's Most Efficient Economy, www.crest.org/repp_pubs/articles/issuebr14/06japan.html

De Boer, Y. (2007). Second Public Hearing of the Temporary Committee on Climate Change (CLIM), European Parliament, Brussels, 4 October 2007, Address by the Executive Secretary, United Nations Framework Convention on Climate Change.

Department of Business, Economic Development and Tourism Strategic Industries Division (2006). *Photovoltaic Electricity in Hawaii*. Honolulu, Hawaii: DBEDT.

Detlef, L and Coviello, M.F. (2005). *Renewable Energies Potential in Jamaica*. Trinidad and Tobago: UNECLAC and GTZ.

East Harbour Management Services (2003). *The Potential for Use of Solar Water Heaters in Motels*, Report to the Energy Efficiency Conservation Authority. Wellington, New Zealand: EHMS.

Energy Publisher (2007). Caribbean Energy Profile, http//:www.energypublishers.com/articles.asp?id=10914. 9/27/2007

Escalante, A. (2003). 'The Role of the Energy Service Company – Caribbean Region', Seminar on Implementing Energy Efficiency Projects in the Caribbean. Jamaica: E+Co, PCJ, USAID, EAST, November.

Fairbaim, P. (2004). 'Pacific Energy Partnership Initiative', *Pacific Islands Energy for Sustainable Development (PIESD) Newsletter 1*, South Pacific Applied Geosciences Commission (SOPAC), April.

Forum for Energy and Development (1999). *Proceedings from the Global Conference on Renewable Energy Islands*, Aero, Denmark, November.

Global Sustainable Energy Island Initiative (GSEII), Spring 2007.

Goldenberg, J. and Johansson, T.B. (2004). *World Energy Assessment*. New York: UNDP Bureau for Development Policy.

*Green Chip Review* (2007). http://www.greenchips.com.

Haughton, E. (2003). 'Energy Conservation for Jamaican Industrial, Commercial, Health, and Commercial Facilities. Proven Energy Conservation Measures that Save $$$', Seminar on Implementing Energy Efficiency Projects in the Caribbean, E+Co, PCJ, USAID, EAST, November.

International Network for Sustainable Energy (2007). *Sustainable Energy News, INFORSE Newsletter*, No. 56, April.

Isaacs, R. A. (2008). 'Progress in Geothermal Power Development', Presentation at Platts 8th Annual Caribbean Energy Conference, 21–22 January, Coral Gables, Florida.

James, C. (2007). 'Light Brightens as Castro Fades', *Energy Economist*, 304, February.

Kelly, P. (2006). 'Soapberry Wastewater Project to Save Kingston Harbour', Jamaica Information Service, 19 September.

Leavai, P.D. (2003). 'Renewable Energy: A Renewed Approach to Sustainable Development – A Natural Source of Empowerment for the Pacific Islands', *Proceedings of the 2002 National Environment Forum*, No. 4, Samoan Environment Forum, pp. 37–42.

Pacific Hydro (2007). http://www.pacific hydro.com.au/OurEnergy/HydroPower/Fijiprojects/tabid/127/default.aspx.

REN21 (2006). *Update Renewables 2005: Global Status Report*, Renewable Energy Policy Network for the 21st Century.

Schneider, B. and South, D.W. (2007). 'Landfill Capacity Solution – Converting Waste to Energy', Presentation at Platts 7th Annual Energy Caribbean Energy Conference, 2007.

Sopoaga, E.S. (2004). 'The Small Island States: The Challenge of Energy', *New Academy Review*, Climate Change Edition.

Standard Bank (2005). *Energy 2005: Annual Review and 2006 Outlook*, Standard Bank.

*Star Bulletin* 12(151), 31 May 2007.

United Nations (2005).'Draft Mauritius Strategy for the Further Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States', International Meeting to Review the Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States, Port Louis, Mauritius, 10–14 January, 2005, A/CONF.207/CRP.7

—— (2006). *Millennium Development Goals Report 2006*. New York: UN.

United Nations Department of Economic and Social Affairs (2005). Summary of Co-chairs, Second International Experts Meeting on the 10-year Framework of Programmes for Sustainable Consumption and Production, San José, Costa Rica, 5–8 September.

UNDP (2003). *Developing an Energy Agenda for SIDS*, Report of Expert Meeting on Capacity Building for Renewable Energy and Energy Efficiency in Small Island Developing States, Matavai Resort, Niue, 7–11 July 2003.

UN General Assembly (1994). *Report of the Global Conference on the Sustainable Development of Small Island Developing States* (*Barbados Programme of Action*), Bridgetown, Barbados, 25 April–6 May. UN General Assembly, A/CONF.167/9.

—— (2000). United Nations Millennium Declaration, Resolution adopted by the General Assembly, Fifty-fifth session, agenda item 60(b), 18 September 2000, A/RES/55/2.

—— (2001). *Road map towards the implementation of the United Nations Millennium Declaration*, Report of the Secretary-General, Fifty-sixth session, 6 September, Item 40 of the provisional agenda, A/56/326.

Wright, R. (2006). 'Alternative and Renewable Energy – How Far Can the Caribbean Go?', IBC Conference, Port of Spain, Trinidad, 4–5 December.
—— (2003). 'Energy Efficiency – with Particular Reference to Island Economies such as Jamaica', Seminar on Implementing Energy Efficiency Projects in the Caribbean, E+Co, PCJ, USAID, EAST, November.