Title: The Use of Regulation in Promoting the Development of Renewable Energy Technologies in the Caribbean

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Abstract

In this investigation, the status of renewable energy technologies in the Caribbean was analysed using Barbados as a case study. Factors influencing the development or lack thereof were studied in the context of the regulation in place. Regulation was assessed in terms of market structures (vertically integrated, single buyer, open market), regulatory strategy (Command and control, economic incentive, persuasion) and regulatory system (rate of return, price cap and performance based).
Regulation in the Caribbean was then compared to Germany and Europe in general where environmental regulation has led to some degree of successful implementation. International environmental regulation was also addressed using the Kyoto Protocol model as an example.

The following recommendations were made for regulation in the Caribbean based on the analysis:

1. Development of appropriate targets to facilitate Performance based regulation in the long run.
2. Establishment of regional emission reduction target
3. Establishment of single buyer utility structure in the Caribbean
4. Carbon trading scheme for the Caribbean
5. Environmental cost to be factored into current regulatory systems.

1. Introduction

The introduction of renewable energy technologies to increase sustainability in the energy sector has been regarded by many governments as desirable and has formed part of many informal energy policies in the region. A renewable energy source is defined as a source of energy which is infinite or regenerative; these fuels are not depleted with use. Renewable energy sources include solar, wind, biomass, hydropower and geothermal. The introduction of renewable energy is important for the following reasons.

1. Reduces dependence on crude oil derivatives.
2. Reduces global greenhouse gas emissions.
3. Promotes the development of indigenous technologies.

4. Encourages local entrepreneurial opportunities.
5. Provides opportunities for international financing.

With few exceptions, the development of renewable technologies in the Caribbean have remained in the embryonic stage. Projects have been prone to a myriad of technical and financial barriers which have impeded the growth of the industry in general. The electricity utilities which are largely privately owned are more concerned with economic viability than maintaining and improving environmental standards.

In order for development of renewable energy to occur, regulators will need to be involved in facilitating government policies which are relevant to the civil society. There are difficulties in changing the attitudes and approach of utilities within currently existing regulation frameworks. Rate of return regulation which is the main mechanism for electricity regulation generally favours the adoption of technology available which allows the company to remain economically viable.

From the analysis that follows, a framework will be recommended that is designed to increase the use of renewable technology which will in turn lead to more environmentally sustainable electricity sectors within the region.

2. Institutional Arrangements – Electricity Sectors in the Caribbean.

Electricity sectors in the Caribbean have followed the trends of many countries in the world. In the 1970s most utilities were owned by the state, with a "command and control" system of regulation. The international trends in economics towards liberalisation and open market, has meant that electricity utilities have tended to move towards privatisation and liberalisation throughout the 1980s and 90s. This trend was aided by the Adam Smith philosophy in Classical Economics which stated that the market if allowed to operate without external forces would lead to economic efficiency and equity for all.

In spite of the general trend, the movement towards a more open market has not been as rapid as in the neighbouring North American and Latin American jurisdictions. This can be attributed to the fact that the sizes of Caribbean populations make the markets for electricity relatively small.

Electricity utilities have one of three structures.

Vertically integrated – Where there is a single utility with responsibility for generation, transmission and distribution.

Single buyer – Where one utility is responsible for transmission and distribution but can purchase energy from a separate company responsible for generation.

Open Market – Where competition can exist in all phases of generation transmission and distribution.

In countries such as Barbados the structure is a privately owned vertically integrated regulated monopoly with Barbados Light & Power responsible for generation, transmission and distribution (Regulated Integrated). In Trinidad vertical break up has occurred where Powergen is the company responsible for generation and T& Tech is responsible for transmission and distribution. (Single Buyer)

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Open markets in electricity are very rare, but in South America Chile has enjoyed success in there electricity sector through a completely deregulated market with competition existing in all phases. (Olade, 1996 Guide for Policymaking in the Energy Sector Latin America and the Caribbean)

The institutional structure of the sector has implications for the strategy used to promote renewable technologies. In the past, where more utilities were government owned, the state was able to determine energy use from the point of view of overall sustainability for the consumers. The shift towards private ownership means that effective environmental regulation will need to include market based measures since the decision of the private enterprise is based on economic considerations. The primary interest is to attract investors and guarantee shareholders dividends on shares

Governments have a wider mandate, with the entire country as their customers. In many cases governments have obligations under international conventions to ensure that the energy sector is operated in a sustainable manner. The advantage in terms of economic efficiency through privatisation has needed to be balanced by greater government involvement through regulation.

3. Role of Regulation

The reform of the electricity sector which has occurred in the last two decades has made regulation critical. The public utility provides an essential good that is usually in the hands of private players which have no automatic responsibility to the public consumer. The regulators have played a role in protecting the consumer from cost hikes through price regulation and more recently there has been the move towards embracing the aspects of standards of service.

The environment is an example of a public good, it is not owned by a particular individual but is a shared resource which if deteriorated will lead to the overall detriment of society.

The challenge for the regulator is to include these aspects in a way which is compatible with other aspects of regulation.

4. Renewable Energy Use in the Caribbean

Below is a table indicating significant renewable energy developments in some Caribbean jurisdictions.

Antigua	Biogas , Solar Crop Drying, Solar Water Heating
Barbados	Solar Water Heating, Solar Photovoltaic, Bagasse
Grenada	Hydropower, solar crop drying
Guyana	Biogas , Hydropower, solar crop drying , wind power
Jamaica	Wind power, bagasse, biogas hydropower, solar crop drying
St. Lucia	Geothermal, solar water heating
Trinidad & Tobago	Bagasse, solar crop drying

(Source: NEWEN Handbook, CEIS 1996)

The reasons for the current state of renewable energy development is analysed in terns of drivers and barriers.

4.1 Drivers

Many general energy policies in the Caribbean encourage the use of renewable technologies. Similar to many developing countries, Caribbean countries depend almost exclusively on oil & gas imports to meet their energy needs. The major exception is Trinidad & Tobago which has a highly developed oil & gas industry. The dependency on imports for such an essential product has led to the drive to develop forms of energy which are indigenous to the country. Renewable energy sources are attractive in this regard. Solar, wind, hydropower and geothermal have all been explored.

Reducing the dependence on fossil fuels will have a direct effect on the balance of payments deficit in a country; it will also reduce the vulnerability of the energy system in light of the international geopolitical climate. The impact of global politics on energy security has been underlined through the recent war in Iraq as well as the continued political instability in Venezuela.

Generally environmental awareness has also increased over the last 20 years; especially with the influence of the Rio Earth Summit in 1992 this was followed by the Small Island Developing States conference in Barbados 1994. Resulting from these conferences particularly Agenda 21 in the Rio Declaration, developing countries have been given policy directives to develop resources in a manner that does not

compromise the development future generations. Renewable energy sources do not lead to air pollution during their operation and do not lead to depletion of oil and gas reserves which are finite in nature.

Linked to the issue of sustainability for islands is climate change which is a phenomenon that has particularly severe potential consequences on small island states. Potential climate change effects through increased emissions of Carbon Dioxide through increased combustion of fossil fuels include rising sea levels, flooding of coastland and inundation of the beaches. There is also a potential threat to ground water reserves as well as increasingly severe hurricanes. These effects are even more critical when taken in the context that these factors will affect tourism which is the main economy in many Caribbean islands.

4.2 Barriers

In spite of the many reasons for the development of renewable energy, these technologies continue to remain largely undeveloped. There have been many reasons suggested for the lack of development and the Caribbean Renewable Energy Development Project which was established in 2002 has identified major barriers as financing, awareness, policy and capacity.

Technical Challenges

Renewable energy sources tend to require relatively large areas and are also capital intensive. This is due to the fact that there is no cost of fuel but the technology itself is expensive. The transformations are generally inefficient. Solar photovoltaics, for example have an efficiency of 13% and solar water heaters 60% compared to approximately 90% for thermal conversion to electricity. This means that an investor in these technologies needs to have a high level of initial capital although the maintenance costs are much lower than conventional energy systems. This situation is rather similar to the electricity utility itself which is capital intensive with a comparatively lower fuel cost. The utility is able to function in spite of its capital intensiveness through investments and loans which are encouraging to investors due to guaranteed rate of return. Renewable energy does not provide investors with this guarantee and the risk is therefore higher. Consequently investments in many projects have been slow. The end result is that development and research in these technologies has not been funded and the industry has not achieved the “critical mass” necessary to maintain continuous improvement. The market forces as they exist today will therefore not drive the development in the area of renewable energy.

The transition to renewable energy has also been hindered by the fact that it is not a traditional innovative technology. If one analyses the transition in the use of energy sources in history, energy sources with a higher efficiency or energy density have replaced previous ones. Each transition led to a reduced volume of

resource needed to produce the “next generation” energy. Energy density of sources increased from wood fuel to charcoal to coal to oil & gas to nuclear. In each case the reduce volume of fuel needed meant that the cost of production was reduced and this economic benefits drove the transition, since less resources were used the environment benefits were experienced through reduced use of land for energy production.

In each case the change in technology was an innovation. Business innovation may be defined as a change in technology which results in the same service or good produced at a lower cost or the same good modified to produce a higher output at the same cost.

The transition from conventional to renewable t echnology is not an innovation from a business or corporate standpoint.

Renewable energy systems normally have higher cost of capital and less or same output. It can be argued that environmental quality is improved through the use of renewable. This is however a less tangible benefit which is global and often not easily quantifiable.

Another reason for resistance of the utility company to renewable energy is the radical nature of the innovation. In previous changes in technologies the shift has been from the combustion of one material to the use of another. In many renewable technologies the basic engineering principle for energy conversion is completely different, requiring different expertise or core competencies which may not necessarily be present within the utility. This has caused many utilities to resist adoption of the technologies.

5. Regulatory Strategies

Regulation may be viewed as a means of achieving a desired behaviour. There are a range of approaches which can be used from the coercion to gentle persuasion. A mother faced with a child that she wants to raise to be well behaved can use three basic techniques.

1. She can may, punish the child for unwanted behaviour using spanking, to prevent repetition of the unwanted behaviour (command & control technique).
2. She may promise the child a reward by way of offering a special gift or privilege if he behaves in the manner desired (economic incentive technique)
3. She may choose to sit the child down and explain why for the sake of his own development it is important to behave in a desirable manner (persuasive technique).

These same principles can be applied in relation to utility regulation resulting in the three categories

1. Command & Control
2. Economic Incentive
3. Persuasion.

In many instances, as is the case with a mother and her child, a combination of the strategies is the most desirable. Also as in the case with the child the technique will depend on the level of maturity of the utility sector and its unique characteristics. Each strategy has its inherent strength and weaknesses which are considered in this section.

Command & Control:

This option has been used particularly in jurisdictions where the state owns the utility. The government may mandate that a renewable energy technology must be used and specify the percentage of generation that must be produced through renewable energy. This is indeed often specified in general policies of governments. In Barbados, for example the government has stated a goal of 40% of energy to be generated from renewable sources. (Government of Barbados, Draft National Strategic Plan 2000-2010)
The advantage of mandating is that it can be enforced relatively quickly and if the utility has the capability to comply and the penalties are stiff, a change in behaviour may be obtained. In Germany for example, government policy and regulation mandating change in technologies towards renewable has led to that country being today the European country with the greatest use of renewable energy technologies.
There are however many disadvantages to this approach, it can be perceived as a draconian method by the utility especially if they have not been involved in setting the standard to be achieved or have been given no prior indication that the measure would be implemented. In many cases suitable requirements have not been analysed with the appropriate scientific rigour, and this tends to result in companies being technically and financially unable to comply with rules, making the rules unenforceable and ineffective. If this method of regulation is chosen, it must be enforced by careful determination of the standards that are to be set so that companies are required to change their methods to strive for better, but goals are realistic and achievable.

Economic Mechanisms

These have been widely investigated particularly for use in environmental systems. In this mechanism, the cost of acting in the desirable way is significantly less than the undesirable. This can be achieved through placing taxes on non renewable sources or reducing costs for using sustainable technologies. The advantage of this system is that it gives flexibility for the company in implementing its technologies and the company may choose the most economically efficient method of taking advantage of the incentives. This has been the philosophy behind the development of Clean Development Mechanism and Joint Implementation which have been suggested as measures to assist implementation of the Kyoto Protocol, which is discussed later. One of the main disadvantages of this method is that it allows the utility to continue with unsustainable practises if they are able to absorb the economic penalty. If a utility continues in the same mode of operation in spite of the incentives offered for change, the mechanism becomes ineffective or in some cases only effective for utilities with more economic constraints. This often leads to inequity in the system as those with less economic resources are forced to bear the burden and those entities with vast capital resources are able to pay for the right to pollute.
Economic mechanisms are also more difficult to administer since they require determination of relevant indicators, baseline data and a continuously updatable method for evaluation of cost.

Persuasion

This is the least coercive of the measures that can be applied. This involves programmes which educate the public and utility as to why the desired behaviour will benefit all stakeholders. It appeals to the utilities desire to be viewed as a "good corporate citizen". This can sometimes be successful but often needs to be linked directly to economic advantages. One example of a persuasive mechanism is encouraging the use of voluntary standards. This has led, for example, to the Green Globe Certification and for many hotels in the Caribbean. The "Green Globe" is a label which differentiates these hotels in the market which attracts guests which are environmentally sensitive, potentially increasing the number of bookings each year. However if these types of mechanisms are used in isolation there are unlikely to produced widespread changes in utility behaviour since lack of an enforcement scheme may lead utilities to believe that regulators are not serious.

Below is a summary of the general characteristics of the strategies

Command & Control – Equitable, easy to develop, difficult to implement, lack of legitimacy, easy to administer, regulatory cost higher.

Economic – Efficient, may not be equitable, flexible, complex to develop, difficult to administer, regulatory costs lower.

Persuasion - Easy to develop, not enforceable, educates stakeholders.

The regulatory framework chosen should seek to blend the best aspects of the approaches.

6. Renewable Energy Experiences

In light of the strategies identified, actual implementation mechanisms used to promote renewable energy projects will be analysed. Barbados was used as a Caribbean example due to the success of its solar water heating industry and compared to Germany which has been very successful in implementation of renewable energy projects.
Subsequently the implementation of regional and international mechanisms will be analysed using similar criteria.

6.1 Barbados
Solar Water Heating Development

In spite of the challenges experienced, there have been experiences of successes in the development of renewable technologies. The solar water heating industry in Barbados has been very successful resulting in the replacement of many electrical water heating systems. Below is an analysis of the conditions that led to the development of this resource.

6.1.1 Solar Water Heating Industry

The Solar Energy industry was established in 1974, with 4 local companies. This has been so successful, that over 35,000 solar water heaters are installed in Barbados representing one third of households in Barbados. Solar Water Heaters are also widely used in the commercial sector including the hotel sector.

The attractiveness of this resource lies in the availability which relates to the average solar radiation per year (5.3 KWh/m² Day) which is consistent throughout the year. The tropical climate is ideal for this resource. The average radiation is far greater than the international average 4.0 KWh/M day.

Since each square metre of surface area receives about 7 kWh of solar energy on a clear day during the dry season, Barbados receives 3 billion kWh on such a day. This is the energy equivalent of about 1.87 million barrels of oil. The Energy Division (2000) reported that the amount of petroleum products imported into Barbados in 1999 was 2,085,937 barrels; so the solar energy received on a hot day is similar to a year's petroleum imports In addition to the favourable climatic conditions, the solar water heating industry also benefited from the Fiscal Incentives Act of 1974, which allowed the manufacturers to benefit from import preferences and tax holidays. The Homeowners Tax Benefit was also introduced, which allowed the homeowner to deduct the cost of the solar water heater from income tax.

The 35,000 solar water heaters that have been installed, each save 4,000kWh per year, which is a cumulative electricity saving of 128 million kWh. The local cost of electricity is 15¢US/kWh, and this leads to a financial savings by the consumers of $19.2 million US/year. This in turn is the heating equivalent of 227,000 barrels of oil and a foreign exchange saving to the island was about $6.8 million US (based on the 2000 average oil price of $30US per barrel(O. Headley, , Quoted in Barbados Submission To United Nations Framework on Climate Change ,2001).

In addition to the fiscal benefits, a substantial quantity of emissions, such as carbon dioxide, sulphur dioxide and the oxides of nitrogen (CO2, SO2 and NOx) are avoided with the use of solar water heating, and the Barbados Light and Power (BL&P) Company also benefits by not having to produce the equivalent of what is about 19% of its 1998 production total of 658 million kWh.
These water heaters are therefore worth 30 to 35MW of additional electric generating capacity (Headley, 2001). (Quoted in Barbados UNFCCC report 2001)

The development of this industry provides some useful lessons regarding conditions necessary for renewable technology. In this case almost purely economic incentives were the driving force. The economic incentives were conducive to encouraging entrepreneurial development as well as creating incentive for the customers. Government support was important although there was no specific policy or regulatory directives which promoted the replacement of the electric or gas water heaters.
It is important to note that this introduction of technology did not require agreement or negotiation with the power company. This is not the case with implementation of renewable projects such as wind and some photovoltaics which require grid connection.
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6.1.2 Wind Energy

In Barbados, studies carried out in the late 1980s and 1990s suggest that there is technical capacity for the development of wind energy and there have been further studies carried out by international wind energy developers which have produced encouraging results Below is a summary of the developments.

The Government of Barbados has been investigating the possibility of wind generation since 1991. A wind turbine was erected in Lamberts St. Lucy but was operational for less than a year. The wind turbine is still in existence but has been severely affected by vandalism.
In 1998 the Government of Barbados carried out a feasibility study for a wind farm at the north of the island in conjunction with a British Company Renewable Energy Services (RES). The study indicated that winds were almost exclusively easterly, with a mean wind speed calculated at 7.34m at a height of 30m. This was an encouraging result since sights with a wind speed of over 7 m/s at 30 m/s are considered "good" wind sites. (Inter American Development Bank, Barbados Wind Study, 1991). It was concluded from this data that the conditions are favourable for the construction of a wind farm including 10 turbines. The project would have a 10 month setting up phase and a 9 month construction phase, and generate about 16 MW of energy. At the moment the installation of the wind farm has not proceeded since there has been no agreement between (R.E.S) and BL&P for price of electricity. Another barrier is related to the acquisition of the land and obtaining Town and Country Planning Permission that the land be set aside for wind development exclusively since there is the possibility in the future that the land will be desired for other commercial purposes. Since Barbados is a very small island and land is at a premium, the preserving of the land solely for this purpose will be difficult to achieve. (Barbados Submission to UNFCCC, 2001).

The result of these efforts was rather different from the technique used to foster the growth of the solar water heating industry. In the case of wind no economic regulation has been put in place to change utility attitude. Up to this point only a persuasive technique has been used by suggesting to BL&P that this type of development would lead to increase sustainability of the countries electricity sector's sustainability and may lead to opportunities in the future.
The negotiations held between R.E.S and BL&P without clear regulatory direction for the utility has led to implementation delay even though the project is technically and financially feasible. In A sector structure, as obtains in Barbados where there is vertical integration, there is no requirement that the utility buys power from another developer. There is also no legal provision for the supply of power directly to the consumer as an independent producer.

The development of wind energy will depend on the establishment of an agreement between the Barbados Light & Power and a wind energy developer since the Electricity Act does not allow independent power producers.

6.1.3 Solar Photovoltaic Projects

The University of the West Indies CERMES has been involved in the delivery of several photovoltaic projects, which were funded as a part of the solar millennium project. These projects were funded by the National Council for Science & Technology and were designed to show the applicability of the technology in a number of areas. Photovoltaic technology involves the use of photovoltaic cells which convert light to electrical energy. These systems are expensive due to the high purity of silicon needed for their operation. Typical costs are $2.00 to $3.00 per peak Watt.

The projects pursued through this project included

1. Solar Photovoltaic Grid tied system for Harrison's Cave
2. Solar Photovoltaics for powering Computers at Combermere School
3. Solar Photovoltaic for Refrigeration for Skeet's Bay Fishing Complex.
4. Solar Photovoltaic for Lighting at Government Headquarters.

Each of these projects was completed and has been very successful in raising the awareness of the technology in Barbados, especially among the schools. They have however not been sustainable since maintenance programmes were not instituted there was also no buy in by the users before construction. This type of strategy is consistent with a command and control approach to development. The government decided to implement these programmes for the "good" of the country. The effort was successful in that the projects were relatively quickly brought to implementation stage, however since there were not market decision the economic sustainability was not built in to the projects. Materials and processes for this project were not selected based on economics. The development of these projects were also driven by the personal interest and wide reputation of Prof. Oliver Headley former director of the solar institute , whose sudden death in April 2002 has left a void in the capacity and expertise of the institution . It has subsequently been difficult to reproduce more projects on the same scale. The capacity to achieve commercialization was also not built in.

The Barbados experience suggests that successful adoption of renewable energy technology is facilitated when the economic incentives are built into the system. The utility with no obligation to accept the power, negotiates on its own terms and the negotiations tend to stall because the utility is not prepared to make financial concessions in a scenario where the purchase of the power is not mandatory. In order for the development of a renewable technology which involves the utility to occur, there will need to be either a specific directive, requiring the use of renewable technology or an economic mechanism which promotes

the technology. Government initiatives are necessary to drive the interest but must be supported by the appropriate economic mechanisms. In spite of the difficulties which have been encountered Barbados remains one of the leading countries in the area of renewable energy.

6.2 The German Experience

Germany has the reputation as one of the leading countries in renewable energy implementation and its success has been based on proactive policy along with incentive mechanisms. Below is a summary of the measures employed and the results.

The government set a 25% carbon dioxide reduction target by 2005 and a commitment was undertaken double the contribution of renewable energy technologies by 2010. This led to increases of 21% between 1998 and 1999 in wind development and a similarly large increase in the use of photovoltaics.

These policy objectives were met through specific incentive schemes in the electricity market. A 250 MW Wind Programme was introduced through enabling independent electricity producers to feed electricity into the public grid , and utilities were obliged to reimburse the producers 90% of the average tariffs per kWh which private users had to pay

A 100,000 solar roof power programme was introduced where interest free loans were provided for erection and extension of photovoltaic power systems with a capacity of 1KW peak or more.
Source: www.agores.org/Publications/ EnR/GermanyREPolicy2000
This strategy has incorporated aspects of command and control, economic incentives and persuasion. Once again economic measures have been at the forefront, but the will of the government of the people has also been a driver.

6.3 Regional Regulatory Mechanisms (European Commission)
The European commission is responsible for the environmental regulation within the wider European region. This proposal is designed to actively promote the production of electricity from renewable energy sources.
Source: European Commission, www.agores.org

- *The strategic objective of the proposal is to create a framework for the medium-term significant increase of renewable sourced electricity in the EU and to facilitate its access to the internal electricity market. This proposal will offer regulatory certainty, while at the same time respecting the principle of subsidiarity by providing for a wide degree of autonomy to each Member State to allow their particular circumstances to be taken into account.*

- *In the White paper this 12 % share of total renewable energy sources in the gross inland energy consumption has been translated into a specific share for consumption of electricity (= 22,1%) produced from renewable energy sources and it is this specific share to which the promotion of RES-E must contribute.*

THE PRINCIPLES OF THE PROPOSAL

National Targets for RES-E

- *The proposal obliges Member States to establish individual targets for future consumption of electricity from renewable energy sources ('RES-E')*

. Support systems for RES-E

- *The proposal abstains from proposing a harmonised Community wide support system for electricity from renewable energy sources. However, the proposal obliges the Commission to make if necessary a proposal for such a harmonised support system within 5 years, taking into account the experiences gained in Member States with the operation of the different national support systems. This will be done on the basis of a Commission report assessing the various support systems in favour of electricity production from renewable as well as conventional energy sources.*

- *The proposal confirms the application of the State aid rules of the Treaty, to prevent overcompensation of particular producers of green electricity to an extent contrary to the Community interest.*

. Other technical issues to promote RES-E

- *assure priority access for RES-E*
- *to assure that certification of RES-E is both accurate and reliable;*
- *to streamline and expedite authorisation procedures applicable to installation of generation plants for green electricity.*
- *Also, Member States will have to assure that the calculation of costs of connecting new producers of RES-E should be transparent and non-discriminatory.*

Regional strategy has increased the flexibility and expanded markets and chances for sharing of resources to achieve goals. It is also important to note that there is also an opportunity for the regional mechanism to influence national policy.

7. International Regulatory Scheme

Kyoto Protocol

At the Rio Earth Summit in 1992 , the international community made a decision to promote sustainable development , considering social environmental and cultural aspects along with the general economic aspects which have been considered in determining level of development . GDP was previously used as the primary indicator and other indicator but this was expanded to include aspects related to social and environmental effects.

In consideration of sustainability the issue of climate change was addressed as one of the most major global environmental problems. The increase in carbon dioxide levels and other greenhouse gases in the atmosphere lead to increasing temperatures which can give rise to many catastrophic events as stated earlier. The complexity in this issue lies in the fact that the effect of a car bon dioxide molecule is not related to where it is generated. Countries that depend on energy for manufacturing, transportation or electricity will as a consequence emit large quantities of carbon dioxide into the atmosphere. The developed countries are therefore the main contributors to climate change .Ironically, the effects of these emissions are likely to be more severe on developing countries and more specifically small island states which are very sensitive to rising sea levels. In an attempt to reduce emissions globally the Kyoto Protocol was developed in 1997. In this arrangement selected developed countries known as (Annex 1) countries made commitments to reduce their emissions by a determined percentage below 1990 levels by 2010. To date this protocol has not been ratified by enough countries to bring it into effect .In order for the protocol to become effective countries responsible for more than 50% of global emissions must ratify it. The continual rejection of USA has hindered the process. The strategy originally was more in keeping with command and control, with no economic incentives to change the behaviour. In order to address these issues two economic incentives were suggested in order to facilitate the change. Joint Implementation which could be implemented between two developed countries and the Clean Development Mechanism which could be implemented between a developed and developing country.

Under the Joint Implementation mechanism countries could trade carbon credits. Effectively a country could undertake measures to reduce emissions and sell the credits to another company. It was envisaged that this would encourage the change in technology to take place in the area where it was most economically viable which would lead to economic efficiency in the system. Through the Clean Development Mechanism developing countries can obtain financing from developed countries who are allowed to reduce some percentage of their carbon dioxide from overseas.
The extension of the Kyoto Protocol to include economic mechanisms has increased the probability that this Protocol or a similarly derived protocol will be eventually implemented.

8 Regulatory Systems

In Barbados the general system of the regulation is the rate of return system which permits the company to earn a predetermine return on equity and capital.

8.1 Rate of return regulation

This system is very much in line with a command and control strategy which is developed from economic models. Although the revenue requirement and rate of return are economically determined, once set there are no variations and there is no incentive for innovation.
This is the system which has been traditionally used by electricity utilities in the world. Its main asset is that is a simple model which is easily understood by the consumer and the utility. The insurance of a guaranteed rate of return ensures that investors will receive dividends on their investments, considerably reducing risk.

This is important in electricity regulation since fixed costs are high and the ability of the utility to attract loans and investors is of critical importance to its survival. This relates to investments needed to secure plant and equipment which is continuously required to serve the expanding demands. The rate of return system adequately serves the first aspect of rate regulation which is to ensure supply of electricity.

The limitation of the rate of return system lies in the fact that it does not provide incentives for improvements in efficiency and technological or process innovations. This is because any such reductions in operating cost will reduce the rate base and decrease their revenues earned in similar fashion. There is also the temptation for the utility to indulge in over capitalization. (The acquisition of plant or equipment which is not prudent).

This system of regulation in no way promotes the use of environmental technologies such as wind or solar. If such technologies are introduced in the system, any increased costs will be borne by the consumer through increased prices.

Even with improving efficiencies in the area of solar photovoltaics, it is not expected that the cost per installed peak watt will fall below $1.00 per peak watt. (Reference).

Although in the case of wind energy the economics is generally more favourable, with the cost of generation per watt being in the same region as the cost of generation from petroleum products.

8.2 Price Cap

The flexibility provided in this system as well as the ability for the utility to benefit from increased productivity, makes it an economic mechanism which will allow the company to gain from its innovations.

The main difficulty with the price cap as it relates particularly to the development of renewable technologies is the fact that renewable technologies are generally more expensive and their development will not lead to economic advances in these technologies although it encourages energy efficiency and energy conservation within the utility. Price cap will only be effective if Z factor is introduced which can be related to environment as a quality factor.
In this system the allowable price is given by the following formula

Allowable price increase = Initial Price + I-X

I= Changes in Inflation Factor for the year

X= Changes in Productivity Factor

The advantage of this system is that the company can achieve greater economic performance and return for shareholders by means of technological and process innovation. The inclusion of the variable (X), where X represents productivity provides an incentive for increasing productivity which can be achieved through more efficient use of resources. This is consistent with government's objectives of reducing oil imports as well as deleterious emissions from fossil fuels. The cost of price cap regulation is generally less since rate base and "reasonable return do not need to be continuously reviewed.

The main deficiency in this system in regard to renewable technologies is that a company in reducing operational cost may be tempted to also reduce quality of service, resulting in a less overall efficient service to customers. The company may also reduce resources allocated to customers that are more costly to serve, resulting in social inequities. Quality standards need to be implemented alongside price cap regulation in order to ensure effectiveness.

Price cap will promote traditionally corporate innovation and is a good system for encouragement of energy efficiency which is an important component of environmental protection. It however will not support the adoption of more capital intensive renewable energy technologies.

Both of these general systems can be considered if the economic basis is modified to include economic aspects, through use of economic accounting. In economic accounting there is a monetary value attached to each environmental component affected by the industry activity. In such a scenario, there will be a direct economic advantage of using clean technology. The value of such a system will depend on the international environment where there are plans to give, for example a monetary value to Carbon dioxide emissions.
As alluded to previously the carbon dioxide emissions and vulnerability to climate change effects is perhaps the most serious long term environmental problem facing small island states.

8.3 Performance Targets Regulation

This type of regulation provides a direct incentive for efficiency and use of technologies and fuels which are more sustainable. This regulation is ideal for promoting environmental quality standards which are a very critical aspect of general governmental policy. If targets are appropriately specified, these incentives will ensure both economic efficiency and quality of service. The difficulty of this system relates to the determination of challenging but realistic targets, as well as developing relevant indicators and the infra structure and monitoring system to record it. It is useful to use benchmarking from international jurisdictions as a first approximation towards achieving this, but this is not available in a Caribbean context.

Targets set will vary in the sector greatly due to geographic, economic and socio political factors and for this reason it will be necessary to develop targets over time and constantly update benchmarks. If this system is implemented it will need to be phased in over time.

Evaluation of Regulatory Options

The following table was developed based on the arguments presented above

System Of Regulation	Cost Of Implementation	Environmental Benefit	Economic Efficiency	Benefits to Customer	Strategy
Rate Of Return	Low	Low	Low	Low	Command &control/ Economic Incentive
Price Cap	Medium	Medium	High	Medium	Economic incentive
Performance Targets	High	High	Medium	High	Economic Incentive/Persuasion

9. Discussion of Regulatory Options

One of the major weaknesses in using traditional regulatory mechanisms lies in the fact that these systems are based on production costs and revenues. It is not difficult to place a monetary value on plant and equipment but the cost of environmental aspects are far more difficult to quantify on a balance sheet.

The conservation of the environment may not be easily measurable but is still an important resource. Since tourism which is the lifeblood of many Caribbean countries depends on the quality of landscapes beaches,

caves, mountains waterfalls and countless other resources. Destruction of any of these will result in significant financial losses for the country and a qualitative deterioration in standards of living within them.

In order to take into considerations such intangible impacts, many companies have introduced environmental accounting to attribute costs to these items. I environmental accounting, an economic value is placed on each environmental resource which is effected by the business activity in order to arrive at a "real" cost. This process is often complex since the benefits of these resources are shared throughout the society.

The principle of the environmental accounting has also been adopted to an extent by the Kyoto Protocol Mechanisms since in these strategies carbon is traded as an economic commodity. Although this strategy has been viewed as a facilitator to environmental improvement, barriers have arisen in terms of accurately measuring countries carbon dioxide emissions. Double counting can occur when the use of a resource is consumed in more than one country. Firewood, for example may be removed from one area and burned to produce energy in another. In addition there are many occasions where one country produces an energy resource to supply other countries through pipelines but the fossil fuel is not burnt in the country using the resource. In this case the recipient country obtains the benefit of the resource within bearing the penalty of increased emissions.

In spite of its limitation the principle of carbon trading may well be the only appropriate mechanism for promoting renewable energy development. In the Caribbean there may be an opportunity to exploit some natural conditions which exist. Trading of any commodity is most effective between countries which have complimentary supply and demand. This occurs where one country has a ready supply of a good for which there is a demand for the product and a lack of supply. In these conditions one country can secure a ready market and another country can secure its supply, increasing the economic viability and efficiency. This principle has been applied extensively in South America where Bolivia, for example, provides a significant quantity of natural gas to the Brazilian make for production of its energy.

In the Caribbean this type of trading of energy resources has not been in effect since it is more difficult for island states to transfer energy resources such as natural gas across sea borders. Carbon dioxide emission trading in a Caribbean context could conceivably result in the development of renewable technology more economically.

Trinidad and Tobago for example, is dependent on its energy sector in its overall economy. A stipulation that emissions be reduced or renewable technologies be introduced would effect its ability to sustain is economy. However a mechanism where Trinidad & Tobago could finance renewable energy development in a country which may have a greater potential for renewable energy development either due to geographical, capacity or of economy structure could receive funding and develop renewable energy

technologies regionally. Investment could also be made in jurisdictions where the cost of electricity by traditional means is high, in these cases the process would be driven by both environmental and economic factors.

Another advantage of a regional mechanism is that the market for energy generators would be greater than if each generator existed in only one country. There may even be renewable energy possibilities where one system can provide energy for more than one island, in installations such as offshore wind turbines which are becoming increasingly popular internationally. The energy production could become more liberalised with less vertically integrated companies, leading to the more widespread implementation of the single buyer option throughout the region, reducing resistance to changing technologies by public utilities.

The advantage of a regional regulatory framework gives greater flexibility, but there will still need to be a degree of "command and control" to ensure that the mechanisms are adopted. In Europe, as described previously, a regional emissions reduction target was set. A similar target could be set for the Caribbean region, which would be the basis on which specific countries are allocated targets.
.The emission of greenhouse gases can lead to sea level rise, changing weather patterns and flooding and increased severity of hurricanes. Caribbean islands are very vulnerable to these effects although they are not among the leading emitters of greenhouse gases.

Any successful implementation should also include persuasion activities; In the long run the consumer must help to drive utilities to adopt practises. Education programmes to sensitise the public must be undertaken alongside other activities.

10. Conclusion

The above discussion illustrates that the present system although providing a large degree of economic stability, does not promote the government and regulators goal of ensuring that electricity is produced in the most efficient manner. It also is not the most equitable system since the consumer under the present system does not generally enjoy benefits of any increase in efficiencies. The environmental impacts associated with inefficient use of resources is also a drawback related to these economic aspects.

Regulation System

Performance targets have a high potential to lead to the attainment of government macro economic and policy objectives. The implementation costs are however much higher. Given the information which will need to be collected and analysis needed in order to implement this system it is advisable to continue with the rate of return system and phase in to price cap and then to performance targets. This has been the

approach taken by many countries including USA. It is also necessary to conduct an in depth analysis into the methods of rate base calculation and reasonable rate of return to ascertain if these need adjustments. Since these principle methods will be the basis for other rate regulation systems it is important that the most appropriate means are used in these calculations.

Regulation Strategy

The development of a regional Caribbean environmental regulation scheme will be challenging. Efforts in other fields of endeavour have not been widely successful. The overall effectiveness, efficiency and equity of the system will generally be greater than depending on isolated national initiatives for increased penetration.

The following scheme is recommended for the framework

1. Development of appropriate targets to facilitate Performance based regulation in the long run.
2. Establishment of regional emission reduction target
3. Establishment of single buyer utility structure in the Caribbean
4. Carbon trading scheme for the Caribbean
5. Environmental cost to be factored into current regulatory systems.

It is true that although the levels of emissions are small in many countries, the adoption of a system of regulation encouraging use of renewable energy could send a signal to the rest of the world.

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