ENERGY CONSERVATION IN THE CARIBBEAN – A PROFITABLE INDUSTRY for REGIONAL AND FOREIGN ENTREPRENEURS

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Abstract:-

The energy cost in the Caribbean is the highest in the Western Hemisphere and amongst the highest in the world. The cost of energy in various islands range from as low as US$0.20/kwh to as high as US$0.37/kWh. These numbers exclude Trinidad and Tobago, a petroleum producing nation which enjoys an average cost of US$0.05/kWh.

These high energy costs provides numerous business opportunities to energy entrepreneurs which to date has not been exploited for a number of reasons.

This paper will review the energy cost in the various islands and will identify applicable energy saving technologies with an indication as to the feasibility of each. Further, the market size of the region for each ESO will be provided and recommendations for energy entrepreneurs highlighted.

1. CARIBBEAN ISLANDS ENERGY OVERVIEW

The Caribbean consists of numerous self-governed islands each with its own identity. The population of each island, per capital income and average energy cost as recorded by the Caribbean Electric Utility Commission (CARICEC) for 2006 is provided in Table I below. Current energy costs as obtained by the author for 2007 has revealed that many islands are currently over US$0.35/kWh and the cost continue to rise as a result of the increase of fuel cost in the international market.

Table I – Island Energy Cost (US$/kWh)

ISLAND	POPULATION (3)	GDP PER CAPITA US$ (2)	AVERAGE ENERGY COST (2006) US$/kWh (1)
ARUBA	100,000	22,435	0.20
BAHAMAS	303,611	19,333	0.23
BARBADOS	250,010	11,928	0.229
GUYANA	800,000	1,370	-

JAMAICA	2,607,633	3,890	0.238
Netherlands Antilles	185,511	17,379	0.22
O.E.C.S	508,147	6,451	
• GRENADA	102,635		0.268
• ST.LUCIA	157,164		0.293
• ST.VINCENT	109,202		0.30
• DOMINICA	71,239		0.241
•ST.KITTS/NEVIS	45,841		
• ANGUILLA	11,430		0.31
•MONSTERRAT	10,639		0.43
TRINIDAD & TOBAGO	1,262,366	10,911	0.05
DOMINICAN REPUBLIC	8,230,722		0.26
HAITI	5,053,792		-

The average cost of energy in the smaller islands is now equal to between five (5) to seven (7) times that of Trinidad and Tobago and approximately three (3) to four (4) times that in North America and Europe.

This fact simply means that the potential for energy conservation in this region is phenomenal.

2.0 ENERGY CONSERVATION TECHNOLOGIES AND SERVICES

There are numerous energy conservation technologies and services available to assist the region in reducing its energy consumption. Some are low cost/no cost technologies; others require investment but all produce good returns because of the high energy cost existing. A brief description of the following technologies/services is provided hereunder.

2.1 Low Cost/No Cost Solutions

2.2 Engineering Services

2.3 Engineered Solutions / Design/Build Projects

2.4 Design/Product Development Services.

2.5 Financial Services

2.1 Low Cost / No Cost Solutions

Compact Florescent Lamps (CFL) also known as energy saving lamps are the “no brainer” of energy saving technologies. CFL save 70% of energy over the equivalent incandescent type lamps. CFL are available in various types (tubes, spiral), sizes (7W,11W,15W,up to 100W) and replace not only standard incandescent bulbs for residential use, but also the larger 70W to 100W CFL replace the 200W to 400W mercury vapour outdoor lamps.

CFL also have a life of between 8,000 to 10,000 hours which is much larger than the life of an incandescent bulb which is between 1,000 to 2,000 hours. CFL are also available in two (2) colour types, daylight which is similar to florescent lamps and warm light which resembles an incandescent bulb’s yellow colour.

The energy consumed by an incandescent bulb is calculated by the power of the bulbs multiplied by the hours used. As an example if one replaces a 60W incandescent with a 15W CFL, the power savings will be 45W (60W -15W) or 0.045kW (45W/1000).

If the bulb is used for external security lighting from dusk to dawn (6:00pm to 6:00am) or twelve (12) hours per day then the annual energy saved will be power saved multiplied by the hours in use or 0.045kW (45W/1000) x 12hours/day x 365days/year or equal to 197.1 kWh.

The annual energy cost savings in US$ will be the multiplication of the cost of energy by the annual energy saved or US$ 0.30 x 197.10 kWh = US$59.13/year.

If the CFL costs US$3.50 and the incandescent bulbs cost US$0.50, the additional cost of purchasing the CFL will be US$3.00. The simple payback will therefore be US$3.00/US$59.13 or 0.051 years or 0.6 months. This simple payback analysis does not take into account the greater life of the CFL over the incandescent bulb.

A 20 day payback of using CFL in islands where energy costs over US$0.30/kWh is why incandescent lamps retrofit to CFL is sometimes termed “no-brainer”. Appendix 1 attached indicates the annual energy savings of using various types in some Caribbean islands.

Recently, the Cuban Government under a Caricom Assistance initiative provided residential CFL lamp retrofit to a number of Caribbean islands. Cubans actually went door to door in the selected islands and performed this retrofit exercise. VINLEC (St.Vincent’s electric utility) has observed a drop in its energy level of just below 1 MW at night which is as a result of this exercise. The actual data is currently being evaluated. The role of an energy engineer is to determine the economical viable technologies by performing analysis such as indicated above for CFL.

OTHER LOW COST ENENRGY SOLUTIONS

There are other low cost solutions which can be installed into facilities to reduce energy consumption. Table II below identifies these solutions and provides the approximate cost for each, the annual energy savings (based on US$ 0.30/kWh) and the simple payback period with brief remarks.

Table II – Energy Saving Opportunities (ESO)

E.S.O	USE	UNIT COST US$	ANNUAL ENERGY SAVINGS US$	PAYBACK (years)	REMARKS
Electronic Timers	Pool pump, AHU automatic switch off after hours.	$100.00	$876.00	0.12	Savings for a 1.0 kW motor
Occupancy Sensors	Lamps off when no person in washroom/office.	$100.00	$200.00	0.5	
T-12 (40W) to T-8 (32W) or T-5 (28W) florescent lamp retrofit	Offices florescent lamp retrofit	$30.00	$15.00	2.0	Good for new buildings design.
Premium Efficiency Motors	Pumps, air handling units,	$100.00	$131.00	0.76	Based on 1 kW @ 24/365
Low flow showerheads	Showers 1.5 gpm	$5.00	$96.80	0.05	Water – US$3.5/$m^3$ saving 1.0gpm
Faucet aerators	1.5 gpm	$1.00	$75.00	0.01	Water cost US$3.5/$m^3$ saving 0.5gpm
Low flush toilets	1.6gpf instead of 3.0 gpf	$120.00	$70.00	1.7	
Refrigerant retrofit	Replace existing refrigerant with new hydrocarbon refrigerant	$100/ton	$150.00	0.75 to 1.5 years	Saves 10% to 15% of energy

These low cost/no cost energy/water saving technologies together can save hotels, commercial offices and residences approximately 15 to 25% of their annual utility cost, depending on the use of the facility.

There exists a need for more companies providing these types of solutions to service the Caribbean region. The author knows only of one such entity which is based in Jamaica and which has been very successful promoting these no cost/low cost solutions.

2.2 ENGINEERING SERVICES

Facilities require energy studies or audits to determine their actual status with respect to energy use and saving opportunities available. These audits can be performed by certified engineering companies or energy auditors. In addition to providing energy audits, energy focused engineering service firms can provide energy effective designs for new or existing buildings as well as Corporate Utility Management Programs (C.U.M.P).

Many regional consulting engineers are not fully acquainted with the existing technologies available to be implemented that can save their customers large sums of money over the life of a project. The same occurs for extra-regional engineers who design systems for facilities in the region with little or no consideration for the high energy cost existing. As such there is a need for experienced building energy services design engineers to ensure that the most effective and economical building solution is provided to Caribbean customers.

Further, energy trained facility engineers can provide Corporate Utility Management Programs (CUMP) for medium to large scale facilities. This service involves performing analysis and review of facilities and utilities on regular bases with the objective of ensuring that the facility is operated at its optimum level.

2.3 ENGINEERED SOLUTIONS / DESIGN/BUILD PROJECTS

There are a number of energy conservation technologies that can be implemented either individually or in combination as a medium/large scaled project to achieve maximum results for the energy consumer. Some of these technologies are highlighted below.

2.3.1 Absorption Cooling Systems

Absorption cooling systems are fuelled by heat which can be provided either by natural gas, diesel, LPG, waste oil or water heat from another process. There is no compressor and very little moving parts (see Fig. 1 below).

In Trinidad and Tobago, where both electrical and natural gas cost are very low the payback over electrical air conditioning systems will be approximately 3.0 years. In Barbados, where electrical energy cost is over US$0.20/kWh and natural gas costs US$9.60/MMBTU for commercial users above 8,000m^3, the payback of these systems over electric systems is only one (1) year. Accra Beach Resort and The Crane are two (2) resorts who are enjoying the benefits of these systems.

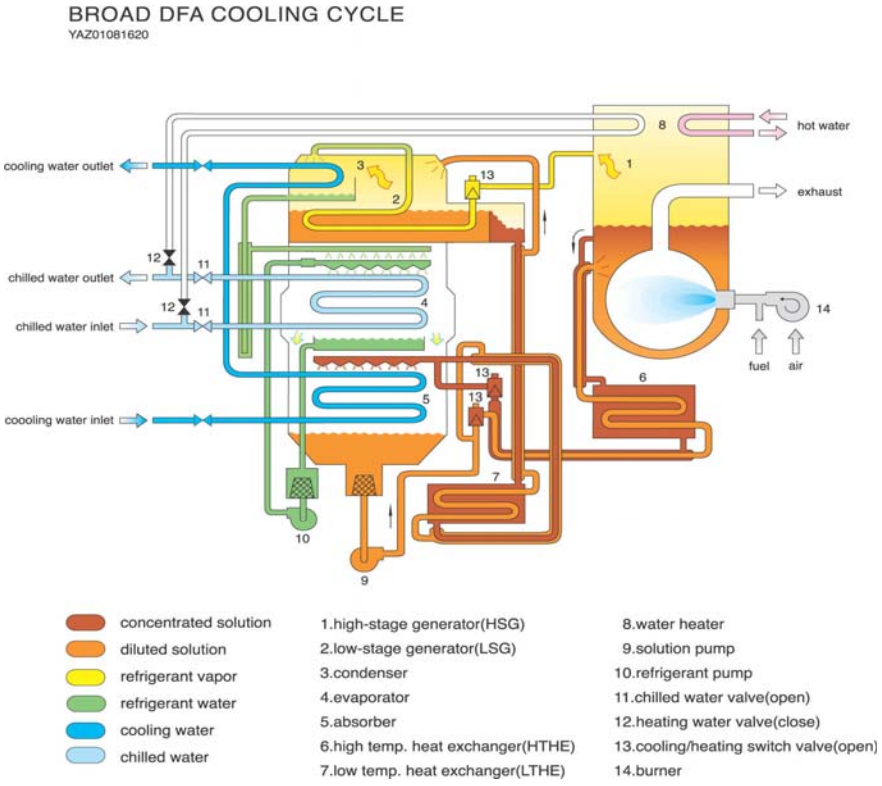
These systems can also operate on waste oil from a cruise ship or automobile garages. These are two (2) known waste oil processing plants in the region. They are in St. Maarten and Trinidad. Treated Waste oil is sold for US$9.00 MMBTU and if used to fuel an absorption chiller can provide a simple payback of less than one (1) year in islands where the costing energy is above US$0.30/kWh.

However, absorption systems when combined with electrical generating power plants can provide the greatest energy savings available to regional energy consumers. The process is referred to as Combined Cooling Heating and Power (CCHP) or Trigeneration. Basically, the fuel supplied to a generator produces power and waste heat (waste heat can

be as much as 70% of the input fuel energy if a gas turbine is used or 60% if a reciprocating engine is used). Instead of emitting the waste heat into the atmosphere it is reused to fuel an absorption chiller to provide cold water for cooling and hot water for domestic heating.

CCHP systems are ideal for an area where there is a great need for power, air conditioning and hot water, such as Hotel resorts, Office Buildings and Hospitals. The effective use of the input energy will be over 80% instead of 35% and is the most economical energy solution currently available.

Fig 1.0 - **Natural Gas Absorption Cycle**

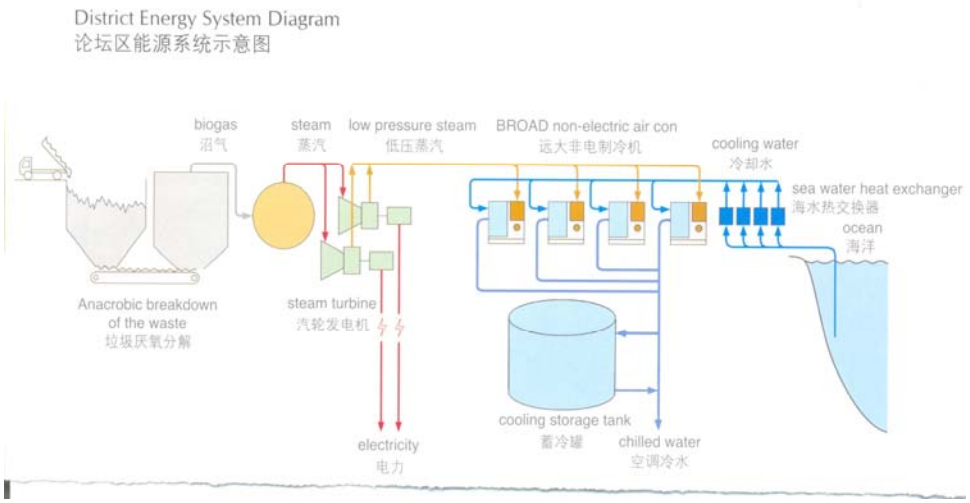


Such plants require capital investments but at energy rates of over US$0.30 will have paybacks of fewer than 2.0 years. Utilities in the region should be encouraged to adopt this strategy as they already have the infrastructure in place to sell energy and can increase their product range and begin selling chilled and hot water to consumers.

An ideal example would be a distributed generating plant located near a group of Hotels. The generating plant will provide power to the Hotels and any neighboring residences or commercial facilities. The waste heat from the plant will fuel absorption chillers and provide chilled water for cooling the hotel and hot water for Hotel laundry and guest use.

To gain the benefits of this solution, regional utilities will therefore have to consider installing smaller distributed generating plants in their territories instead of large central plants. The Island benefit will be a reduction in the import bill of fuel oil.

Fig. 2.0 – District Cooling System Layout



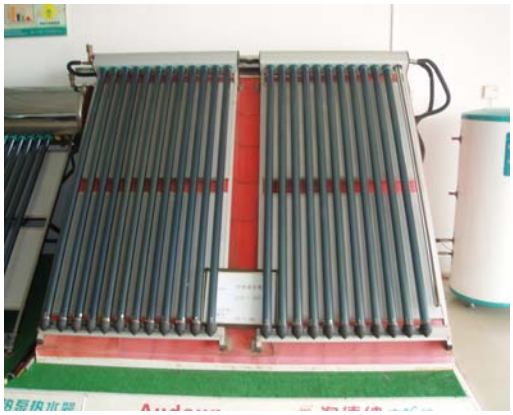
2.3.2 Solar Hot water Systems

Barbados has been the undisputed leader in solar hot water systems regionally for over 30 years. The technology used has not changed much over this period, but the manufacturing cost has increased to over US$2,000 per household system installed. At this initial cost the payback of a solar water heater can be between 2.0 to 2.5 years in the Caribbean Islands (over 6 years in Trinidad), which by international standards is a very good investment as the system can last over ten years.

The main reason that the solar water heater industry has taken off in Barbados and not in the other Caribbean Islands is because of the tax incentives provided by the Barbados government and the initial cost is prohibitive for other islands with a much lower GDP/capita.

However, we see this industry taking off in all islands very soon mainly as a result of new technology and mass production of systems from Asia. These systems can sell for under US$1,500 and will provide a simple payback of less than 1.5 years.

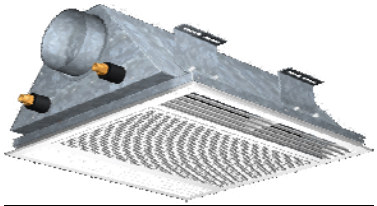
FIG 3 - VACUUM TUBE SOLAR WATER HEATER



2.3.3 Chilled Beams

These systems use 20% primary air to force 80% of return air over a cooling coil and deliver 100% of cold treated air into a space without the use of a fan motor. Therefore 80% fan motor savings is achieved.

FIG 4 - CHILLED BEAM



2.3.4 High Efficiency Air Conditioning Systems

These are new high efficiency air conducting systems available which use between 15% to 30% less energy than standard systems. The first is the Variable Refrigerant Volume system termed VRV. These systems use condensing units with a variable speed drive on the compressor to supply numerous fan coil units. These units are very efficient at part load conditions.

Another high efficient system is called the mini chiller with heat recovery for free hot water production. This system uses high efficient compressors to produce chilled water which is piped throughout the facility. It also can produce free hot water by using waste heat from the hot compressor refrigerant discharge to heat water for domestic use. Overall savings of between 30% to 40% can be attained using these systems which are ideal for small to medium sized Hotels. The above systems have to be engineered or designed in to facilities in order for the owner to secure the benefits of using same.

Fig. 5 – High Efficiency Mini Chiller with Heat Recovery

2.3.5 Building Envelope:

Roof insulation systems have generally been accepted in the Caribbean as a proven energy conservation solution. Fibre glass insulation has generally been the lead product used however more recently radiant barrier (industrial grade foil) systems are becoming more prevalent.

What has not been promoted by regional engineers or architects is wall insulation and double paned glass systems. In the northern countries wall insulation and double paned glass is standard construction practice to retain heat in homes and offices during the winter months. The converse applies to the Caribbean where energy cost as high as US$0.30/KWh, wall insulation and double paned glass should be standard building practice at least for buildings that are air conditioned.

Fig. 6 – Radiant Barrier Systems

2.3.6 Desiccant Heat Recovery Systems

Desiccant Heat Recovery Units in hot and humid climates are used to pre-treat hot outside air using cold exhaust air from the building. Energy savings of 30% can be obtained from using these systems which is an effective air to air heat transfer system. Desiccant systems are also ideal for humidity control purposes as the desiccant wheel removes humidity from the fresh air before it is discharged into the facility. Ideally uses include Hotels, schools, large office buildings and Hospitals which require large volumes of fresh hot air for ventilation.

Fig. 7 – Desiccant Heat Recovery Unit

2.3.7 Other Engineered Solutions

There are other engineered solutions that can be installed into facilities to reduce energy consumption such as Power Factor correction systems which are mainly applicable where there exists a demand charge by the utility. Demand Charges are mainly applied in Aruba, Trinidad and Tobago and Jamaica.

Other systems include Building Automation Systems (BAS), Variable Speed Drives and Guest Room Controls for Hotels.

2.4 Design / Product Development Services:-

Most of the technologies and systems mentioned herein are designed and developed in countries where the cost of energy is not as high as in this region. Therefore, there exists opportunities for regional energy system designers, research laboratories and/or universities to take advantage of the extremely high energy cost prevailing and develop suitable new products which can have a significant impact on the energy cost of regional facilities. Effective solutions developed will quickly find a viable market.

2.5 Financial Services:-

The simple payback of using all of the technologies identified is under two (2) years and in most cases, under one (1) year. These can translate to Internal Rate of Return (IRR) of over 50% which is much better than investing in the stock exchange or leaving money in a Bank. There exists a wealth of money for regional financial institutions to capitalize on the opportunities provided by the regional energy conservation industry.

3.0 Regional Energy Conservation Markets:-

The Caribbean market for energy conservation products and services can be broken down into the following segments:

a) Residential
b) Commercial
c) Industrial

A brief description of each, indicating its potential size and products is presented hereunder:-

3.1 Residential:-

The total population in the region is approximately 15M, excluding Haiti, Cuba and Puerto Rico. Estimated number of total households is 3M. Using this assumption, and further assuming that only 20% of the households will be able to afford energy products we can estimate the market value for Energy conservation products as follows:-

Table III – Residential Energy Conservation Market

Energy Conservation Product	Qty./Household	No. of Qualifying Households	Cost per ESO US$	Total Market Value US$
Solar Water Heaters	1	600,000	1,500	900,000,000
CFL	6	600,000	$3.50	12,600,000
Low Flow Shower heads	1	600,000	$5.00	3,000,000
Faucet Aerators	2	600,000	$1.00	1,200,000
Radiant Barrier for Roofs	1,000 ft^2	600,000	$0.75	450,000,000
Low Flush Toilets	1	600,000	$120.00	72,000,000
Total Value US$				**1,438,800,000**

A conservative estimated market size for residential energy saving products is therefore equal to **US$ 1,438,800,000**. If we assume that these products are required every ten years, then the annual market size is estimated as **US$ 143,880,000**.

3.2 **Commercial:-**

The commercial market in the Caribbean can be broken down into two main sectors as follows:-

a) Hotel sector

b) Offices Buildings

The market size for each and related energy conservation products are estimated hereunder.

a) Hotel Sector.

The Caribbean Hotel Association (CHA) represents a membership which together account for 120,000 Hotel rooms in the Caribbean. The Energy use profile of a typical small Hotel is shown in Figure 8 below.

Fig. 8 - Small Hotel Energy Use Profile

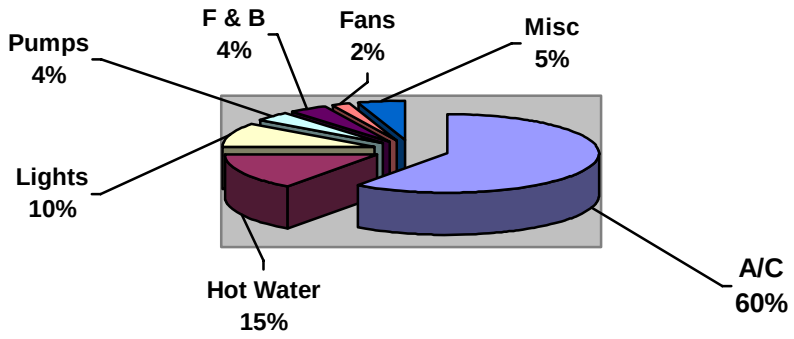


Table IV – Hotels Energy Conservation Market

Energy Saving Products	No. of Units/Room	No. of Rooms	Cost/ESO US$	Market size US$
CFL	5	120,000	3.50	2,100,000
Electronic Timers	2 /hotel	2,500 Hotels	100	500,000
Air Conditioning Systems	1	75,000	2,000	150,000,000
Guest Room Controls	1	75,000	250	18,750,000
Double Paned Glass	1	75,000	500	37,500,000
Solar Water Heater	0.5	120,000	1,500	90,000,000
TOTAL Value US$				**298,850,000**

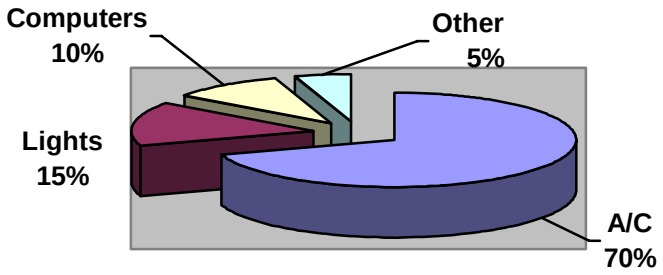
The total estimated market value is portrayed in Table IV above and is equal to **US$ 298,850,000** and assuming that each system last ten years the annual market value will be **US$ 29,885,000.**

b) Offices:-

The profile of energy consuming systems in a typical office in the Caribbean is portrayed in figure 9.

Energy saving opportunities should be focused on air conditioning systems, building envelope (roof and wall insulation products and double paned glass) and lighting systems.

Fig. 9 - Typical Office Energy Use Profile



An estimate of the market size of energy conservation products for Caribbean offices is a little more difficult to determine. If one assumes the market to be at least twice the size of that for the Hotel sector, we can estimate a total market size of **US$ 600,000,000** and an annual market size of **US$ 60,000,000** assuming the products have to be replaced every ten (10) years.

3.3 Industrial

The author has not performed an analysis of the size of the industrial sector throughout the Caribbean. Most of the industrialized plants are located in the larger islands such as Trinidad and Tobago, Jamaica and the Dominican Republic. However an analysis of the distillery industry throughout the Caribbean has been performed for which the ESO and market size is indicated hereunder.

a) **Distilleries**

Most Caribbean islands have distilleries. The use of back pressure energy steam turbines will provide energy savings to distilleries. High pressure steam, produced by distilleries boilers need to have the pressure reduced before entering the distillery process. This reduction in steam pressure is normally performed by a pressure reducing valve.

Installing a back-pressure steam turbine will provide power to operate the distillery and at the same time provide low pressure steam needed for the distillery process.

The cost of this system depends on the size of the distillery but can be between US$200,000 to US$ 500,000 with a payback period of 1.5 years. The estimated total market size is approximately **US$ 7,500,000**.

One distillery in the Caribbean uses waste oil from Cruise ships to fuel it boiler. This process has been ongoing for over ten (10) years with great success. Cruise ships prefer to give their waste oil to regional organization at no cost rather than pay an environmental tax and other costs in the developed countries. The cost of treating waste oil has been worked out to be US$ 2.50 / MMBTU, which is far less than the cost of diesel which sells at over US$ 22.00 / MMBTU, but less than the cost of natural gas in Trinidad at US$ 1.65 / MMBTU.

Procuring and selling waste oil can be another viable business venture.

4.0 Discussion / Conclusion:-

The energy cost in the Caribbean is the highest in the Western Hemisphere and amongst the highest in the world. Most energy saving opportunities provides payback of less than 2.0 years. The annual market value for energy conservation entrepreneurs can be estimated as follows:

MARKET	ANNUAL VALUE US$	TYPE OF BUSINESS
Residential	145,000,000	Retail – Sale of Products
Commercial Hotel	30,000,000	Engineered Projects
Commercial Offices	60,000,000	Engineered Projects
Professional Services	300,000	Engineering Services
Distilleries/Breweries	7,500,000	Engineered Projects
Total Annual Market Value US$	**242,800,000**	

There are opportunities for retail businesses, engineering consulting firms and energy engineering service companies to build profitable sustainable business and at the same time assist the region to reduce their energy costs. In addition there are also opportunities for Financial Institutions (provide funding) and Design / Product Development Companies to benefit from this vast but slow moving industry...

One needs to bear in mind that although the market is estimated at US$ 242,800,000 annually, there are numerous obstacles that the potential energy entrepreneur must face. These include:

1. Lack of awareness by regional energy consumers of the technologies available. This means that much marketing and awareness training is essential.
2. Lack of trained technical personnel within companies and regional consultants
3. Availability of competent suppliers
4. Poor Legal Infrastructure within islands
5. Difficulty of consumers in obtaining funding (financial institutions unaware of industry)
6. High import duty on energy technologies in some islands.

Despite these obstacles, the energy entrepreneur will find little competition and will have the ability to choose the projects and customers he wishes to serve.

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