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U.S. VIRGIN ISLANDS COMPREHENSIVE ENERGY STRATEGY

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Southern States Energy Board

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EXECUTIVE SUMMARY

A U.S. Virgin Islands energy strategy is needed to ensure the availability of affordable and reliable energy for the future and maintain a high standard of living for the citizenry.

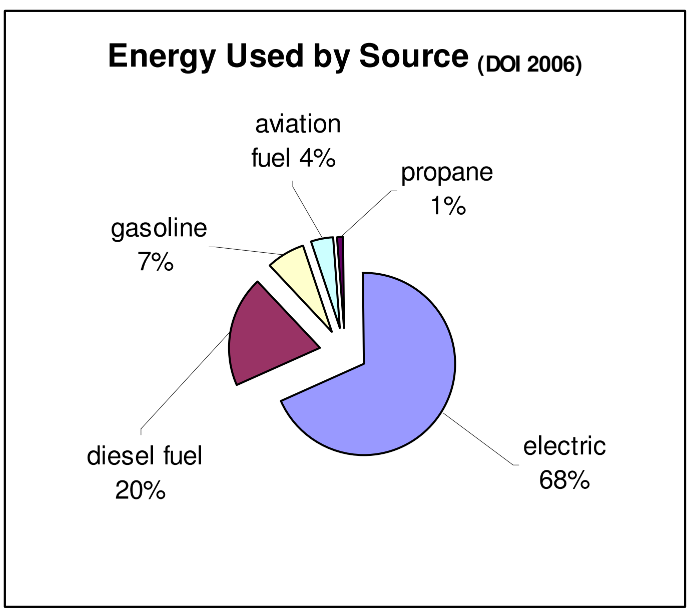
The main objectives of the strategy are to

- Reduce energy costs
- Increase efficiency of energy use and production
- Increase fuel diversity and reliability
- Promote clean energy

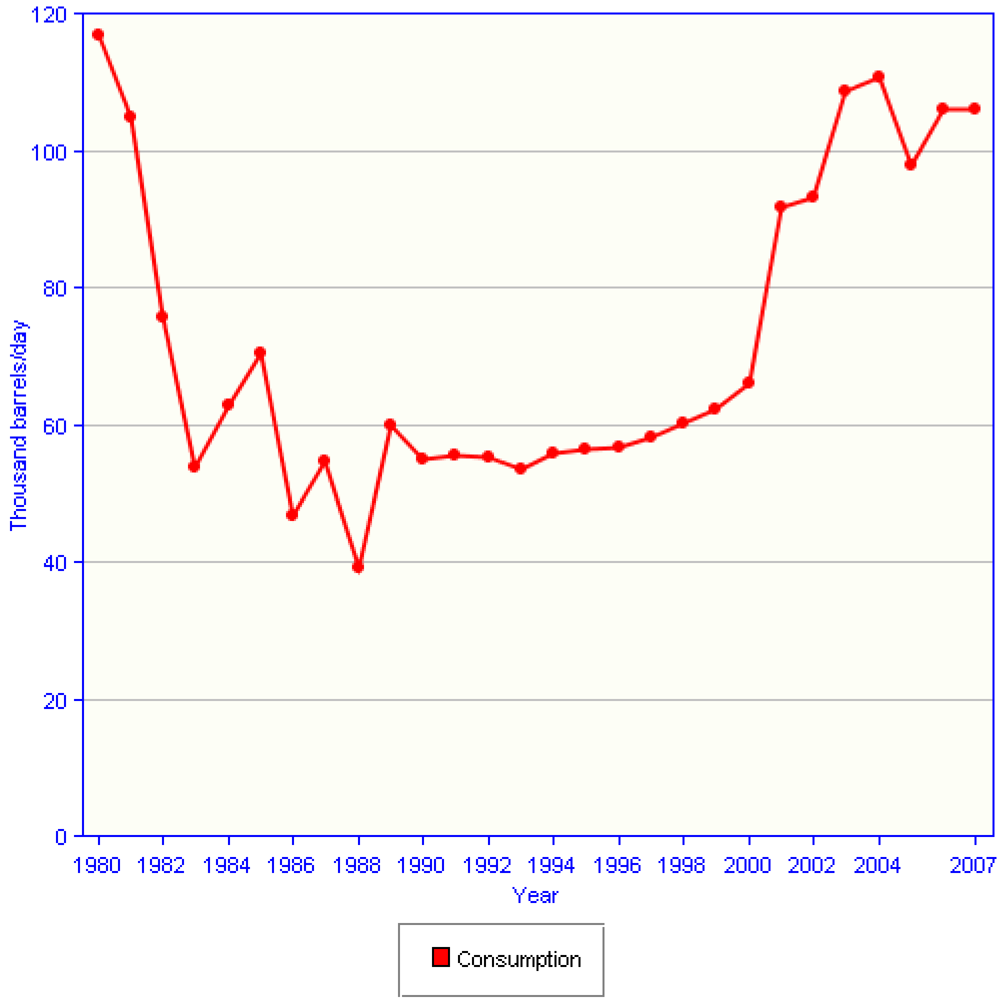
The Southern States Energy Board has worked in partnership with stakeholders and government of the U.S. Virgin Islands to develop this strategy. The strategy outlines the current energy situation, notes energy resource options, and lists specific strategies to meet the main objectives.

The available options to meet energy needs in the U.S. Virgin Islands are limited because of the lack of an interconnecting grid and the consequential ongoing electric spinning reserve being maintained for system balancing and reliability, the need to produce desalinized water, limited availability of land and water resources, and current generation infrastructure that relies on almost 100 percent imported petroleum fuel.

About two third of energy used is the islands is for electricity and water production while the remainder fuels transportation needs.



Petroleum Consumption
(EIA USVI Profile 2008)



The U.S. Virgin Island Water and Power Authority (WAPA) provides electricity and water. The WAPA generation system power station on St. Thomas supplies electricity to St. Thomas and St. John with a generation capacity of 199 MW that includes an emergency diesel generating unit on St. John. Water Island, located a half mile off the coast of St. Thomas, is also served by power from the St. Thomas system via underwater cable. St. Croix is supplied by a separate power station not interconnected with the St. Thomas system that has generation capacity of 122MW. Overall, the system has 232MW available from combustion turbines and 87MW of capacity from steam generation all supplied by No. 6 or No. 2 fuel oil, and just over 2.5 MW from diesel-fuel powered backup. System peak demand in 2008 was 83MW for the St. Thomas system and 51 MW for St. Croix. Just over 54,000 customers, pretty evenly divided between the two systems, are served.

The WAPA generation system serves a total of 54,005 customers almost evenly divided between the two systems. WAPA's energy sales from July 1, 2007, to June 30, 2008 were 829,146 MWh, up seven percent from the previous twelve month period. (WAPA RFP 2007, WAPA Data 2008)

The two WAPA electricity transmission systems on St. Croix and St. Thomas are separated by a distance of about 40 miles with an ocean depth of two to six kilometers between them. The two systems are not interconnected. As is typical for non-grid-tied island units, a spinning reserve is maintained in each system and backup units are run for redundancy to avoid system outages. (DOI 2006) Fuel costs for WAPA from July 1, 2007 through June 30, 2008 were $217 million, compared to $165 million for the same period in the previous year.

Annual Electric Sales, in MWH	**St. John**	**St. Thomas**	**St. Croix**	**Total**
Residential	**12,066**	**150,390**	**125,445**	**287,901**
Commercial	**6,132**	**74,801**	**54,033**	**134,966**
Large Power	**12,279**	**150,772**	**109,666**	**272,717**
Primary Service	**7,645**	**92,268**	**21,610**	**121,523**

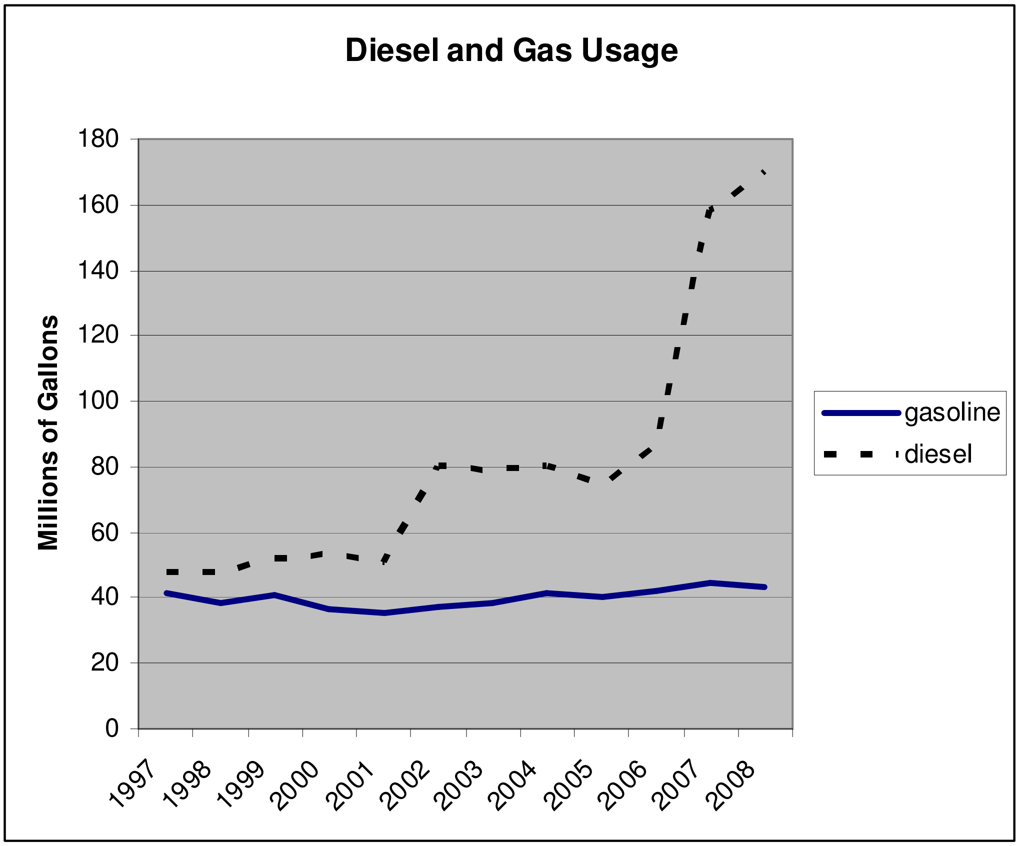
The HOVENSA refinery is a major industrial presence that produces its own electricity and water. Other industries in the U.S. Virgin Islands include rum distilleries, construction, port facilities, and other transportation related business. The commercial sector is dominated by tourism related businesses including hotels and shops.

For a median income of $33,474 the average U.S. Virgin Islander is paying nine percent of his or her income for electric power, not including the costs for transportation and the elevated costs for goods and services that result from higher energy costs. (Census 2008) For the median household in the U.S. as a whole, the energy use is almost double that of the average U.S. Virgin Islands resident, yet the amount paid for electricity is just over two percent of income. (EIA 2006) This is an even higher difference than what is expected for the Caribbean region, where typically small island economies pay upwards of 47 to 93 percent higher electric rates and 36 to 50 percent more for goods and services. (ITC 2008)

Annual fuel usage for transportation was 158.1 million gallons of diesel and 44.4 million gallons of gasoline in 2007. Diesel usage has increased 83 percent over the past year and gasoline usage has only increased 6.2 percent over the past year. Since the year 2000, gasoline usage has increased by 20 percent while diesel usage has increased such that usage is now triple what it was in the year 2000. (Annual Economic Indicators 2008) The increased usage of diesel is attributable to people turning to more efficient diesel engines for transportation to avoid high gasoline costs, and to purchases for running of backup generators on diesel.

Transportation on the islands is generally by private vehicle, though there is a public bus system between urban and residential areas. Modified pickup trucks with bench seats also provide transportation for residents and tourists. The number of registered vehicles on the islands has decreased from a high of 74,280 in the year 2000, but has shown a recent increase of from 2006 to 2007 of almost 6 percent to 73,353 registered vehicles.

(Annual Economic Indicators 2008) The U.S. Virgin Islands also have ferries, taxi service, two main airports, and sizeable ocean ports that service some 750 tourist cruise ships per year, primarily in St. Thomas. Many of the hotels and resorts have their own transport vans. (DOI 2006) There are eight marinas on St. Thomas and three marinas on St. Croix offering over 800 slips, and numerous mooring and anchoring areas on the different islands. In total, the islands entertain over 2.6 million visitors each year. (Annual Economic Indicators 2008)



(Annual Economic Indicators 2008, Bureau of Internal Revenue 2009)

Water desalination units operate using process extraction steam from the WAPA generation units on each island system to create the drinking water supply. WAPA provides water to over 12,000 customers and the average customer uses 2,400 gallons of water per month. (Kossler 2008) About 10 percent of the energy produced by WAPA generators is used for water production. (DOI 2006) WAPA customers paid $32.9 million for water in 2007. (WAPA Financial 2008)

A range of energy options, including energy efficiency programs, renewable energy, fossil fuels, grid interconnection, water production, and transportation have been and are continuing to be studied. Based on study figures from eleven states enacting comprehensive utility energy efficiency programs, energy savings from efficiency for the U.S. Virgin Islands represents an annual potential savings of $2.6 million and a total savings potential of over $50 million. Energy efficiency programs can cost as little as half the cost of new generation and reduce overall costs while reducing the need for additional power units.

The following 31 strategies are being adopted to support the U.S. Virgin Islands Energy Strategy goals:

STRATEGY 1: Develop a comprehensive biennial energy plan that tracks energy usage and costs by sector and end use.

STRATEGY 2: Analysis of options and proposals for energy generation should give a priority to those options that: 1) reduce energy costs, 2) increase efficiency of energy use and production, 3) increase fuel diversity and reliability, and 4) promote clean energy.

STRATEGY 3: For fuel diversity and reliability, WAPA energy generation should move toward a goal of having more than just one dominant fuel source as demonstrated by having at least 30 percent of power generated by energy sources differing from the primary energy source by the year 2025.

STRATEGY 4: Include and give priority to energy that can be saved through efficiency programs as an energy resource and alternative to new generation options.

STRATEGY 5: Develop utility demand side management programs for customers to improve energy efficiency and reduce peak load demand levels.

STRATEGY 6: Utilize trends from the comprehensive biennial energy plan with results from the utility demand side management programs to determine if an energy efficiency portfolio standard is needed to meet goals.

STRATEGY 7: Develop performance measures, set goals, and track quarterly progress in reducing WAPA transmission and distribution system losses.

STRATEGY 8: Promote cogeneration for larger hotels and resorts, and utilize technical assistance from the EPA's Combined Heat and Power Partnership to assess project viability and identify opportunities for financial and project assistance.

STRATEGY 9: Adopt and update the model Tropical Energy Code.

STRATEGY 10: Assess the adequacy of current personnel resources for codes enforcement. Conduct training for codes enforcement officials and apply for Federal funding to offer this training for architects and builders as well.

STRATEGY 11: Investigate options for low-cost financing of energy efficient construction. Consider offering incentives whereby loan interest rates are "bought

down" in exchange for meeting certain building qualification standards, such as LEED® or ENERGY STAR.

STRATEGY 12: Step up efforts to carry out the Executive Order requiring the purchase of lowest life cycle cost alternatives for all government procurement including vehicle fleets. Establish systems to verify that this requirement is being carried out and provide training to help purchasing personnel meet the requirement if needed.

STRATEGY 13: Conduct one or more training classes on best practices for operations and maintenance of heating, ventilation, and air conditioning equipment for the personnel who operate and maintain the associated government building equipment.

STRATEGY 14: Use a tracking tool, such as the ENERGY STAR Portfolio Manager or building audits with energy bill logs for each building, to track energy usage of all government buildings (2000 square foot or greater) that use energy. Audit and track the energy use of at least 20 percent of government buildings, on a square foot basis, each year.

STRATEGY 15: Use results from benchmarking and tracking government occupied and leased building energy usage to rank buildings and identify those that offer the greatest energy savings opportunities.

STRATEGY 16: Require all new government building construction over 2000 square feet to be built to the performance criteria to meet ENERGY STAR qualification or the U.S. Green Building Council's LEED® rating.

STRATEGY 17: Promote energy efficiency by making it a criterion in assessing all projects that receive government funding.

STRATEGY 18: Investigate opportunities for energy efficient home mortgages.

STRATEGY 19: Investigate and institute low-cost loans for homeowners to use for completing upgrades identified by WAPA and VIEO audits. Consider offering incentives whereby loan interest rates are "bought down" in exchange for completing a certain level of home energy efficiency improvements.

STRATEGY 20: Continue efforts to access a higher share of LIHEAP Block Grant and Emergency Contingency funds. Develop a position paper identifying how such additional funds would be used in the Territory, their effects on the populace, existing poverty levels, and energy costs for low income households in the Territory.

STRATEGY 21: Investigate options for a contractor-funded performance contract to reduce leaks and system losses in the water distribution system and reimburse system improvement costs from the resulting savings.

STRATEGY 22: Pursue funding options and Federal assistance to replace WAPA's existing water desalination units with higher efficiency units offering long-term life cycle cost savings.

STRATEGY 23: Re-examine the rate structure for water sales which currently offers lower rates for large water use customers. Options to consider include a tiered approach which charges higher rates as water usage increases, and reducing metering increments (less than 1000 gallons) to provide greater incentive for using water efficiently.

STRATEGY 24: Expand efforts to promote efficient use of water through consumer leak detection and recycling of condensate from HVAC, steam trap, and process systems.

STRATEGY 25: Expand the existing net metering program to include renewable energy systems up to 500kW in size for public facilities, up to 100kW for commercial facilities, and up to 20kW for residences.

STRATEGY 26: Adopt the following renewable portfolio targets:

Targets	By 2015	By 2030
Minimum Percent of Electricity from Renewable Sources	20	25

STRATEGY 27: Develop options for utility or government administered turn-key solar water heating installations for business and residential customers.

STRATEGY 28: Develop economic incentives, such as rebates or gross receipt and excise tax breaks, to promote alternative fuels and alternatively fueled vehicles like ethanol fuel blends and electric cars.

STRATEGY 29: Require all new governmental and WAPA vehicles purchases be hybrid electric vehicles for relevant vehicle classes. Purchases of vehicle types for which hybrid electric vehicles are not available should be high efficiency diesel powered models.

STRATEGY 30: Develop a task force to examine viable projects for grant applications and target Federal funds and assistance opportunities available from different Federal agencies.

STRATEGY 31: Identify options and partners to promote and train the workforce for "green collar" jobs to develop needed resources and improve local job opportunities. Well-trained technicians, designers, installers, and builders are needed to enact the many goals of this strategy. Work with institutions such as the University of the Virgin Islands and sustainable tourism groups to make use of or develop training and certification programs in these areas.

1.0 INTRODUCTION

This strategy was developed to help create an overarching energy approach for the U.S. Virgin Islands and meet the following goals:

GOAL 1: Reduce energy costs
GOAL 2: Increase efficiency of energy use and production
GOAL 3: Increase fuel diversity and reliability
GOAL 4: Promote clean energy

This section of the report explains how and why this strategy was developed and the elements that make up the strategy. An energy strategy that looks at both short and long-term energy needs and priorities is essential to improve the standard of living of the citizenry and to reduce the financial drain caused by imported fuel sources that are becoming more expensive and less reliable. Embracing an energy strategy can also create local jobs and maintain a steady and reliable energy base that attracts future investment and strengthens energy security. This report identifies a series of steps that will lead to a more affordable and more independent energy future for the U.S. Virgin Islands.

In its simplest form, the main elements of an energy strategy are the setting of goals, an assessment of the current situation, evaluation of possible options, and the choice of strategies to be adopted to meet the goals. The process to produce an energy strategy requires communication with stakeholders, benchmarking to find what has been successful (both in the U.S. Virgin Islands and in other locations), evaluation of short and long-term needs, identification of barriers and risks, and a study of new and existing technologies and policies. The energy strategy provides a framework to set and communicate common goals and establish a common base. From there, programs and policies can be developed or better aligned to further those goals with specific action plans.

At the Governor's request a team of energy policy and technology experts and stakeholders came together to begin developing this strategy in the latter part of 2007. Stakeholder meetings were held in the U.S. Virgin Islands beginning in early 2008 to gather additional input from key stakeholders including representatives from the Territorial government, industry and commercial businesses, the Public Service Commission, and the WAPA. A first draft of the strategy was completed in the latter part of 2008 and was the basis for additional input from key stakeholders that has been incorporated into this version. Invaluable information was collected from many sources including the U.S. Department of Energy and Environmental Protection Agency's (EPA's) National Action Plan for Energy Efficiency, and the American Council for an Energy Efficient Economy's National Review of Exemplary Energy Efficiency Programs. A survey of the effectiveness of other state energy strategies and programs also helped expand information on the range of opportunities available; however, the special characteristics of the U.S. Virgin Islands, as a Territory of islands which currently obtains almost all its energy from imported petroleum, requires a strategy tailored to the

Territory's individual resources, needs, and goals. Following release of the strategy, more detailed action plans will need to be developed that will assign responsibilities and specific tasks to implement the strategies. Ultimately, the success of this energy strategy will rely on leadership and partnership from within the U.S. Virgin Islands government, the electric and water utility, the Public Service Commission, the business community, public groups, educational institutions, and the public as a whole, to change the current course of the U.S. Virgin Islands and set a new direction through innovation, commitment, and action.

In Section 2.0 this strategy describes the current energy situation of the U.S. Virgin Islands and attempts to project future trends based on current data and past trends. Section 3.0 examines a broad range of the most compatible energy options and opportunities considered. Other barriers and opportunities associated with identified strategies are evaluated in Section 4.0. Specific strategies to address issues are noted in sections 3.0 and 4.0, and reiterated in Section 5.0 with timelines for completion.

2.0 ENERGY ASSESSMENT

The public, energy providers, and the government of the U.S. Virgin Islands are all confronting the challenge of higher energy costs and seeking solutions that help in the short-term, while also providing for sustained, long-term improvements. This section gives a snapshot of the current energy situation to lay the groundwork for assessing energy alternatives in Section 3.0.

2.1 GEOGRAPHY AND CLIMATE

The U.S. Virgin Islands are volcanic islands with a steady population of about 110 thousand concentrated mainly on the islands of St. Croix, St. Thomas, and St. John. The land area is roughly 134 square miles including the smaller Water Island and some fifty smaller islands and cays. The island environment, characterized as subtropical, mountainous, and varying between rolling hills and rugged terrain with sandy beaches, has low humidity and little temperature variation through the year but is subject to droughts, occasional floods, earthquakes, and hurricanes. The U.S. Virgin Islands as a whole have a highly diverse biological ecosystem including the U.S. Virgin Islands National Park that comprises over half the land area on St. John. Only about six percent of U.S. Virgin Islands' land area is considered arable and about half of that is planted in crops. Most food items are imported. (DOI 2006)

2.2 EMPLOYMENT

The U.S. Virgin Islands' economy is dominated by tourism which employs about two thirds of the work force. Another quarter of the workforce is employed by the Territorial government. The HOVENSA refinery on St. Croix is the largest private employer with 2500 employees. HOVENSA imports up to 500,000 barrels per day of crude oil, mainly from Venezuela, which is refined for export in the form of gasoline and heating oil to the Eastern U.S. (EIA 2007) Another significant industrial site is the adjacent St. Croix

Renaissance Park which includes a 65 megawatt electric (MW) coal-fired power plant, an ethanol dehydration facility, and a two million gallon per day water desalination facility. (Renaissance 2008)

2.3 ENERGY USAGE

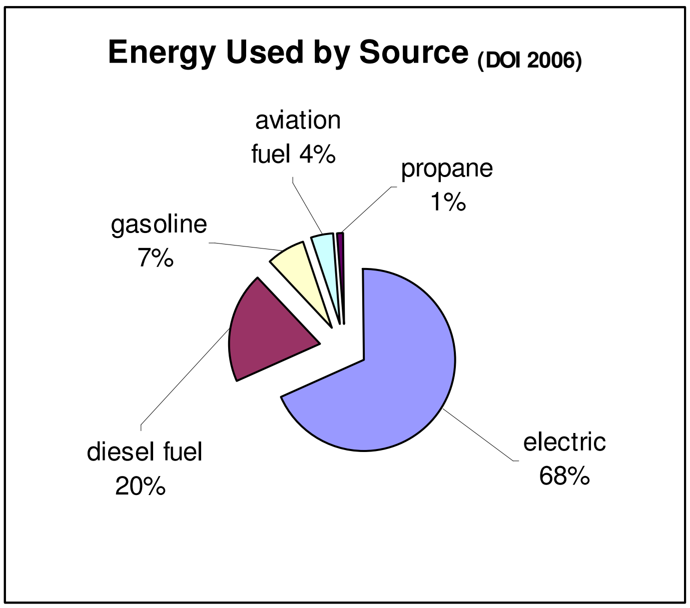
Energy use in the U.S. Virgin Islands can be categorized by uses and users:

Uses

- Production of electricity
- Production of heat or steam for private or business uses
- Production of drinking water through desalination
- Transportation of people and goods via automobile, watercraft, and aircraft

Users

- General public and tourists
- Commercial business such as shops, offices, and hotels
- Governmental and public facilities such as schools, parks, and hospitals
- Industrial facilities such as rum distilleries and construction operations



For most customers electricity and water are provided by the U.S. Virgin Islands Water and Power Authority (WAPA), and transportation fuels and propane are provided by private suppliers. Many commercial and industrial businesses have a generator, often diesel powered, that either acts as a backup in case of power loss, or operates on an ongoing basis to provide electricity and/or steam. Small volumes of propane and liquefied natural gas (LNG) are used as well. Propane is used primarily in homes for cooking. For overall energy usage in the Territory, some sixty-eight percent of energy use is for production of electricity and water, with another 31 percent going for transportation (diesel fuel 20 percent, gasoline 7 percent, and aviation fuel 4 percent). Some 90 percent of the petroleum fuel used is supplied by the HOVENSA Refinery. (DOI 2006) The HOVENSA refinery produces its own energy and its energy usage is not included in these figures.

The amount of money spent for energy represents about 20 percent of the total U.S. Virgin Islands gross domestic product. (CIA 2008, WAPA Financial 2008)

Total Fuels Used in the U.S. Virgin Islands, 2007

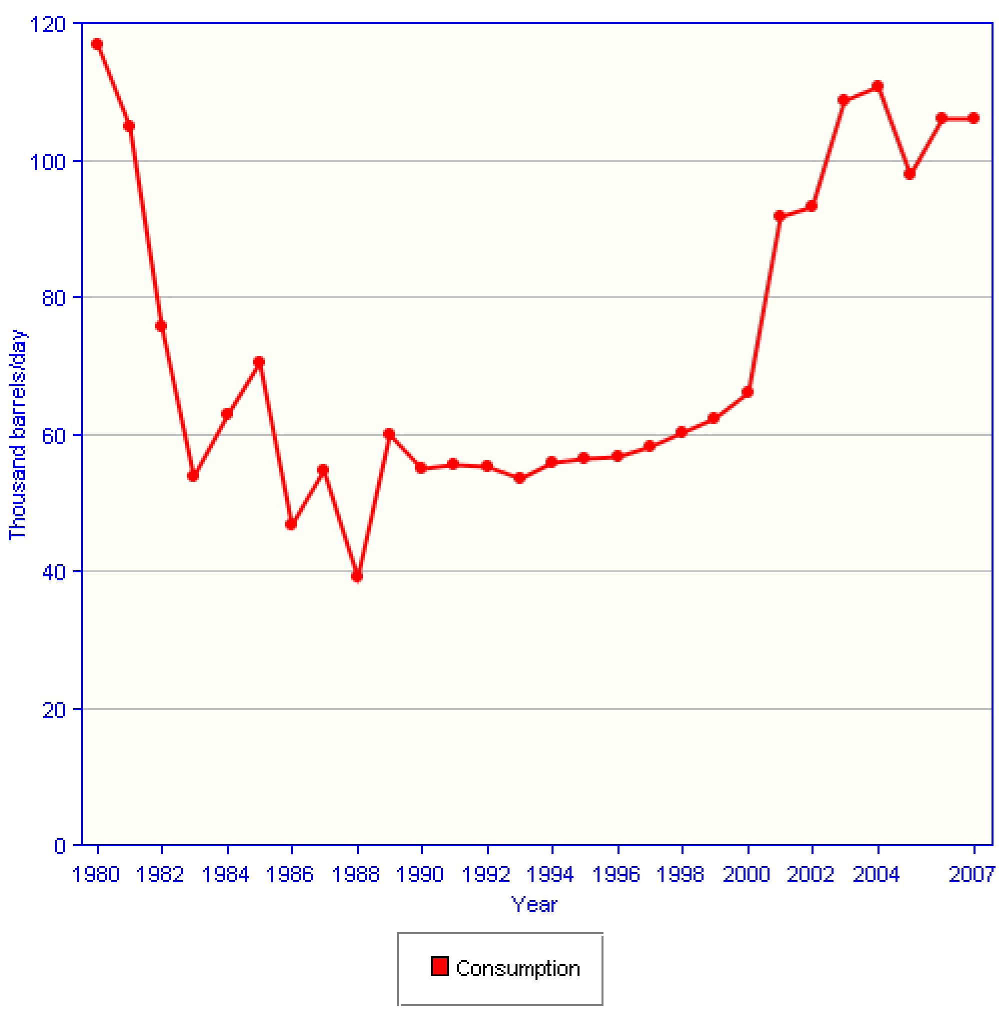
(Annual Economic Indicators 2008)

(millions of gallons)	
Diesel	158.1
Gasoline	44.4
Fuel oil	100.4

Usage includes transportation fuels, industrial uses, electricity and water generation, and residential uses.

Petroleum Consumption

(EIA USVI Profile 2008)



2.4 KEY GOVERNMENTAL STAKEHOLDERS

The Governor appoints and the legislature confirms members of the U.S. Virgin Islands Public Service Commission who set rates for electricity and water delivery through WAPA, an autonomous not-for-profit public corporation. The legislature also confirms the Governor's appointment of the WAPA Board of Directors. Key governmental divisions that relate to energy use are the U.S. Virgin Islands Energy Office (VIEO) in the Office of the Governor, and the Division of Environmental Protection and the Division of Building Permits, which are both part of the U.S. Virgin Islands Department of Planning and Natural Resources. Created in 2004, the U.S. Virgin Islands Waste Management Authority oversees collection, treatment, and disposal of wastes including solid waste and wastewater.

2.5 WAPA ELECTRICITY GENERATION AND TRANSMISSION SYSTEM

WAPA's electricity generation system power station on St. Thomas supplies electricity to St. Thomas and St. John with a generation capacity of 199 MW that includes an emergency diesel generating unit on St. John. Water Island, located a half mile off the coast of St. Thomas, is also served by power from the St. Thomas system via underwater cable. St. Croix is supplied by a separate power station not interconnected with the St. Thomas system that has generation capacity of 122MW. Altogether the system has 232MW available from combustion turbines and 87MW of capacity from steam generation all supplied by No. 6 or No. 2 fuel oil, and just over 2.5 MW from diesel-fuel powered backup. System peak demand in 2008 was 83MW for the St. Thomas system and 51 MW for St. Croix. The WAPA generation system serves a total of 54,005 customers almost evenly divided between the two systems, and on both island systems approximately 80 percent of customers by number are residential. In total WAPA's energy sales from July 1, 2007, to June 30, 2008 were 829,146 MWh, up seven percent from the previous twelve month period. (WAPA RFP 2007, WAPA Data 2008) Waste heat is recovered for use in the steam turbines or the evaporative water desalination units at plants in both systems, however, ongoing construction of a new recovery steam generator at the Richmond Plant on St. Croix and planning for a new recovery steam generator at the Harley Plant in St. Thomas are expected to increase unit efficiencies and result in additional customer savings. (WAPA Connect 2008) Many of the system generation units are older, ranging in age from 5 to 42 years, and some are beyond their design life but have been refurbished. According to the Power Supply Evaluation commissioned by WAPA and released on February 25, 2008, WAPA has not established expected retirement dates for any of the units.

The two WAPA electricity transmission systems on St. Croix and St. Thomas are separated by a distance of about 40 miles with an ocean depth of two to six kilometers between them. The two systems are not interconnected. As is typical for non-grid-tied island units, a spinning reserve is maintained in each system and backup units are run for redundancy to avoid system outages. (DOI 2006) This translates to having a number of units running at low, inefficient levels to provide system reliability. For example, about a third of the unit capacity available can serve the average load on St. Thomas, but two thirds of the unit capacity is running at any given time. (ORNL 2008) The generating units used by WAPA are already of lower efficiency with system efficiencies in the range of 25 percent compared to diesel engine systems used by many small grid systems. With operational efficiencies in the range of 39 percent, comparable systems with large low-speed diesel engines are as much as 50% more efficient than WAPA system efficiencies. (DOI 2006) For the period of June 30, 2007 through June 30, 2008, WAPA reported 13.12 percent of electricity produced was either unaccounted for or was consumed by distribution line losses. This loss percentage rose from the previous year's loss of 10.75 percent. (WAPA Data 2008) These losses would be considered higher than what is expected, though geography and the size and age of the system grids are at least partially responsible for the elevated system losses.

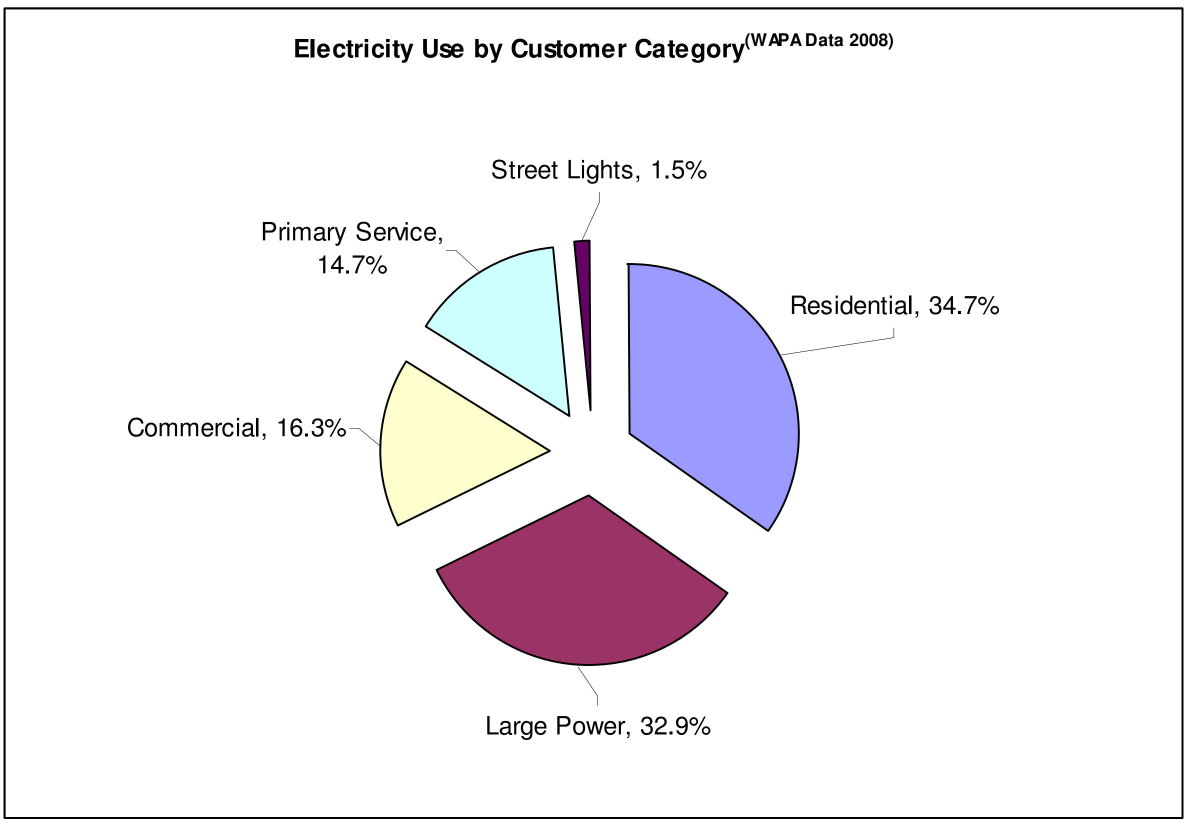
System inefficiencies must be viewed as a whole in relation to the specific conditions and constraints the generation and transmission system is operating under. Factors that figure into the overall efficiency include unit thermal conversion efficiencies, operational characteristics and spinning load requirements that affect unit efficiencies, and distribution losses including theft. Some of the inefficiencies of the current system are technical and maintenance related, while others are a result of how the existing equipment must be operated to provide backup and ensure high system availability.

Most areas of the Caribbean are 90 percent or more dependent on petroleum products and are experiencing exponential increases in energy prices. (CARILEC 2008) WAPA also has high levels of debt which have been exacerbated by an inability to fully recover fuel costs. Fuel costs for WAPA from July 1, 2007 through June 30, 2008 were $217 million, compared to $165 million for the same period in the previous year. The latest data available for WAPA's fuel use is for June 2008, when average fuel costs were $241 per barrel for #2 fuel oil and $120 per barrel for #6 fuel oil. Average costs for #2 fuel oil and #6 fuel oil were $183 and $167 per barrel, respectively, over the twelve month period from July 2007 to June 2008. In 2007 prices for the same fuel averaged $70 per barrel. These charges are for the reduced rate received from the HOVENSA refinery that is based on the lesser of the average cost of crude delivered to the refinery or a reduction in the rate for the same fuel if landed in the New York harbor. WAPA takes delivery of an average 202,000 barrels of fuel oil per month and hedges about 20 percent of its fuel usage which helps levelize costs. (DOI 2006) A barrel of fuel oil contains 42 gallons yielding an equivalent WAPA usage of 8.5 million gallons of fuel oil annually. (WAPA 1/22/09)

2.6 CUSTOMER ENERGY USAGE

WAPA's electric sales are divided into the categories of residential, commercial, large power, primary service, and street lighting. Commercial customers are defined as residences or businesses with a consumption of less than 25 kilowatts (kw) while customers consuming 25 kw or more are in the category called Large Power. Very large electric users are in a separate category called Primary Service. Residential and commercial customers may be single or three phase. Each of these customer classes pays a base rate with an additional charge for each kilowatt hour (kwh) used and an additional fuel cost surcharge called the levelized energy adjustment clause (LEAC). The LEAC is reviewed twice a year by the Public Service Commission and is designed to allow WAPA to recover the cost of fuel used for power generation. Large Power customers also pay a demand charge if they maintain their own substation. When the LEAC rate increases due to increases in fuel costs, the increase is proportional across all customer classes. As of December 2008 the per kilowatt electric charges for the customer classes are: Residential – 10.65 cents per kwh, Commercial – 13 cents per kwh, Large Power Customers – 10.28 cents per kwh but with decreasing rates as energy use in this class increases, street lighting – ranging from 10.06 to 17.51 cents per kwh.

Annual Electric Sales, in MWH	**St. John**	**St. Thomas**	**St. Croix**	**Total**
Residential	**12,066**	**150,390**	**125,445**	**287,901**
Commercial	**6,132**	**74,801**	**54,033**	**134,966**
Large Power	**12,279**	**150,772**	**109,666**	**272,717**
Primary Service	**7,645**	**92,268**	**21,610**	**121,523**
Street Lighting	**414**	**5,043**	**6,632**	**12,089**
Total	**38,536**	**473,274**	**317,386**	**829,196**



Average WAPA electric costs ranged from 23 cents per kWh up to 41 cents per kWh between the summer of 2006 and 2008 due to spiking petroleum prices. In contrast, average electricity rates in the mainland U.S. ranged from 6 to 12 cents/kWh. (EIA Data 2008) Electricity sales to Territorial government facilities accounted for just over nine percent of WAPA sales, and fall into several customer classes. As petroleum prices have fallen, WAPA has reduced the LEAC rate in October and December of 2008 and plans another reduction in April 2009. (Fields 2009)

The HOVENSA refinery is a major industrial presence but produces its own electricity and water. Other industries in the U.S. Virgin Islands include rum distilleries, construction, port facilities, and other transportation related business. The commercial sector is dominated by tourism related businesses including hotels and shops. Energy end uses in the commercial sector vary widely but typical end use percentages are: 45 percent for heating, ventilation, and cooling (HVAC); lighting 18 percent; water heating 9 percent; office equipment 7 percent; cooking 5 percent; and refrigeration 3 percent. (EIA 2005)

Typical end uses in a home are 26 percent HVAC, refrigeration 14 percent, lighting 9 percent, water heating 9 percent, dryer 6 percent, and the remaining 36 percent for cooking and miscellaneous loads. Over half of U.S. Virgin Island households use liquefied petroleum gas for cooking and at least half of households have some type of air conditioning. (DOI 2006) The last census showed slightly more households living in rental units (54 percent) than owner-occupied housing. (Census 2000) For a median income of $33,474 the average U.S. Virgin Islander is paying nine percent of his or her income for electric power, not counting costs for transportation and the elevated costs of goods and services that result from higher energy costs. (Census 2008) Many U.S. Virgin Islanders are struggling to pay their energy bills; those in poverty are paying up to 14 percent or more of their incomes on energy costs. For the median household in the U.S. as a whole, the energy use is almost double that of the average U.S. Virgin Island resident, yet the amount paid for electricity is just over two percent of income. (EIA 2006) This is an even higher difference than what is expected for the Caribbean region, where typically small island economies pay upwards of 47 to 93 percent higher electric rates and 36 to 50 percent more for goods and services. (ITC 2008)

WAPA planning projects individual customer usage rates to increase based on past usage. The WAPA Consulting Engineer's Report released in June 2007 projected annual growth rates from 2012 through 2027 to average 0.5 percent for St. Croix and 1.2 percent for St. Thomas. (Beck 8/26/08) WAPA electricity sales have increased on average less than two percent per year over the last five years across sectors, while in the past year, comparing data from June 30, 2006, to June 30, 2007 against sales from June 30, 2007, to June 30, 2008, overall sales have decreased 1.5 percent with the highest reduction coming in the residential customer class with a drop of 3.4 percent in electricity sales. (WAPA Financial 2008, WAPA Connect 2008, WAPA Data 2008)

2.7 POTABLE WATER

Many households in the U.S. Virgin Islands use cisterns for water collection and storage, and some use rainwater with supplemental supplies from the WAPA water system when needed. Water desalination units operate using process extraction steam from the WAPA generation units on each island system to create the drinking water supply. A small amount of groundwater from St. Croix supplements the water desalination units. WAPA provides water to over 12,000 customers and the average customer uses 2,400 gallons per month of water. (Kossler 2008) WAPA customers paid $32.9 million for water in 2007. (WAPA Financial 2008) Water usage is projected to remain the same over the coming decade. (Beck 8/26/08) WAPA's rate structure for their water customers includes three categories: Residential, Commercial, and Large Water Customers. Customers pay a monthly charge for service based on usage and a LEAC fuel surcharge also proportional to usage. The LEAC rate is the same for each customer category, while the usage rates are lower for Large Water Customers who meet criteria established by the Public Service Commission. Water usage directly correlates to energy usage since water from WAPA is produced using energy. (WAPA 1/22/09) About 10 percent of the energy produced by WAPA generators is used for water production. (DOI 2006)

2.8 PUBLIC ASSISTANCE PROGRAMS

The VIEO manages several programs that provide financial and technical assistance in the area of energy. The energy office provides assistance and grants that promote wind and solar energy including solar water heating. Of particular interest, since 1990 the VIEO has offered an Energy Rebate Program that provides a rebate to help offset costs of the following renewable and energy efficient products: photovoltaic panels, solar water heaters, wind turbine generators, and ENERGY STAR compact fluorescent light bulbs, refrigerators, clothes washers, room air conditioners, and ceiling fans. Over 1800 rebates have been processed in the program since 2001 for $1.24 million in rebates including 120 kW of photovoltaic panels, ten wind turbine systems, and over 1300 appliances and air conditioners. Since most of these systems and appliances will have a long operating life, this represents a significant investment in the long-term for energy efficiency in the Territory. The VIEO also operates a discretionary program that provides financial assistance for building retrofit and renewable energy projects for public facilities such as schools and hospitals. Education mini-grants of $1500 are also offered for educational programs in energy efficiency and renewable energy. The office is very active with public educational events, conducting energy audits, and providing assistance with renewable energy installations.

Federal tax credits that cover a percentage of the cost for installing renewable energy systems and energy efficient upgrades were reinstated at the beginning of 2009. These credits have maximum caps but offer a credit for a range of installations including insulation, storm doors, windows, heat pumps, air conditioners, water heaters, and residential solar and wind energy systems.

The U.S. Department of Health and Human Services' Low Income Home Energy Assistance Program (LIHEAP) provides financial assistance to states and territories to assist low income households. The stated goal of LIHEAP is to assist low-income households, particularly those with the lowest incomes, that pay a high proportion of household income for home energy. The U.S. Virgin Islands receives limited financial assistance through LIHEAP, despite the high poverty rate and energy prices that are much higher than the U.S. average and represent a much higher percentage of income in most households, due to caps in the program and a program focus on areas with high heating bills. (IGIA 2008) One in four households in the U.S. Virgin Islands is classified at or below the poverty level. (Census 2000) For 2009, the U.S. Virgin Islands' allotment from LIHEAP was calculated at $78,000 out of the entire budget of $1.7 billion. For the U.S. Virgin Islands, LIHEAP is administered by the Territorial government's Department of Human Services. LIHEAP also offers Emergency Contingency Funds to assist households with energy costs in times of emergency or natural disaster, however, these funds are generally awarded based on temperature extremes and, consequently, the U.S. Virgin Islands has received little of these monies. (Nation Priorities 2009)

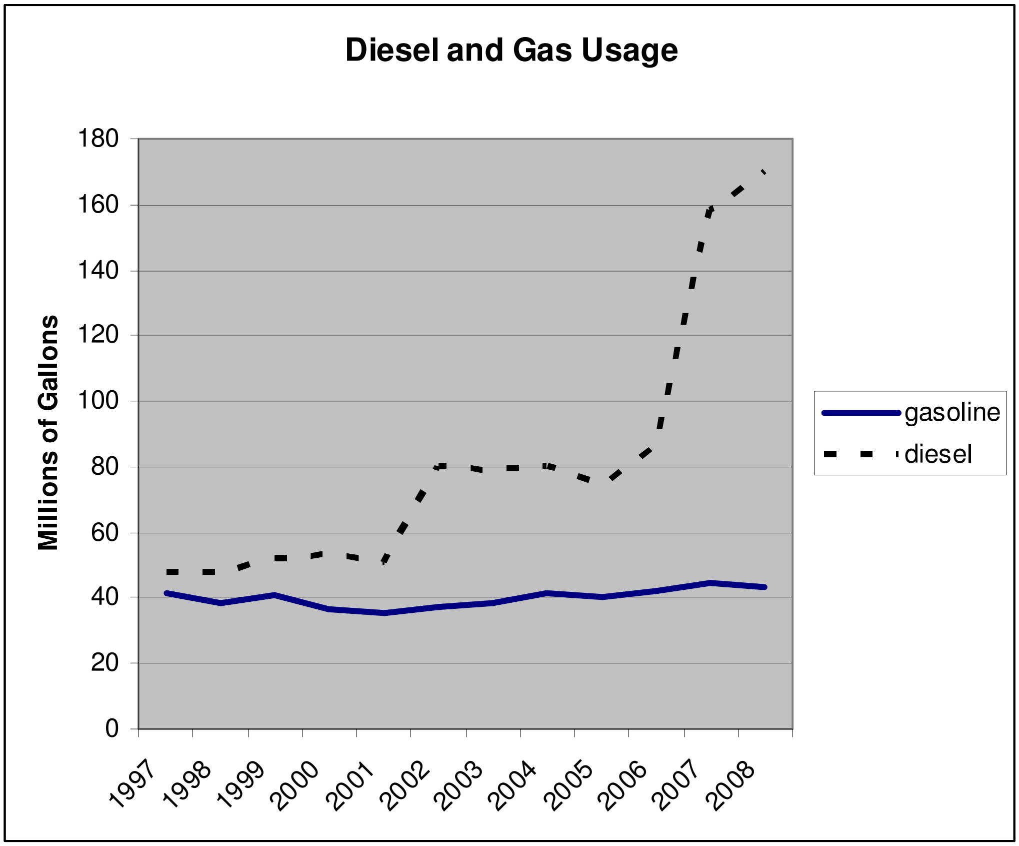
As a result of intervention by the government of the U.S. Virgin Islands and other territories, regulations for administration of the DOE Weatherization Assistance Program are being amended and the U.S. Virgin Islands is receiving funding from this program for the first time in 2009. The American Recovery and Reinvestment Act of 2009 greatly increased funding for Weatherization Assistance and has also expanded the number of people eligible to receive assistance by raising the cap on recipient income level. The Weatherization Assistance Program provides funding for energy efficient upgrades, such as additional insulation or upgraded windows, to homes of low-income individuals and families to reduce their energy bills.

2.9 TRANSPORTATION

Annual fuel usage for transportation was 170.2 million gallons of diesel and 43.1 million gallons of gasoline in 2008. (Bureau of Internal Revenue 2009) Fuel usage in 2007 was 158.1 million gallons of diesel and 44.4 million gallons of gasoline. Since the year 2000, gasoline usage has increased by 20 percent while diesel usage has increased such that usage is now triple what it was in the year 2000 (Annual Economic Indicators 2008)

The increased usage of diesel is most likely attributable to people turning to more efficient diesel engines for transportation to avoid high gasoline costs, and to purchases for running of backup generators on diesel. Tracking of fuel sold in the U.S. Virgin Islands does not differentiate between end uses for diesel fuel, though diesel and gasoline usage is tracked based on whether fuel tax is paid or exempted. Forty-nine percent of the diesel used in 2008 was exempted from fuel tax. Exempted sources include industrial sources and motor vehicles not operating on public highways such as aircraft, motorboats, and yachts. Other exempted sources are the VI government and foreign businesses with no local or U.S. trade. (Bureau of Internal Revenue 2006) Based on the percent exempted, it is reasonable to assume that automobile transportation fuel accounts for less than half of the total diesel used.

Transportation on the islands is generally by private vehicle, though there is a public bus system between urban and residential areas. Modified pickup trucks with bench seats also provide transportation for residents and tourists. The number of registered vehicles on the islands has decreased from a high of 74,280 in the year 2000, but has shown a recent increase of from 2006 to 2007 of almost 6 percent to 73,353 registered vehicles. (Annual Economic Indicators 2008) The U.S. Virgin Islands also have ferries, taxi service, two main airports, and sizeable ocean ports that service some 750 tourist cruise ships per year, primarily in St. Thomas. Many of the hotels and resorts have their own transport vans. (DOI 2006) There are eight marinas on St. Thomas and three marinas on St. Croix offering over 800 slips, and numerous mooring and anchoring areas on the different islands. In total, the islands entertain over 2.6 million visitors each year. (Annual Economic Indicators 2008)



(Annual Economic Indicators 2008, Bureau of Internal Revenue 2009)

An ethanol dehydration facility operating on St. Croix produces up to 110 million gallons annually. Most capacity is currently exported to the mainland U.S. A 50 cent per gallon tariff on imported ethanol is not applicable to the plant. (REW 2006)

2.10 BENCHMARKING

The U.S. Virgin Islands can gain ideas and valuable information by observing the steps other similar entities are taking to diversify fuel sources and move away from dependence on petroleum.

The Hawaiian Islands bear the similarity of being American island chains highly dependent on petroleum and tourism, though the comparisons end there with Hawaii having a much greater land area and population. Hawaii is currently reliant on 90 percent petroleum for their energy. In January of 2008 the U.S. Department of Energy created a partnership with Hawaii to create the Hawaii Clean Energy Initiative. This initiative has been called a model for U.S. insular areas to follow in their efforts to reduce dependence on petroleum. Through this initiative Hawaii is developing partnerships and working groups, completing studies and demonstrations, employing new renewable technology sources, expanding underwater electrical interconnections, and setting new energy goals. Hawaii's goals are to achieve 10 percent of their electricity from renewable sources and energy efficiency by 2010, 15 percent by 2015, and 20 percent by 2020. By 2030 they intend to have 70 percent of energy coming from clean energy sources. (Hawaii 2008)

Nevis and Bonaire, also in the Caribbean, have smaller land areas and about a tenth of the population of the U.S. Virgin Islands. Nevis is pursuing development of geothermal energy plants and wind energy to reduce living costs for island inhabitants while generating clean, renewable energy. Geothermal developers project Nevis will become the first Caribbean island powered entirely by renewable energy by the year 2010. (West Indies 2005) Bonaire developers also have the goal to become the first Caribbean island fully powered by sustainable energy. To reduce dependence on fossil fuel Bonaire is developing a 14 MW biodiesel plant, 11 MW of wind turbines, and a 3 MW backup battery system. Their plan calls for about half of their energy to be generated from the wind turbines while the remaining half will be produced by created algae biodiesel. Projections are for the island to achieve 44 percent of their energy from renewables by the end of 2009 and meet the goal of 100 percent renewable energy by 2014. (Travel Daily News 2009)

Under the 2005 Energy Policy Act (EPAct), energy consumption goals were set for states and territories. For the U.S. Virgin Islands the EPAct goal is 834 million BTUs per person and 43 BTUs per $1000 gross domestic product. Figures in the table below show consumption for the baseline year 1990, an update for 2003, and estimates for 2012 based on usage trends. Goals are for a 25% reduction from 1990 levels. (EERE 2007) Clearly, there is much to be done if these goals are to be met.

PER CAPITA ENERGY CONSUMPTION

In million BTUs per person (EERE 2007)

	1990	2003	2012	EPAct Goal
National	341	339	338	256
U.S. Virgin Islands	1,112	2,126	2,829	834
American Samoa	171	138	115	128
Guam	193	202	208	145
Puerto Rico	85	133	167	63
Pacific Islands	20	17	14	15

The inordinately high per capita values for the U.S. Virgin Islands are most likely attributable to a variety of factors including output from the HOVENSA Refinery, tourism, transportation fuels, and industrial uses.

3.0 ENERGY OPTIONS

A range of energy and fuel options exist that differ in their levels of performance, cost, environmental consequences, and reliability. The available options to meet energy needs in the U.S. Virgin Islands are constrained by the particular issues discussed in the last section: lack of an interconnecting grid, spinning reserve used for system balancing and reliability, need for water production, risk of hurricanes and associated damage, use of imported fuels, reliance on mainly one fuel, cost recovery issues, and the age and condition of existing generation and transmission infrastructure. Overall efficiency and cost in delivery of energy to the customer is more important than the efficiency of any one part of the system, and the total cost and effect of the energy generated, including the effects on the U.S. Virgin Islands economy, all members of the U.S. Virgin Islands community, and the natural environment, have to be considered over the long term.

Energy choices must address short and long term needs, including up-front capital costs versus long term operational costs; expected fuel costs over time; financing options; smooth transition from existing energy production infrastructure to new choices; and available technology options. Decisions made must balance the needs for system reliability, environmental stewardship, fuel diversity, and investment costs against the risks of escalating fuel costs and the risks associated with adopting greener and more efficient technologies and approaches that are less mainstream and may be less proven and less reliable. Keeping in mind the goals noted in Section 1.0 – reduce energy costs, increase efficiency of energy use and production, increase fuel diversity and reliability, and promote clean energy – helps define limits to the options under consideration.

A baseline of how energy is used is needed for developing energy strategies and measuring progress toward meeting goals. The foundation for improvements requires ongoing tracking of energy usage and costs throughout the Territory and periodic analysis of that data and associated trends. Ideally, metrics for energy usage would track and compare the following:

- electric use by different sectors (residential, commercial, industrial, government)
- electric use by end uses for each sector and subsector (e.g. lighting versus refrigerator in homes, steam production versus air conditioning for manufacturing facilities, electricity used by computers in office buildings, electricity for street lights and airport lighting)
- usage of other fuels by end use (e.g. transportation by type of vehicle and usage such as private boats or commercial vans, industrial fuel usage for creating electricity or hot water, diesel used commercially or residentially for backup electric generation)
- similar but less extensive usage data for water produced from desalination

To do this requires tracking of utility data, surveys on end uses, calculation of energy usage per square foot, and additional metering. Such tracking must also take weather and usage changes into account as trends are developed. Evidence of the effectiveness of different energy saving measures can then be validated using this type of information.

This strengthens the case for supporting measures that are shown to be effective and also may improve opportunities for additional funding for energy projects. Such tracking does require time but presumably pays for itself by providing additional information that facilitates improvements and energy savings.

STRATEGY 1: Develop a comprehensive biennial energy plan that tracks energy usage and costs by sector and end use.

For the goals of this strategy to be met, these goals must be incorporated into the planning process for meeting electricity demand. Energy is often thought of in terms of production, but energy efficiency is usually a cheaper resource. While energy efficiency is being actively pursued and promoted, it has not been considered as a resource under recent power supply evaluation reports and requests for proposal from the utility. As part of its efforts to examine options for power generation replacements or additions, WAPA commissioned R.W. Beck and Associates to produce a high-level analysis of alternatives to consider that would reduce costs while maintaining system operational needs and reducing reliance on fossil fuels. The results were reported in a Fatal Flaw Analysis report released on February 25, 2008. Results from that study were used to examine options in more detail in the subsequent R.W. Beck Power Supply Evaluation completed on August 26, 2008. These documents form a basis for planning future generation addition and replacements for the power supply. Under a request for proposals (RFP) released in 2007, WAPA is seeking supplemental electricity sources from energy providers via a 20 year power purchase agreement. A prime criterion of this RFP was that the proposed systems not be fueled by petroleum. This criterion supports the third goal of this strategy to increase fuel diversity and reliability. Evaluation criteria for the RFPs also include a number of factors with various weights to help evaluators judge which responses best meet system needs as a whole. Currently the rating criteria in the RFP address important factors affecting the ability of the proposal offerer to perform as described in their response including: proof of secure financing sources, experience in operating systems similar to the one being proposed, knowledge of requirements for environmental permitting, and realistic planning and scheduling for system output and operations. How the criteria are weighted affects the range of options available. To better meet the goals of this energy strategy, these goals need to be integrated into evaluation of energy alternatives and be given a priority in the rating systems for choosing those alternatives. Energy efficiency should also be treated as a “generation” alternative, as is discussed in an upcoming section.

STRATEGY 2: Analysis of options and proposals for energy generation should give a priority to those options that: 1) reduce energy costs, 2) increase efficiency of energy use and production, 3) increase fuel diversity and reliability, and 4) promote clean energy.

STRATEGY 3: For fuel diversity and reliability, WAPA energy generation should move toward a goal of having more than just one dominant fuel source as demonstrated by having at least 30 percent of power generated by energy sources differing from the primary energy source by the year 2025.

3.1 ENERGY EFFICIENCY PROGRAMS

The "first fuel" to consider as part of the mix of new generation and energy solutions is energy efficiency because avoided energy use can reduce the need for new power plants, lessen the need to purchase imported fuels, and minimize environmental pollution.

The National Action Plan for Energy Efficiency Report, published in July 2006, summarizes the accomplishments of two decades of experience with energy efficiency programs in the U.S. and provides the recommendation that energy efficiency must be regarded as a high-priority energy resource to be fully developed. Like new power generation and new fuel sources, energy efficiency requires planning and up-front investment in order to achieve a return of greater savings over time.

Savings from energy efficiency also has the added benefit of revenue that can be redirected back into the local economy and providing more employment opportunity than if the funds were spent directly on purchasing energy instead. Because energy is lost in conversion to electricity and distribution, the effects of savings are multiplied many times over in terms of fuel used, energy saved, and emissions avoided. (NAPEE 2006)

Energy efficiency resources are an important part of a well-diversified energy generation portfolio and can be substituted for building new generation in some cases. Utilities in the U.S. have pursued energy efficiency programs for rates often half the cost of new generation and sometimes as low as 2.5 cents/kWh, helping to reduce overall costs and limit new generation requirements. (ACEEE 2004, EIA 2006)

Studies from eleven states show there is a median potential of 24 percent of energy use that could be saved. Annual utility investments in energy efficiency programs in the U.S. range from zero up to 3 percent of electricity sales with an average annual investment of one half of one percent. While there are many differences between energy usage in these states and energy usage in the U.S. Virgin Islands, as a point of comparison we can extrapolate their percentages of annual available savings from energy efficiency programs (1.2 percent) and average annual energy efficiency program investment from electric utilities (0.5 percent). Using WAPA annual sales numbers from June 30, 2008, the equivalent available savings would be $4.3 million and the equivalent annual utility investment would be $1.7 million. (WAPA Data 2008)

STRATEGY 4: Include and give priority to energy that can be saved through efficiency programs as an energy resource and alternative to new generation options.

Components that contribute to effective energy efficiency programs include:

- Comprehensive energy strategy planning
- Benchmarking
- Setting specific goals

- Measuring results
- Ensuring implementer full cost recovery
- Program synergy
- Consistent funding aligned with goals

An energy strategy and its planning bring together the stakeholders to address problems, identify threats and barriers, build a shared vision for the future, and set policy with regards to energy options to consider, consistent criteria for assessing those options, and acceptable levels of reliability, investment, and risk. Evaluation of impacts on low income residents and possible mitigation measures can also be examined in the process. Roughly half the states in the U.S. have developed energy strategies encompassing some or all of these elements. (NAPEE 2006, ACEEE 2008) While programs that are effective in Wisconsin won't necessarily be effective in the U.S. Virgin Islands, evaluating strategies that have been successful elsewhere, especially in areas more similar to the U.S. Virgin Islands in terms of fuel use and geography, broaden the number of options to consider and provide a basis for planning and comparison. Adopting best practices by class, such as high performance schools or ENERGY STAR lighting, provide a straightforward approach with existing program support already in place.

3.1.1 STATE AND TERRITORIAL TARGETS FOR ENERGY EFFICIENCY

Specific Energy Efficiency Portfolio Standards (EEPS) have been enacted by 18 states establishing or legislating targets for energy efficiency. Most targets are in the range of a reduction of one to two percent of electricity sales per year, with higher aggregate goals up to 25 percent over time. Maryland set targets of 15 percent reduction in peak load and electricity use per capita by 2015 based on 2007 usage levels. (Maryland 2008) Colorado has a binding goal to save 11.5 percent of energy use by 2020. (ACEEE 2008) The EEPS can be voluntary targets or legislated goals and can also be tied to forecasted electricity growth, measured on a per capita basis, or energy reduction percentages from a measured base year. (ACEEE 2008, Maryland 2008)

Most states implement energy efficiency programs by setting goals and requiring utilities to implement programs to meet those goals. In some cases, outside contractors or state-appointed groups take on the role of developing and implementing the programs while working in concert with the electric utilities. In either case, the programs must be carefully designed both for success, but also to allow the implementing organization to recover direct and indirect costs for the programs. Power utilities often oppose EEPS as being unrealistic and not taking important factors like reliability and energy security into account. (CARILEC 2008) Utility groups bear the obligation to create and ensure system reliability and the lowest rates for their customers. It is precisely because system requirements are complicated, and that embracing energy efficiency programs and renewable energy technologies do hold elements of risk, that setting percentage goals via portfolio standards can be useful. Typically the utility carries out the efficiency programs and adjusts rates to cover program costs. Changes to policy and/or legislative requirements may be necessary to allow utilities to charge customers to pay for the programs.

STRATEGY 5: Develop utility demand side management programs for customers to improve energy efficiency and reduce peak load demand levels.

STRATEGY 6: Utilize trends from the biennial comprehensive energy plan with results from the utility demand side management programs to determine if an energy efficiency portfolio standard is needed to meet goals.

Energy efficiency programs are more effective when they reap the effects of synergy from designing programs to address all economic sectors, including residential and low income, small and large commercial, industrial, transportation, and governmental. Usage of the full range of program tools including consumer education, rate structuring, and rebate programs, as well as working with other stakeholders such as contractors, manufacturers, distributors, and retailers, also increases program success.

3.2 EFFICIENCY OF EXISTING ENERGY GENERATION SYSTEMS

3.2.1 WAPA GENERATION AND TRANSMISSION SYSTEM

Losses for the U.S. Virgin Islands power distribution system are 8 percent, higher than typical values of about 6 percent and representing a loss in the range of some $2 million per year for inefficiency above that 6 percent level. (DOI 2006, WAPA Financial 2008) WAPA is improving the system through equipment upgrades and maintenance following a transmission and loss study and is ramping up its theft prevention program to decrease losses due to electricity theft. (WAPA Transmission 2008) As was noted in section 2.0, because of equipment inefficiencies, maintenance issues, and the need for spinning reserves, overall WAPA system efficiencies lag those of other U.S. insular areas that are the next best comparison with somewhat comparable conditions and restraints. (DOI 2006)

While a grid-connected utility can afford to run their most efficient units as base load and either run more expensive and/or less efficient units or purchase energy to satisfy peak loads, WAPA's system must run most of its units including the less efficient ones to serve as its own backup via spinning reserves. Because so many of the units must be run to provide this backup, they can only be run at lower capacity levels. Units of this type are more efficient at higher capacities and less efficient when operated at lower capacities. Further, the types of generation units used by WAPA are less efficient in the sizes needed to meet their loads. In recent years WAPA has reduced night time spinning reserves to reduce costs and system efficiency, although system availability is reduced as well. In a 2008 study, initial review indicated that introduction of a Supervisory Control and Data Acquisition (SCADA) system and load control system held the possibility of offering increases in efficiency and reduced need for expanding generation capacity. (ORNL 2008) These systems have now been deployed on all three islands. (WAPA 1/22/09)

The PSC has pushed for improvements to increase efficiency in the transmission system and also to replace the existing units with more efficient technology. WAPA has conducted numerous studies for assessing the existing system and exploring options to either upgrade or replace the existing units over time. Of note are studies including the previously noted R.W. Beck Power Fatal Flaw Analysis Report completed on February 25, 2008, the more detailed R.W. Beck Power Supply Evaluation completed on August 26, 2008, the previously mentioned June 2008 Transmission and Distribution Loss Study, and the Harris Group Condition Assessment Study completed on October 31, 2005. A number of options were assessed through these studies including interconnection between St. Croix and St. Thomas, and evaluation of a selection of renewable and non-renewable electricity generation systems. Details from these studies are noted under several sections in this report. Other options related to upgrading the existing units were also considered.

The Harris Group Condition Assessment Study completed in 2005 recommended taking some of the oldest and least efficient units, including combustion turbines No. 12 and 14 and boiler No. 11 on St. Thomas and boiler No. 10 on St. Croix, out of regular service and using them only for emergency or backup with a goal of eventual full retirement. (Beck 8/26/08)

The 2008 Transmission and Distribution Loss Study provided an assessment and identified strategies for reducing loss including increasing maintenance, conductor upgrades, implementing new DOE Transformer Efficiency Standards, improving voltage regulation in each system, increasing infrared camera inspections, increasing tree trimming, improving QA/QC of metering data, implementing system-wide automated meter reading, and improvements in billing and accounting. (WAPA June 2008)

STRATEGY 7: Develop performance measures, set goals, and track quarterly progress in reducing WAPA transmission and distribution system losses.

The Beck Fatal Flaw Analysis and Power Supply Evaluations completed in 2008 were undertaken with the goal of reducing operating costs and reducing dependence on fossil fuels. The Fatal flaw Analysis concluded – 1) two technologies investigated reduced operating costs and reduced dependence on petroleum – circulating fluidized bed (CFB) units burning pet coke from HOVENSA and coal from Columbia and supplemental wind turbine energy, 2) reverse osmosis water units should be considered as alternatives to the existing multi-effect distillation water production and for future expansion, and 3) WAPA should consider other fuel supply options such as methanol and LNG and interconnection alternatives. (Beck 2/25/08, Beck 8/26/08)

Environmental issues, mainly air quality permitting, also limit the options available to WAPA. Cost and the ability to obtain financing appear to be hurdles beyond the technical issues and constraints unique to the U.S. Virgin Islands. On April 12, 2008, in testimony before the Subcommittees on Insular Affairs and on Energy and Mineral Resources of the Committee on Natural Resources of the U.S. House of Representatives, the Director of WAPA stated:

> "We know from the Beck analysis, and the other information we have received, that all of the potential initiatives are extremely expensive, and will, at a minimum, severely strain the Authority's limited resources (and the resources of our citizens). In some cases, it appears almost certain that the Authority will not be able to pursue promising approaches without significant financial help—either because it has inadequate resources to invest, or because the risks are just too great for it to assume on its own. For some of the more promising alternatives, it appears all but certain that we will not be able to pursue them without significant assistance from the federal government." (Hodge 2008)

WAPA is requesting Federal government financial assistance from the Department of Interior to fund energy upgrades, and specifically notes the interconnect between St. Thomas and St. Croix as being a prime project suitable for federal funding. (Hodge 2008). Capital investment cost estimates for alternatives considered in the Beck Power Supply Evaluation range from a low of $46 million up to $1.1 billion, and savings estimates from the various alternatives described are estimated at up to $97 million over the period of 2008 to 2027. The following sections include a look at the benefits, downside, and suitability of different fuels and technologies for future energy generation in the U.S. Virgin Islands and include estimates and results from this study.

WAPA solicited a request for proposals (RFPs) to enter into 20 year power purchase agreements with energy providers in 2007. Fourteen proposals were submitted by the May 2008 deadline in response to the RFP. One purpose of the Beck Power Supply Evaluation Report was to provide analysis to support review of proposals submitted under this RFP. WAPA has since selected six proposals for further consideration and negotiation. WAPA expects to enter into definitive agreements for one or more of the proposed project by April of 2009. (WAPA 1/14/09) WAPA has also stated that they are evaluating more efficient combustion turbines for when older units are replaced or new generating capacity is to be added. (Hodge 2008)

3.2.2 NON-WAPA GENERATION UNITS

The VIEO offers assistance to industrial and commercial facilities to help facilitate energy saving improvements. Cogeneration, whereby electricity is generated at the source of use in conjunction with production of hot water or process heat, offers an opportunity for increasing efficiency levels up to as high as 85 percent. In a previous study, major hotels and resorts were identified as cogeneration opportunities that would increase efficiency and further increase grid backup generation. Lack of qualified personnel to maintain and operate the cogeneration systems reliably was identified as a major reason cogeneration was not being actively pursued by the hotels and resorts large enough (typically in the range or 100 rooms) to effectively utilize cogeneration units. (DOI 2006)

STRATEGY 8: Promote cogeneration for larger hotels and resorts and utilize technical assistance from the EPA's Combined Heat and Power Partnership to

assess project viability and identify opportunities for financial and project assistance.

3.3 BUILDING EFFICIENCY

Typically energy use in buildings accounts for 35 to 40 percent of total energy used. (DOE 2007) Because of this, buildings are the largest contributor of greenhouse gas emissions in the U.S. At any time the new buildings being constructed represent a small percentage of the total building inventory, but because each new building will be used for a long time thereafter it is of critical importance to design it to meet high levels of energy efficiency. Further, studies show energy efficiently designed buildings offer greater tenant comfort and can increase productivity and reduce absenteeism. Higher efficiency levels can, but don't always, cost more up front, but do pay back the investment over relatively short time horizons. In addition, building efficiency designs can reduce the need for and use of water by up to 40 to 50 percent.

In 1984 the Territory adopted Standard 90-80 "Energy Conservation in New Building Design" from the American Society of Heating, Refrigeration, and Air-conditioning Engineers. The U.S. Virgin Islands adopted the 2003 International Building and Residential Code in 2004. A number of Executive Orders have also been adopted, primarily focusing on energy efficiency in construction and operation of government buildings.

Energy codes developed by the VIEO in 2003 were not adopted. The VIEO has since developed a model tropical energy code that addresses the local climate conditions and applies to commercial buildings and housing units with greater than ten units. This code was developed in conjunction with the local building community and stakeholder input was gathered using a feedback website, review and comment response and incorporation for multiple drafts, and meetings on St. Thomas and St. Croix. Response to the proposed code has been mixed. Feedback noted the need for more education of the public on the benefits of buildings with better insulation, sealing, and more efficient HVAC and lighting; more training for building professionals on designing and building more efficient homes and buildings, and more incentives to create better buildings, such as low cost loans. The latest draft version of this code was released on January 6, 2009.

STRATEGY 9: Adopt and update the model Tropical Energy Code.

Current building code for the U.S. Virgin Islands is the 2003 International Building Code and 2003 International Energy Conservation Code. Additional resources for codes enforcement and training of codes officials would greatly contribute to codes compliance efforts. A 2003 analysis of code proposals estimated code improvement to be one of the most cost-effective actions available to ensure major long-term benefits and improve energy efficiency for the U.S. Islands. (DOI 2006)

STRATEGY 10: Assess the adequacy of current personnel resources for codes enforcement. Conduct training for codes enforcement officials and apply for Federal funding to offer this training for architects and builders as well.

Beyond minimum code level a number of high performance building qualification standards exist. The primary standard for efficient buildings and, more recently, homes, is the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®). LEED® offers varying levels of certification that incorporate energy efficiency and building performance along with a focus on water conservation, recycling of wastes, and reliance on environmentally friendly building products. LEED® standards have been adopted by many governmental organizations as a show of leadership in high performance, green building. The certification process does have a cost, though savings are recouped from energy savings and various worker productivity and reduced maintenance factors. The ENERGY STAR program managed by the EPA and DOE also has qualification standards for commercial buildings and new homes, in addition to efficiency standards for products like lighting and appliances. ENERGY STAR offers two kinds of qualification; one in which buildings and homes are built to a certain standard to achieve ENERGY STAR and one in which existing buildings and homes are tested and rated and achieve the qualification if they meet preset standards. Portfolio Manager is an EPA rating tool used to make a comparison of a building's energy efficiency compared to code levels. Portfolio manager can be a useful way to benchmark the energy use of a building and track its performance score relative to others buildings. Buildings must rank in the top 25 percent of facilities in terms of energy use for their building type to earn the ENERGY STAR.

STRATEGY 11: Investigate options for low-cost financing of energy efficient construction. Consider offering incentives whereby loan interest rates are "bought down" in exchange for meeting certain building qualification standards, such as LEED® or ENERGY STAR.

3.3.1 NON-RESIDENTIAL

The VIEO is the arm of the U.S. Virgin Islands government responsible for energy efficiency in the government as well as for promoting energy efficiency throughout the U.S. Virgin Islands. The VIEO conducts many outreach programs across all sectors including their popular Adopt-a-School program which promotes energy efficiency education and energy efficient schools. The VIEO offers joint audits with WAPA for commercial, government, and residential buildings.

The U.S. Virgin Islands government has an existing requirement to use least life cycle cost criteria for purchasing (Executive Order 231-1979), to assign a person responsible for tracking energy use and conservation in each government building, and to track energy usage by department for Territorial facilities. Carrying out these requirements takes planning, personnel training, and adequate personnel time. These practices need to be reintroduced and training and resources need to be provided in those locations or parts of the government where additional resources are needed to meet these requirements.

STRATEGY 12: Step up efforts to carry out the Executive Order requiring the purchase of lowest life cycle cost alternatives for all government procurement including vehicle fleets. Establish systems to verify that this requirement is carried out and provide training to help purchasing personnel meet the requirement if needed.

The 2005 EPAct set an energy efficiency goal for each state or Territory to reduce energy use by 25 percent within its state in comparison to 1990 levels. There is also a mandate for U.S. Virgin Islands government facilities to reduce total energy consumption by 20 percent by 2012. (VIEO 2008) A study of U.S. Virgin Islands government facilities in 2001 identified numerous opportunities for energy improvements by upgrading lighting and HVAC units with more efficient models. One major issue noted in the study was that a lack of personnel trained to provide proper maintenance coupled with the marine environment had led to damaged and inefficiently functioning HVAC equipment in a fair number of the buildings. (DOE 2001)

STRATEGY 13: Conduct one or more training classes on best practices for operations and maintenance of heating, ventilation, and air condition equipment for the personnel who operate and maintain the government building equipment.

A number of new initiatives are ongoing as part of the U.S. Virgin Islands Government Energy Demand Reduction program, including new energy and water conservation audit reports of all agencies and buildings and improvements to facility maintenance. The VIEO are specifying that security lighting be replaced with motion sensor lighting instead, and all incandescent lighting will be prohibited and replaced by more efficient lighting options. Plans are being made for Executive Orders requiring government purchase of ENERGY STAR appliances or equipment and installation of programmable thermostats in government buildings to save energy. Thermostats will prevent air conditioning from being set below 76 degrees Fahrenheit. Planned efforts also include the installation of additional cost-effective renewable energy technologies including solar outdoor lighting, solar water heating, and grid-connected photovoltaic panels. A formal tracking of energy usage and upgrades completed per building, and the energy usage and savings results over time, provides useful information for targeting worthwhile efforts in other building and helps show the payback from investments in building efficiency. Benchmarking government building performance using the ENERGY STAR Portfolio Manager tool is one way to track and assess building energy usage over time.

STRATEGY 14: Use a tracking tool, such as the ENERGY STAR Portfolio Manager or building audits with energy bill logs for each building, to track energy usage of all government buildings (2000 square foot or greater) that use energy. Audit and track the energy use of at least 20 percent of government buildings, on a square foot basis, each year.

STRATEGY 15: Use results from benchmarking and tracking government occupied and leased building energy usage to rank buildings and identify those that offer the greatest energy savings opportunities.

Making sure that newer government facilities are built to high levels of energy efficiency will help support green building and result in savings over their lifetime.

STRATEGY 16: Require all new government building construction over 2000 square feet to be built to the performance criteria to meet ENERGY STAR qualification or the U.S. Green Building Council's LEED® rating.

The DOE is assisting the VIEO with the development of an Energy Service Company (ESCO) energy services performance contract (ESPC) to fund more lighting and HVAC equipment upgrades. The ESCO contract will pay for upgrades, oversee their installation, guarantee their savings, and recoup the investment through reduced power bills. The VIEO is working to put together an ESCO project to fund industrial and commercial efficiency upgrades and also hold educational and training programs to assist industry in adopting energy efficient practices. For example, many commercial businesses are air conditioned but entrance doors are left open to attract customers; using air curtains or ceiling fans are a better option to save energy and still invite customers in.

STRATEGY 17: Promote energy efficiency by making it a criterion in assessing all projects that receive government funding.

Rate designs that increase energy cost per unit as energy use increases, and real time pricing that encourages customers to use energy at lower peak times are two options to help reduce and level out customer loads that should be examined for future application as these technologies mature.

3.3.2 RESIDENTIAL

More than ever, high energy bills have made it cost-effective to upgrade to efficient ENERGY STAR appliances and solar water heaters in the U.S. Virgin Islands. Many home air conditioning units in the U.S. Virgin Islands are window units and upgrades to more efficient units would be cost-effective. The VIEO has extensive programs offering homeowners rebates, training, information, and assistance and their website serves as a clearinghouse for energy and water saving information. Reducing energy use of products that draw power continuously or run most of the day, such as refrigerators, televisions, and phones, offer an opportunity for savings when replaced with more efficient models or, in the case of televisions or computers, are unplugged or turned off through a power cord when not in use. The VIEO already has existing programs in these areas and will continue to expand efforts and promote renewable energy and energy efficiency for the public, government, and business sectors.

WAPA was awarded a 2008 ENERGY STAR Partner of the Year award for Excellence in ENERGY STAR Promotion. Customers will save an estimated $8 million dollars over the life of the 60,000 efficient compact fluorescent light bulbs (CFLs) WAPA distributed as compared to the inefficient incandescent bulbs they replaced. WAPA also provides customer education materials, media campaigns, and has conducted in-store events to promote ENERGY STAR appliances and products as part of its energy conservation public education program. (Hodge 2008)

A typical home in the U.S. Virgin Islands still has cost-effective opportunities to upgrade to more efficient lighting, appliances, and a better building envelope through improved insulation, home sealing, and energy efficient windows. Low or no-interest loans offered through the power company can provide additional opportunities for implementing energy saving projects in homes. A number of finance companies (e.g. GeoSmart) specialize in financing of energy efficiency upgrades through a utility or their selected contractors. An energy efficient mortgage differs from a traditional bank mortgage by adding energy efficient upgrades into the house as it is purchased. These mortgages can be an effective cost-reducing and energy saving strategy, and can help people qualify for a home they otherwise could not because the bank knows their energy costs will be lowered in the process.

STRATEGY 18: Investigate opportunities for energy efficient home mortgages.

STRATEGY 19: Investigate and institute low-cost loans for homeowners to use for completing upgrades identified by WAPA and VIEO audits. Consider offering incentives whereby loan interest rates are "bought down" in exchange for completing a certain level of home energy efficiency improvements.

Another option for encouraging energy efficiency often used by utilities is a graduated multi-level residential rate schedule where energy use above a certain amount incurs a higher rate. Some utilities also employ a lower rate schedule for homeowners that implement recommendations from an energy efficiency audit or who purchase ENERGY STAR homes. Use of tools like real-time pricing and smart meters, where customers are aware of and pay actual electrical costs on an ongoing basis, encourage homeowners to reduce energy use at peak times and save money by simple actions like running the washing machine or dishwasher at nighttime, however, these kinds of metering and real-time pricing programs are expensive to implement and thus would be strategies to consider for the future.

New funding from the DOE Weatherization Assistance Program in 2009 will complement the limited funding received under the LIHEAP Program. The LIHEAP program administered by the VI Department of Human Services provides direct assistance in paying power bills for those of low-income needing assistance. Both LIHEAP and the Weatherization Assistance programs reduce electric bills for low-income families and individuals, but upgrades to improve energy efficiency completed under the Weatherization Assistance Program will continue to provide cost savings over time by providing permanent upgrades to the housing inventory and thereby reducing the need for additional financial assistance. The VIEO also has plans to expand installation of solar water heaters in low-income homes using available funds from the Weatherization Program.

The Territorial government has been active along with other territories and states in the Southeastern U.S. to change how the grants from the LIHEAP Program are calculated and applied. The current formula for the block grant funds and the Emergency Contingency Funds do not take into account the grid size, lack of grid interconnection, and fuel constraints that exist in the U.S. Virgin Islands, but rather focus on cold weather states and conditions of extreme high or low temperatures. The conditions in the U.S. Virgin Islands create higher energy prices and non-weather related emergency energy situations that differ from the energy issues normally addressed by this program. Efforts to change the formula and situations to which energy emergency funds are applied continue with the goal of bringing in a larger share of these available funds to help pay energy costs for the U.S. Virgin Island's low-income households.

STRATEGY 20: Continue efforts to access a higher share of LIHEAP Block Grant and Emergency Contingency funds. Develop a position paper identifying how such additional funds would be used in the Territory, their effects on the populace, existing poverty levels, and energy costs for low income households in the Territory.

3.4 WATER CONSERVATION

Due to the energy required to produce desalinated water as well as the cost of distribution and heating, water conservation saves energy as well. Water use in the U.S. Virgin Islands is less than half the level used elsewhere in the U.S. but costs more on average. WAPA's current multi-effect distillation water production units work in concert with the electric generation units. Recent studies estimated there would be a cost savings if WAPA switched to reverse osmosis water desalination units instead of their current multi-effect distillation water production units. (Beck 8/26/08) While the water production units help reduce the inefficiency of the large spinning reserve maintained by WAPA for reliability reasons, the need for water production should not be the key factor in determining the suitability of new sources of energy. While overall efficiency and cost savings are an ultimate goal, considering the two systems as one could tie the utility into investment in electricity and water generation options that are not the best possibilities for either production need in the long term. Leak detection programs are one opportunity to improve efficiency of the water distribution system. According to the Beck Fatal Flaw Analysis report commissioned by WAPA and completed in 2008, systems losses and leaks accounts for 22 percent of water distributed, which is equivalent to a cost of roughly $7.2 million per year. WAPA has noted that the system has higher than normal leaks due to system age. There are additional distribution losses due to the long distances from the location of water production, currently near the power generation units in order to receive steam, to the population centers. Water production units on each system cost an average of $5 million in maintenance per year, an expense that could be foregone with retirement of the existing units and installation of reverse osmosis units. Reverse osmosis units could also be moved closer to population centers since they would not have to be co-located with electric units to receive steam. This would also allow for more operating flexibility for the WAPA power generation units since their operation would not be constrained by the need to produce continuous steam for the water production units. In the Beck Power Supply Evaluation, capital investment to replace existing WAPA water production units with new reverse osmosis units was estimated at $46.7 million. If this change was completed, the net savings after capital costs and maintenance savings over the period from 2007 to 2027 would be $7.1 million. (Beck 2/25/08, Beck 8/26/08)

STRATEGY 21: Investigate options for a contractor-funded performance contract to reduce leaks and system losses in the water distribution system and reimburse system improvement costs from the resulting savings.

STRATEGY 22: Pursue funding options and Federal assistance to replace WAPA's existing water desalination units with higher efficiency units offering long-term life cycle cost savings.

STRATEGY 23: Re-examine the rate structure for water sales which currently offers lower rates for large water use customers. Options to consider include a tiered approach which charges higher rates as water usage increases, and reducing metering increments (less than 1000 gallons) to provide greater incentive for using water efficiently.

STRATEGY 24: Expand efforts to promote efficient use of water through consumer leak detection and recycling of condensate from HVAC, steam trap, and process systems.

3.5 ENERGY STORAGE

Energy storage systems, such as flywheels, battery systems, or pumped storage hydro, are an alternate way to provide the backup spinning reserve WAPA maintains in case one operating unit shuts down unexpectedly or must be taken out of service. Such systems either have system requirements that cannot be met the Territory due to geographical limitations, or are too expensive to be justified. However, energy storage may be an important option to consider in the future as technologies mature and equipment prices decline.

3.6 INTERCONNECTION

Interconnection offers an opportunity for savings that would be long-term and help reduce power outages over the entire system. At the Governor's request in early 2008 Oak Ridge National Lab (ORNL) conducted an assessment of the possibility of interconnection between St. Thomas and St. Croix by a 100 MW undersea cable. This study is attached at the end of this report. The study noted that all power cable systems presently in service are in waters less than 1,000 meters deep and the ocean bed between St. Thomas and St. Croix is 2,000 to 6,000 meters deep in the best possible interconnection route. The cost of such an interconnect was estimated by ORNL to be $160 to $225 million and would require two to three years to build. The depth of the interconnection route does presents technical challenges that would require careful planning to mitigate associated risks. (ORNL 2008)

WAPA received a proposal for building a 60 to 80MW interconnection between the two islands in their latest request for proposal (RFP) solicitation in 2007, but that proposal was not selected for further evaluation and negotiation. WAPA is currently considering a geothermal proposal received under this request that would supply electricity to the U.S. Virgin Islands via underwater cable. The preliminary estimate from the WAPA Power Supply Evaluation Report for a 150MW interconnect was $300-350 million, however, there was no savings analysis in this study for the interconnection alone; analysis in this report focused on installation of an interconnect in unison with building of CFB boilers burning petroleum coke and coal.(Beck 8/26/08) An interconnect alone was evaluated in the Beck Fatal Flaw Analysis released on 2/25/08 with the determination that such an interconnect between St. Thomas and St. Croix was not cost-effective without changes to the current generation systems dependent on petroleum fuels. This analysis calculated that present spinning reserves could be reduced from a current 20 percent down to 10 percent, yielding a cost savings in the range of $3.8 to 6.9 million annually. (Beck 2/25/08) The ORNL study done in March 2008 assessed spinning reserves to be much higher, in the range of 60 to 85 percent. In that case, annual savings would double, with additional cost savings related to fewer operating hours and reduced maintenance costs.

An interconnect of this depth has not been done, however, similar projects are in the planning stages in other parts of the world and new materials are being developed that will help make such a cable more viable. (ORNL 2008)

Interconnects to other islands, including the British Virgin Islands, Puerto Rico, and Nevis have also been proposed to expand the WAPA grid, but would face the same barriers and issues as the proposed interconnect between St. Thomas and St. Croix.

3.7 ENERGY SOURCES

WAPA, the Public Service Commission, and the U.S. Virgin Islands government are well aware of the need to move away from petroleum as a primary electricity generation source and that transitioning to a different imported fuel source could duplicate current problems in the future. A diversified energy portfolio is vital to reduce costs, improve energy security, and provide system flexibility to adapt to market conditions.

The U.S. Virgin Islands is abundant in resources but not in the most commonly used fuel resources. Using indigenous resources is not always cheapest but does offer additional energy security and limits price volatility for that resource. Use of local resources also keeps funds spent on energy purchases in the U.S. Virgin Islands where additional jobs can be created. Developing the range of fuel resources the U.S. Virgin Islands does have, if only as a fraction of the energy mix, makes sense and helps build infrastructure for a future where energy prices are expected to continue rising.

There is a hint of truth to the statement that any technology once installed is already obsolete. Planning for future energy needs requires time, capital, evaluation, and some risk. Future fuel costs can be projected but there are uncertainties that can be volatile as recent experience with petroleum fuel has clearly shown. Reliance on somewhat standard technology and a fuel supply with little diversity has translated into high electricity bills in the U.S. Virgin Islands today. A new energy portfolio will balance costs with the need for fuel diversity and a transition to innovative sources of energy.

A number of fuels and technologies are noted below for further evaluation. A few technologies, such as hydroelectric and nuclear power, can be dismissed outright as being unsuitable due to geographic limitations.

3.7.1 FOSSIL FUELS

World energy needs are expected to increase by 55 percent by 2030 compared to energy use in 2005 and 84 percent of that increased demand is expected to be supplied by fossil fuels. Oil counts for about 35 percent of the world's energy use today while coal supplies 25 percent. Oil will continue to dominate the energy markets, especially for transportation, though its price is predicted to continue rising with some volatility expected for weather, seasonal usage patterns. The costs for other fossil fuels are predicted to continue to be lower than but linked with escalating petroleum prices as demand levels rise. (IEA 2007)

Fossil fuels reliably provide most of the world's current energy needs and will continue to be the key energy producers in the years to come. However, new technologies are not increasing market share substantially due to the expense as well as utility aversion to technological, financial, and economic risk. (EPRI 2008) Consequently, competition for fossil fuels is expected to drive prices even higher as evidenced by rates of price increases over the past five years: diesel oil at 228 percent, natural gas at 69 percent, coal at 157 percent, and petroleum coke at 228 percent. (JEA 2008) Plans for future generation will need to take environmental costs into account in balance with capital and other operating costs as a long-term energy strategy is developed for the U.S. Virgin Islands. While all fossil fuels release greenhouse gases that contribute to global warming, newer technologies and modern air emissions cleanup systems can be employed. When clean technologies are used, fossil fuels can be utilized to meet the goals of promoting clean energy while increasing fuel diversity, however, costs to utilize the latest clean technologies may result in higher energy costs.

3.7.1.1 DIESEL

Diesel generators have been examined as alternatives for WAPA's existing generating units that burn fuel oil and some diesel. They are widely used in the Caribbean and for isolated islands, offering higher efficiency than WAPA's current generating units. WAPA commissioned studies noted that installing diesel generators would be considered cost-effective, but would be a challenge to permit due to air emissions. On balance moving to diesel generators would not increase fuel diversity or provide relief for future escalating fuel prices, and so would not meet these U.S. Virgin Islands' goals. (DOI 2006, Beck 2008) WAPA is still evaluating a full range of options including more efficient diesel combustion turbines for when older units are replaced or if new generating capacity is added. (Hodge 2008)

3.7.1.2 PETROLEUM COKE

A number of cleaner coal technologies have increased possible plant efficiency levels from a typical 35 percent up to 45 percent or more with reduced environmental emissions. Petroleum coke, a coal-like but denser, higher sulfur emitting, and cheaper fuel produced as a waste by-product from petroleum coker units is an available fuel source with practical applications depending on future fuel costs and environmental consequences.

HOVENSA produces and sells petroleum coke from their operations on St. Croix and have expressed interest in supplying petroleum coke for WAPA generation. WAPA has investigated both firing of petroleum coke in a circulating fluidized bed boiler in an equal mix with coal to reduce emissions, and making methanol from pet coke to burn in the existing WAPA generators with some modification. The methanol production would require additional equipment and safety precautions due to the fuel's low flash point and the WAPA units would require modification to handle the different fuel. Resulting emission levels would also be lower. In the 2008 Beck Power Supply Evaluation commission by WAPA, two 20MW circulating fluidized bed (CFB) generation units burning a nearly even combination of petroleum coke from HOVENSA and coal from Columbia were evaluated for addition to the WAPA generation system. The cost of the two systems was estimated at $402 million. Installation of this option was listed as one of the top cost-effective measures investigated, however, this option only provided a positive savings when coupled with a larger generation system on one of the two main islands with an interconnection between St. Thomas and St. Croix such that the main plant supplies much of the energy needs of both island systems. Without this interconnection, the CFB option evaluated was actually projected to result in an added cost of $91 million from 2007 to 2027 above that of the existing WAPA generation system. With the interconnection as described, the CFB option capital cost was estimated at $574 million and savings over the period of 2007 to 2027 after capital investment would be $96 million. (Beck 8/26/08) As noted earlier, interconnections at the depths between St. Thomas and St. Croix have not been demonstrated but similar projects are in the planning stages and technologies to support such interconnections are developing.

CFB technology is a cleaner coal technology that offers the advantage of lower NO_x emissions and being more fuel flexible than most boilers, but also produces a high volume of byproduct ash solid waste. Typically this ash and limestone waste can be sold for other uses such as making of roadways or producing concrete; however, shipping costs could make the waste unmarketable. If sufficient uses could not be found for the waste within the Territory, additional expense would be incurred to dispose of it. Siting of the type of unit analyzed in the report would require 25 to 35 acres and substantial water resources. Coal burning with the petroleum coke improves air emission levels by offsetting some of the high petroleum coke sulfur emissions without requiring additional limestone in the circulating bed to capture the sulfur. Current air emission requirements and ambient air quality levels make siting of a coal or combined coal and petroleum coke plant difficult and would likely require additional and costly flue gas cleanup equipment to reduce emissions to very low levels.

Building CFB plants would increase the level of fuel flexibility for the generation system since such units could burn coal or a combination of coal and petroleum coke and should reduce costs if petroleum levels continue to climb, at least in the next decade. However, the addition of such units alone does not greatly add to the level of fuel diversity used by the U.S. Virgin Islands since all fuel sources are still fossil fuels. (Beck 8/26/08)

3.7.1.3 COAL

The Beck Power Supply Evaluation of 2008 did not include an analysis on coal alone, but rather in combination with petroleum coke as described in the previous section. Coal was proposed to be burned with petroleum coke in order to reduce air emissions to allowable levels without the additions of large volumes of limestone to decrease sulfur emissions.

While becoming increasingly more variable, coal has not had the kind of price spikes experienced by petroleum-derived fuel oils. Clean coal is defined by the DOE as a new generation of energy processes that sharply reduce air emissions and other pollutants from coal-burning power plans. Clean coal technology includes a range of high efficiency fuel cleanup, advanced fuel combustion and gasification, and flue gas cleanup technologies including those that meet performance criteria of subtitle Title IV, Subtitle A, of the Energy Policy Act of 2005. Examples of clean coal projects include next generation integrated gasification combine cycle power plants, pressurized fluidized bed combustion, combustion systems with carbon capture, and advanced emission control systems for removal of sulfur dioxide, oxides of nitrogen, and hazardous air pollutants. (DOE 2/2009)

One of the proposals being evaluated by WAPA under its 2007 RFP is a 60 to 65MW pulverized coal burning unit on St. Croix that could be operational by 2011. (WAPA 5/1/2008) Traditional pulverized coal burning generation would not be considered a “Clean Coal” technology without design changes or the addition of advanced flue gas cleanup equipment.

3.7.1.4 LIQUID NATURAL GAS AND METHANOL

Modifying existing generation equipment to burn liquid natural gas (LNG) was one of the scenarios investigated in the 2008 Beck Power Supply Evaluation. Capital costs for using LNG were estimated to be substantially less than for methanol production. Electricity production from methanol has been tested but there are no such generation units operating; the Beck Evaluation noted added technical and financial risks associated with producing electricity from methanol derived from gasification of petroleum coke since it is not a proven application. (Beck 8/26/08) Modifying existing capacity and fuel handling equipment to fuel generation units with either produced methanol or purchased LNG is estimated to lower fuel costs compared to existing generation, but would not improve fuel flexibility or fuel diversity since this would be essentially a switch from one fossil fuel to another, albeit cheaper, fossil fuel. Under the scenario evaluated by the Power Supply Evaluation LNG would be delivered from the Ecoelectrica LNG facility in

Puerto Rico. Environmental and siting concerns would be similar to those noted for coal and petroleum coke installation, with the prime barrier being air permitting. Estimated capital costs ranged from $134 million to $158 million, with an estimated savings of $12 million per year, depending on the cost differential between fuel oil and CNG. (Beck 2/25/08)

WAPA noted at its annual board meeting in July 2008 that discussion with the Puerto Rico Electric Power Authority for procuring electricity made from LNG via a submarine cable between Culebra and St. Thomas were ongoing. WAPA indicated expectation of a substantial reduction in electric prices should that project proceed. (WAPA 8/26/2008)

3.7.2 RENEWABLES

Despite widespread interest in renewable energy, solar, wind, and geothermal generation combined still contribute less than one percent to world energy production. Photovoltaic energy supplies less than a tenth of a percentage of electricity used in the U.S. and between three and four times that much in Germany which leads the solar market. Worldwide biomass accounts for 10 percent of energy production, including 15 percent of transportation fuels, making it the most-used renewable energy source. (Allianz 2008)

A renewable portfolio standard (RPS), which designates a specific percentage or amount of renewable energy that must be included in energy sold, has been enacted in 21 states in the US and is recommended but voluntary in four additional states. The area covered by these RPSs represents a physical area covering 40 percent of the U.S. electric grid. The RPS requirements in different states specify a minimum fraction of renewables in the energy generation mix from 2 percent to 30 percent. Some RPSs also require specific amounts of that generation to be of one technology type, such as wind or solar. States enact renewable portfolio standards to stimulate development of renewable energy sources in their state, to build infrastructure for expansion of renewable energy projects in their states in the future to reap long-term benefits, and to encourage utilities to move beyond standard offerings that depend solely on fossil fuels, among other reasons.

Utilities have noted that enacting a RPS can have a downside if electric utilities are not included in decision-making, if reliability is not considered as a critical component during goal setting, if too much generation without adequate load balance is added too quickly, and if target dates for adding generation do not allow enough lead time for unit and transmission line approvals and construction. Enacting a RPS without adequate planning can lead to failed goals, reduced system reliability, load balance problems, damaged equipment, and additional costs for battery or backup units. (Carnegie Mellon 2008)

The VIEO has a long history of promoting renewable energy, installing demonstration projects, and assisting with and providing funding for cost-effective renewable energy projects. Many people in the U.S. Virgin Islands have solar water heaters and there are several functioning photovoltaic systems installed. These installations represent a fraction of the energy used in the U.S. Virgin Islands but have saved energy and been very important resources for building renewable infrastructure in the Territory.

The approval of a net metering pilot in February 2008 by the Public Service Commission and WAPA was a big step in encouraging renewable energy in the U.S. Virgin Islands. Net metering allows photovoltaic, wind, and other types of renewable energy systems installed and operated by homeowners or commercial customers to resell excess energy back to WAPA at the customer rate. This is especially useful for technologies such as wind and photovoltaics that produce energy intermittently. The pilot program will accept up to 10MW on the St. Thomas system and up to 5MW on St. Croix of renewable capacity. The VIEO, who worked with WAPA to develop the net metering program, will also monitor these projects to collect additional operational and grid connection data, and provide technical and financial assistance for proposed wind projects in the pilot. Five projects have been initiated to date. Expanding the limits to allow larger systems from the maximum system size of 10kW up to higher levels would greatly increase the viability of such projects based on economies of scale. The U.S. Virgin Islands already has legislation in place ensuring continued access to solar and wind resources for owners of solar or wind energy systems in the Territory. Passed in 1984, this forward-thinking legislation further prohibited deed restrictions or conditions that could limit the installation of wind or solar energy systems.

STRATEGY 25: Expand the existing net metering program to include renewable energy systems up to 500kW in size for public facilities, up to 100kW for commercial facilities, and up to 20kW for residences.

All energy generation system are at risk to hurricane damage, but those that use renewable energy can represent a somewhat heightened risk since they are generally more capital-intensive while non-renewable system costs include both capital and fuel.

Establishing standards for improving energy efficiency or increasing renewable energy generation allows the government and the people as a whole to make a choice to move in a different direction for future benefit, even if it means accepting some risk, some cost, and some possible loss of reliability as that new direction is set. Setting such goals asserts that taking no risk - making no investment - is the greater risk to the future.

STRATEGY 26: Adopt the following renewable portfolio targets:

Targets	By 2015	By 2030
Minimum Percent of Electricity from Renewable Sources	20	25

Setting achievable and tightening goals will build infrastructure and allow assessment of the changes and programs required to meet those goals. Based on the current energy climate and needs, these would constitute aggressive but achievable goals.

3.7.2.1 BIOENERGY AND BIOFUELS

Three types of bioenergy are potential opportunities for the U.S. Virgin Islands: using municipal solid waste to produce electricity; creating biodiesel from crops or waste oils to use for electricity or transportation; and extracting landfill gas to either produce electricity or create transportation fuel. Environmentalists are not always quick to embrace waste-to-energy or landfill gas projects as “green” energy sources, but a study by the EPA found that the net greenhouse gas emissions from combustion of mixed municipal solid waste are lower than those that result from leaving the mixed solid waste in a standard landfill. (EPA 2002) Energy generated by a waste-to-energy project also further reduces greenhouse gas emissions by offsetting emissions that would have been produced by creating the same energy using fossil fuels. Furthermore, combustion of the solid waste reduces the volume to be disposed of in a landfill by 95 percent. The Sussanberg landfill on St. John has been closed for a number of years and all waste from the island is barged to the Bovoni landfill on St. Thomas for disposal. The Bovoni landfill is itself now slated for closure. St. Croix’s solid waste is disposed of in its Anguilla landfill. The landfills have had some environmental problems including fires, requirements to either flare or collect landfill gas, and nuisance from birds. Minimizing the landfilling of solid waste in the U.S. Virgin Islands would be a major benefit to implementing waste-to-energy power plants. (IAEA 2006)

Estimates for the available energy in the U.S. Virgin Islands from the burning of municipal solid waste are in the range of 6-8MW or higher. (Gershman 1994) Two of four waste-to-energy proposals submitted in response to WAPA’s 2007 Request for Proposals are being further evaluated for possible 20 year power purchase agreements. Each proposal expects to produce in the range of 10 to 13.5MW each on St. Thomas and St. Croix. Limited amounts of waste are likely being supplemented by estimates for importing additional waste for these proposals. One of the projects has proposed operations beginning by 2009 and the other proposed operations beginning by 2011. (WAPA 5/1/08) Meeting air permitting limits could represent a technical or cost issue for a waste-to-energy project. In the 2008 Beck Fatal Flaw Analysis done for WAPA initial evaluation of using municipal solid waste for power generation was considered. Under their evaluation scenario municipal waste from the U.S. Virgin Islands was estimated to be sufficient to fuel a 10MW steam turbine generator via stoker or CFB combustion of the waste, and the area near the Bovoni landfill on St. Thomas was noted as being well suited as a location for such a plant. Expected cost was estimated at $105 million with annual operating and maintenance costs of $8.7 million, however, even considering that no fuel would have to be purchased, costs per MWh were estimated in this study to be higher for this option than other options such as a CFB burning petroleum coke and coal.

In the U.S. Virgin Islands available land for growing bioenergy crops is limited. Previous studies have been conducted on growing saltwater algae on land or in shoreline ponds. Algae are a very productive bioenergy crop on a per acre basis. The other source for biodiesel is waste oil from restaurants, industry, and wastewater treatment. Either algae or waste oil could be processed into biodiesel and then used to produce electricity,

waste heat, or transportation fuel. Beneficial use of waste greases and cooking oils would also reduce the costs for their management and disposal. Biofuels for transportation can include biodiesel and ethanol which now account for almost 15 percent of the transportation fuel used worldwide. Biodiesel from waste oils and biogas from landfills could be used to create transportation fuel thereby providing some locally produced source of transportation fuel. Research efforts for developing both fuel sources are ongoing with the VIEO and the Southern States Energy Board. Estimates for amounts of waste cooking oils and trap grease available were taken from a study of 30 U.S. cities and extrapolated based on the U.S. Virgin Islands number of restaurants and water treatment facilities. An estimated 216,000 gallons of biodiesel could be produced from recovered waste cooking oils and trap grease from restaurants and water treatment plants annually based on these calculations. (Wiltsee 1998) This biodiesel would provide a small but useful and symbolic measure of transportation fuel independence.
Various studies over the years predict an estimated 4 to 7MW combined could be generated from landfill gas extracted from the Anguilla landfill on St. Croix and the Bovoni landfill on St. Thomas. In 2007 the U.S. Virgin Islands Waste Management Authority and the VIEO completed a study on the feasibility of biogas recapture and energy production from the Bovoni landfill. Planning on the Bovoni landfill gas project continues and designs have been submitted for environmental review. The Maguire Group conducted a study in 1999 that estimated that the St. Thomas Bovoni landfill was currently producing 460 million cubic feet per year of landfill gas and the St. Croix Anguilla landfill was producing 520 million cubic feet per year of landfill gas. Using these numbers, the Maguire Group estimated that the St. Croix landfill could generate 1,200 kW over 15 years and the St. Thomas landfill could generate 2,000 kW over 15 years. (Kelly 1999)

Since the 1999 study was completed additional solid waste has been placed into these landfills. The St. Croix Anguilla landfill has had several fires over the years making it difficult to know if landfill gas could be extracted and, if so, the potential amount available. A new study is currently being conducted in conjunction with the Southern States Energy Board on the landfill gas potential of the Bovoni landfill. The preliminary results of this study indicate that the Bovoni landfill could generate usable quantities of landfill gas for the next 16 years and that the amount of landfill gas available could vary from 525 million to 788 million cubic feet per year, depending on the type of landfill gas collection system installed. Using an average value of 657 million cubic feet per year the landfill gas from Bovoni could generate roughly 5,200 kW of electricity per year over 16 years. (WMA 2007, 2008)

In addition to ongoing work in biodiesel fuels and landfill and treatment plant gas, the Southern States Energy Board and the VIEO have been working with a number of public and private groups, including the U.S. Virgin Islands Waste Management Authority and the University of the Virgin Islands, to explore more opportunities to create energy from within the U.S. Virgin Islands including research projects on energy from process waste materials and guinea grass.

3.7.2.2 OCEAN ENERGY

Current technology under development includes the production of electricity from the ocean using either kinetic energy or thermal energy. Kinetic energy from the ocean involves capturing energy from water motion and is generally considered in two distinct categories as tidal energy or wave energy. Energy generated from the ocean based on temperature is termed ocean thermal energy conversion (OTEC).

Wave and tidal energy production technology is becoming more commercially proven but is still not in wide commercial use. The possible energy resource is large worldwide but barriers include high construction costs, a limit to the number of viable locations that can produce the amounts of electricity needed to make the projects cost-effective, possible detrimental impacts to sealife, and a propensity for ideal generation locations to be far away from the cities and industrial centers where the energy would be used. (EPRI 2009, DOE 3/2009) Wave and tidal energy systems have been tested at numerous locations and at various sizes. Operational wave energy systems include the 2.25MW Agucadora Wave Park in Portugal (planned to be expanded to 21MW in a second phase), a number of smaller scale demonstrations in Hawaii in the range from 20-40kw, and future plans for larger energy generation wave buoys in England, Scotland, and Australia in the range from 3 to 20MW. The U.S. Department of Energy notes the best sites for generating electricity from waves are the coasts of Scotland, Australia, parts of Canada and Africa, and the northern parts of the continental U.S. coasts. For tidal power, the U.S. Department of Energy estimates fewer than fifty sites exist in the world that experience the tidal differential (at least 16 feet difference between low and high tides) necessary for this type of energy to be productively harnessed. The northern parts of the continental U.S. coast are among the sites with tidal energy generation potential. (DOE 3/2009) Currently operational systems include the pioneering 240MW La Rance plant on the coast in northern France which has operated since 1966, the 18MW Annapolis Royal Generating Station operating in Nova Scotia, Canada, since 1984, and smaller 1 MW systems operating in the Ireland and the Soviet Union. A 254MW system is slated to begin operation in South Korea in 2009. (OREC 2009, Kaya 2007, Robinson 2006, Allianz 2009) The large tidal differential needed is generally located at distances far from the equator, making viable sites in the U.S. Virgin Islands unlikely. (Viscarolasaga 2008) No known assessment for wave or tidal energy potential or installation costs has been completed for the U.S. Virgin Islands.

OTEC generates electricity from the differential between ocean surface and deep ocean temperatures using a heat engine. In the open-cycle configuration potable water is a by-product of OTEC electricity production while cold water discharged from the process can be used for refrigeration, air conditioning, or for culturing crops such as kelp or shrimp. OTEC can be sited on land near the shore, on offshore platforms on an underwater shelf, or free-floating in deep ocean water. The OTEC technology has been proven but sizeable commercial applications have not had been constructed to date. Consequently, operations data for a large-scale unit does not yet exist. The mooring for an offshore OTEC plant is considered to be a typical application of an offshore gas or oil drilling platform and does not represent a new technical challenge, though the frequency of hurricanes in the U.S. Virgin Islands should be considered both for design and reliability considerations and in analysis of costs. The fabrication and installation of large diameter cold water piping is a remaining technical challenge that the U.S. Department of Energy is currently exploring via a grant with Lockheed Martin. (NREL 2009, Rubens 2008) A number of small-scale OTEC units are operational and a 1MW OTEC unit, to be completed for a cost of $10-15 million, is being built in Hawaii and is slated to be operational by 2009. (WEC 2007, Thompson 2006) The state of Hawaii and the Taiwan Industrial Technology Research Institute announced in December of 2008 a joint collaboration to develop another 10MW OTEC unit in Hawaii. U.S. Navy Support Facility Diego Garcia in the Indian Ocean is also testing an OTEC generation system producing electricity as well as drinking water and sea water air conditioning, but no further details are available about the project or its size. (Kauffman 2008)

The U.S. Virgin Islands would appear to be the ideal candidate for OTEC generation because of its warm climate and the depth of its surrounding ocean bed, though the fact that OTEC technology has not been commercially proven increases the risk of technical failure, schedule delays, or cost increases. However, these risks could be mitigated by the technology vendor by providing their own financing or providing performance bonds. One of the two OTEC proposals WAPA received in response to their 2007 request for proposals is under consideration for implementation of a 20 year power purchase agreement. The proposal would create a 10MW OTEC unit for St. Croix followed by a 10MW OTEC unit for St. Thomas and be operational by 2012. The OTEC process also offers potential for production of desalinated water in conjunction with open- or hybrid-cycle plants. A match between the location of an OTEC facility and its intended users of produced cooling, water, and energy would increase paybacks for such an installation. Capital costs for system installations are high but little cost data on construction or savings is available. Unlike some other renewable energy sources, OTEC production is available continuously, making dispatching and connection to a grid system much easier. Experts in OTEC research from Lockheed Martin have identified the north and west coasts of St. Croix from Salt River around to Butler Bay as having prime OTEC resources within one mile of the shore as evidenced by a 21 to 24 degree Celsius temperature differential between the surface and 1,000 meters below surface. (Haines 2009)

In the Beck analysis completed for WAPA in 2008, the location in the vicinity of Rust Up Twist on St. Croix was identified as a candidate location for siting an OTEC facility, but OTEC was dismissed from further analysis or consideration in the study because OTEC has not been commercially proven above the one MW size. (Beck 2/25/08)

3.7.2.3 GEOTHERMAL

Geothermal is a renewable energy source that uses heat from inside the earth's crust to produce electricity. Several Caribbean locations such as Dominica, St. Lucia, and Montserrat have been identified as having geothermal potential and a 15MW geothermal energy unit is producing electricity on Guadeloupe. Preliminary investigations in the 1990s did not yield results sufficient to warrant further examination of geothermal for energy production on lands within the U.S. Virgin Islands. (IAEA 2006) West Indies Power currently has geothermal projects under development on the islands of Nevis, Saba, St. Lucia, Dominica, and St. Vincent and intends to develop an interconnection between various Caribbean islands for export of electricity. They estimate being able to supply 100MW of electricity to St. Thomas and St. Croix at a cost of 11 to 12 cents per kwh to the U.S. Virgin Islands via ocean submarine cable by 2011. (West Indies 2005) ORNL estimated a cost for the supply interconnects of $435 million with an annual savings of $120 million as compared to current WAPA operating costs, but still notes challenges associated with the underwater electrical interconnects. The ORNL analysis is included in this report as an attachment.

One proposal to use geothermal energy for electricity is currently being considered by WAPA under its 2007 request for proposals. If that project were to be built it would produce 130MW and begin operation in 2010. The issues of risks, costs, and benefits associated with an interconnection between St. Thomas and St. Croix would also apply to geothermal as all electricity from these sources would have to reach the U.S. Virgin Islands via underwater cable.

3.7.2.4 SOLAR ENERGY

Solar energy includes passive uses, such as building to take advantage of heat from sunlight, solar thermal including solar water heating, and photovoltaics to create electricity. Most home solar water heating systems have a favorable payback overall, especially when available rebates are factored in. One option to further encourage installation of solar hot water systems for homes and businesses in the U.S. Virgin Islands would be offering system installation through the utility. In this case the system could be installed with minimal or no up-front cost for the customer with financing included in monthly customer bills.

STRATEGY 27: Develop options for utility or government administered turn-key solar water heating installations for business and residential customers.

The VIEO has also targeted funding from the Weatherization Assistance Program and the federal energy efficiency block grant to be spent on installing more solar hot water systems in low- and mid-income homes.

Photovoltaic systems can either be built to a utility scale or built to run one or more buildings with either grid interconnection or battery backup systems. Installing photovoltaics on roofs, such as large government or airport terminal roofs, is a good option if sunlight is not shaded. The energy produced by photovoltaic systems is variable depending on the available sun resource, shading, and weather; this makes it more difficult to include solar in a small power grid. Photovoltaics are still expensive at $5,000-7,000 per kW. A utility scale photovoltaic system takes up a sizeable area. Solar thermal collectors used to heat water to steam and produce electricity require extensive areas, in the range of nine acres for each MW, and would be difficult, if not impossible, to site in the U.S. Virgin Islands.

The VIEO has assisted with numerous solar and photovoltaic installations on the islands and work with a wide array of partners including the U.S. Department of Energy, the Florida Solar Energy Center, schools, industry, and private solar equipment suppliers to promote solar energy. A solar energy system installed at the emergency management center on St. Croix in a joint project between the VIEO and the Florida Solar Energy Center keeps the center powered during storms even if the electric grid goes down. The VIEO also offers substantial rebates for solar water heaters and photovoltaic systems.

WAPA is still considering a 7.2 MW photovoltaic project proposed under its 2007 RFP as one of its choices for future generation. (WAPA 1/14/09) Photovoltaic generation was considered as an alternative or future energy source at the 10 MW size under the Fatal Flaw Analysis study commissioned by WAPA and released in 2008. This analysis estimated sixty acres would be required to site a 10 MW array of photovoltaic cells and noted that, while potential sites were available on St. Croix, potential sites were limited on St. Thomas. Estimated costs from the study were $8500 per kilowatt installed and were noted as one of the more expensive alternatives.

3.7.2.5 WIND ENERGY

Wind energy has seen wide deployment and installation costs have dropped by 90 percent over the last two decades. Wind power installation costs on land are around $1,600 per kW and about one and a half to two times as much when built offshore. Costs are now down to 5 to 9 cents/kWh for typical on-land installations. Energy production from wind turbines, as with photovoltaics, is dependent on weather, and that inconsistent supply can make it more difficult to add wind energy into a small power grid. Progress continues on new technologies for wind turbines and grid interconnects that are demonstrating that wind systems can be more dispatchable and their output more predictable than earlier models. One of the challenges related to including wind power in a generation mix is that wind's high variability can have a negative effect on voltage and power quality. Variability associated with wind generated energy can require higher spinning reserves, the same spinning reserves that currently drive up energy costs in the U.S. Virgin Islands. Forecasting of wind speeds and system connection modeling assessments can help address problems caused by the variability of wind power generation.

Wind surveys from the National Renewable Energy Laboratory and VIEO wind resource assessments indicate the U.S. Virgin Islands have moderate to good wind power resources (class 3 and 4) at varying locations with the best sites on high ridge crests and exposed capes free of trees and building obstructions. The rugged terrain could make installation more difficult and more costly. Wind turbines are now designed to withstand hurricane force winds with minimal damage, however, since the U.S. Virgin Islands are prone to frequent hurricanes, system reliability and possible damage costs should be considered in the system design and costs analysis. Other environmental considerations are siting wind systems away from the paths of migratory birds or in locations near airports where they could offer possible radar interference effects. Locations where the VIEO has had wind data collected and the wind resource measured are: Bee Hill on the east end of St.

Croix, Crown Mountain on the existing Innovative Communications Tower, and on Bordeaux Mountain on the Ackley Tower on St. John. (VIEO 2006)

WAPA has investigated installation of wind generation previously. In 2006 WAPA negotiations to supplement their generation with a 19.8 MW wind farm on St. Croix fell through due to contract issues related to hurricane damage liability. Wind turbine generation was also evaluated in the two Beck energy alternatives studies completed for WAPA in 2008. Wind data for the analysis was taken from a 2006 report commissioned by the VIEO from Energy Answer Corporation entitled "A Detailed Wind Energy Case Study for Point Udall on St. Croix, Crown Mountain on St. Thomas and Estate Concordia on St. John." The data was not deemed complete enough for detailed projections for locating wind turbines on St. Thomas, but projections were completed to evaluate a 10 MW wind turbine installation on St. Croix. WAPA reports estimated a cost of $30 million each to install two 10MW multiple turbine systems on St. Thomas and St. Croix and suggested further investigation was needed. (Energy Answers Corp 2006, Beck 2/25/08, Beck 8/26/08)

Due to the irregular load expected from wind turbines, WAPA would expect to use wind turbines as supplemental energy for no more than 20 percent of their total installed capacity and maintain their spinning reserve for grid reliability. As part of their latest request for proposals, WAPA investigated a proposal for a 20 year agreement to purchase power from a 7.2 MW installation of photovoltaics and wind power to be installed on St. Croix. In January 2009 WAPA announced that the wind aspect of this project had been withdrawn due to the offerer's inability to obtain financing.

The VIEO will continue to offers rebates for a percentage of wind turbine system costs, and provides training classes and monitoring for wind system installations. The VIEO and the VI Department of Planning and Natural Resources have been instrumental in development of information, resources, and protocols for installing wind systems in the U.S. Virgin Islands. In January 2008 the VIEO sponsored a St. Thomas Wind Workshop that drew over 250 participants. Co-sponsors for the workshop included the U.S. Department of Energy's Wind Powering America Program, Sandia National Laboratory, and the National Energy Technology Laboratory. A wind working group has been formed as a result of the workshop.

3.8 TRANSPORTATION

Transportation improvements can be brought about in several ways: using more efficient fuel, increasing vehicle fuel efficiency, decreasing average travel distances through density planning, or creating more effective mass transit and encouraging alternative transportation options including biking and walking. Biofuels for transportation can include biodiesel and ethanol which now account for almost 15 percent of the transportation fuel used worldwide. Opportunities for producing biodiesel from waste oils and biogas from landfills were mentioned in the bioenergy subsection. In both cases wastes could be used to create transportation fuel. Research efforts for developing both fuel sources are ongoing with the VIEO and the Southern States Energy Board. An estimated 216,000 gallons of biodiesel could be produced from recovered waste cooking oils and trap grease from restaurants and water treatment plants annually. Landfill biogas is undergoing further evaluation to be used for producing electricity or thermal energy, but could also be cleaned and compressed for use as a transportation fuel.

A mixture of ethanol and gasoline, commonly as a mix of 85 percent ethanol with 15 percent regular gasoline called E85, can be used to fuel ethanol flexible fuel vehicles. The VIEO is evaluating ethanol mixtures as alternative fuels in the U.S. Virgin Islands and for government vehicles. Gasoline mixed with up to ten percent ethanol reduces cost and can be used in regular gasoline powered vehicles.

St. Croix has a currently operating ethanol dehydration plant that could conceivably serve as the ethanol source. At this point the volume of ethanol available from this plant, in the range of 110 million gallons/year, exceeds the annual 2007 U.S. Virgin Islands gasoline usage of 44.4 millions gallons. Additional ethanol penetration would require infrastructure development and improvements to distribution and delivery systems; however, if a simplified blending process could be utilized, widespread use of E85 and purchase of additional vehicles that can use E85 would increase fuel diversity and could significantly decrease transportation fuel costs. The ethanol dehydration facility is not subject to the 50 cent/gallon tariff against ethanol. Since the latter part of 2007 ethanol prices have ranged from 5 to 50 cents less per gallon than gasoline. When produced on a mass assembly-line basis, costs to convert a car to flex-fuel running on gasoline or an ethanol blend costs less than $200 extra per car. (Dineen 2008)

STRATEGY 28: Develop economic incentives, such as rebates or gross receipt and excise tax breaks, to promote alternative fuels and alternatively fueled vehicles like ethanol fuel blends and electric cars.

Hybrid electric vehicles increase automobile efficiency by storing energy normally wasted in a gasoline powered automobile and using that energy to supplement fuel usage. The U.S. Virgin Islands government has made a commitment to purchase hybrid electric vehicles for future fleet requirements for relevant vehicle classes. When hybrid electric vehicles are not an option, diesel vehicles will be purchased, as they get 30 to 35 percent greater mileage per gallon of fuel than gasoline fueled vehicles. Newer diesel technologies also provide smoother and cleaner operation than older diesels. The U.S. Virgin Islands government is also expanding its policies and procedures to ensure its fleet of vehicles is well-maintained for maximum efficiency and that job-appropriate types of vehicles are assigned from the fleet.

STRATEGY 29: Require all new governmental and WAPA vehicles purchases be hybrid electric vehicles for relevant vehicle classes. Purchases of vehicle types for which hybrid electric vehicles are not available should be high efficiency diesel powered models.

Increasing vehicle efficiency with newer efficient vehicles will take several years to affect the average fuel efficiency of the public vehicle fleet in use on the U.S. Virgin Islands. Incentives to increase the purchase of hybrid electric vehicles and retire less efficient vehicles are recommended for the future. In addition, taxes or disincentives on new fuel inefficient vehicles and imports of any such vehicles, new or used, from outside the U.S. Virgin Islands are possible methods to increase vehicle efficiency averages. Rental cars types could also be limited to those with a minimum fuel efficiency standard. Another option to consider would be development of no-car or slow speed areas where electric carts or small electric cars (such as global electric motorcars) could be used for transportation.

To increase higher occupancy travel in vehicles, the U.S. Virgin Islands Department of Public Works and Office of Transportation are evaluating several options to pursue including Park and Ride lots, bike lanes, high occupancy vehicle (HOV) lanes, and programs to promote mass transit, carpooling, and ridesharing.

4.0 OTHER BARRIERS AND OPPORTUNITIES

Financial assets, detailed planning information, partnership infrastructure, communication, and a well-trained workforce are the primary resources needed to meet the goals of this energy strategy.

4.1 FEDERAL FUNDING AND RESOURCES

A number of Federal agencies provide funding and, more often, technical support for energy efficiency and renewable energy projects. Funding databases for the EPA and the U.S. Department of Energy (www.epa.gov/ogd/grants/funding_opportunities.htm and e-center.doe.gov) provide updates on the numerous periodic and one-time assistance opportunities available. U.S. Department of Energy programs such as Wind Powering America and Clean Cities offer funding support for studies and training on an annual basis. National Laboratories also frequently can provide free technical assistance for projects deemed worthy. To anticipate availability of funds, projects and application information should be prepared ahead of time so that applications can be prepared within the sometimes short windows when applications are accepted. Federal funds often require a significant governmental or private cost share.

STRATEGY 30: Develop a task force to examine viable projects for grant applications and target Federal funds and assistance opportunities available from different Federal agencies.

4.2 PRIVATE FINANCE COMPANIES

Lack of funding is a barrier to increasing energy efficiency and developing a portfolio of fuel diverse energy generation. Energy services companies (ESCOs) can provide funding for cost-effective efficiency improvements if a sufficient cost volume of measures can be bundled into a large enough project. Projects can be funded from the ESCO and the capital cost recouped from savings over time through an energy services performance contract (ESPC). After the payback period and contract is complete, savings continue to accrue. ESPCs can also be used to fund renewable energy projects.

The VIEO is spearheading an effort to develop ESCO financing for cost-effective energy saving projects through an RFP released in 2008 as part of its Energy Alliance Program. A private ESCO implementation agent will be chosen to investigate and prepare plans for financing potential demand reduction projects at chosen sites in the U.S. Virgin Islands.

4.3 TRAINING AND PARTNERSHIPS

The VIEO is working with the Department of Labor and the Department of Education to develop a comprehensive training program on the maintenance and installation of solar electric and thermal systems. Well-trained technicians, designers, installers, and builders are needed to enact the many goals of this strategy. Training, education, and partnership building are especially needed in the following areas: construction and design of buildings and homes, installation and maintenance of renewable energy systems, cogeneration system operation, and HVAC operations and maintenance.

STRATEGY 31: Identify options and partners to promote and train the workforce for "green collar" jobs to develop needed resources and improve local job opportunities. Work with institutions such as the University of the Virgin Islands and sustainable tourism groups to make use of or develop training and certification programs in the key areas of operator experience for HVAC and cogeneration equipment, installation and maintenance for renewable energy systems, and design and construction of energy efficient buildings.

4.4 DISINCENTIVES

Energy costs are not typically among a builder or operator's priorities since those entities do not pay the utility bills. New homes are often built inefficiently without proper sealing or insulation. New homeowners are not aware of the associated higher electricity costs until after the home is purchased. Construction budget cuts to new public building budgets can be praised as cost saving measures but can result in removal of energy efficient features, such as higher efficiency HVAC units, that will end up costing much more over the life of the building. Thus, full life-cycle costs must be a consideration in the overall evaluation of building design and operation.

5.0 STRATEGIES

In this section timelines for completion are assigned to the strategies identified in Sections 3.0 and 4.0 and the strategies are tied back to the goals from Section 1.0:

GOAL 1: Reduce energy costs
GOAL 2: Increase efficiency of energy use and production
GOAL 3: Increase fuel diversity and reliability
GOAL 4: Promote clean energy

The strategies recommended for immediate (within one year), mid-term (within two to four years), and long-term (five years or more) implementation were developed with input from key stakeholders and technical and policy experts, using examples from successful energy strategies, and a comparison of expected costs and benefits of various alternatives.

STRATEGY 1: Develop a comprehensive biennial energy plan that tracks energy usage and costs by sector and end use.

Implementation: Mid-term
Supports goal(s): 1 and 2

STRATEGY 2: Analysis of options and proposals for energy generation should give a priority to those options that: 1) reduce energy costs, 2) increase efficiency of energy use and production, 3) increase fuel diversity and reliability, and 4) promote clean energy.

Implementation: Immediate
Supports goal(s): All

STRATEGY 3: For fuel diversity and reliability, WAPA energy generation should move toward a goal of having more than just one dominant fuel source as demonstrated by having at least 30 percent of power generated by energy sources differing from the primary energy source by the year 2025.

Implementation: Long-term
Supports goal(s): 3

STRATEGY 4: Include and give priority to energy that can be saved through efficiency programs as an energy resource and alternative to new generation options.

Implementation: Immediate
Supports goal(s): 1 and 2

STRATEGY 5: Develop utility demand side management programs for customers to improve energy efficiency and reduce peak load demand levels.

Implementation: Immediate
Supports goal(s): 1 and 2

STRATEGY 6: Utilize trends from the comprehensive biennial energy plan with results from the utility demand side management programs to determine if an energy efficiency portfolio standard is needed to meet goals.

Implementation: Long-term
Supports goal(s): 1 and 2

STRATEGY 7: Develop performance measures, set goals, and track quarterly progress in reducing WAPA transmission and distribution system losses.

Implementation: Immediate
Supports goal(s): 1 and 2

STRATEGY 8: Promote cogeneration for larger hotels and resorts and utilize technical assistance from the EPA's Combined Heat and Power Partnership to assess project viability and identify opportunities for financial and project assistance.

Implementation: Mid-term
Supports goal(s): 1, 2, and 3

STRATEGY 9: Adopt and update the model Tropical Energy Code.

Implementation: Immediate
Supports goal(s): 1 and 2

STRATEGY 10: Assess the adequacy of current personnel resources for codes enforcement. Conduct training for codes enforcement officials and apply for Federal funding to offer this training for architects and builders as well.

Implementation: Immediate
Supports goal(s): 1 and 2

STRATEGY 11: Investigate options for low-cost financing of energy efficient construction. Consider offering incentives whereby loan interest rates are "bought down" in exchange for meeting certain building qualification standards, such as LEED® or ENERGY STAR.

Implementation: Mid-term
Supports goal(s): 1 and 2

STRATEGY 12: Step up efforts to carry out the Executive Order requiring the purchase of lowest life cycle cost alternatives for all government procurement, including vehicle fleets. Establish systems to verify that this requirement is carried out and provide training to help purchasing personnel meet the requirement.

Implementation: Immediate
Supports goal(s): 1, 2, and 4

STRATEGY 13: Conduct training classes on best practices for operations and maintenance of heating, ventilation, and air condition equipment for the personnel who operate and maintain the government building equipment.

Implementation: Immediate
Supports goal(s): 1 and 2

STRATEGY 14: Use a tracking tool, such as the ENERGY STAR Portfolio Manager or building audits with energy bill logs for each building, to track energy usage of all government buildings (2000 square foot or greater) that use energy. Audit and track the energy use of at least 20 percent of government buildings, on a square foot basis, each year.

Implementation: Immediate
Supports goal(s): 1 and 2

STRATEGY 15: Use results from benchmarking and tracking government occupied and leased building energy usage to rank buildings and identify those that offer the greatest energy savings opportunities.

Implementation: Mid-term
Supports goal(s): 1 and 2

STRATEGY 16: Require all new government building construction over 2000 square feet to be built to the performance criteria to meet ENERGY STAR qualification or the U.S. Green Building Council's LEED® rating.

Implementation: Mid-term
Supports goal(s): 1 and 2

STRATEGY 17: Promote energy efficiency by making it a criterion in assessing all projects that receive government funding.

Implementation: Immediate
Supports goal(s): 2

STRATEGY 18: Investigate opportunities for energy efficient home mortgages.

Implementation: Immediate
Supports goal(s): 1 and 2

STRATEGY 19: Investigate and institute low-cost loans for homeowners to use for completing upgrades identified by WAPA and VIEO audits. Consider offering incentives whereby loan interest rates are "bought down" in exchange for completing a certain level of home energy efficiency improvements.

Implementation: Immediate
Supports goal(s): 1 and 2

STRATEGY 20: Continue efforts to access a higher share of LIHEAP Block Grant and Emergency Contingency funds. Develop a position paper identifying how such additional funds would be used in the Territory, their effects on the populace, existing poverty levels, and energy costs for low income households in the Territory.

Implementation: Immediate
Supports goal(s): 1

STRATEGY 21: Investigate options for a contractor-funded performance contract to reduce leaks and system losses in the water distribution system and reimburse system improvement costs from the resulting savings.

Implementation: Mid-term
Supports goal(s): 1 and 2

STRATEGY 22: Pursue funding options and Federal assistance to replace WAPA's existing water desalination units with higher efficiency units offering long-term life cycle cost savings.

Implementation: Mid-term
Supports goal(s): 1 and 2

STRATEGY 23: Re-examine the rate structure for water sales which currently offers lower rates for large water use customers. Options to consider include a tiered approach which charges higher rates as water usage increases, and reducing metering increments (less than 1000 gallons) to provide greater incentive for using water efficiently.

Implementation: Mid-term
Supports goal(s): 1 and 2

STRATEGY 24: Expand efforts to promote efficient use of water through consumer leak detection and recycling of condensate from HVAC, steam trap, and process systems.

Implementation: Immediate
Supports goal(s): 1 and 2

STRATEGY 25: Expand the existing net metering program to include renewable energy systems up to 500kW in size for public facilities, up to 100kW for commercial facilities, and up to 20kW for residences.

Implementation: Mid-term
Supports goal(s): 3 and 4

STRATEGY 26: Adopt the following renewable portfolio targets:

Targets	By 2015	By 2030
Minimum Percent of Electricity from Renewable Sources	20	25

Implementation: Long-term
Supports goal(s): 3 and 4

STRATEGY 27: Develop options for utility or government administered turn-key solar water heating installations for business and residential customers.

Implementation: Mid-term
Supports goal(s): All

STRATEGY 28: Develop economic incentives, such as rebates or gross receipt and excise tax breaks, to promote alternative fuels and alternatively fueled vehicles like ethanol fuel blends and electric cars.

Implementation: Mid-term
Supports goal(s): 1 and 3

STRATEGY 29: Require all new governmental and WAPA vehicles purchases be hybrid electric vehicles for relevant vehicle classes. Purchases of vehicle types for which hybrid electric vehicles are not available should be high efficiency diesel powered models.

Implementation: Immediate

Supports goal(s): 1, 2, and 4

STRATEGY 30: Develop a task force to examine viable projects for grant applications and target Federal funds and assistance opportunities available from different Federal agencies.

Implementation: Immediate
Supports goal(s): All

STRATEGY 31: Identify options and partners to promote and train the workforce for "green collar" jobs to develop needed resources and improve local job opportunities. Well-trained technicians, designers, installers, and builders are needed to enact the many goals of this strategy. Work with institutions such as the University of the Virgin Islands and sustainable tourism groups to make use of or develop training and certification programs in these areas.

Implementation: Immediate
Supports goal(s): 1 and 2

In conclusion, the U.S. Virgin Islands is poised to take a new direction toward a cleaner and more diverse energy supply. Fortunately, recent advances in renewable and clean energy technologies and improvements in energy efficiency have provided new opportunities for the U.S. Virgin Islands to reduce dependence on imported petroleum for transportation, electricity, and other energy needs. With planning, clear goals, commitment, partnerships, and communication the U.S. Virgin Islands will be able to achieve the objectives of more reasonable energy costs, a diversified energy portfolio, a greater measure of energy stability, and a burgeoning green economy.

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7.0 ATTACHMENTS

1. Weatherization Assistance Program Letter
2. Oak Ridge National Lab U.S. Virgin Islands WAPA White Paper

WEATHERIZATION ASSISTANCE PROGRAM LETTER

U. S. Virgin Islands WAPA White Paper
(Spinning Reserve Issues, Interconnections, & West Indies Power Proposal)

Prepared by
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March 2008

The U. S. Virgin Islands faces many of the same problems encountered by all small island nations. One of these problems is a relatively small power system with limited interconnection and generation that is based on older technology petroleum fueled with relatively poor heat rates. This is often further complicated by a reliability criteria that requires that the online generation have in spinning reserve a capacity that is equal to the largest of the two generating units that are presently online (the N-2 criteria). This criteria leads to excessively high spinning reserve margins and excessive costs which are further increased by the recent upturn in petroleum costs. While replacement with more modern higher efficiency, multi-fuel generation is a technical solution; the utility is probably not in a position to handle a large financial outlay. **The use of demand side management via a modern SCADA system and load control system as a means of shedding load and supplying an alternative to added generation** is a also possibility but was not considered here because of the limited scope of work.

Generation and Spinning Reserve Issues

Examining the average and peak loads on the WAPA main islands (St. Croix [SC] and St. Thomas - St. John [STSJ]) and the break out of the generating capacity for each system, we find a system with nominal peak / average loads in 2005 of about 90 MW / 65 MW for STSJ and 56 MW / 42 MW for SC. Without going into detail and since the heat rates for the plants are not known to the author**, it is evident form the generation mix available that for STSJ only about 35% of the capacity can serve the average load but 65% of the capacity is on line at that time (a near 85% spinning reserve margin). During peak load the values climb to 50% of capacity serving load with 83% of total capacity online (a near 60% spinning reserve margin**. Similar statements hold for the system on SC. The problem is complicated by the use of steam plant boilers in the desalination process. The author bases this analysis on the report Territorial Energy Assessment (Wade, 2005). It is not possible to estimate the cost of the spinning reserve component form this information but fuel expenses are reportedly very high (Devan Smith, private communication).

Conservation, Demand Side Management, and Renewable Energy

The aforementioned Territorial Energy Assessment provides several strong recommendations with which the author strongly agrees. The most important being improved generation efficiency with newer generation, increased conservation efforts, and the use of renewable energy where possible. Wind was briefly evaluated but must be considered carefully because of the variable nature of the resource and limited spinning reserve margins available. In most applications, the maximum wind resource could not exceed 20% of installed capacity without severe impacts and unit sizes would probably be less than 1 MW. Providing incentives for hotel, large business, and the limited large industry on the island to accept curtailed loads or allow there generation to be connected to the islands grids in emergency should be explored because it would allow a lower spinning reserve margin and relieve load on the distribution grid. On the conservation side, it is evident to the author that at least for the commercial side high electricity prices do not seem to curtail use. A very good example is the open shop door to attract customers (B. Smith, private communications and authors observation during visits to the VI). The author suggest the use of air curtains and ceiling fans coupled with incentives to set thermostats higher as a means of reducing this wasteful energy practice.

Interconnection of St. Thomas (ST) and St. Croix (SC) Systems

As a means of increasing system reliability and reducing spinning reserve requirements without adding new generation, it has been suggested that the two island systems be interconnected by the use of an undersea cable between ST and SC rated at 100 MW. The author has referenced the literature and prepared an estimate of the cost of such an interconnection. It is not possible to estimate the savings because many operational parameters are not available during this short study. The distance, the capacity, and the voltage ratings used present few technical problems with the cost estimates since all are within present cable capability. The world’s presently installed power cable systems have exhibited long life and high reliability (more than 20-30 years with limited maintenance). However, the depth of the seabed between ST and SC (2-6 km) is a **large issue** (Hawaii Interisland Cable). All power cable systems presently in service are in waters less than 1000 meters deep. A contract has been awarded to ABB/Prysmian for a cable between Italy and Sardinia that will reach 1600 meters and cover a 75 km distance. The Prysmian web site suggests that depths up to 2000 meters are possible with careful design and additional R&D using composites for strength and careful insulation system design. Discussions with ABB (Rosenqvist, private communication) indicate that the depth is an issue because of the mechanical stress that the able must be designed to withstand during installation and repairs, such as the cable weight plus other forces; e.g., current and bottom drag. Because the cable must be designed with minimal weight and the possibility of using the ocean and earth as return conductors, a dc cable is the preferred and potentially least expensive system (Russia-Finland presentation, ABB, Siemens, Prysmian web sites). In addition, the dc link would provide very controlled power flow in both directions. The best available technology is the use of high voltage dc obtained by using voltage source inverter stations with either bi-polar sea return or metallic return. Such systems are available from ABB, Siemens, Areva et al. with cable supplied by

ABB, Prysmian, Nexans et al. Long term reliability remains to be established but results have initially been favorable.

It is possible to provide a rough estimate for the cost of such a system by examining published cable system prices for inverters and cables. Inverter station costs for a 100 MVA voltage source, HVDC inverter (nominally +/- 100 kV) would be $125/kVA or for two stations a total price of about $25M installed. The cable presents the major difficulty but assuming 1) the earth is used for the return current, 2) an installed distance of an estimated 135 km that follows the undersea ridge east from SC and returns from the east to ST staying above the 2000 m depth, 3) two conductors in cable at $500/m leads to an estimated cable cost of about $135M or a total system cost of $160M installed. If a metallic return (third conductor) is included for operating flexibility and enhanced reliability the cable cost increase to $200M for a total cost of $225M. Design and installation time 2-3 years. The VI WAPA can estimate whether this cost is viable as a means of offsetting spinning reserve and adding capacity but at present fuel prices the author suspects that it is viable. However, it is **strongly advised that the availability of cable** that can be installed and operated in the area be discussed with cable and HVDC systems suppliers such as ABB, Siemens, Nexan, Prysmian et al. prior to performing a full systems design effort.

West Indies Power Geothermal Proposal

West Indies Power (WIP) a Caribbean based independent power producer specializing in the development and operation of geothermal power plants and their offshoots has approached the Virgin Islands WAPA. WIP is a Netherlands Antilles company with offices in Charlestown, Nevis, W.I. and in Roseau, Commonwealth of Dominica, W.I. and is owned by Caribbean and European shareholders.

WIP proposes to invest in the expansion of the geothermal plants on Nevis and Saba and the submarine HVDC cable to supply the USVI with 100MW's of firm power in 2011 at a price of USD $0.11-0.12/kWh escalating at labor, expendables, and material costs with a cap. Benefits to the WAPA are said to be the following:

- Lower electrical prices
- Known escalators for planning purposes
- Eliminate dependence on importation of diesel
- Clean renewable reliable power
- Multiple power plants to insure security of supply
- Savings from not having to purchase imported oil
- No land or pollution issues.

With the requirement that WIP and WAPA enter into a long term Power Purchase Agreement (PPA) in which WIP will supply 100MW's of geothermal power to WAPA at an agreed upon price and delivery date (

Is this proposal viable? Given the fact that the U.S. Department of Energy estimates potential availability of geothermal energy as 202 MW from Saba and 610 MW at Nivis with 200 MW and 600 MW available for export, the question becomes is there a cable route that is viable and highly reliable at a reasonable cost to WIP. **The question again is one of depth (install above the 2000 m level) and an experienced supplier with appropriate warranty**.

An estimate of the cable cost to supply 100 MW each to SC and ST using the methods of the previous paragraph and nominal lengths of 135 km to SC from Saba and 150 km from ST to Nivis gives estimated cable costs of $135 M and $150 M respectively. Metallic return costs are $202 M and $225 M and is preferred for reliability and flexibility. To this one adds the inverter costs of four (4) inverter stations $50 M and generating plant costs of a nominal $100 M for a total investment of $435 M.

Using a VI WAPA electric use of 1 B kwh/year and the proposed tariff results in revenue of $120 M /year which with 10% ROI leads to 5-6 year payback. So if a cable can be designed to work at the depths and voltages suggested, the investment and offer look very attractive. Interestingly, the entire chain of Caribbean islands with it's 10,000 MW potential can be linked with HVDC in a multi-terminal arrangement and connected to the North and South American grids. This is a ***very ambitious but perhaps achievable*** project.

The limited details of the WIP proposal do not provide sufficient detail to determine the true cost or savings to the WAPA. Clearly, WAPA would not scrap all existing generation because of possible emergency needs. Details are beyond the scope of this effort.

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