FEDERAL FACILITIES in the U.S. VIRGIN ISLANDS:

OPPORTUNITIES for ENERGY and WATER EFFICIENCY INVESTMENTS

United States Department of Energy RFQ-00-004

U.S. Department of Energy
Federal Energy Management Program
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Advantek Consulting, Inc.

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Table of Acronyms

ARO	Atlanta Regional Office of the Department of Energy
DOE	U.S Department of Energy
DSM	Demand-Side Management
ECI	Energy Cost Index, Dollars per square foot per year
ESCO	Energy Service Company
ESE	Environmental Science & Engineering
EUI	Energy Use Index, Btu per square foot per year
FEMP	Federal Energy Management Program
FSEC	Florida Solar Energy Center
MVA	Mega Volt Amperes
NPS	National Park Service
O&M	Operations and Maintenance
OTEC	Ocean Thermal Energy Conversion
PURPA	Public Utilities Regulatory Polices Act
PV	Photovoltaic
REM	Resource Efficiency Manager
ROI	Return on Investment
USPS	United States Postal Service
USVI	United States Virgin Islands
VIEO	Virgin Islands Energy Office
VOC	Volatile Organic Compound
WAPA	Water and Power Authority of the Virgin Islands

1. Executive Summary

The intent of this study is to present a comprehensive plan and strategy for the identification and financing of energy and water efficiency improvements in federal facilities located in the U.S. Virgin Islands. This document provides information that will be useful to the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP) personnel in strategically targeting its resources towards achieving the goals of the Atlanta Regional Office (ARO) in the Caribbean. The intent is for leveraged partnerships and funding to ultimately lead to rapid implementation of energy efficiency projects in the U.S. Virgin Islands financed with utility or private sector capital.

Electric rates in the U.S. Virgin Islands can be as high as $0.19 per kWh, roughly three times average U.S. mainland prices. The local governments have minimal resources to invest in energy efficiency projects and most of the Federal facilities are too small to attract an energy service company (ESCO). Federal energy and facility managers are interested in implementing energy saving and renewable energy projects; however, their needs are not well defined. Federal agencies have minimal resources to invest in energy efficiency projects at the local level.

The common barriers to the implementation of energy efficiency and renewable energy projects in the U.S. Caribbean are: (1) the small size of federal facilities is insufficient to attract the interest of most ESCOs; and (2) there is a lack of awareness of the savings and other benefits available through energy improvement projects among many federal facility managers.

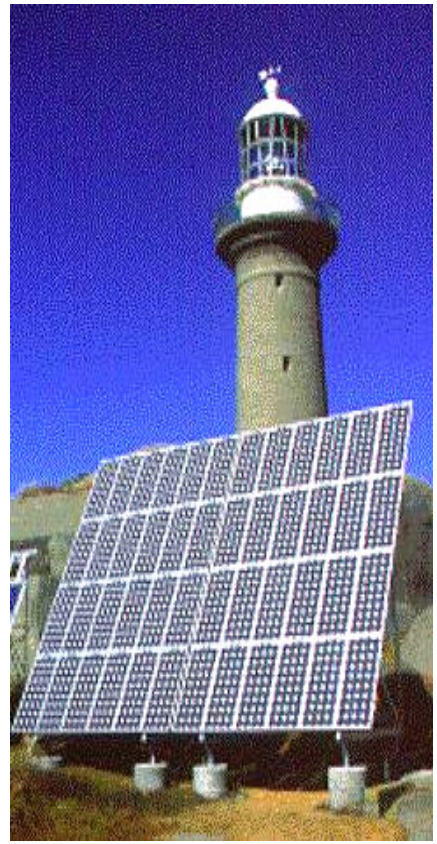
In the Virgin Islands, combining all federal sites and the larger USVI government sites into one public-private program might create a project large enough to attract an ESCO.

It is proposed that the selected ESCO employ local contractors to the greatest extent possible in order to build local energy project implementation capabilities. This will help the local energy offices encourage technology transfer from the federal sector to the local private sector and continue implementation of energy projects beyond the present government effort. Following FEMP's lead, it is hoped that enough commercial and industrial operators decide to improve the energy efficiency of their facilities to have a significant beneficial effect on the local economy.

Box 1-1. Proposed action plan for energy projects in the U.S. Virgin Islands.

Virgin Islands Action Plan

1. **Partner with the serving utility, WAPA.**
2. **Conduct energy and water audits**
3. **Prioritize schools, government, and commercial buildings**
4. **Perform detailed wind energy studies**
5. **Offer a training and workshop event**
6. **Secure the services of an ESCO**
7. **Implement projects and verify savings**
8. **Take measures to maintain savings**



One potential action plan for federal facilities in the Virgin Islands is provided. It aggregates local government and commercial facilities into a single performance contract. It also includes approaches for partnering with the serving utility and the local energy office, conducting energy and water audits, and providing training and/or strategic planning assistance.

2. Background

The mission of the U.S Department of Energy's (DOE) Federal Energy Management Program (FEMP) is to reduce the cost of Government by encouraging increases in energy and water efficiency and promoting renewable energy sources. This is accomplished by creating partnerships, leveraging resources, transferring technology, and providing technical guidance and training. Each of these activities directly makes government more cost-efficient and promotes wise management of Federal financial and personnel resources.

The U.S. DOE's Atlanta Regional Office (ARO) is charged with increasing energy efficiency in the U.S. Caribbean. FEMP is specifically tasked with implementing Executive Order 13123. The order directs agencies to reduce building energy use 30 percent by 2005 and 35 percent by 2010. The ARO's goal is to partner with Federal agencies in the Caribbean to assist them in meeting these requirements while stimulating public-private partnerships to improve the region's energy efficiency, economic stability, and curtail its almost total reliance on imported fuel oil for electric generation.

The intent of this study is to present information leading to a comprehensive strategy for the identification and financing of energy and water efficiency improvements at Federal facilities located in the U.S. Virgin Islands. This document provides details that will be useful to DOE / FEMP personnel in strategically targeting its resources towards achieving the goals of the ARO in the Caribbean. The intent is for leveraged partnerships and funding to ultimately lead to rapid implementation of energy efficiency projects in the U.S. Virgin Islands financed with utility or private sector capital.

The U.S. DOE / FEMP competitively selected energy consultants (Harding-ESE and Advantek Consulting, Inc.) to identify energy conservation and renewable opportunities and obstacles to their implementation at federal facilities in the U.S. Virgin Islands. The combination of high utility rates and antiquated building infrastructure almost ensures that energy conservation projects could be implemented successfully and with a high return-on-investment (ROI). The

abundance of solar and wind energy and dependence on a sole utility provider are just two of many indicators of the potential for enormously successful renewable energy project implementations in the region. Nonetheless, the region currently lags many years behind the mainland U.S. in terms of both technology level and project execution.

The territory of the United States Virgin Islands comprises three major islands: St. Croix (population 52,000), St. John (population 5,000), and St. Thomas (population 55,000); and 57 smaller islands and cays. They are located about 1,100 miles east-southeast of Miami, Florida and about 50 miles east of Puerto Rico. Taken together, the territory encompasses a total land area of about 135 square miles or 110,000 acres characterized by central mountain ranges and relatively small coastal plains. Total non-seasonal population is about 110,000. Peak elevations are 1,165 feet on St. Croix (Mount Eagle), 1,550 feet on St. Thomas, (Crown Mountain) and 1,297 feet on St. John (Bordeaux Mountain). The islands are 2 to 6 miles wide, with no land location far from the coastal waters. The islands lack perennial streams or large fresh-water lakes or ponds. All data in this report focus on facilities located on the main islands of St. Croix, St. John, and St. Thomas.

3. Objectives and Methodology

3.1 Primary Objectives of this Study

1. Identify and document opportunities and resources for increasing energy and water efficiency and renewable sources of energy in the U.S. Virgins Islands.
2. Identify obstacles to energy project implementations in the U. S. Virgin Islands.
3. Develop a comprehensive strategy and action plan for financing and implementing renewable and energy and water efficiency projects at federal facilities located in the U.S. Virgins Islands.
4. Assist the DOE Atlanta Regional Office (ARO) in fostering a productive relationship between the ARO and the federal agencies located in the Caribbean, and in marketing FEMP services.

3.2 Project Activities

Harding-ESE and Advantek collected information on the opportunities for and obstacles to implementation of energy/water efficiency and renewable energy projects using all accessible resources. Data and information was collected, compiled, and analyzed using a cost-effective mixture of activities:

- Interviews and meetings with key staff of the Virgin Islands Energy Office;
- Review of previous related programs, studies, and publications;
- Tours of facilities with agency Energy Managers, U.S. Virgin Islands Energy Office representatives and local maintenance personnel;
- On-site data collection from facility energy and water using equipment;
- Utility billing statements from energy managers and/or the serving utility company;
- Telephone conferences, meetings, and discussions with DOE-FEMP personnel;
- Discussions with ESCOs;
- Internet accessible resources; and

- Meetings with and subcontracting to the Caribbean Alliance for Sustainable Tourism (CAST) to provide a comprehensive summary of energy-efficient and renewable products and services available in the region.

A kick-off meeting was held on January 26, 2001 in St. Thomas, USVI to discuss the opportunities for and impediments to implementation of energy conservation, demand-side management, and renewable energy projects in the USVI territories. Each of the agencies participated in a spirited roundtable discussion, followed by continued discussions during tours of selected facilities.

An initial round of facility surveys was performed January 26-28 to asses the current status of the potential for energy and water projects. A second round of surveys was conducted in the USVI March 27-30 to further delineate project opportunities. A meeting was conducted on June 26 in Atlanta to discuss report findings, recommendations, and presentation of results.

4. Electric Utility Status

The U.S. Virgin Islands is somewhat unique in that one user-owned utility provides all electric service on the islands and there is an abundance of solar and wind energy available. Also, there is a large refinery located on St. Croix that provides transportation and power plant fuels.

The overall cost of power to the 49,700 Virgin Island's customers is about 24% higher per kWh than for the 1,300,000 customers in nearby Puerto Rico, and about twice that of much of the mainland U.S. Energy use per customer in the Virgin Islands is about 19,000 kWh per year.

4.1 Resources and Management

The Virgin Islands Water and Power Authority (WAPA)[1] was created by the Legislature in 1964 as a public corporation and instrumentality of the Virgin Islands Government. The authority generates and distributes electricity to the Virgin Islands. It also desalinates seawater, which it distributes and sells to the public. WAPA does not currently offer demand-side management services nor does it offer any rebates or incentives to implement demand-side management projects.

WAPA is run by a nine-member Governing Board. Of these, six members are appointed by the Governor with the approval of the legislature; three are from the district of St. Thomas-St. John and three are from the district of St. Croix. The other three members are members of the Governor's cabinet. The board appoints an executive director to administer the operations of the authority and carry out the policies of the board.

The Virgin Islands Energy Office operates a 2.5 kW demonstration solar-PV site along the main road from the St. Thomas airport to the cruise ship docks in Charlotte Amalie.

[1] Virgin Islands Water and Power Authority
Address: Post Office Box 1450, Charlotte Amalie, U.S. Virgin Islands 00804
Telephone Number: (340) 774-3552, Fax Number: (340) 774-3422

The government considered selling the utility in 1997. Management was recently taken over by Southern Energy Virgin Islands, LLC, an 80/20 partnership with the USVI government, Southern Energy Virgin Islands, LLC and Virgin Islands Electricity and Water, LLC. There had been rumors that Southern Company was interested in investing money with the Virgin Islands Water and Power Authority (WAPA). Southern Company had offered $100 million in cash and $150 million in bond debt to buy 80% of the U.S. Virgin Islands' Water and Power authority. Southern Company already owns majority stakes in the electric companies on Grand Cayman Island and in Trinidad and Tobago. Five Virgin Island residents, including WAPA employees, are suing their government, claiming that the legal requirement for an open, competitive bid was not met. The sale of WAPA would provide cash to the U.S. Virgin Islands' government, which is saddled with a $1.1 billion debt.

4.2 Capacity

WAPA's on-line generating capacity is between 238 and 323 MW. Annual usage is about 0.95 billion kWh with a 7% transmission loss. Almost all generation is from petroleum products, mostly fuel oil with a small portion of LNG, and minor amounts of coal. The Hovensa St. Croix refinery has a capacity of 525,000 barrels of oil per day, and is the largest refinery in the Caribbean accounting for 31% of total capacity in the region. The St. Croix refinery is 50% owned by the Venezuelan oil monopoly PdVSA. WAPA serves 49,700 customers from which total annual revenue is about 78 million dollars. Average revenue per kWh sold is $0.12. WAPA also supplies about 5 million gallons per day of desalinated water. It appears that desalination accounts for 20-30% of energy use. Building managers interviewed as part of this project indicated that electric outages are frequent. Research indicates that WAPA outage rates are approximately 100 hours per year.

5. Project Opportunities

Electric rates in the U.S. Virgin Islands can be as high as $0.19 per kWh, roughly three times average U.S. mainland prices. The local government has minimal resources to invest in energy efficiency projects and all but a few Federal facilities are too small to attract an ESCO. Federal energy and facility managers are interested in implementing energy/water saving and renewable energy projects; however, their needs are not well defined. Federal agencies have minimal resources to invest in energy efficiency projects at the local level, and it appears that implementing projects at facilities located in the Caribbean may hold a lower priority than projects on the U.S. mainland.

5.1 Federal Facilities by Agency

NATIONAL PARK SERVICE

Fort Christiansted, St. Croix – ~ 4,000 square feet

Virgin Islands National Park, St. John – ~2,500 square feet

UNITED STATES POSTAL SERVICE

The USPS operates 15 facilities ranging from 1,254 square feet (Cruz Bay Main Office) to 43,782 square feet (Charlotte Amalie Main Office.) Total square footage is 150,518 with an average size of 10,035 square feet. Approximate annual electric bill for this agency is $565,000.

GENERAL SERVICES ADMINISTRATION (GSA)

Federal Building, St. Croix – 49,500 square feet, c.1991

Federal Building, St Thomas – 54,900 square feet, c.1972

PORT AUTHORITY

St. Thomas Airport – 300,000 square feet

St. Croix Airport – 55,000 sq ft

The St. Thomas Federal Building has significant opportunities for improving energy efficiency.

5.2 Potential energy, water, and dollar savings

To say there is great potential for dollar and resource savings in the Virgin Islands is an understatement. The economy of the Virgin Islands expends about 16% of its Gross Domestic Product on energy and water, roughly twice the percentage of the U.S. as a whole. The Virgin Islands economy is also at severe risk in terms of almost total dependence on imported oil and desalinated water.

Based on projected FY2001 electric expenditures of about $81 million per year, total energy efficiency potential can be roughly estimated to be on the order of $15 million per year. This savings equates to an energy efficiency product and service market potential of around $75 million for the entire Virgin Islands territory. Federal energy expenditures are about $1.8 million per year with an estimated savings potential of $620,000 per year. It is estimated that approximately $3.5 million in total financing across all Federal agencies in the USVI will be required to realize this savings within a six to eight year payback period using a combination of technology retrofits and installation of solar, wind, and ground-source equipment.

5.3 Energy and water audits

Power reliability, power surges, and expense of power were all major concerns of the Federal agencies in the USVI as reported by agency representatives. Detailed audits, renewable power sources, infrastructure improvements, and maintenance training projects were requested. Based on our observations, site visits, and interviews, comprehensive energy and water audits with an emphasis on renewable technology implementations are needed at these facilities. The audits need to be prepared at an investment grade level to prove useful in the project implementation phase. It is our opinion that limited energy surveys would have little or no useful purpose for these facilities. The opportunities are tremendous and need to be quantified, not qualified, at this point.

The Aubry Main Post Office.

The Christiansted National Historic Site on St. Croix is a prime location for a demonstration solar photovoltaic project. Grid-connected solar panels could be erected on a cover over the visitors parking lot.

5.4 Technology retrofits

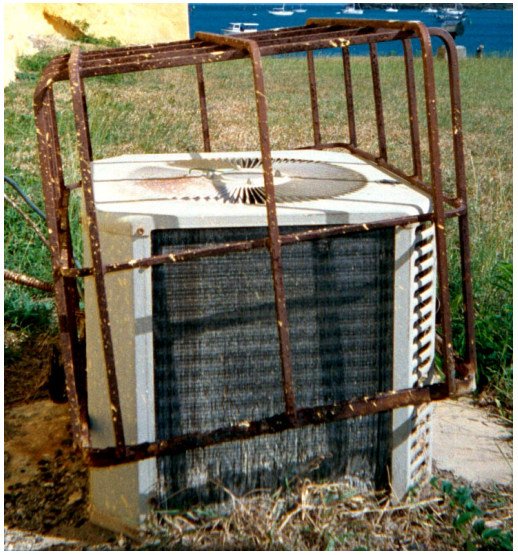
There are opportunities at almost every facility for retrofit of high efficiency lighting, air conditioning, and control technology. Our findings are consistent from facility to facility: lighting is typically provided by inefficient T12 lamps coupled with magnetic ballasts; HVAC equipment has low energy efficiency ratings (EER) ratings and is in very poor condition mostly due to salt air corrosion and neglect; automatic controls are virtually non-existent; there is evidence that maintenance was rarely if ever performed at many sites; filters were observed to be clogged; and evaporator coils were observed to be fouled and contaminated.

The relatively new Federal building in St. Croix contained a few energy efficient features, including occupancy sensors in restrooms and janitor closet areas, and compact fluorescent lamps. However, the restrooms were substantially over-illuminated with T12 lamps, and lighting in the facility was primarily T12. The air-cooled chiller is inefficient and has significantly degraded condenser coils. Retrofit of the T12 lamps/ballasts to T8 with electronic ballasts, and upgrade or replacement of the chiller with a ground-source heat exchanger, and installation of automatic energy saving controls are the primary retrofit opportunities.

Most of the St. Thomas Federal building is lit by T12 lamps. Although there is a significant open area with available day lighting, incandescent lamps are still used in the courtyard area. There are approximately 100 two-lamp T8 fixtures in the library providing 75 foot-candles, but no controls to reduce lighting in unused areas. Many over-illuminated areas were observed. An occupancy sensor is used in the restrooms. Water conservation devices are not being used in the restrooms. Motors for the chilled water pumps were minimal efficiency (80%-efficiency rating). The chiller plant consisted of 360 tons of air-cooled equipment. The condenser coils are in poor condition and crumbled to the touch.

Fort Christiansted is undergoing a lighting retrofit of exterior lighting. Approximately thirty 175- and 250-Watt metal halide lamps were being installed at the time of our site visit. The Fort itself was observed to have low energy use for its size. Daylighting and natural ventilation are being used extensively. Air conditioning is being used sparingly – 6.5-tons total for the entire facility – but it is in poor condtion. Energy Star features are enabled on office equipment.

Most opportunities for retrofit of high efficiency motors are at the larger buildings.



This deteriorated low-efficiency condensing unit at Ft. Christiansted should be replaced with a unit rated at SEER 12 or higher unit (2-tons).

Utility bills were collected on-site and indicate minimal use. Nonetheless, there is opportunity to replace several T12 fixtures with high efficiency T8 units, upgrade incandescent lamps with compact fluorescents, and upgrade small split system and window unit air conditioners to high efficiency units.

Lighting at the Christiansted Main Post Office is provided by 40-Watt T12 lamps with magnetic ballasts. Lighting controls are manual with control options not being used to turn off unnecessary lighting. Several split-system air conditioning units were inspected. One 5-ton condensing unit is located in an enclosed space preventing air from circulating to it. As a result the condenser is being cooled by air at 110 degrees F despite an ambient temperature of 85 degrees F. This short-circuiting condition is causing an efficiency loss about 20%. Substantial lighting, air conditioning, and automatic controls conservation opportunities exist at this facility.

Inefficient T12 light fixtures at Ft. Christiansted need upgrading to modern T8/electronic ballast fixtures.

The Port Authority building contains mis-matched T8 and T12 lamps with electronic ballasts. Multiple 175-Watt metal halide fixtures were reported to be on 24 hours per day. Air conditioning is provided by two Trane air-cooled screw compressor chillers. The condenser coils are protected from corrosion by Bronz-Glo coating and were observed to be in good condition.

A missing filter was blown against the evaporator coil, allowing unfiltered air to foul the coil.

In addition to these facilities, seven commercial facilities, two government hospitals, several schools, two post offices, and local government office facilities were surveyed for comparison purposes. Findings at these sites echoed those above, with significant opportunities for retrofitting lighting, air conditioning and controls.

5.5 Advanced and renewable technology implementation

The Virgin Islands government has long recognized that WAPA meets 98 percent of its energy needs from imported oil. Numerous studies have identified and repeatedly confirmed solar and wind technology as viable for many applications. Distributed generation could provide peak shaving, substation capacity deferral, and improved power quality and reliability. Ocean

thermal energy conversion[5] (OTEC) and waste-to-energy power plants may also be economically viable renewable energy sources for the Virgin Islands. Solid waste is now burned, landfilled, or hauled off the island at great expense. Despite the potential, these indigenous resources remain largely under-developed.

It is anticipated that significant infrastructure improvements, renewable technologies, and demand side management strategies will be targeted for implementation as part of a larger energy project. There exists significant opportunity for application of solar air conditioning, grid-connected photovoltaic and wind electric generation systems, solar water heating, ground-source heat pumps, day lighting, combined heat and power, and waste heat-to-energy technology. Possible projects identified at Federal sites include installation of solar-PV panels over the Fort Chritiansted visitor parking lot, installation of a water-source heat pump at the St. Thomas Federal Building, installation of a wind turbine at the NPS site at the eastern tip of St. Thomas, and installation of small solar water heating systems.

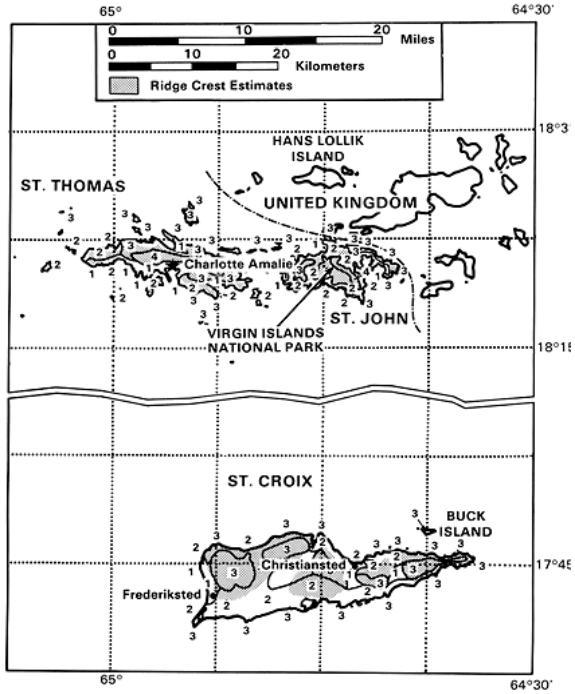
Under the Public Utilities Regulatory Polices Act (PURPA), utilities are required to purchase electricity from small power producers such as solar and wind generators. On the Virgin Islands, generators will most likely need to be smaller than 100kW so that grid interconnection and net-metering requirements can be simple. Installations smaller than 25 kW usually require very little evaluation of the local distribution system. Benefits to WAPA may include delayed investment in grid upgrades, reduction in transmission losses and increased load serving capability. Costs for constructing a wind electric unit have ranged from $1,000 to $3,000 per installed kW at existing sites in the U.S. and Europe. The cost of electricity generated from the turbines ranges from $0.07 to $0.15 per kWh – competitive with utility power currently priced at from $0.12 to $0.19 per kWh in the Virgin Islands. At a total installed cost of around $6,500 per kW and a 20-year system life, solar-PV electricity could be produced competitively at $0.14 to $0.18 per kWh.

Solar PV parking lot lighting near the St. Croix federal building.

[5] A 1988 study done by FSEC found that the north shore area of St. Croix has several sites which are potential candidates for a 10 MW-scale pilot electric generating plant.

Areas that are potentially suitable for wind energy applications are rated as class-3 and above. Class-3[6] wind sites in St. Thomas may include the northern coast in view of open water, as well as the exposed points at the southeast tip. In central St. Thomas, the higher ridge and summits may have class-4 power. Some of the slightly lower peaks, particularly on the northeastern side of the island, are estimated to be class-3. In St. Croix, the central ridge runs east-west the entire length of the island. The orientation of the island and its ridgeline suggests that the areas of highest wind power would be the higher peaks as well as their northern and southern shoulders, where acceleration of the prevailing easterlies occurs as they flow around these topographical barriers.[7] The eastern tip of St. Croix points into the trade winds. This tip, the exposed points on the northern and southern coast and Buck Island (off the northeastern coast) are all estimated to have class-3 annual average wind power. A ridge about 1,000 feet long paralleling the western shore of Coral Bay on St. John appears to have class-4 wind power. The irregular coastline leaves many jutting points along the northeastern, eastern, and southeastern coasts; these points may have annual wind energy densities near class-3.[8], [9]. For comparison purposes, class-4 is found immediately along the coast of New England and Block Island, while class-6 exists along the outer capes and islands such as Cape Cod and Nantucket Island. Most of Florida's coast is rated class-2.

The abundance of solar energy in the Virgin Islands is among the world's highest, averaging about 2010 kWh per square meter annually[10]. Together with the high cost of electricity and



This wind map of the U.S Virgin Islands is available from the U.S. Department of Energy's Pacific Northwest Laboratory. Due to the mountainous terrain, wind power can vary considerably over short distances, from what is shown on the map.

[6] Classes of wind power density, 0 through 7 are an indicator of the potential for electric generation. Class-3 corresponds to 150 to 200 Watts per square meter and 11.5 to 12.5 mph, class-4 is 200 to 250 W/m^2 and 12.5 to 13.4 mph mean wind speed at a height of 33 feet. Annual average wind speed of existing, successfully operating wind generators ranges from 8.0 to 13.4 mph.

[7] Wind Energy Resource Atlas of the United States, Pacific Northwest Laboratories.

[8] Wegley, H. L., D. L. Elliott, W. R. Barchet, and R. L. George. 1981. Wind Energy Resource Atlas: Volume 12 - Puerto Rico and the U.S. Virgin Islands. PNL-3195, WERA-12, Pacific Northwest Laboratory, Richland, Washington.

[9] Pennell, W. T. 1982. Siting Guidelines for Utility Application of Wind Turbines. RP 1520-1, Electric Power Research Institute, Palo Alto, California.

[10] At a solar collector tilt angle equal to the latitude. For comparison, Atlanta GA averages about 1,860 and Honolulu averages 2,080 kWh/m2; Anchorage, AK 1,100; New York 1,680; and Solar One, CA averages 2,400

warm climate, this makes the islands well suited for cost-effective installations of solar water heating panels and PV systems. The Virgin Islands Energy Office is working with the Florida Solar Energy Center of the University of Central Florida to pilot approximately ten solar photovoltaic and solar water heating energy demonstration projects.[11] The National Park Service (NPS) has assisted with the installation of a PV site on St. John. Nationwide, the NPS has installed over 500 PV systems and may be the first agency to work with FEMP on pilot solar and wind sites in the Virgin Islands.

Ground-source heat pumps use the relatively constant temperature of soil, estimated to be about 77 to 80 degrees F in the Virgin Islands, as a heat sink for a heat pump, which provides cooling for buildings. A variation that uses surface water as a heat sink may be viable for facilities located close to the sea or a harbor, such as the St. Thomas Federal Building and Ft. Christiansted. The equipment does not have a coil exposed to the corrosive salt air like conventional air conditioners. Instead it uses a buried coil of tubing to reject heat to the ground, or submerged at the bottom where the water is cooler. The higher initial cost of is more than offset by the lower costs for maintenance and energy.

Almost every building of any size is equipped with a Diesel or LNG back-up electric generation set.

5.6 Water Resources

The desalination of seawater for potable water consumption has increased on a per person basis from 5,000 gallons to over 15,000 gallons over the past decade and continues to climb. Meanwhile, the use of rain catchment / cistern systems is on the decline. Use of solar distillation, rainwater catchment, and graywater recylcing systems is yet another opportunity for major water and energy savings. Also, an OTEC plant could produce about 400,000 gallons of fresh water per day per MW of plant capacity.

A solar hot water heating tank.

Existing water quality standards do not support drinking water from ground or surface sources. Most drinking water comes from the Virgin Islands reverse osmosis and flash desalinization

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kWh/m^2. Source: Solar Radiation Data Manual for Flat-Plate and Concentrating Collectors; 30-Year Average of Monthly Solar Radiation, 1961-1990; U.S. DOE/NREL.

[11] http://www.fsec.ucf.edu/pvt/vieo/INDEX.htm

plants or from traditional rainwater cisterns (still required for some new construction). No surface water is used directly for any drinking water supply, although questions have been raised about whether sea water intakes of contaminated water is capable of passing bacteria contamination through the relatively low temperature (60° C) flash desalinization processes. The discharging of wastes overboard directly into the sea by boat owners contributes to non-point source pollution problems in the Virgin Islands. Point Source Pollution is attributed to failing and overloaded municipal sewage systems. Poor preventive maintenance practices and negligence has resulted in a pattern of frequent "bypasses" that empty sewage directly into surface waters.[12]

The Virgin Islands' ground water is contaminated with bacteria, saltwater, and volatile organic compounds. Failed septic tanks, leaking municipal sewer lines, and sewage bypasses contaminate ground water with bacteria. Overpumping of aquifers has caused saltwater intrusion in the past. VOC contamination is due to leaking underground storage tanks and indiscriminate discharges of waste oil.[13]

The scarcity and expense of potable water makes efforts at conservation, recylcing, and rain water catchment especially worthwhile. Retrofitting restrooms with waterless urinals, 1.6 gpf water closets, 1.5 gpm faucet aerators would reduce water use by 3.8 gallons per day for each person working in the building, a reduction of approximately 60 percent.

This solar shower needs a 2.5 gpm head.

Replacement of wall-hung 3.0 gpf or 1.0 gpf units with waterless models is a significant water saving opportunity at all Federal sites visited.

5.7 Planning, management, training, and O&M

The USVI Energy Office staff is extremely interested in implementing energy saving and renewable energy projects in all sectors and at all levels. The local government has little resources to invest in energy efficiency projects and Federal facilities are too small to attract an ESCO. A creative approach will be required in order to implement projects at Federal facilities. One strategy for pursuing projects here might be through a Federal-State-Private sector

[12] U.S. Environmental Protection Agency, 305(b) Report to Congress 1996/1998.
[13] 1998 WATER QUALITY ASSESSMENT for the United States Virgin Islands, Division of Environmental Protection, Department of Planning and Natural Resources, Government of the Virgin Islands of the United States.

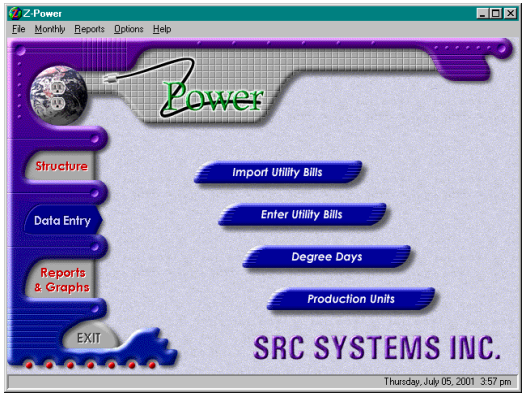
aggregated energy efficiency performance contract. The project could include three federal buildings, two forts, five post offices, as well as facilities from the private and State sectors to increase the size of the project enough to attract the interest of ESCOs.

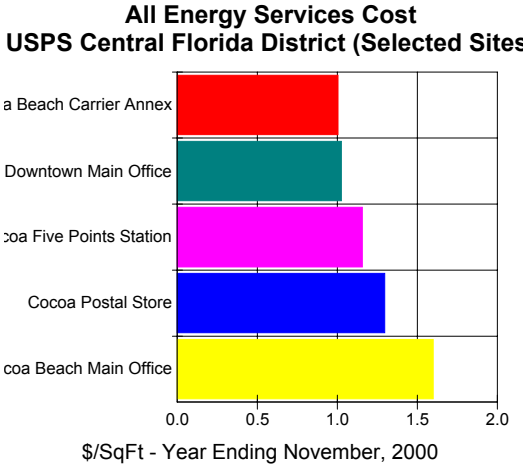
The need for training is comprehensive in the Virgin Islands. Maintenance practices are sub-standard compared with the mainland U.S. Examples of deficiencies include T12 lamps installed with electronic ballasts, T8 lamps installed with magnetic ballasts, dirty filters and evaporator coils on HVAC equipment, corroded condenser fins, inoperative controls, and inadequately maintained mechanical equipment.

5.8 Energy and water consumption accounting

Tracking and analysis of energy and water use at the facility level will be critical for identifying savings opportunities, aggregating facilities, and to verify that savings are being realized once projects are implemented. Collection and review of utility bills, comparisons between months and with other like facilities, before/after comparisons, EUI/ECI index analysis, and dissemination of the results all serve to increase awareness as well as to validate the efficiency program. Moreover, these activities alone have resulted in as much as 5% savings at other federal sites, equal to $90,000 savings per year for the Federal agencies in the USVI.

A designated Resource Efficiency Manager, dedicated full time to tracking use & savings, implementation of projects, and identification of additional savings opportunities for all the USVI Federal facilities would more than pay for him/her self. Tracking usage, demand, and costs would best be facilitated by WAPA providing utility bills in electronic format, or on a web site, that could be imported into inexpensive utility analysis software such as Z-Power. However, even manual entry of utility bills would prove worthwhile …"*You can't manage what you don't measure.*"





Software to track and analyze energy use and utility expenditures is a very useful tool for any energy management project. Z-Power is one of the more inexpensive software options.

6. Barriers to Implementation

Common barriers to the implementation of energy efficiency and renewable energy projects in the U.S. Caribbean are: (1) the small facility sizes are insufficient to attract the interest of most ESCOs, and (2) the lack of awareness of the savings and other benefits available through energy improvement projects.

The primary barrier in the USVI is lack of funding to implement the projects. A performance contract approach will be required to implement projects on the Islands. During our data collection we were unsuccessful in identifying local firms specializing in energy engineering; however, there are local contractors who could implement energy projects given guidance from qualified energy engineers and design documents.

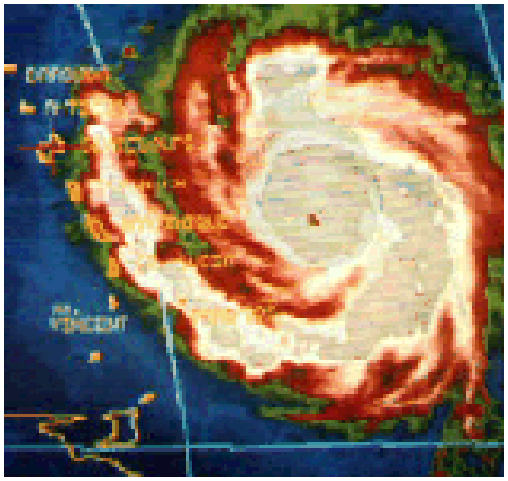
The major barrier for ESCO-assisted implementation is the size of the Federal facilities. The 54,882 square foot Federal Building (GSA) is the largest of the conditioned Federal facilities on the USVI The annual electric utility cost for this facility is $247,000. The approximate utility cost for all Federal facilities on the Islands, totaling about 600,000 square feet, is $1.8 million. These facilities are located across the three islands of St. Thomas, St. John, and St. Croix and represent four separate Federal Agencies (GSA, National Park Service, USPS, and the Port Authority). Most ESCOs are somewhat uninterested in implementing projects at sites having annual utility expenditures less than $0.5 to $1 million. Although these projects, if aggregated, would exceed this threshold, no single agency approaches this threshold alone. Multiple Federal agencies cannot be bundled[14] into a project for a competitive ESCO award; therefore, an alternative ESCO approach will be required.

A secondary barrier to project implementation is the credit rating of the USVI government. Because of failure to pay debts and significant delays in processing payments, the USVI

[14] source: meeting with DOE-FEMP staff at the ARO.

government has been categorized as a high-risk investment. Many companies are hesitant to invest in the infrastructure because of this poor credit rating.

Also, the threat of tropical storms and hurricanes poses a significant risk to investments within the Islands' infrastructure, especially to wind power.



Hurricanes that have passed near or hit the Virgin Islands include Hose and Lenny (1999), Georges (1998), Bertha and Hortense (1996), Luis, Marilyn and Sebastian (1995), Hugo (1989), ...

7. Project Implementation Strategies

In the Virgin Islands, combining all Federal sites and the larger government and private sector sites into one public-private performance contract should be considered.

If an ESCO is selected to finance and implement such a project, local contractors should be used to the greatest extent possible in order to build local energy project implementation capabilities. This will help the local energy office encourage technology transfer from the Federal sector to the local private sector and continue implementation of energy projects beyond the present government effort. Following FEMP's lead, it is hoped that enough commercial and industrial operators decide to improve the energy efficiency of their facilities to have a significant beneficial effect on the local economy.

7.1 Approaches to Project Implementation

The key to project implementation will be to combine a diverse group of facilities and to craft a win-win scenario among the key players. The optimum approach would be to organize under a contract with WAPA with the support of the V.I. Energy Office. The Director of the Energy Office has sent a letter to the WAPA Board of Governors requesting a hearing to discuss the viability of a partnering arrangement under which WAPA, the USVI Energy Office, and an ESCO would work together to provide demand-side management services to Federal agencies.

In order to increase the size of the project and the impact on the region, the St. Croix Development Foundation was contacted by the Energy Office and is now under contract to recruit potential commercial customers for this program. Proposals for investment grade audits have been submitted to the USVI Energy Office to be used in securing the services of an ESCO. Upon completion of these investment grade audits, the opportunities in the Islands will be objectively defined at six representative facilities.

To attract an ESCO for project financing, all Federal facilities, State facilities, schools, and hospitals could be aggregated as one project under a WAPA / VIEO / FEMP agreement. The addition of the commercial sector and local government facilities would improve the likelihood

of securing the support of WAPA and the USVI government. The advantages of this approach to the USVI Energy Office, FEMP, and the ESCO are as follows:

As the providing utility, WAPA can hold a non-competitive demand-side management (DSM) services contract with all interested parties (Federal, Local Government, and Commercial). This will minimize contracting issues and be more attractive to interested ESCOs. WAPA's ownership of the contract will facilitate utility rate reviews and rapid verification of savings. Utility payments, as well as payments to the ESCO resulting from utility savings, will ensure that all facilities pay less each month. WAPA is uniquely positioned to easily enforce the repayment schedule, which will reduce the risk and cost of the ESCO-financed phases of the project. Having WAPA hold the contract increases the likelihood that the Federal facilities and the Energy Office are included in the performance contract package. There may be opportunities for WAPA to avoid the cost of supply side infrastructure improvements as a result of decreasing loads from certain demand side sectors. In all likelihood the advantages to WAPA would be sufficient to secure their interest in the program.

If WAPA's Board of Governors decided to not participate, the effort can still go forward with a Federal-V.I. government-private sector ESCO partnership. Another variation would be to competitively contract with one or more small business ESCOs that may be interested in financing relatively low dollar value projects for individual agencies.

Another approach is to use hybrid performance contracting to meet the needs of the region. Under this approach, comprehensive audits and design concept documents would be prepared which include extensive application of renewable energy resources. The ESCO would then be

In a Hybrid-ESPC the ESCO finances the two most costly of the five main components of an energy project.

tasked to finance and install the identified projects as designed. It is believed that this approach would maximize the benefits to the USVI and the agencies responsible for paying Federal energy bills. This approach will also mitigate some of the project risks and increase the likelihood of securing the services of an ESCO, and could be used in combination with the above described partnerships.

To help assure the success of any approach taken, an intensive (one or two full days) seminar be provided for maintenance personnel, facility managers, engineers, and technicians on the Virgin Islands. The course should cover proper maintenance of advanced energy-efficient technologies and the impact on energy consumption. Specific topics should address the opportunities and deficiencies noted in the previous sections, including but not limited to the effects of mis-matching lamps and ballasts, basic HVAC maintenance, geothermal HVAC maintenance and opportunities, and the benefits and maintenance of renewable technologies.

7.2 Action Plan

An action plan for realizing savings at Federal facilities in the Virgin Islands is presented below. It is based on aggregating local government and commercial facilities with Federal agencies in a performance contract administered by the local utility company, WAPA. The plan also includes the elements of partnering with the local energy office, conducting energy and water audits, and providing training and/or strategic planning assistance. To increase the likelihood of success, federal facility managers in the Virgin Islands may want to jointly establish a Resource Efficiency Manger position. FEMP has considerable experience and lessons learned from REM programs at other Federal sites, and could offer support and guidance.

1. Partner with WAPA

It is suggested that DOE-FEMP present a packaged approach to WAPA that will ensure they become a partner in an aggregated performance contracting venture.

2. Conduct energy and water audits

Well-defined projects and savings will greatly increase the number of ESCOs interested in the USVI because the magnitude of the opportunities will be clarified and risk will be lessened. Audits will form the basis for the project and, in turn, the audit results will form the basis for contracting with WAPA to implement one or more performance contracts. Audits should be performed at a hospital, school, and government facility on both St. Thomas and St. Croix. Audit tasks could be funded by the USVI Energy Office; in addition to jump-starting the project, this arrangement would establish a precedent for future deliverables via the USVI Energy Office.

3. Prioritize schools, government, and commercial buildings

Because Federal facilities would have difficulty attracting an ESCO as a stand-alone project due to their small size, other facilities should be included. These facilities need to be identified and have their savings potential quantified. In an effort to assess the potential for savings at schools, government and commercial buildings, utility bills, square footage, date of construction, and walk-through assessments of each school and government facility on St. Thomas, St. John, and St. Croix are needed. This will enable the VI government to develop an implementation schedule based on reliable information. The resulting data will also be useful in putting together packages of information and presentations to key decision makers to intensify their support.

The V.I. Energy Office will be instrumental in identifying non-federal facilities that would benefit from the aggregated performance contract approach. The St. Croix Foundation is tasked with active recruiting of commercial customers who will be rolled into a performance contract with WAPA or an ESCO, and implementation of energy projects will continue under the contract as new facilities are added. The process will result in the maximum savings being acquired in year one of the program rather than further into the future.

4. Perform detailed wind energy studies and establish standards

Wind studies are needed to investigate local wind power availability at specific candidate sites; grid and substation capacities; hurricane protection; siting, permitting and zoning issues; and

sources for purchase/shipment of turbines and towers. It would be beneficial for such a study to address costs, including the cost of resource assessments, capital costs (turbine, tower, foundation, grid connection), the interconnection approval process, O&M, and land costs; and include a small scale pilot demonstration.

A utility engineer should be tasked to evaluate each proposed installation. Establishment of Predefined Interconnection Standards to streamline evaluation of proposed installations for various distribution regions is needed. A primary consideration for siting grid connected wind turbines, as well as non-storage photovoltaic panels, is the robustness of the electric distribution system at the point of interconnection. Three-phase lines are required within one mile of the site for connecting turbines larger than about 20 kW. Turbine capacity can be no greater than 5% to 10% of the line rating[15]. Power quality considerations may constrain siting to within 10 miles or less of a substation. Capacity may be limited to the kW that would cause no more than a 2% voltage variation on the line.

5. Offer a training/workshop event

An intensive two-day seminar for maintenance personnel, facility managers, engineers, and technicians on the Virgin Islands is needed. The event should cover proper maintenance of advanced energy-efficient technologies and the impact on energy consumption. Specific topics should address the effects of mis-matching lamps and ballasts, basic HVAC equipment, and solar and wind generation.

6. Secure the services of an ESCO

After the USVI Energy Office has completed investment grade audits at Federal, local government, and commercial facilities, an attractive initial offering can be presented to WAPA. After WAPA has been satisfied that the audits are technically and contractually viable, interested ESCOs can be contacted through WAPA and the USVI Energy Office with technical support from DOE-FEMP. An ESCO will be selected that is willing to work in accordance with the best interests of the respective clients. It is anticipated that this will include a willingness to

[15] expressed as short-circuit MVA – MegaVolt-Amperes

use the prepared investment grade audits in preparation of cost estimates for implementation of renewable and energy-efficient projects.

7. Implement projects and verify savings

The selected ESCO will provide a proposal for implementation of projects where investment grade audits have already been performed. Upon acceptance of the ESCO's proposal by WAPA and the facility owners, the construction phase will proceed. Local subcontractors will be employed to the maximum extent possible with the ESCO providing any additional personnel needed. At this time another round of audits will be performed. It is estimated that the program could be implemented over approximately four years.

9. Take measures to maintain savings

To the maximum extent practicable, local personnel should be trained in operation and maintenance of installed systems. It should be noted that many facilities will be capable of maintaining their own facility improvements. Where staff are available for this function, training should be provided to these staff. This will minimize the payments to the ESCO for post-construction services and provide for a more attractive payback. At facilities where staff are not available, the ESCO may be tasked with providing O&M services. Although this will increase the cost of the project and consequently the associated payback period, the additional investment will ensure that the equipment will continue to function as designed and that comfort conditions as well as savings will continue to be realized.