US Virgin Islands Renewable Energy Future

by

Brian Oldfield

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Abstract

The US Virgin Islands must face drastic changes to its electrical system. There are two problems with electricity production in the USVI—it's dirty and it's expensive. Nearly one hundred percent of the electricity in these islands comes from imported diesel, brought in by ship. Expensive fuel and inefficient power generation facilities have caused residential electricity rates to soar to $0.58 per kWh—five times the national average.[1] These electricity prices are causing businesses to close their doors and residents to camp in the dark in their own homes because they are unable to pay the bills. This must change. Electricity prices must come down, else risk political and economic disaster.

The thesis proposes a set of policies to help USVI get cleaner as its energy gets cheaper. Nearly year-round, the Caribbean sun shines and the Trade Winds blow, yet both are virtually unused. The USVI is in a position to be a world leader in clean energy. The USVI government has demonstrated its commitment to this role as a clean energy leader. In 2009, Governor John P. DeJongh passed Act 7075, creating an ambitious renewable energy standard. By 2025, the USVI will reduce fossil fuel use by 60 percent. Having committed itself, the USVI must determine how it may meet this goal. In this paper, I analyze the issues and propose specific paths towards the USVI clean energy future.

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Summary of Recommendations to USVI Government:

- Create new branch of government dedicated to promoting cost-effective, clean energy

- Fill the net-metering limit
  - Includes 10 MW of solar on St. Thomas/St. John and 5 MW of solar on St. Croix
  - Continue to provide tax incentives for net-metered homeowners
  - Ensure limit is measured by total power produced, not total peak capacity
  - Fix the current net-metering system:
    - Expedite the approval process
    - Be tough on improper installation and inefficiency

- Support the proposed 18 MW utility-scale solar project
  - Includes 9 MW on St. Thomas and 9 MW on St. Croix

- Develop Clean Coalition DG+IG Project on St. John
  - Includes 12 MW of solar, energy storage, and grid upgrades

- Develop Tibbar Energy Biomass Project on St. Croix
  - Includes 7 MW on renewable, dispatchable biomass energy

- Install landfill gas collection on all existing landfills
  - Produce approximately 5 MW of renewable and dispatchable energy
  - Comply with EPA regulation under Clean Air Act

- Support and expedite development of Bovoni and South Shore St. Croix wind projects
  - Includes an estimated 22.5 MW across St. Thomas and St. Croix

- Oppose interconnection with Puerto Rican electrical grid

- Support fuel supply expansion to liquefied petroleum gas and liquefied natural gas
  - WAPA estimates a 30 percent reduction in fuel costs
  - Ensure this project does not crowd out generation efficiency projects

- Require WAPA to pursue generation efficiency improvements
  - Includes heat recovery steam generators (HRSG) and reverse osmosis for water production

- Work to create education program to develop local expertise in solar, wind, and energy efficiency

Introduction

The US Virgin Islands are a group of islands in the Caribbean Sea, located approximately 40 miles to the East of Puerto Rico. Visitors and locals alike consider these islands Paradise, for their year-round warm climate, clear waters, and white sand beaches. The USVI is composed of three main islands, St. Thomas, St. Croix, and St. John, with many other small islands. Total land area over the territory is 346 square kilometers—only twice the size of Washington, DC. St. Thomas is the economic center and is the most populous, with 51,634 residents as of the 2010 census. Charlotte Amalie, St. Thomas is the capital city of the territory. St. John lies about four miles to the east of St. Thomas, accessible via ferry, and has a population of only 4,170. St. John remains relatively undeveloped, for about three quarters of the land is owned by the US National Park, donated by Lawrence Rockefeller in 1956. St. Croix is the second most populous with 50,601 residents, but is the largest in terms of land mass. St. Croix is distinct from the other islands, for it is 30 miles to the south of the others, and has much flatter. Geographically, the USVI are very hilly, with little level, arable land, except for St. Croix. This flat land has lead St. Croix to have the most agricultural activity.[2]

The economy of the USVI depends heavily upon tourism. About half of local employment and half of the GDP involve tourism, trade, and other service industries. The other half of the economy is roughly split between government and manufacturing. The main manufacturing products are rum, electronics, pharmaceuticals, and watches. The agriculture sector is small, and most food is imported to the islands. Total GDP is approximately $1.577 billion, with $14,500 per capita. In 2002, it was estimated that 28.9 percent of residents live below the poverty line.[3]

Historically, the USVI was a major producer of sugar cane and rum, fueled by African slave labor. About 76 percent of residents are of African heritage, mostly descendents of those brought over during the slave trade in the 18th and 19th centuries. Before colonization from the West, the islands were inhabited by three tribes of indigenous people, the Caribe, the Arawak, and the Taino. St. Croix, St. Thomas, and St. John became Danish colonies in 1754. The slave trade thrived for a hundred years thereafter, but was abolished in 1848. The USVI economy crumbled after abolition. In 1917, the US purchased the islands from the Danish, as a tactical move during World War One. Currently, the region is an unincorporated territory of the US, meaning it is subject to US law and government, but has its own local government.[3]

In recent history, the USVI has faced problems with its outdated electrical system. There are two problems with electricity production in the USVI—it's dirty and it's expensive. Nearly one hundred percent of the electricity in these islands comes from imported diesel, brought in by ship. Expensive fuel and inefficient power generation facilities have caused residential electricity rates to soar to $0.58 per kWh—five times the national average.[1] These electricity prices are causing businesses to close their doors and residents to camp in the dark in their own homes because they are unable to pay the bills. This must change. Electricity prices must come down, else risk political and economic disaster.

The Virgin Islands Water and Power Authority (WAPA), has many challenges to overcome to achieve improvements to the current electrical system. At present, nearly one hundred percent of electrical generation comes from fuel oil—an energy source that is both terrific and terrible for the Caribbean. Compared to its other fossil fuel competitors, coal and natural gas, oil is much cheaper to transport by ship. The generation facilities cheap to build and are easily scalable to incorporate larger energy demand—perfect for small, isolated islands in their development stage, as the USVI was in 1964. For these reasons, 71 percent of the electrical generation in the entire Caribbean comes from fuel oil. By contrast, less than 1 percent of electrical generation in the United States comes from fuel oil.

Fuel oil may be convenient for the USVI, but it has serious drawbacks. The USVI uses two grades of fuel oil in its power generation facilities: fuel oil #2, which is used as diesel fuel in cars and trucks; and fuel oil #6, also known as Bunker C, which is a common fuel for large naval ships. During oil refining, Bunker C is literally the bottom of the barrel—it is what is left when the more valuable fuels has boiled off. It has many undesirable impurities, including high sulfur, water, and soil contents.[4] In spite of these properties, Bunker C is used because it is the cheapest oil that can be bought. Yet, it is not cheap enough to provide power for all.

In July of 2009, the US Virgin Islands signed Act 7075, a renewable portfolio standard for electricity generation. It requires an ambitious 60 percent reduction in fossil fuel use by 2025, including 30 percent of electrical generation from renewable sources. This renewable energy standard will be referred to hereafter as 60x25. This act is intended to free the islands from the electricity prices that currently keep residents without power and from dependence on fossil fuels. The USVI government has partnered with the Department of Energy (DOE) and the National Renewable Energy Lab (NREL) to create a pathway to this goal. NREL has conducted a very thorough baseline assessment of energy options in the USVI, including wind, solar, storage, waste-to-energy, landfill gas, biomass, heat recovery steam generators, and an undersea cable to Puerto Rico (NREL 2010). Act 7075 and the NREL and DOE partnerships mark the beginning of a large step forward for renewable energy in the USVI.[1]

This thesis creates a set of specific paths forward, available for use by elected government officials to improve and achieve more effective policy. The NREL report, called the USVI Energy Road Map, includes analysis of costs and capacities of the technologies, but does not suggest any specific policy action. I will rely upon the work of NREL, local news articles, and interviews with local Senators, energy providers and installers, consumers and possible investors to describe the current state and possible futures of electricity production in the USVI.

This information will be used to translate NREL's options into realistic, specific action plans to reduce electricity prices and meet the 60 percent by 2025 goal.

Chapter 1: Important Players

- USVI Water and Power Authority (WAPA)
- Public Services Commission (PSC)
- USVI Government
- Virgin Islands Energy Office (VIEO)
- US Department of Energy (DOE)
- National Renewable Energy Lab (NREL)
- USVI Residents and Business Owners
- Current Policy
- Outside Investors
- Act 7075

Reviewing the activities of currently important players in USVI energy, we can identify both constraints on change and opportunities for improvement. The USVI is in a position to make drastic improvements to its electrical system, for it has the public will and the outside expertise. Yet, it is evident that the actors must work to align their individual interests in order to better progress towards the goal of clean, cheap energy for the USVI. The 60x25 goal is ambitious, and will require cooperation between all actors in order to be fulfilled. Among the actors, there is a tendency to resist change and to be skeptical of outside influence—a significant hindrance to development. There is a lack of trust in the government and WAPA among the people. This perception is fed by perceived inefficiency and government corruption scandals. While the government passed Act 7075, it still must work to unify elected officials behind the 60x25 goal.

USVI Government

The USVI government is lead by Governor John P. DeJongh, Lieutenant Governor Gregory R. Francis, and a fifteen member Senate. Seven senators are elected from each of St. Thomas and St. Croix, and one is elected at-large. The USVI elects a delegate in the House of Representatives, Donna C. Christensen, who may not vote, but can serve in committees. USVI citizens vote for local officials but may not participate in presidential elections.[2]

The government has made clear its dedication to the development of clean energy in passing Act 7075, creating the 60x25 goal. This is commendable, for it shows a desire to improve the future of the islands. Yet, the government, the single largest consumer of electricity, has a long history of late and nonpayment of its electric bills. Low finances are a persistent problem for the government. Residents see inefficiency and corruption as the root cause of their financial troubles, for many government officials have been accused of severe corruption and embezzlement of millions in public funds. Corruption appears to be decreasing, since the worst offenders have been identified, but public perception is slow to change.

In conversations with Senator-at-Large Craig Barshinger, it is evident that the government feels a lot of pressure from the public to decrease electricity costs. There are two ways one may view this problem: See the electrical generation system as a flawed system, and completely overhaul it; or try to reduce fuel costs within the existing system. It is a question of treating the symptoms or finding a cure. In reality, the solution will be a mix of the two. The government is split between those who want to treat the symptoms and those who want a cure. Many believe that system upgrades are costly and uncertain; that outside investors are untrustworthy; and that change may jeopardize the jobs and political support of constituents. Many do not understand the issues fully. Advocates of energy system overhaul, like Senator Barshinger, are relatively few, but gaining strength. High electricity prices and the unpopularity of WAPA have convinced many members of the public that change is necessary.

WAPA

Currently, the USVI gets its electricity from a fleet of fuel oil power plants run by the Virgin Islands Water and Power Authority (WAPA). As per the name, WAPA also provides municipal water with eight desalination plants across the islands. The utility was created in 1964 by the USVI government to serve the emerging economy at that time. WAPA has a nine-member governing board composed of both government employees and members of the private sector. As such, it is considered semi-private. WAPA is not directly run by the government, but is regulated closely by the government board members and the PSC.[5]

St. Thomas/St. John – Randolph Harley Generation Station			
Technology	Fuel Type	Capacity (MW)	In-Service Date
Reciprocating Engine Generator	No. 2 Oil	2.5	1985
Fired Boiler STG*	No. 6 Oil	18.5	1968
Simple Cycle CTG	No. 2 Oil	12.5	1970
Simple Cycle CTG	No. 2 Oil	12.5	1972
Fired Boiler STG*	No. 6 Oil	36.9	1973
Combined Cycle CTG/HRSG*	No. 2 Oil	20.9**	1981
Combined Cycle CTG/HRSG*	No. 2 Oil	23.5**	1993
Simple Cycle CTG	No. 2 Oil	24.0	2001
Simple Cycle CTG	No. 2 Oil	39.5	2004
Total		146.4	
St. Croix – Estate Richmond Generating Station			
Fired Boiler STG*	No. 6 Oil	10.0	1967
Fired Boiler STG*	No. 6 Oil	19.1	1970
Combined Cycle CTG/HRSG*	No. 2 Oil	20.9**	1981
Combined Cycle CTG/HRSG*	No. 2 Oil	21.9**	1988
Simple Cycle CTG	No. 2 Oil	22.5	1994
Simple Cycle CTG	No. 2 Oil	22.5	1994
Total		74.1	

*Fired boilers and HRSGs deliver steam to steam headers and four MED production units
**Capacity shows CTG output only
Source: R.W. Beck 2010

Figure 1: USVI Generating Fleet. It can be seen that only two of fifteen generating facilities were constructed since 2000. Eight of the fifteen facilities use excess steam to provide municipal water, while only four use excess steam to run a heat recovery steam generator.[1]

The generation fleet on St. Thomas has an installed capacity of 191MW. The peak load on the St. Thomas system is between 78MW-88MW, and the average load is 65MW. St. Croix has an installed capacity of 117MW to provide a peak load of 50MW-55MW and an average load of 40MW. The generation fleet consists of 72 percent combustion turbines, 28 percent steam turbines, and a few small internal combustion generators. In the USVI, there are two distinct grids with no interconnection. Generators on St. Thomas provide power to St. John, Hassel Island, and Water Island via undersea cable. St. Croix provides all of its own electricity. Interconnection between St. Thomas and St. Croix has never occurred due to a deep trench between the two islands.[1]

WAPA also provides municipal water for the territory. There are eight multiple effect distillation plants across St. Thomas and St. Croix, which create potable water from seawater. As mentioned earlier, this distillation process limits efficiency of generation facilities since distillation uses steam that may otherwise be used to produce electricity. One reverse osmosis facility was recently installed on St. Croix and currently provides over half of the total water consumption of St. Croix.[4] This is a major upgrade since this reverse osmosis facilities is eight times more fuel efficient than the multiple effect distillation plants and operates at half the cost.[1]

Lack of financial resources plagues WAPA. WAPA attributes this to chronic late payment and nonpayment by customers. Others feel it is due to organization inefficiency, corruption, and incompetence. Further research on financial records would be necessary to substantiate these claims. Whatever the cause, lack of funding has hurt both WAPA and VI residents. Routine maintenance has gone undone, causing more emergency downtime events. Spinning reserves, running generators used to stabilize the grid during emergencies and unforeseen loads, have been low, impacting system reliability.[1]

WAPA suffers from a poor reputation in the eyes of nearly all, including PSC, residents, and members of the USVI government, for its inefficiency, unreliability, and its lack of cooperation. WAPA has consistently performed well below market average in terms of generating efficiency, when compared to other island nations. Worse, the organization shows no signs of attempting to improve. Millions of dollars have been given to WAPA for efficiency and reliability, but performance stagnates. Many wonder where this money is spent, but WAPA refuses to open its books. The lack of cooperation combined with abysmal performance has eroded WAPA's reputation and created conflict with its regulator, the PSC.[6]

Nearly one hundred percent of electricity production comes from imported fuel oil. This dependence on fuel oil has severe drawbacks. Price volatility is a constant problem. The price of a barrel of oil has varied from $11 in December of 1998 to $147 in July of 2008. The presence of HOVENSA, a large oil refinery on St. Croix, allowed WAPA to purchase fuel oil below market price. Though the WAPA price was lower than market, WAPA still felt the price volatility since their below market price was pegged to the market price. Worse, HOVENSA closed in February of 2012.[1]

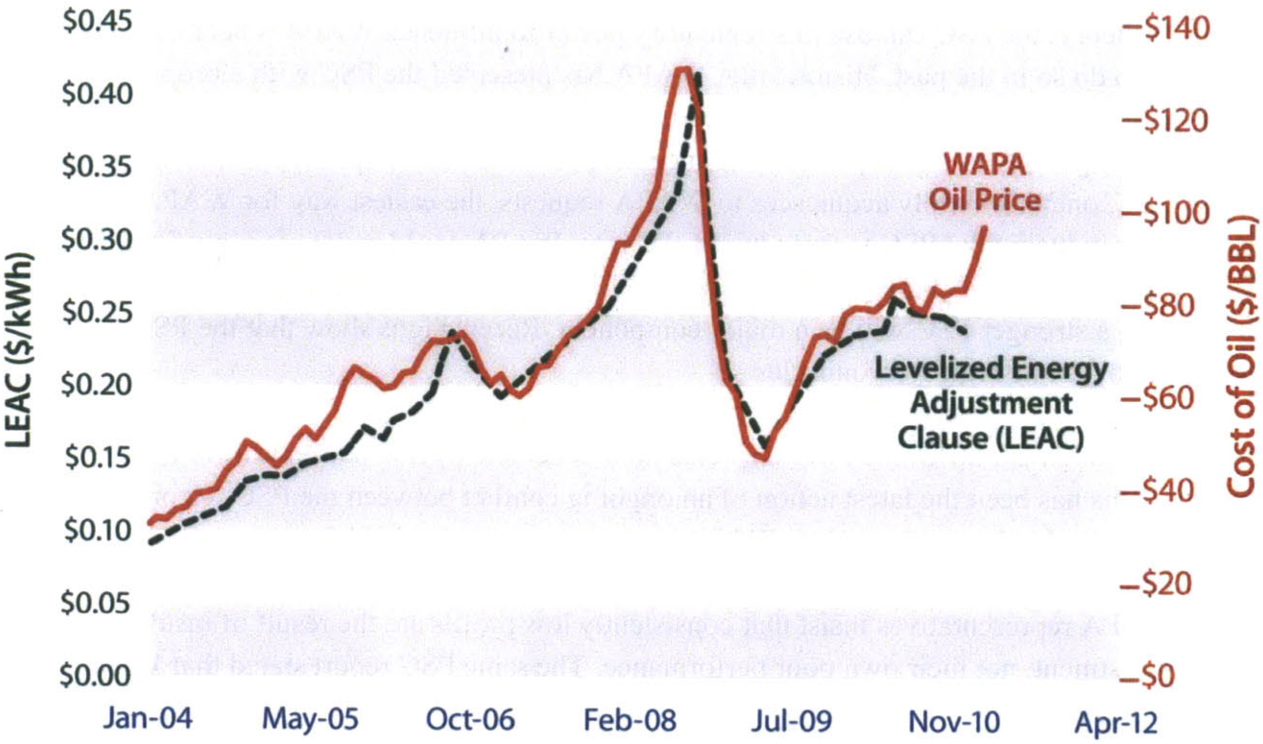

Figure 2: Cost of oil to WAPA and LEAC rate between 2004 and 2010. It can be seen that oil prices vary over 400 percent within this six year period. The LEAC rate primarily reflects the fuel cost to WAPA per kWh of production.[1]

Public Services Commission (PSC)

The main responsibility of the Public Services Commission (PSC) is to regulate the Levelized Energy Adjustment Clause (LEAC) rate every three months. The LEAC rate is a cents per kWh value included in electricity bills that accounts for fuel and fuel-related costs to WAPA. Fuel prices are highly volatile, so frequent adjustment of the LEAC rate is necessary in order ensure that WAPA maintains profitability. To help make decisions about the LEAC rate, the PSC uses the expertise of Georgetown Consulting Group.[6]

Also included in the LEAC rate is the Rate Financing Mechanism, which provides WAPA about $17 million annually to allow for: lease of an emergency combustion turbine; deferred and extraordinary maintenance; spare parts for generation facilities; and help from an Independent Agency Contractor to improve reliability and efficiency. Approximately 76 percent of WAPA's spending is on fuel costs (and is included in the LEAC rate), and the other 24 percent goes to personnel, transmission, distribution, debt service, maintenance, insurance, and other very predictable costs. Through the LEAC rate mechanism, the PSC can regulate WAPA's profits and consumer electricity prices.[7]

In theory, the PSC can use this regulatory power to influence WAPA's behavior, but it has failed to do so in the past. Historically, WAPA has presented the PSC with a proposal for the LEAC adjustment, and the PSC has accepted the proposal. Regularly asks for increases in the rate, which is granted and thus provides no incentive for WAPA to improve its efficiency. With a weak PSC, one that simply acquiesces to WAPA requests, the easiest way for WAPA to raise profits is by inducing the PSC to raise the LEAC rate. WAPA could make more profit by running more efficiently, but it is far simpler to raise the LEAC rate. If the USVI wishes to meet the 60x25 goal, a stronger PSC will be a major component. Recent signs show that the PSC is beginning to flex its regulatory muscles.

On March 27, 2013, the PSC surprised all and denied WAPA's proposal for a LEAC increase. This has been the latest action of an ongoing conflict between the PSC, Georgetown, and WAPA. Each adjustment period, WAPA proposes to raise the LEAC rate even if fuel costs remain constant because the desired level of profit is consistently unmet. According to a PSC report, WAPA representatives insist that consistently low profits are the result of insufficient LEAC adjustment, not their own poor performance. The same PSC report stated that WAPA continually sets unrealistic performance goals that it always fails to meet. As a result, more fuel is consumed than is expected, and total fuel costs to WAPA are higher than projected. The PSC sees WAPA's habit of underestimating fuel consumption as a technique to ensure the LEAC continues to increase even if fuel costs remain constant. Worse, WAPA refuses to open its books to the public or to Georgetown, so nobody knows if the profits WAPA reports are true or not. By refusing WAPA's proposal, the PSC intends to put pressure on WAPA to improve efficiency and disclose budgetary information.[8]

USVI Residents and Business Owners

The economy of the USVI depends heavily upon tourism. About half of local employment and half of the GDP involve tourism, trade, and other service industries. The other half of the economy is roughly split between government and manufacturing. The main manufacturing products are rum, electronics, pharmaceuticals, and watches. The agriculture sector is small, and most food is imported to the islands. Total GDP is approximately \$1.577 billion, with \$14,500 per capita. In 2002, it was estimated that 28.9 percent of residents live below the poverty line. Historically, the USVI was a major producer of sugar cane and rum, fueled by African slave labor. About 76 percent of residents are of African heritage, mostly descendents of those brought over during the slave trade in the 18th and 19th centuries.[3]

All are feeling the pain of \$0.58 per kWh electricity. These are electricity prices five times the national average. Businesses are shutting down and residents are forced to camp in their homes. This has truly created a crisis situation in the USVI. Public sentiment is that WAPA and the government are not serving the good of the people. Many believe these organizations are short of cash because of their inefficiency and corruption. The view of many is well-summarized by the words of one resident Greg Hargus, "Fire all in WAPA and start over. We need somebody to take it over and do it right. The equipment and lines are falling apart yet I can find WAPA employees drinking and smoking pot all over the island every day." Outages, high rates, and a lack of transparency have all damaged the credibility of WAPA in the public eye. Government scandals have made it difficult to trust elected officials. This widespread distrust will make any large development difficult, for large projects on government land require public approval in order to proceed. The usual cultural response to any large project is negative, for fear of exploitation and of changing the beautiful island landscape. That being said, all residents feel the pain of high electricity bills. Most find it strange to burn expensive oil when the Caribbean sun shines year-round.

VIEO

The Virgin Islands Energy Office (VIEO) was created to promote policies to support cheap, clean energy. VIEO was awarded $32 million in American Recovery and Reinvestment Act money. A million of this was given to schools, churches and other buildings to install wind, solar, and energy efficient devices. Improvements included rooftop solar, small-scale wind, solar water heaters, light-emitting diode (LED) lighting, compact fluorescent lighting (CFL), day-lighting, and high-efficiency air conditioning. VIEO regularly publishes articles on how residents can save energy on its website www.vienergy.org.

Department of Energy (DOE) and National Renewable Energy Lab (NREL)

The DOE is a department of the President's cabinet that creates energy policy. It is lead by the Secretary of Energy. A major part of DOE's job is to operate dozens national labs and research facilities, including NREL. NREL focuses on fundamental science, energy analysis, and commercial product testing in clean energy technology. These are very valuable partners for the USVI. These large, powerful organizations are full of industry experts to guide the development of the USVI energy sector. The USVI can be seen by clean energy experts as a proving ground for renewable energy. With the engagement of DOE and NREL, development of clean energy in the USVI will bring much-needed help to the islands and will stand as a demonstration of the US commitment to sustainability.

Outside Investors

For US-based developers of energy infrastructure, the USVI is relatively unknown, but very tempting. Solar developers in the states have never seen a region with $0.58 per kWh electricity. Assuming costs are similar to costs in the states, this means enormous profit margins for the developer. This same fact applies to developers of wind, biomass, landfill gas, and waste-to-energy. If projects are desired, high margins will make it very easy to entice companies to build them. Outside investors rely upon public acceptance in order to get their projects approved by the government. They must work to build a good reputation among the public by employing locals and involving people in the decision-making process.

Act 7075

Act 7075 is an energy bill signed in 2009 that creates a series of three goals, ending in the 60 percent fossil fuel reduction by 2025. By 2015, 20 percent of electricity generation must come from renewable sources. This increases to 25 percent in 2020 and 30 percent in 2025. Act 7075 provides incentives for wind and solar and reduces barriers to their adoption. This act removes import duties on components for wind and solar systems. Building codes will be revised to be compatible with wind and solar systems. Tax exemptions are given for wind and solar equipment. Rooftop solar water heaters that supply at least 70 percent of the consumption are required on all government buildings, new commercial buildings, and new residential buildings. The government is required to build public awareness of energy issues and to train specialists, in order to stimulate private sector involvement and local investment. This includes a solar energy training program through the VI Career and Technical Education Program.

Act 7075 establishes a formal net-metering system, and expedites the application process. Total net-metered capacity is not to exceed 5MW on St. Croix and 10MW on St. Thomas and St. John combined, for reasons of grid stability. Residential net-metered systems may not exceed 20 kW AC of the rated peak capacity. Commercial systems and systems on public facilities may not exceed 500 kW and 1MW, respectively. These limits may be exceeded if the system has energy storage exceeding 25 percent of the rated peak capacity and a power control system that will ensure that ramping up or down will take at least 15 minutes. Net metered systems must comply with the following safety standards: The National Electric Code, Underwriter's Laboratories UL 1741, IEEE 929 and 1547, and International Building Codes. The system must be located with a quarter mile from a large load or a substation, and its output may not exceed 75 percent of the transformer capacity.

To install a net-metered system, an application must first be approved by the Department of Planning and Natural Resources (DPNR), and another application must be submitted to WAPA for approval and installation. The DPNR application process is the main hold-up, for it usually takes six weeks or more, costs several hundred dollars, and must be completed fully before the WAPA application may proceed. Act 7075 includes two important statements to protect the customer and to ensure WAPA compliance with net metered systems. Once an application is submitted, WAPA must review the application, approve the application, and install a net meter cable with five business days. This prevents WAPA from stalling applications, which it has been known to do. Also, WAPA may not charge customers for electricity they provide to the grid if the project has been approved by DPNR. Often electricians connect net-metered systems into the grid after approval by DPNR but before WAPA approval. This is done because of the long delays in processing by WAPA. Many customers, including the Gifft Hill School on St. John, have complained that they were charged for power they put into the grid, instead of credited, during this time period before WAPA approval.[9]

Chapter 2: What are the Options?

The USVI is poised to be a world leader in clean energy. Developing clean energy in the USVI will be a sound economic decision and a clear improvement to the current system. All the pieces are in place. Renewable energy sources in the region are cost-competitive with fossil fuels. Investors are interested. There is widespread public dissatisfaction with the current electrical system. DOE and NREL have renewable energy expertise and are willing to help. All that's needed is the right actions. The USVI took a major step forward in passing Act 7075 to create the 60x25 goal. Now, the USVI must move forward to meet its ambitious goal. In this paper, I will suggest the actions that will bring the USVI to this goal and further.

First, let's look at the requirements. Below are the criteria for plans forward, in order of importance:

- Electricity cost reduction
- Local support and involvement
- 60 percent reduction in fossil fuel use

Any plan must put the highest priority on the wellbeing of the USVI people. As such, the most important factor in a plan forward is to reduce electricity costs. The USVI is facing the real possibility of a shrinking economy as businesses shut down. Hundreds of residents are forced to camp in their homes, without water or electricity because they are unable to pay for $0.58 per kWh electricity. This is unacceptable. Unless costs come down, the USVI risks severe political and economic pain. The next in order of importance is local involvement in the decision-making process and in development. Any plan must create jobs for the USVI people and must reflect the public desire. Without public support, development will be slow and will not benefit the residents as much as it should.

Finally, the plan must advance the USVI towards a 60 percent reduction in fossil fuel use by 2025. I believe clean, sustainable energy production is a valuable pursuit unto itself, but it is also the clearest way to satisfy the two higher goals. Development of renewable energy sources will lock-in electricity prices for many years in the future, freeing residents from the burden of fuel oil price shocks. Furthermore, there is popular support of clean energy among residents. USVI people have a lot of pride and appreciation for the beautiful islands they live in. This pride translates into a firm belief that the local resources like the persistent trade winds and hot Caribbean sun should be utilized to serve the people. Residents have tolerated expensive diesel-fired electricity from WAPA for decades. Now is the time to initiate the change they have been waiting for.

In 2010, NREL prepared an in-depth report on the energy options for the USVI, entitled U.S. Virgin Islands Energy Road Map. This detailed report was funded by the DOE, under the

Energy Development in Island Nations (EDIN) initiative. It was the beginning of a partnership between the USVI government, DOE, and the Department of the Interior (DOI), created to plan how the USVI will meet the 60x25 goal. The Road Map addresses many of the pros and cons of potential clean energy sources. The report suggests three different pathways towards achieving the 60x25 goal. This analysis relies on and then expands the work of NREL to include political concerns, local issues, and economic and technological developments since 2010. This chapter identifies all the possible energy sources and their potentials. The next chapter focuses on the most viable options, creating a plan forward.

Technology	Resource Potential in USVI	Technical Maturity	Approximate Cost of Delivered Energy*	Estimated USVI (Island-Specific) Installation Cost	Land Use Impact	Included In Road Map
Biomass Power	Medium	Commercial	$0.13 - $0.18 /kWh	$8,500/kW	High	Yes
Concentrating Solar Power	Low					No
Geothermal Power	None					No
Landfill Gas	Medium	Commercial	$0.18 - $0.27/kWh	$1,715/kW	Low (existing landfills)	Yes
Marine and Hydro-kinetic Power	Uncertain, likely low	R&D/ prototype				No
Ocean Thermal Energy Conversion	High	R&D/ prototype				No
Solar Photovoltaics	High	Commercial	$0.19 - $0.36 /kWh	$6,000/kW (utility) $8,000/kW (residential)	Medium (5-8 acres per MW)	Yes
Solar Hot Water**	High	Commercial	$0.15 - $0.20 /kWh	$4,000/system (4-person household)	Low (typically rooftops)	Yes
Waste-to-Energy	Medium	Commercial	$0.08 - $0.16 /kWh	$8,200 - $8,500/kW	Low	Yes
Land-Based Wind Power	High	Commercial	$0.10 - $0.20 /kWh	$3,600/kW (utility) $4,000/kW (residential)	Medium (~2 acres per MW)***	Yes
Offshore Wind Power	High	No commercial facilities in North America	$0.20 - $0.30 /kWh	>$4,250/kW	Low	No

Figure 3: Table of potential sources of renewable energy in the USVI, prepared by NREL in the Road Map. Of those considered, NREL finds biomass, landfill gas, solar PV, solar water heating, waste-to-energy, and land-based wind to all be promising.[1]

Figure 3 shows the potential sources of renewable energy in the USVI. Of those considered, NREL finds seven sources to be promising: biomass, landfill gas, solar PV, solar water heating, waste-to-energy, and land-based wind. Of these, waste-to-energy is estimated to have the lowest cost of energy delivery, next to wind and solar hot water. Solar PV, although it is growing in popularity among home and business owners, is estimated to have the highest cost of energy delivery. The avoided cost for WAPA, in terms of dollars per unit energy, is about $0.24 per kWh. By NREL's estimates, all but offshore wind can provide electricity at a price below the avoided cost. The technologies with the potential for the highest impact, in terms of avoided barrel of oil per year, are wind, solar PV, and solar water heating. Waste-to-energy and landfill gas electricity output are both limited by the volume of trash production. Solar and wind utilization are limited by available land area.[1]

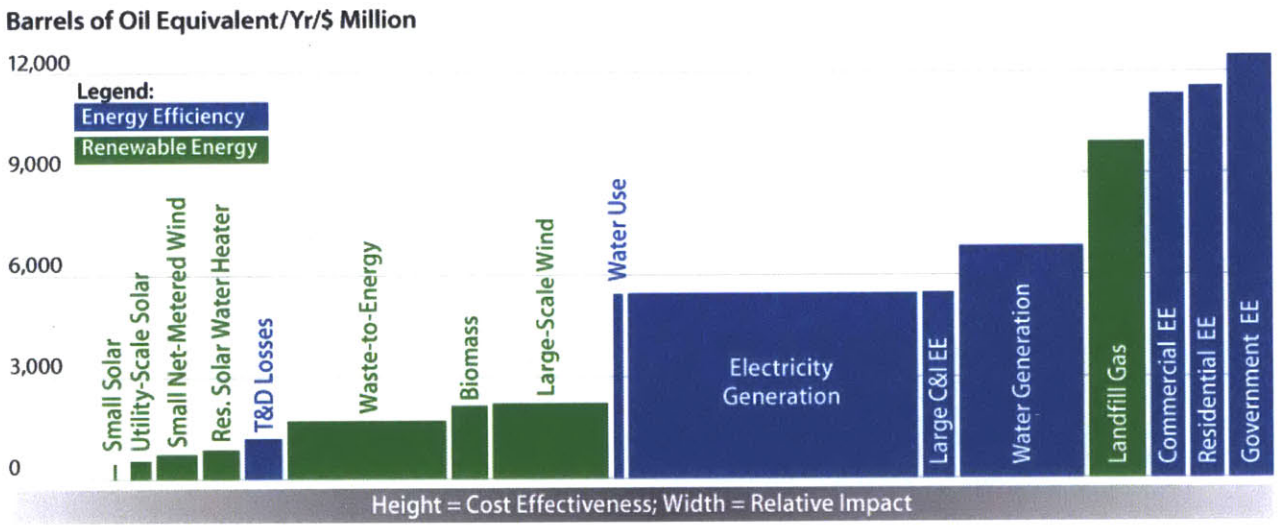

Figure 4: This is a bar graph of cost effectiveness vs. relative impact. Cost effectiveness is measured in barrels of oil avoided per year per million dollars. Relative impact is measured in total barrel of oil per year that can be avoided. It can be seen that the technologies with the largest potential impacts are waste-to-energy, wind, electrical generation efficiency, and water generation efficiency. The most cost-effective improvements are consumer efficiency improvements for the government, residents, and businesses.[1]

Figure 4 shows the cost effectiveness of each technology versus the relative impact it may have in reducing fossil fuel use. Cost effectiveness is measured by the number of barrels of oil per year that are avoided per million dollars invested in the technology. Relative impact is measured in the total number of barrels per year that may be avoided by fully implementing the technology. It can be seen that end-user efficiency improvements are the cheapest, but they can only reduce fossil fuel use by a relatively small amount. The technologies with the largest potential impacts are fuel supply expansion, electrical generation efficiency improvements, water generation efficiency improvements, waste-to-energy, and wind power. On the other side, utility-scale solar is estimated to be both expensive and to have a small impact.[1]

Fuel Supply Expansion

WAPA has purchased fuel oil from HOVENSA below market prices in the past, but HOVENSA is no longer operational. Currently, WAPA is searching for new suppliers and looking to expand fuel compatibility to natural gas and propane. WAPA plans to move forward such that fuel oil, natural gas, and propane can all be supplied to and burned in their power plants. In this way, WAPA may respond quickly to changes in price and fuel supply availability. The intention is to reduce and stabilize fuel costs. WAPA estimates that it may lower its fuel costs by 30 percent by implementing this tri-fuel solution.[12]

In October 2012, WAPA issued a Request for Qualifications to supply liquefied petroleum gas (LPG) or liquefied natural gas (LNG), and received thirteen responses for LPG and eight for LNG. In January of 2013, WAPA issued a press release including a short list of three LPG suppliers: Trafigura AG, an international commodities trading company based in the Switzerland; Vitol, an international commodities trading company based in the Netherlands; and a consortium between Geogas, an international LPG trading company based in Switzerland, and Polaris, a company I can't find any information on. The selected LPG supplier must design and implement a solution for reliable supply, fuel storage, fuel transportation, and turbine conversion to allow compatibility with all three fuels. The press release included a short list of LNG suppliers: Pacific Rubiales; Gasfin; LNG Enterprises; and Cheniere.[10]

WAPA plans to convert to LPG first then convert to LNG later. The USVI does not have a port of sufficient size to accommodate a large-scale LNG ship, and small or mid-scale LNG is not currently available in the Caribbean. LPG is currently available for the Caribbean at desirable prices compared to fuel oil, and the ships are small enough for the USVI. LPG conversion is expected to take 18 months after a contract is signed, including air quality approval by the EPA and permitting approval by DPNR. A contract for LNG may be signed as early as summer 2013.[10]

Electrical Generation Efficiency

Not only do WAPA power plants burn oil, but they are also horrendously inefficient. Most of the generators use the excess steam to desalinate seawater to provide water to homes and businesses. This desalination process, in part, leads to very low fuel efficiencies since a great deal of heat is not used to produce electricity. Power plants in the USVI average over 15,000 BTU/kWh, while those in Hawaii and Guam average around 10,000 BTU/kWh. Two plants on St. Thomas and two on St. Croix have installed waste heat recovery steam generators (HRSG) to improve production efficiency. With HRSG, excess steam is used to run a second turbine, not municipal water production. Instead of desalination for water production, reverse osmosis could be used instead. Reverse osmosis plants are approximately eight times more efficient than distillation. If all facilities were retrofitted with HSRG, WAPA could see a large in generation efficiency.[1]

According to NREL, WAPA may be able to realize as much as a 22 percent increase in generation efficiency by installing HSRG, switching to reverse osmosis, and improving operations. This is a huge improvement. NREL also estimated that WAPA may reduce distribution losses by 2 percent. Together, HSRG and distribution upgrades could improve efficiency by 24 percent, which amounts to 40 percent of the 60x25 goal. From figure 4 it can be seen that generation efficiency improvements are among the most cost-effective upgrades that can be made, only more expensive than end-user efficiency, landfill gas collection, and water generation.[1]

End-User Efficiency

According to NREL, residential, commercial, and industrial end-users may reduce their energy use by 20 to 40 percent by implementing energy efficient technologies. In figure 4, it can be seen that these end-user improvements in efficiency are the most cost-effective ways to reduce fossil fuel use, although they have a small relative impact on total fossil fuel use. They may be cheap, yet these improvements to non-government end-users are difficult for the government to control. New building codes can ensure that new construction is energy efficient, but they will not apply to existing buildings. Before efficiency upgrades can be made, the industry must develop. Currently, I know of no operating end-user efficiency contractors.[1]

Solar

The solar resource in the USVI is abundant. There is frequent sun and lots of south-facing slopes and roofs. Though the islands are small, there is more than enough land area to provide for the territory's electricity needs entirely by solar. If this is true, why not run the whole territory on solar? In the Roadmap, NREL writes that cost will be the major limiting factor for solar installation. NREL is not entirely correct. Solar is the highest cost renewable, but it is currently flourishing in the USVI. In 2010, NREL wrote that solar would lie between 6 and 13 MW of installed capacity. Including installed and projects currently in progress, the USVI will have at least 20 MW of installed solar capacity within the next few years. To NREL, I declare that solar may be expensive, but WAPA's oil-fired power plants are even more expensive.

In reality, the most important limiting factor for solar will be grid stability. Current practice limits grid-tied photovoltaic systems to 15 to 25 percent of the peak electrical demand. If more PV is installed, back-up power sources may not be able to fill-in intermittencies in PV output quickly enough. The result is an unreliable electrical grid, prone to blackouts. This unreliability can be avoided with energy storage, improved power electronics, forecasting, and increased communication on the grid. Yet, these all come at an additional cost. According to one estimate, this cost is still below the avoided cost to WAPA of $0.24 per kWh. Clean Coalition, a bay-area nonprofit, plans to provide 25 percent of St. John's electricity with 12 MW of PV at a cost of $0.20 per kWh. If this estimate is correct, then high percentages of PV are not only possible, but cost-effective.[1]

In the USVI, solar has some significant advantages over other renewable energy sources —primarily ease of transport and installation. By contrast, wind, biomass, and waste-to-energy all require a very high degree of expertise for installers. Solar panels can be easily shipped to the USVI, whereas wind turbines are much more difficult. A traditional electrician can install a residential photovoltaic system. In fact, many savvy homeowners have done their own installations, and had the final connections done by a licensed electrician.

The residential solar industry is facilitated by various tax exemptions and a net-metering program. Net-metering is a great deal for the consumer/producer, since the consumers sell their produced power at the retail price, eliminating the need to install pricey energy storage. It is a terrible deal for WAPA, since net-metered electricity is the most expensive that they buy. As a result, WAPA and net-metering customers are at odds. Meters have been installed incorrectly by WAPA; applications have been delayed for months; and customers have been charged instead of credited for the power they produce. Many customers and installers feel that this dysfunction on the part of WAPA is a purposeful effort to hinder the development of net-metering. Whether purposeful or not, WAPA has, at the very least, delayed development of residential and small commercial solar. From the point of view of WAPA, purchase power agreements (PPAs) are much more desirable, for WAPA can still turn a profit. In the case of net-metering, WAPA is giving away electricity for free.

According to local residential solar developer, William Osborn of Pro Forma Solar, installers number less than a dozen over the three islands. Typical systems for Pro Forma Solar have been 10-20kW residential systems. Current policy limits net-metered systems to 10MW on St. Thomas/St. John and 5MW on St. Croix. Current system capacity has not been published by WAPA yet. It is fairly certain that WAPA will calculate net-metered capacity based upon the total nominal rated power output, which is far-removed from the true power output. If solar is to make up a significant portion of the 60x25 goal, the net-metering system must be improved and more utility-scale solar PPAs must be negotiated.

In 2011, 451 kW of solar was installed along the landing strip of the Cyril E. King Airport on St. Thomas, funded by the DOE through ARRA. This is the largest existing solar installation in the USVI, and will provide 15 percent of the airport's power requirements. Four different utility-scale solar installations across territory, totaling 9 MW on both St. Thomas and St. Croix, are currently in development. WAPA requested proposals for solar projects, and received 27 different proposals. With the help of DOE and NREL, WAPA agreed to sign six PPAs in June of 2012. The projects are planned to provide WAPA electricity at an average of $0.18 per kWh for 25 years. This is an historic project for the USVI, for the 9MW will provide almost 20 percent of the peak demand of St. Croix.[1]

The above project is part of a rapid increase in solar installations. At current rates, the 15 MW net-metering limit will certainly be met by 2025. If the 18MW project and the 12MW Clean Coalition project on St. John are both installed, this gives a total of 45MW of installed solar capacity, about a third of peak demand. This would give the USVI one of the highest solar penetrations in the world.

Wind

Sailors have long known of the consistent trade winds in the USVI that blow year-round. On land, these winds are strongest along ridgelines and on Southern coasts. Unlike PV, the performance of wind turbines can vary a great deal from site-to-site, and is difficult to predict without several years of wind data. Two promising sites have been identified: the Bovoni landfill on St. Thomas and the Southeastern shore of St. Croix. These sites were chosen they are already industrialized and they have consistent winds. Data is currently being collected on both sites to assist in designing the systems. Though the data and simulations are not complete, NREL estimates that the USVI will receive 22.5 MW across the two systems.[1]

These two proposed projects have been very slow in development. Several years passed between the time the projects were brought before the Senate and the time that anemometers were installed to collect wind data. Now that the anemometers are installed, some three to five years of data are required for statistical significance. If the anemometer approval process serves as an example, it could be a decade or more before these wind projects are installed and producing. Wind has a bright future in the USVI, but it will be a long time coming.

Interconnection with Puerto Rico

Interconnection of the USVI and the British Virgin Islands with Puerto Rico has been studied by Siemens PTI. This could be a big step forward towards the 60x25 goal. The interconnection has the potential to reduce the cost of energy, improve reliability, and allow a higher penetration of renewable energy development in the USVI. The Puerto Rican electrical utility (PREPA) has an installed capacity of 5.8 GW and a peak load of 3.3GW. According to PREPA, 68 percent of its energy production comes from oil, 15 percent from coal, 15 percent from natural gas, and 2 percent from hydroelectric resources. PREPA is planning to add 200MW of wind power and 150MW of PV to their portfolio. Electricity prices are approximately half that of the USVI.[12]

While the electricity from Puerto Rico will not be completely "clean", it will allow a much higher penetration of intermittent renewable generation in the USVI without disrupting the electrical grid. If the penetration of renewable generation is capped at 20 percent of peak demand, wind and solar are limited to about 28 MW. If connected to the relative giant that is PREPA, the intermittencies of wind and solar may be easily absorbed, allowing renewable penetrations near one hundred percent. Connection with PREPA will make upgrades to WAPA generation facilities much easier since they can be taken offline without disrupting the grid.[13]

A feasibility study, funded by DOE, was conducted by Siemens PTI in 2010. The study investigated three different interconnections: A 50-mile 100MW-200MW AC or DC link between Puerto Rico and St. Thomas; a 20-mile AC link between Tortola and St. Thomas; and a DC link between St. Thomas and St. Croix. A major factor in the feasibility of a submarine cable is the depth of water between the islands. The PREPA-WAPA interconnection would have a maximum ocean depth of 60 meters, which is easily attainable by current technology. A connection between St. Thomas and St. Croix would be the deepest submarine cable ever installed. A deep sea trench exists between the two islands that is 2200 meters in depth at its shallowest. It is feasible to connect St. Croix to Puerto Rico, since ocean depths are 1700 meters at the deepest between the two islands. The deepest operational submarine link lies at 1650 meters of depth, but 1700 meters is within the capabilities of current technology.[13]

A DC-link from Fajardo, Puerto Rico is estimated to cost $176 million, while a similar AC-link is estimated to cost $120 million.[12] These are large sums of money, and it is unclear who will be willing to pay for it. USVI government and WAPA finances are weak, so money spent on this interconnection would surely decrease funding towards renewable energy project and energy efficiency upgrades. PREPA has little incentive to finance this project because the USVI market is so small. Such a project would take a very long time to construct, and would provide no benefits until complete. This may not be suitable for solving the USVI energy crisis.

Distributed Grid

The main reason to pursue the interconnection with Puerto Rico is to allow for high penetrations of intermittent renewable power in the USVI. This is not the only way to increase the wind and solar limit above 20 percent penetration. One alternative solution, proposed by a bay-area nonprofit Clean Coalition, is distributed solar photovoltaic generation combined with an intelligent grid with energy storage (DG + IG). In a February 2013 letter from Craig Lewis of Clean Coalition to Senator Craig Barshinger, Lewis writes that Clean Coalition can provide 25 percent of St. John's electrical demand and improve grid reliability through a DG + IG program. Lewis writes that electricity can be provided for 20 cents per kWh, less than the avoided cost of 24 cents per kWh. What is more, those prices are locked in for the twenty-year lifetime of the solar panels. Since the price volatility of fuel oil, natural gas, and propane is a significant issue, a price guarantee is very attractive. The plan for St. John includes 12 MW of solar PV, but Lewis writes that there are enough sites on St. John to install much more than that. If the St. John project is successful, the approach may be expanded to other substations.

Waste-to-Energy

In addition to an energy problem, the USVI has a waste disposal problem and an associated air quality problem. Since these are islands, land is scarce. The few existing landfills are full and often do not meet environmental standards. The Anguilla landfill on St. Thomas has failed to meet EPA regulations for the last 25 years. The EPA sued the VI government 2012, yet it still remains open. Landfills continually fail to meet EPA standards because landfill gas is not collected. In the past, there have been several instances of dump fires, caused by build-up of methane in the landfill gas. The Susannaberg landfill on St. John was closed in the early 1990's due to an underground fire. Waste-to-energy has the potential to be very beneficial to the USVI, but projects in the past have faced widespread public opposition.

There are two ways the USVI may fix the waste disposal system: Landfills may be retrofitted with gas collection equipment and landfill gas burned to run an electrical generator; or the incoming trash may be sorted and used to produce electricity. The former option is the minimum requirement of the EPA. The latter option, called waste-to-energy, is especially attractive in an island environment because only a small percentage of the waste enters landfills. The trash may be directly burned, or it may be used in a process called gasification to produce syn gas, which is burned to run a generator. A worry among Virgin Islands residents and legislators is that such a plant may be worse than the landfills in terms of pollution.

In February of 2012, a plan for a waste-to-energy plant on government land on St. Thomas was rejected by the local Senate. Alpine Energy Group, the project developer, had been working with the VI government and WAPA since 2009. This was the second time a proposal was rejected by the Senate. After creating an initial plan in 2010, Alpine was rejected because of the use of petroleum coke, an oil refining byproduct, as a supplemental fuel to the trash. In 2012, Alpine removed the petroleum coke from the plans, but was rejected again due to expensive waste processing and continued public opposition. According to Don Hurd, President of Alpine, "Our project was chosen because it provides the least cost option. If you don't process the trash in the way which we are going to, you either have to ship it off-island, or build a landfill, or come up with another waste-to-energy facility." The sentiment among much of the public and some senators is that a waste-to-energy facility will be a bad deal for the government, and that government money should not go to outsiders like Alpine. The future of waste-to-energy is unclear in the USVI, but political unpopularity will be a major obstacle.[14]

Landfill Gas

As mentioned in the previous section, the EPA has ordered the closing of several landfills for violation of the Clean Air Act. Landfill gas collection is the standard way for facilities in the US to comply with the Clean Air Act. The collected gas is burned to produce electricity. Some consider this process as renewable energy production, while others do not. Whatever the classification, it would bring the USVI closer to the 60x25 goal since it does not use fossil fuels. In reaction to EPA warnings, the government has taken steps towards implementing landfill gas collection. In July 2012, Governor John DeJongh signed a Memorandum of Agreement, allowing Island Roads Corporation to construct a landfill gas collection facility at Bovoni landfill on St. Thomas that would produce 815 kW. The project is funded by $3.01 million by the DOE. The landfill has already been outfitted to collect and burn the naturally-occurring gas, according to EPA regulation. This project will allow the landfill to generate revenue from the collected gas, estimated to be $1 million per year for the next ten years.[15]

Biomass

One outside investor, Tibbar Energy USVI plans to build a 7MW biomass facility of the south shore of St. Croix. The facility will include over 1000 acres of Giant King Grass, which will serve as the feedstock for an anaerobic digestion process. The digestion produces biogas, which may be burned and used to run an electrical generator. This facility will provide dispatchable power, meaning the generators can be turned on and off to match demand. Additionally, Giant King Grass can be stored for several months, so it can provide consistent electricity if growing conditions are poor or if there is a natural disaster. Giant King Grass is not native to the USVI, but it has been grown successfully by Tibbar and is not invasive.[16]

Chapter 3: Pathway Forward

Now, let's look at how this 60x25 goal should be met, recalling that 60x25 refers to a sixty percent reduction in consumption of fuel oil by 2025.In the Roadmap, NREL suggests three scenarios for meeting this 60x25 goal: The high renewable case; the high efficiency case; and the base case, what NREL expects the true outcome to be. In any of these cases, renewable will need to comprise 35 to 49 percent of the 60x25 goal. This means that 21 to 30 percent of the electricity generated in the USVI must come from renewable sources. If this 21 to 30 percent is to come from intermittent renewable like wind and solar, this requires additional installed capacity to account for times when renewable sources are not producing. According to NREL, this ranges from 40MW of installed renewable energy capacity (including 16.5 MW waste-to-energy) in the high efficiency case and 71.5 MW in the high renewable case (including 16.5 MW waste-to-energy). Without the waste-to-energy, which can run at all hours of the day, these installed capacities would need to be higher. Peak demand is approximately 130 MW across the three main islands, so 71.5 MW of renewable energy sources will provide over half of the energy at peak hours.[1]

Technology/Area of Focus	Action Required	Share of Overall Goal
Supply-Side Efficiency		
Generation	Install state-of-the art heat recovery and operational practices	28%
Desalinization	Install state-of-the art RO technology	12%
Transmission and Distribution	Substation and distribution upgrades	3%
Subtotal		**43%**
End-User Efficiency		
Government (Water & Power)	Reduce 75% of consumption by 25%	5%
Residential (Power Only)	Reduce 25% of consumption by 25%	3%
Large C&I (Water & Power)	Reduce 25% of consumption by 25%	3%
Small Commercial (Power Only)	Reduce 25% of consumption by 25%	2%
Subtotal		**13%**
Utility-Scale Renewables		
Waste-to-Energy	16.5 MW	16%
Wind	22.5 MW	12%
Landfill Gas	5 MW	6%
Biomass	3 MW	4%
Solar Photovoltaics	9 MW	2%
Subtotal		**40%**
Distributed Renewables		
Solar Hot Water	40% penetration on residences	4%
Solar Photovoltaics	1 MW	>1%
Small Wind	0.5 MW	>1%
Subtotal		**4%**
Total		**100%***

**Totals may not sum due to rounding*

Figure 5: Base case to meet 60x25 goal. It can be seen that this includes 57.5 MW of renewable energy, a small amount of end-user efficiency upgrades, and a significant upgrade to supply-side efficiency.[1]

What I recommend:

I recommend a scenario akin to the base case as it is represented in this chart by NREL. This pathway will allow the USVI to reach the 60x25 goal primarily by supply-side efficiency upgrades and renewable energy generation. End-user efficiency will make up a relatively small percentage of the goal.Like this base case, I recommend all of the proposed energy efficiency upgrades for the WAPA generation facilities, reverse osmosis for all municipal water production, and transmission/distribution efficiency upgrades. This is estimated to improve overall production efficiency by 24 percent. Efficiency alone achieves 40 percent of the 60x25 goal.

Using NREL's analysis, approximately 60MW of installed renewable capacity is necessary. I recommend and predict that there will be more solar than wind. NREL's base case includes 22.5 MW of wind and 9 MW of solar. This 9 MW of solar will certainly be surpassed, since an 18 MW solar project is already planned across St. Thomas and St. Croix. According to Clean Coalition, 12 MW of solar can be developed on St. John. If these sources are developed and the 15 MW net metering limit is met, there will be 45 MW of installed solar capacity. This is the highest that can be expected to be developed within twelve years. Though the islands are small, 45 MW is not the upper limit on solar development, so in the future solar may be able to expand to provide an even higher percentage of energy.

After efficiency and solar, 15MW more of renewable energy is required. This can come from a variety of sources, including waste-to-energy, landfill gas, biomass, and wind. The 16.5 MW of waste-to-energy is a desirable choice. As mentioned earlier, this would solve a waste disposal problem as well as the energy problem, but it is politically unpopular due to cost and pollution concerns. A major benefit to waste-to-energy is that it provides base load power, day and night, unlike wind and solar. In my view, waste-to-energy could be a great part of the USVI energy portfolio, but it needs political will. Alpine Energy has been voted down twice, but plans to provide a third proposal for a facility in Bovoni. This proposal should be taken seriously and evaluated realistically.

Another possibility is 5MW of landfill gas, as recommended in the base case. Like waste-to-energy, landfill gas has the benefit of providing dispatchable power. Also like waste-to-energy, landfill gas would serve two purposes. The EPA requires landfill gas collection by the Clean Air Act, so landfill gas energy would allow the landfills to comply by regulations and produce dispatchable energy. The 7MW of biomass energy planned by Tibbar Energy will also provide dispatchable energy. These two projects can be characterized as renewable, but their ability to be dispatched to meet current demand mean they do not require costly energy storage like wind and solar. One successful landfill gas collection project already exists on St. Croix.

The other clear choice is wind, though it has had a slow start compared to solar. Potential developments in Bovoni, St. Thomas and the South Shore of St. Croix are currently under investigation. These projects have been very slow in development. It was several years after the projects were proposed until anemometers were installed just to take wind speed data. Five years of data is necessary to obtain statistically significant estimates of the potential power output of a wind farm. Including the likely drawn-out political and planning processes, these wind projects could easily take ten years to develop. Yet, if both areas are developed, the 22.5 MW of wind recommended by the base case could be met.

If all solar, wind, waste-to-energy, biomass and landfill gas projects that are currently being investigated are all developed, this will mean 96 MW of renewable electricity generation capacity. Without waste-to-energy, which is politically unpopular, this leaves 79.5 MW. This is far above what is required by the 60x25 goal. With dedicated effort by the USVI government and WAPA, these projects can be developed and the 60x25 goal can be met easily. The real challenge will be to provide back-up power for the intermittent energy sources.

Renewable Energy Project	Installed Capacity (MW)	Dispatchable?
Net Metering STT/STJ	10	No
Net Metering STX	5	No
Planned Utility-Scale Solar STT	9	No
Planned Utility-Scale Solar STX	9	No
Clean Coalition DG+IG STJ	12	No
Tibbar Energy Biomass STX	7	Yes
Landfill Gas	5	Yes
Alpine Waste-to-Energy	16.5	Yes
STT+STX Wind	~22.5	No
Total	96	
Total w/o Waste-to-Energy	79.5	

Of this 79.5 MW, only 12 MW are dispatchable (landfill gas and biomass). With 67.5 MW of intermittent renewable energy, a source needs to provide energy when wind and solar do not. Gaps in electrical output range from several seconds when clouds pass over to several days when there is a large storm. The large gaps may be filled in by starting one of WAPA's generation facilities, but the small gaps occur much faster than a power plant can start up. For this reason, some quickly-dispatchable source of energy is necessary. The USVI has two options to solve this problem, energy storage and interconnection with Puerto Rico. Both options will require significant upgrades in the grid so that back-up power can respond quickly.

I recommend that the USVI look to develop energy storage instead of interconnection with Puerto Rico. The interconnection is estimated to cost $130 million by Siemens. I believe this to be a generous estimate. The question remains as to who will pay the bill for the project. PREPA, the Puerto Rican electrical utility has little incentive since the USVI is a very small market. The USVI government and WAPA are struggling financially. Not only is this project enormously expensive, it is a tremendous endeavor, and will likely take many years. Worse, it offers no benefit until the project is complete. Unless the interconnection is completed several years before 2025, the 60x25 goal will not be met. Furthermore, large projects in the USVI are frequently aborted before they are complete. The USVI energy future is too important to rely completely upon the success of a single project.

By contrast, development of energy storage is beneficial on an incremental basis. Energy storage can be constructed at the same rate as renewable energy sources are developed. Outside organizations like Clean Coalition can bring together the investors to fund energy storage projects. In this way, the USVI can enjoy a steady rate of renewable energy development instead of waiting for the completion of one project.

With NREL and DOE on board to solve energy issues, the USVI is in a position to serve as a global example of sustainability. The abundant solar and wind resources, combined with relative remoteness make the USVI an ideal location for self-sufficient, clean energy production. The experts at NREL and DOE are willing to help in the design. Outside investors are very interested because of high electricity prices. Solar and wind are mature industries in places like California and Arizona. The companies who develop these projects have never seen electricity rates as high as 58 cents per kWh of electricity. If these companies can be guaranteed a long-term rate, in a PPA or feed-in-tariff, many will be willing to invest. The resources exist. We just need to use them correctly.

Summary of Recommendations to USVI Government:

- Fill the net-metering limit
    - Includes 10 MW of solar on St. Thomas/St. John and 5 MW of solar on St. Croix
    - Continue to provide tax incentives for net-metered homeowners
    - Ensure limit is measured by total power produced, not total peak capacity
    - Fix the current net-metering system:
        - Expedite the approval process
        - Be tough on improper installation and inefficiency

- Support the proposed 18 MW utility-scale solar project
  - Includes 9 MW on St. Thomas and 9 MW on St. Croix
- Develop Clean Coalition DG+IG Project on St. John
  - Includes 12 MW of solar, energy storage, and grid upgrades

- Develop Tibbar Energy Biomass Project on St. Croix
  - Includes 7 MW on renewable, dispatchable biomass energy

- Install landfill gas collection on all existing landfills
  - Produce approximately 5 MW of renewable and dispatchable energy
  - Comply with EPA regulation under Clean Air Act

- Support and expedite development of Bovoni and South Shore St. Croix wind projects
  - Includes an estimated 22.5 MW across St. Thomas and St. Croix

- Oppose interconnection with Puerto Rican electrical grid

- Support fuel supply expansion to liquefied petroleum gas and liquefied natural gas
  - WAPA estimates a 30 percent reduction in fuel costs
  - Ensure this project does not crowd out generation efficiency projects

- Require WAPA to pursue generation efficiency improvements
  - Includes heat recovery steam generators (HRSG) and reverse osmosis for water production

- Work to create education program to develop local expertise in solar, wind, and energy efficiency

This list gives the desired outcomes, but does not say how to get there. It describes the "what" but now the "how". The "how" is, in many ways, a more difficult question to answer than the "what", for the development of the electrical system must occur with many interests in mind. The needs of residents, business owners, the electrical utility, outside investors, politicians, the EPA, and other groups must all be included in the solution. As is, there is no organization to communicate between all actors and to determine the "how". Furthermore, there is no organization that is fully dedicated to energy development in the USVI. WAPA has energy experts, but is new to renewable energy. The USVI government is not composed of energy experts, and has many other issues to consider other than energy development. The US Department of Energy has the expertise but also has many larger issues than USVI energy. No organization is dedicated to the implementation of the 60 percent reduction in fossil fuel use.

A new department of the government is necessary, with the exclusive purpose of developing cost-effective, clean energy in the USVI. Such an organization would interface between the Senate, Executive Branch, WAPA, outside investors, the public, and US government organizations to attract and develop clean energy projects. This organization would communicate with the Senate and the public to help guide beneficial projects through the approval processes. This group will give a boost to USVI energy development.

Careful design of this group is necessary in order to ensure good performance. Members must be knowledgeable of energy issues, politics, and of the USVI. The creation of a new organization brings a risk of more bureaucratic inefficiency. This may end up as just one more hoop to jump through before a project may be developed. To prevent this, I suggest that this organization be very performance-oriented. If beneficial projects are not developed, the department should be restructured and new members should be found as needed. The year 2025 is fast-approaching, so the USVI cannot afford to be inefficient.

Beyond 2025

Though the 60x25 goal established by Act 7075 is ambitious, it is very attainable, given a dedicated effort by the USVI government. Looking past 2025, when renewable energy makes up a high percentage of the energy mix, the USVI will need to develop a means of large-scale energy storage. With very high penetrations of wind and solar, variations in power output will become too large for the back-up system to fill in. Some form of energy storage is necessary to ensure grid stability and continuing development of clean energy. Many options exist today and are in development, but no one is perfect. Among the most promising and widely-used are pumped hydro, compressed air, and batteries.

Pumped hydro involves pumping water uphill when there is excess energy supply, and allowing it to flow downhill to generate electricity when there is excess energy demand. This is among the cheapest ways to store energy. Water can be stored uphill for an indefinite length of time, with minimal loss. One major drawback exists for the USVI—there are no rivers. Typically pumped hydro energy storage occurs on a dammed river, where water is pumped to the top of the dam. Artificial reservoirs can be created in the USVI, but this may result in a significant amount of environmental damage caused by excavation and run-off.

Compressed air storage uses excess energy to compress air, to be expanded to generate electricity when needed. The majority of currently operational compressed air storage projects involve underground caverns, which serve as the container for the compressed gas. The USVI does not have any suitable underground caverns. There are, however, several companies developing products for compressed air storage that use a tank to contain the air. Products like this can be installed anywhere, and may be a suitable option in the coming years.

Batteries store and discharge energy using electrochemical reactions. Countless battery technologies exist, with no clear winner. Sodium sulfur batteries are considered the most mature. Many other technologies are in development. Nearly all development is aimed at reducing battery cost, which is the main limiting factor to battery use. Energy storage is an integral part to the USVI clean energy future, especially after 2025. All methods of energy storage need to be evaluated for suitability in the USVI.

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