Island Energy Innovations, LLC.
Integrating Utility Scale Renewables

Testimony on
Feasibility of Bulk Energy Storage
before the
Energy and Environmental Protection Committee
31st Legislature of the US Virgin Islands

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Thank you for the opportunity to testify before the 31st USVI Legislature Energy & Environmental Protection Committee on the need for energy storage as an integral part of a USVI sustainable energy portfolio. My name is Paul Chakroff. I testify today as a partner in Island Energy Innovations, LLC, a USVI-based energy system design and development group that specializes in environmentally sound, sustainable energy generation in small island developing states.

We applaud WAPA, the VI Energy Office, and the Legislature for initiating programs in energy efficiency & conservation (e.g. energy star, energy conservation in schools , and solar hot water (SHW) projects) and renewable energy (utility scale and distributed SHW photovoltaic (PV) net metering and Feed-In-Tariff, and Acts 7075, 7705 and 7586). These initiatives have placed us on par with California, Germany and other World leaders in PV energy grid penetration capacity per capita. We are also pleased to see a 31% reduction in WAPA bills due to a 38% reduction in cost of fuel oil and a lower WAPA unrecovered account balance (per WAPA Executive Director, Hugo Hodge's April 8 2015 testimony before this committee). Finally, we applaud WAPA for bringing on 19 MW Solar PV installed capacity @$0.155/kWh from RFPs.

That is all good news. We are concerned, however, that the USVI is reaching or has virtually reached the limits of our ability to accept additional variable renewable energy (wind and solar PV) onto our grid. The cap on non-baseload renewables severely limits future grid-connected PV installations (residential, commercial and utility). We are presently facing a sunset of net metering program for residential systems larger than 10KW. Going into the future we will be subject to the high costs and uncertainty of future fossil fuel prices for over 60% of our electric energy generation according to the highest renewable energy scenario in the USVI Energy Roadmap prepared by the National Renewable Energy Laboratory (NREL).[1] According to Hugo Hodge, fuel oil prices may be expected rise within 12 to 18 months (April 8, 2015 testimony before this committee).

How does IEI's approach compare with WAPA's and the USVI Energy Roadmap Analysis going forward?

It is our understanding that WAPA / Energy Roadmap plan / Act 7075 is as follows for energy generation:

Today	Peak energy load satisfied with ~15% solar PV + ~85% diesel fuel combustion
Jan 1, 2015	(per Act 7075 §1152) 20% of peak demanded WAPA generating capacity derived from renewable energy

1 U.S. Virgin Islands Energy Road Map: Analysis, Eric Lantz, Dan Olis, and Adam Warren, Technical Report NREL/TP-7A20-52360, September, 2011

Jan 1, 2020	(per Act 7075 §1152) 25% of peak demanded WAPA generating capacity derived from renewable energy
Jan 1, 2025	(per Act 7075 §1152) 30% of peak demanded WAPA generating capacity derived from renewable energy
	(per the USVI Energy Roadmap high renewable scenario) ~20% wind/solar + (by deduction) ~20% baseload renewables (biomass, WtE and landfill gas) + ~60% fossil fuel (LNG/LPG/diesel tri-fuel)
Some date beyond 2025	(per Act 7075 §1152) "a majority" of WAPA's generating capacity derived from renewable energy + up to 50% fossil fuels (LNG/LPG/diesel tri-fuel)

Based upon th IEI/Gridflex Services pre-feasibility study,[2] we propose that the following goals are readily achievable **IF** WAPA integrates bulk energy storage into our St. Croix and St. Thomas portfolios:

2020	(per Act 7075 §1152) 25% of peak demanded WAPA generating capacity derived from renewable energy
2020	90% of peak demanded WAPA generating capacity derived from renewable energy: STT - - 42% wind, 27% Solar PV, 8% WtE + 16% LNG/LPG/diesel tri-fuel STX - - 27% wind, 29% Solar PV, 23% biofuel, 12% WtE + 8% LNG/LPG/diesel
2025-2030	virtually 100% of WAPA's day-to-day generating capacity derived from renewables

While the IEI goals are progressive, they are not out of line with other forward-thinking island states:

- In 2012 the South Pacific Territory of Tokalu (pop. 1,400) become is the first island state to achieve 100% power generation from renewables (solar PV/battery)[3]
- As of August 2015 El Hierro, Canary Islands (pop. 10,000) achieved its 100% renewables goal (wind/pumped hydro storage)[4]
- Bonaire (pop. 16,500) close to achieving 100% of its energy from renewables (wind/biodiesel).[5]
- Faroe Islands (pop. 49,000) is on track to achieve 75% renewable energy (primarily wind / hydro/ pumped hydro storage) generation by 2020 and 100% by 2030.

Because it is similar in many ways to the USVI, I will take a few minutes to describe the renewable energy policy of the Faroe Islands, an 18 island self-governing country within the Kingdom of Denmark located 200 miles north of Scotland. According to a recent article in Discover Magazine:[6]

> "Because of the Faroe Islands' small size, when volatile weather knocks out power in one spot, it often effects the power supply elsewhere as well. And since it is isolated from mainland Europe's energy sources, the Faroe Islands historically has relied on imported oil to generate electricity and

2 A Renewable Energy + Storage Base for the United States Virgin Islands, Island Energy Innovations, LLC and Gridflex Services, LLC, September 2014
3 http://www.the9billion.com/2012/11/14/pacific-island-tokelau-successfully-reaches-100-renewable-energy-goal/
4 http://elpais.com/elpais/2015/08/20/inenglish/1440063550_895429.html
5 http://blog.rmi.org/blog_2015_01_07_a_caribbean_island_says_goodbye_to_diesel_fuel
6 POWER ISLAND, An isolated North Atlantic archipelago courts a renewable energy boom, Sarah Kollmorgen, Discovery Magazine, July/August 2015

keep the lights on. In 2011, about 60 percent of the region's power came from imported oil - - a practice that will only become more costly if oil prices rise."

"To circumvent the volatility of the oil market and preserve their slice of Eden, Faroe Island residents are developing a power system based on renewable energy. At the heart of their plan is an unusually ambitious goal: to produce 75% of the nation's electricity from renewable resources by 2020….."

"So how does this little-known fishing nation with a population of 49,000 plan to achieve this? By marketing itself as the perfect playground for experimental green energy technology."

"If the Faroe Islands succeeds in developing a stable energy system that integrates large amounts of renewable energy, not only will the country secure its own economy, it also could light the way toward low-carbon energy solutions around the world."

"The islands are ripe with fuel for wind, hydro and tidal power….. In this remote archipelago, harnessing the elements to supply its power make perfect sense."

"Similar to larger countries attempting to expand renewables, the Faroe Islands' biggest problem lies in storage and integration into the grid.

Does this sound familiar? The Faroe Islands are an isolated island state with 49,000 population, excellent domestic renewable energy resources, with annual rainfall of 50 inches, suffering from high and volatile energy costs due to dependency on imported oil.

Yet, according to Faroese Electricity Company (SEV) project manager Terji Nielsen[7], "Faroe Islands aims to get 100% of its electricity from renewable sources by 2030.

We should seriously consider the Faroe Islands example. If they can aspire to achieve 75% energy generation from renewables by 2020 and 100% by 2030, the USVI certainly can. In many ways we have better resources than they do - - wind, solar, ocean currents, OTEC, low-delta temp geothermal, longer growing season for biofuels. We have the infrastructure - - long runway airport, deep water ports, piers and industrial zoning on south shore of St. Croix. We have the location - - under three hours flight from Miami, on maritime shipping routes to Africa, S. America, Mediterranean, and Asia via the Panama Canal. We are better situated from a resource, geographic and infrastructure basis than Faroe Islands.

I don't propose we strive to achieve a 90% or 100% renewable goal to be listed as a world leader in renewable energy development and climate change abatement. Although that notoriety and market position would definitely have economic benefits to the USVI. I promote renewables because they provide a sustainable, affordable, energy future that is not subject to the price volatility of petroleum pricing not under our control.

Like the Faroe Islands, we must think inside as well as outside the box. In order to escape the costs and volatility of imported petroleum, we need to move to commercially-proven renewable energy technologies (like wind, solar, biomass, and WtE) to meet current energy demand, while creating a climate favorable for economic development from private-sector research and development of cutting-edge energy technologies.

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7 The Faroe Islands Are Getting Europe's First Lithium-Ion Battery Directly Supporting Wind by Jason Deign, Greentech Media, April 24, 2015, http://www.greentechmedia.com/articles/read/Faroe-Islands-Support-Wind-With-Lithium-Ion-Battery

In highlighting Faroe Islands I am making the point that IEI's proposed energy future for the USVI that is achievable not extreme. Integrated variable energy / storage portfolios like the one we propose is being implemented in the Faroe Islands and elsewhere in the world as we speak.

The critical component required for enabling grid penetration of variable wind and solar energy above 20% or 25% is storage, including both (short-discharge time and low rated power) battery storage and (long discharge time & high rated power) "bulk energy" storage. The Faroe Islanders understand the need for both short-term and bulk energy storage.

Returning from the North Atlantic to the Caribbean Sea, I will summarize my points and ask my partner, Steve Garner to guide us through a brief PowerPoint presentation highlighting the findings IEI's pre-feasibility study on the 90% renewable energy + energy storage portfolio that enable the US Virgin Islands to escape the high and price-volatile costs of imported petroleum fuel that debilitate our economy and degrade our environment.

Today we are asking for the Senate to support an in-depth study of the feasibility of integrating bulk energy storage into St. Croix and St. Thomas/St. John grids in order to maximize penetration of variable wind and solar energy into those grids. In the year since IEI and Gridflex produced our pre-feasibility study for energy storage in the USVI, substantial improvements have been made in battery storage technology performance and economics. The feasibility study currently recommended by IEI for the USVI should investigate several bulk energy storage alternatives, including pumped hydro storage, and solid state and flow batteries.

IEI agrees with WAPA and Senate actions to date, including solar water heater, net metering, Feed-in-Tariff and propane initiatives. We also agree with WAPA for the need to adjust net metering and FIT rates for sale and purchase of electricity to make the program economically sustainable for the utility. We understand WAPA's position on a net metering sunset for residential customers after 2025; but we feel that that sunset would not be necessary under the IEI scenario.

We disagree with WAPA's proposed next steps that would:

- invest in new gas turbines;
- cap additional wind and solar PV;
- force exodus of consumers with access to private capital from the WAPA grid;
- burden less fortunate electricity consumers with higher rates due to reduced ratepayer base;
- commit the USVI to decades of high (60% or greater) dependency on price-volatile fossil fuels for electric energy generation.

WAPA's highest renewable energy scenario for 2025 reflects a ~20% grid penetration from variable output renewables (wind & Solar PV), a reasonable limit for islands that are not interconnected with larger grids. IEI's dramatically higher penetration of wind and solar (56% on St. Croix and 69% on St. Thomas/St. John) is enabled by storing a modest amount of variable output energy for use when demanded. In the IEI scenario:

- 68% and 76% of wind /solar energy go directly to the grid to meet load demand on STX and STT/STJ, respectively;
- 18% and 11% of wind / solar energy is stored for future use on STX and STT/STJ, respectively;

- 14% and 13% of wind / solar energy is curtailed on STX and SRT/STJ, respectively. The curtailed energy has the potential to satisfy some high-load demands, such as RO desalinization and industrial loads.

Benefits of IEI approach to ratepayers and WAPA include:

a. Fixed wind and solar costs below fossil fuel costs;

b. Taking advantage of continuing cost reductions for wind and solar technologies;

c. Fixed cost of electricity, not 60% of USVI energy portfolio subject to oil price volatility;

d. Maintaining WAPA customers rather than loosing customer base , with remaining ratepayers covering WAPA's fixed costs;

e. Meeting USEPA greenhouse gas goals over next decades;

f. Public health and quality of life benefits for the citizens of the Virgin Islands; and

g. Continuing to maintain a position of national, regional and international leadership in integration of green technologies.

Our next step in moving forward is to undertake a detailed feasibility study (actually series of studies) for STX and STT/STJ, including alternatives analyses for various energy storage technologies. IEI's proposed feasibility study is included in the 2015 USVI Comprehensive Economic Development Strategy (VICEDS), is consistent with the USVI's 60% by 2025 goal, USVI Energy Production Action Plan, the USVI Energy Roadmap Analysis, EDIN's USVI Energy Challenge, and the Integrated (Energy) Resource Plan.

Our request today is for the Committee on Energy and Environmental Protection to support reprogramming to the appropriate USVI government entity of $500,000 originally appropriated for Durant Tower Construction for the purpose of assessing the feasibility of constructing renewable energy generation, storage and transmission infrastructure on the islands of St. Croix and St. Thomas. A Scope of Work for the proposed feasibility study is attached four your consideration.

Thank you for the opportunity to testify before the 31st USVI Legislature Energy & Environmental Protection Committee on the need for bulk energy storage to be included as an integral part of a USVI sustainable renewable energy portfolio.

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