The USVI energy sector provides electricity to 45,000 residential and 9,000 commercial customers across five islands. Delivering this power is a complex undertaking that relies on two fossil fuel power plants, three solar facilities, eight substations, undersea cables, and more than 1,000 miles of transmission and distribution cables, a large portion of which are above ground. Most of the infrastructure is owned and run by USVI Water and Power Authority (WAPA), a public utility overseen by a board of directors and regulated by the USVI Public Service Commission.

The vast majority of the Territory’s power comes from old and inefficient fossil fuel power plants. Partly as a result, WAPA’s electricity rates are nearly three times higher than average rates throughout the US and are among the highest in the Caribbean and the world. While USVI residents use, on average, less than half the energy of an average American residential customer, they pay $30 more a month in electricity bills. This disparity is even greater for commercial and industrial customers. This, compounded by a historically unreliable grid and a dramatic decrease in solar and battery storage prices, is driving customers to install their own generation systems.1 WAPA’s electricity sales dropped 15 percent between 2010 and 2016, the most recent period for which data is available.

This trend has exacerbated WAPA’s existing state of financial distress. A recent report by the Congressional Research Service found WAPA’s revenues do not adequately cover its expenses, which is partly due to a high non-payment rate across its customer base.2 At the end of Fiscal Year 2017, customers owed WAPA $46 million, including: $22 million from the Government of the Virgin Islands (GVI), $13 million from commercial and industrial customers, and $11 million from residential customers. In addition, WAPA has a large unfunded pension liability.3 These factors, combined with declining sales, led the rating agency Moody’s to downgrade WAPA’s credit rating in 2017 to below investment grade.4

While WAPA was already in a difficult position before the hurricanes, the unprecedented landfall of two Category 5 hurricanes within 14 days caused the kind of damage from which even a well-positioned utility would struggle to recover. More than 90 percent of WAPA’s aboveground power lines were damaged, cutting power to all of WAPA’s customers. Four of the utility’s 18 fossil fuel generators and all of its solar fields—together representing over 20 percent of WAPA’s generation capacity—were impaired as well. The island of St. John was hit particularly hard: utility power was not available for 49 days, and customers on the eastern side of the island waited for more than 100 days for power to return. Across the Territory, power restoration took more than three months. WAPA met the Governor’s goal and, with the help of over 800 off-island linemen, over 90 percent of eligible customers were restored by Christmas.

In the future, high winds and storm surge from more intense hurricanes and rising sea levels will pose increasing risks to the USVI’s energy system, with potentially similar consequences as the 2017 hurricanes. The influx of federal funding to recover from the hurricanes presents a once-in-a-generation opportunity to transform the USVI’s energy system to better face these risks. Money alone, however, will not address the structural challenges facing WAPA that have pushed the utility to a near-crisis state. New investments must be paired with significant regulatory reforms and a push to catch up to industry best practices.

Increasing the resilience and reliability of the USVI energy system requires a focus on four separate goals. First, WAPA needs to transform its generation portfolio by replacing aging generators with more efficient units and increasing the use of renewable energy to achieve renewable generation capacity equal to 75 percent of the USVI’s peak demand by 2025.5 This includes rebuilding St. John’s energy network to provide close to 100 percent of peak demand with on-island renewable assets during the day and enabling the island to operate independently from St. Thomas in the event of an emergency—

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1 WAPA has improved system stability over the past several years. According to WAPA’s strategic plan, average interruptions per customer per year have declined from 6.5 in 2010 to 1.6 in 2016 and the average length of the interruptions has declined from over 500 minutes to 187 minutes. Both of these benchmarks, however, are above the US average.
3 As of 2016, WAPA’s share of the USVI government’s net pension liability was $258 million. WAPA also distributes other post-employment benefits to retired employees; WAPA’s net obligation to that fund was $48 million in 2016.
4 Moody’s lowered WAPA’s rating from a Baa2 and Baa3 in 2012 (moderate credit risk) to a Caa1 and Caa2 (speculative investment with very high credit risk) in 2017 with a negative outlook.
5 For this goal, peak demand is defined as the peak generating demand in the USVI before the 2017 storms, which was ~100 MW.
establishing St. John as a global model of resilience. Second, WAPA must modernize its grid—primarily its control and monitoring systems—to fully benefit from a more advanced, distributed, and diverse generation portfolio. Third, the utility must fortify its energy infrastructure against climate risks—particularly hurricanes. Fourth, the USVI must strengthen its energy planning and regulatory structures to make sure that the Territory can continually adapt to new technologies, industry best practices, and changes in the energy sector.

Achieving these goals will take time, effort, and funding. WAPA, with support of federal resources and the Governor’s Office, has already made major strides in advancing these recommendations. Further work has the potential to truly transform the USVI energy system, lowering electricity rates, increasing system reliability, and significantly reducing grid defections. No grid can be fully hurricane-proof, but the strategies proposed in this report will enable the system to bounce back more quickly from the next event and increase the overall resilience of the USVI.

HOW THE ENERGY SYSTEM WORKS

The USVI energy system consists of two separate energy networks that serve approximately 45,000 residential customers and approximately 9,000 commercial and industrial customers across five islands. The island of St. Croix is managed as one network; the islands of St. Thomas, St. John, Hassel and Water Islands are all served by a second network. Each network includes three primary components: generation assets that produce electricity, primarily from the fossil fuel power plants on St. Croix and St. Thomas; a transmission and distribution network that transports energy from generation assets to customers; and customers, who consume electricity.

Generation

The vast majority of USVI power generating capacity—242 MW—comes from two WAPA-owned fossil-fueled power plants on St. Croix and St. Thomas. The remainder—approximately 24 MW—is provided by solar panels throughout the Territory, including three utility-scale fields and numerous small installations on individual rooftops (see chart: Generation assets by type and capacity).\(^6\)

The two fossil-fueled plants are Estate Richmond Power Plant on St. Croix and Randolph Harley Power Plant on St. Thomas. Each houses six operational fossil fuel generators that can produce 101 MW and 141 MW of electricity, respectively. Both plants used to run on fuel oil, but WAPA has been converting them to Liquefied Petroleum Gas (LPG) to lower costs (since LPG is historically cheaper than fuel oil). All but one unit on St. Croix have been converted to LPG; on St. Thomas, only one unit has been converted. The remaining units on both islands will follow.

Generation assets by type and capacity

\(^6\) It is important to note that fossil fuel capacity cannot be directly compared to solar capacity only on the basis of MW installed. The reason is that the same peak possible production of different technologies does not translate into the same amount of energy produced over time: for example, solar facilities can only produce power when the sun is shining, while fossil fuel plants can work around the clock. This difference is accounted for using a metric called capacity factor, which equals average power generated divided by peak power. In the US in 2017, according to EIA data, combined cycle gas turbine (CCGT) plants had a 55 percent capacity factor, while solar installations had a capacity factor of 27 percent, meaning that an average solar installation rated to the same MW peak output produced, over a period of time, half the amount of power that an average CCGT facility did.
Aboveground electric lines
Underground electric lines
Power plant
Substation
megawatts of power. The airport solar field was built by the Virgin Islands Port Authority (VIPA) with funding from the American Recovery and Reinvestment Act of 2009. It is relatively small, generating 0.5 MW of power. All of the facilities have come online in recent years, starting with the VIPA field in 2011. Prior to that, WAPA depended almost exclusively on fossil fuels. This reliance was in line with the broader Caribbean region, which generated 95 percent of its electricity from fossil fuels in 2015. To lessen this reliance, WAPA has pursued more than a dozen renewable PPAs, but only the USVI 1 and Toshiba solar fields have been built. A number of factors have prevented the remainder from moving forward, including challenges with the PPA process and WAPA’s low credit rating.

Finally, another 15 MW of solar energy is generated through WAPA’s Net Metering Program. Created in 2007, the program allows customers to install their own rooftop solar panels and feed excess power back to the grid in exchange for a credit on their bill equal to WAPA’s retail electricity rate. The program’s generation capacity was capped at 15 MW, a limit that was met in 2016. In addition, WAPA has added small solar panels to the top of street lights on all three islands, which have a capacity of 3 MW. Additional solar power may be generated by privately owned assets that are not part of the net metering program, but the USVI does not track how much power is generated that way. To address this challenge, the Virgin Islands Energy Office is in the process of compiling a Distributed Generation Inventory and Analysis for all renewables, alternative fuels, and backup power sources in the Territory.

**Transmission and distribution**

Once electricity is generated, it is sent via high-voltage transmission lines to substations that step down the voltage and send it to lower-voltage distribution lines. This network includes eight substations (five on St. Thomas, two on St. Croix, and one on St. John) and more than 1,000 miles of power lines, of which approximately 10 percent were buried underground prior to the hurricanes (57 miles on the St. Croix network and 18 miles on the St. Thomas-St. John network). The underground lines served approximately 75 percent of the Territory’s business districts.

The St. Croix network is confined to the island. On the St. Thomas grid, the network carries power generated on St. Thomas to customers on Water, Hassel, and St. John Islands. All three of those islands are connected to St. Thomas through submarine cables: one for Water and Hassel Islands and three for St. John. Cables from the East End Substation on
St. Thomas conduct power to the St. John Substation. Customers on St. John’s west end are then served by the substation directly. Customers on the east end in Coral Bay depend on an aboveground distribution line that carries power to them along the island’s Centerline Drive.

**Consumption**

WAPA's peak demand—the maximum energy load consumed by customers at any point in a year—was approximately 107 MW before the storms. Peak demand has dramatically declined in recent years, driven by a variety of factors, including population decline, the closing of the Hovensa Refinery in 2012, and customers leaving the grid. Between 2011 and 2017, peak demand dropped 18 percent (see charts: WAPA electricity sales and peak demand; Change in WAPA sales by customer type between 2008 and 2016).

Since the hurricanes, this has declined further, reaching 66 MW in May 2018. This will likely rebound to some degree as the Territory rebuilds and recovers; however, it is unclear how quickly or by how much. Overall sales have declined as well, especially for large power customers, which have fallen 22 percent since 2010 (see chart: WAPA sales by customer type between 2010 and 2016).

WAPA is able to monitor its customers’ energy usage through Advanced Metering Infrastructure (AMI) installed in all of its customers’ buildings over the past few years. AMI enables WAPA to read meters remotely and gain insight into how and when its customers use energy.

**WAPA energy rates**

Electricity rates in the USVI are among the highest in the world, varying between 36 and 43 cents per kilowatt hour (kWh) depending on customer type (compared to an average of 10 cents on the US mainland; see chart: Power prices in the USVI).

In the past, fuel costs have driven these rates as high as 52 cents per kWh (see chart: WAPA residential energy rate vs. US average).

WAPA’s rates are made up of several different components. Almost half of WAPA’s electricity rates is the base rate, called the Energy Charge, which funds the cost of producing and delivering

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7 A kilowatt-hour (kWh), as distinct from kilowatt (kW), is a unit of energy equivalent to one kilowatt (1 kW) of power sustained for one hour. kW is a measure of demand or generation at a moment in time. kWh is a measure of energy used over time. For this reason, utility bills are priced based on kWh.
electricity, plus investment in the power plants, transmission systems, and other facilities. Another large component is the Leveled Energy Adjustment Clause (LEAC), which also makes up nearly half of the rate. The LEAC almost exclusively funds the fuel needed to run WAPA’s generators. As a result, it is highly variable and more frequently updated by the PSC, which oversees rate-setting for the utility, than other elements of WAPA’s rates. The next largest portion of the electricity rate (approximately six percent of the total) is a maintenance charge, which funds ongoing repairs, maintenance, and upgrades to WAPA’s system. The remaining two percent of the rate is made up of several small fees (see table: Components of WAPA’s residential rate for consumption above 250 kWh, 2018).

**Regulation and planning**

WAPA is an autonomous government-owned public utility holding the exclusive right to generate and distribute electricity throughout the Territory. A number of other entities also have jurisdiction and influence over the USVI energy sector. This includes the US Virgin Islands Public Service Commission (PSC), the USVI Legislature, and the USVI Energy Office (VIEO). The federal government is also involved, mainly through supporting initiatives in renewable energy, energy efficiency, and energy conservation, and by providing ad hoc technical assistance.

The PSC sets customer rates for all regulated utilities in the USVI (including electricity, water, telephone, cable TV, and ferry operations). The main mechanism through which the PSC engages with WAPA is the rate case. In the rate case process, WAPA details proposed changes in rates along with the rationale for those changes. The PSC is tasked with regulating utility rates to ensure that residents receive high-quality service in a safe and efficient manner. The PSC can also approve Qualified Facilities, which are vendors able to enter into contracts with WAPA to sell power.

The USVI Legislature plays an oversight role and enacts policies related to the USVI energy sector. One of the most important acts that it has passed in this regard is the US Virgin Islands Renewable and Alternative Energy Act of 2009 (Act 7075). Act 7075 set the goal of increasing renewable generation in the USVI to 30 percent of peak demand by 2025 and continuing to increase from there until it reaches 50 percent. Act 7075 also established the USVI’s Net Metering Program and required the installation of
The USVI’s energy system faces many challenges that existed before, and were exacerbated by, Hurricanes Irma and Maria. These challenges have led to higher rates and a historically unreliable grid, which has pushed an increasing number of customers to move off the grid and supply their own power. While WAPA has worked to address several of these challenges, substantial financial and governance challenges have delayed progress on many of these issues.

**Aging, inefficient, and oversized infrastructure**

WAPA’s fossil fuel generators are generally old. Only three of the utility’s 18 generators were installed in the past 15 years; more than half are over 25 years old. These older units are inefficient and significantly less reliable than newer technology. This means WAPA must burn more fuel to create energy and has to regularly shut down units for repairs.

The generators are also larger than the utility needs: following standards set by the North American Electric Reliability Corporation (NERC), WAPA maintains enough installed generation capacity to meet the USVI’s peak load and has enough reserve to support that load in the event that the utility’s two largest non-renewable generation units are offline. This must be done for both the St. Croix and St. Thomas-St. John portions of the grid. Given the current sizing of WAPA’s generation assets—which include some large generators (producing more than 30 MW of electricity)—WAPA must operate a significant amount of installed generation capacity well above each network’s current peak load.

WAPA recently purchased three new 7 MW Wartsila generators to replace some of its older generation assets and has plans to continue to modernize its generators with smaller, more efficient units.

**Heavy reliance on imported fossil fuels**

The current mix of generators on the islands means that WAPA relies heavily on imported fuel oil and LPG. These fuels have become expensive compared to renewables; fuel oil in particular is also vulnerable to unexpected price shocks. In 2016, over half of WAPA’s operating costs went to fuel purchases.

By comparison, renewables have relatively low operating and maintenance costs. Solar photovoltaic panels (PV) have an average operating and maintenance cost of 0.4-0.5 ¢/kWh, which is approximately three percent of the operating costs of diesel reciprocating engines.\(^8\) The Levelized Cost of Electricity (LCOE), which is the total capital and operating cost to generate a kWh of energy (including fuel costs), of recent renewable projects in the Caribbean is estimated at 7-20 ¢/kWh for wind and 9-15 ¢/kWh for solar.\(^9\)

It is anticipated that these prices will only continue to fall. In just the past year, Bloomberg New Energy Finance noted that global solar PV prices declined 20 percent. This comes on the tail of a decade of dramatic global price declines: 85 percent for solar and 79 percent for lithium ion batteries—but WAPA has yet to take advantage of these at a significant scale.

**Fragile, isolated grid structure**

WAPA faces a challenge common to many island nations: the need to operate a grid that is completely isolated from other utility structures. In the mainland US, many utilities are interconnected and can rely on neighboring utilities to provide power when disruptions occur at their own power plants. In the USVI, WAPA must allocate resources across two relatively small power grids that function independently. Additionally, while undergrounding power lines can help reduce the risk of damage from hurricanes, the rocky soil and steep terrain on St. John and St. Thomas make it challenging.

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\(^8\) Lazard Global Benchmark Utility-Scale Renewable Project Costs, 2009-2016.

\(^9\) Rocky Mountain Institute.
and very expensive to implement underground power lines. Last, the nature of WAPA’s network means there are multiple single points of failure, each of which can cause widespread outages if a piece of the transmission and distribution system fails or is damaged.

Lack of collaboration between the PSC and WAPA

Working together, the PSC and WAPA could make strides toward decreasing electricity rates for customers, while increasing the amount of sustainable energy in the Territory and increasing resilience. Prior to the storms, while both parties agreed on several key issues, there had not been substantive progress on instituting solutions.

For example, WAPA and the PSC both agree WAPA and its customers would benefit if customers were able to install rooftop solar and sell their power back to WAPA at a lower rate than the current net metering program offers. Although there is alignment about the need for this solution, WAPA and the PSC have not reached an agreement on how to move forward. In addition, the USVI PSC’s regulatory authority is restricted to approving rates, which is more limited than some other jurisdictions. Finally, PSC commissioners are part-time and receive a $50 stipend per session, which also limits the PSC’s ability to make informed decisions on complex rate challenges that WAPA faces.

Limited traction of energy efficiency programs

Given WAPA’s high rates, energy efficiency programs are a critical opportunity for residents to lower bills. Offering energy efficiency programs is also advantageous for WAPA because lower energy use would allow the utility to reduce its costs through lower fuel use and avoided or deferred system upgrades. If efficiency were included in WAPA’s rate structure—it is not currently included—the utility could recoup its investments and pass on a portion of the savings to customers. The USVI has developed several small-scale programs to expand energy efficiency measures to help lower customers’ bills: the VIEO has had success in several energy audits and energy efficiency projects at GVI-owned facilities, and WAPA launched viEnergize to expand its focus on energy efficiency, but those programs have not gained substantial traction.

Financial challenges

WAPA’s financial challenges put a further strain on the system. WAPA has reduced its costs by 30 percent since 2012 to keep pace with declining revenues, but this reduction is almost exclusively the result of declining fuel costs. The rest of WAPA’s operational costs have increased by nearly 50 percent in the same time period. WAPA also faces a variety of broader financial issues that have led it to receive a below-investment-grade credit rating. These include a 17 percent non-payment rate across its customer base (including approximately $22 million from the Government of the Virgin Islands, a significant unfunded pension liability, and long-term debt commitments of $265 million).

Customer defections

WAPA’s high energy rates have led some customers—particularly larger commercial and industrial ones—to leave the grid. Several users, including major hotels, have installed stand-alone diesel generators to ensure access to more reliable power, even though these systems are often more costly than simply paying for WAPA power. Customers of all sizes have also explored installing rooftop solar panels outside of WAPA’s net metering program. Under WAPA’s current rules, customers who install PV outside of net metering need to disconnect from the grid. Before the hurricanes, this restriction held many customers back; after the hurricanes and the extended loss of power that they brought, customers are increasingly choosing to disconnect from the grid and rely on a mix of solar power, batteries, and diesel generators instead. This presents a critical challenge for the utility: moderate and high-income customers are likely to continue to turn to off-grid solutions, leaving low-income customers to pay higher rates to cover the utility’s fixed costs—and potentially accumulate further unpaid billing liability.
solar water heating systems on all new construction and government buildings.

The VIEO primarily oversees several energy efficiency programs and serves as the point of contact for the Territory’s engagement with federal energy entities. The VIEO is the energy policy-making arm of the Governor’s Office, but the policy-related role of the office is currently limited due to insufficient resources. The VIEO’s primary contribution to informing policy issues is the Energy Roundtable, a forum created by the Energy Office for the major energy stakeholders (e.g., WAPA, PSC, federal agencies, and private sector energy companies) to discuss solutions to energy-related issues.

The federal government’s involvement in the USVI has mostly focused on clean energy programs and technical assistance delivered by the US Department of Energy (DOE) and the US Department of the Interior (DOI). In 2010, the two federal agencies signed a memorandum of understanding (MOU) with the USVI to reduce the Territory’s fossil fuel consumption by 60 percent by 2025. The USVI and DOE signed a second MOU in 2015, reaffirming the Territory’s commitment to transitioning its energy system.

In 2016, WAPA developed a plan (known as its Integrated Resource Plan, or IRP) to guide investments to meet these goals. Through a relationship managed by the VIEO, WAPA has also worked closely with the DOE and the National Renewable Energy Laboratory (NREL) to develop a path to achieve the USVI’s ambitious fossil fuel reduction and renewable energy goals. DOE and NREL have conducted several technical studies in an attempt to incorporate more renewables into the grid and regularly provide WAPA with technical assistance. Most recently, in the aftermath of the storms, FEMA and the Department of Energy assigned the National Renewable Energy Laboratory and Naval Postgraduate School this task: to evaluate and model WAPA operations and provide guidance to improve the operation, efficiency, and resilience of the Territory’s energy grid. Their report is scheduled for completion and further coordination in September 2018.

In 2013, the utility launched an initiative called viEnergize to provide customers with energy efficiency programs that can reduce their bills while helping WAPA avoid additional generation investments. To date, WAPA has not had the capacity to fully develop these programs, and customer uptake has been limited. The VIEO and WAPA are in talks to cross promote existing VIEO programs under viEnergize.
IMPACT OF THE HURRICANES

The USVI energy system was in a state of crisis before Hurricanes Irma and Maria. The unprecedented landfall of two Category 5 hurricanes in the span of 14 days wrought catastrophic damage to WAPA’s physical infrastructure, exacerbated many of the challenges facing the system, and led to a $2.3 billion need for federal support of both emergency and permanent repairs and resilience measures. This included damage to 90 percent of the USVI’s overhead transmission and distribution network and 20 percent of WAPA’s power generation capacity, leaving 100 percent of WAPA’s customers without power after the storms. While power restoration began within 72 hours, the breadth and scale of the damage caused large-scale restorations to take much longer. However, with the help of more than 800 off-island linemen, more than 90 percent of customers that could receive power were restored by Christmas. This was far quicker than after previous hurricanes.

Generation

The storms damaged power generating units on both St. Thomas and St. Croix. On St. Thomas, coastal flooding damaged four units at the Randolph Harley Power Plant. This resulted in a loss of 20 percent of power generation capacity at the plant for almost one month. On St. Croix, the Richmond Power Plant suffered minor damage that did not have a substantial impact on service.

Solar PV facilities experienced varying levels of damage. Some panels were not installed properly and were destroyed when the wind lifted them off their base; others that were installed well only suffered damage from flying debris. The USVI Solar 1 field on St. Thomas sustained catastrophic damage and most, if not all, of the facility will need to be rebuilt. The Toshiba solar field in Spanish Town fared much better: debris damaged only a few of the solar panels, and flooding caused minor damage to some equipment. The solar field adjacent to the airport on St. Thomas suffered substantial damage to inverters and electronics when the area around the array was flooded; the facility will need to be rebuilt.

Many of the small-scale rooftop solar systems installed through WAPA’s net metering program did not sustain substantial damage nor did most privately owned diesel generators.

Transmission and distribution

The hurricanes decimated the islands’ transmission and distribution (T&D) systems, damaging 90 percent of aboveground power lines and knocking down half of the USVI’s utility poles. All told, the storms damaged more than 20,000 poles, 1,100 miles of transmission and distribution lines, and 5,300 distribution transformers. WAPA’s underground T&D system was not damaged, enabling the utility to quickly repower certain areas of both islands served by these lines.

Winds and flooding also damaged several substations, including the East End, Tutu, and Donald Francois substations on St. Thomas, and the Richmond and Gregory Willocks substations on St. Croix.

The hurricanes also damaged WAPA’s recently installed Advanced Metering Infrastructure (AMI). This limited the utility’s ability to leverage real-time insight into the grid during the restoration process. Additionally, the damage prevented WAPA from automatically reading energy meters. As a result, WAPA had to revert to and hire contractors for manual meter reading, which delayed its ability to promptly and accurately bill residents after the storms.

10 Units 9B, Unit 14, Unit 15, and Unit 18 were damaged, primarily due to water incursion into the plant. Emergency units, APR Units 25 and 26, were successfully brought online on September 10.
11 Units 10, 11, 17, and HRSG 24 suffered minor damage; Units 11 and 17 were repaired by December 2017.
Eligible WAPA customer restoration progress by island
% of customers restored

Time post-storm to reach a given level of eligible WAPA customer restoration, by island
% of eligible customers; number of weeks

Note: For St. Thomas and St. John, the bars represent the number of weeks after Hurricane Irma. For St. Croix, the bars represent the number of weeks after Hurricane Maria. The number of customers who were eligible to receive power changed slightly throughout the restoration process as customers addressed damage to their homes that had made them ineligible to reconnect to the grid. For the purposes of this chart, the restoration percentages are calculated using a static eligible customer number from 12/25/2017.
Hurricane response

WAPA began repowering efforts immediately after the storms. While the Randolph Harley Power Plant was back online within four days, the transmission and distribution restoration effort was more complex. WAPA’s efforts initially focused on neighborhoods with underground power lines and neighborhoods adjacent to those lines. On St. Croix, downtown Christiansted and surrounding neighborhoods were repowered before WAPA turned to the western portion of the island. On St. Thomas, WAPA first repowered Charlotte Amalie and surrounding neighborhoods, including Yacht Haven Grande and public housing communities such as Savan, Oswald Harris Court, and Pearson Garden. On St. John, the design of the T&D system has several single points of failure, which made restoring power there more difficult and time consuming than on the other two major islands. Power supply to the Coral Bay community on the eastern end of St. John depends on a single aboveground line connecting it to Cruz Bay on the western end; that line was destroyed. Cruz Bay’s power, in turn, comes from St. Thomas via undersea cables; the aboveground lines connecting St. Thomas Randolph Harley Power Plant to the substation that feeds those undersea cables were damaged. As a result, Cruz Bay was without utility power for approximately 49 days until crews could rebuild the overhead supply network on St. Thomas. Coral Bay had to wait for almost 100 days until its link to Cruz Bay could be restored.

Despite the challenges of restoration, the USVI government’s active engagement with WAPA, federal agencies, and external partners enabled the Territory to restore its energy system faster than other islands impacted by Irma and Maria. While power restoration took as long as six months for previous hurricanes, Governor Mapp set a target of restoring power to 90 percent of customers who could receive electricity by Christmas 2017. WAPA worked with a number of partners to bring in more than 800 off-island linemen to meet this goal, and power was restored to over 90 percent of eligible customers across the three big islands by January 1, 2018. Some homes had suffered substantial damage to their electrical infrastructure from the storms and were not able to safely receive power until they repaired their electrical equipment; those homes were repowered later (see charts: Eligible WAPA customer restoration progress by island and Time post-storm to reach a given level of eligible WAPA customer restoration, by island).

Until power was fully restored, backup generators provided some relief. Critical public sector facilities, including the airports and hospitals on both St. Thomas and St. Croix, received generator assistance from the US Army Corps of Engineers (USACE) and the Virgin Islands Territorial Emergency Management Agency (VITEMA). Privately owned critical facilities (e.g., radio stations or private cell phone towers) were not eligible to receive USACE generators, which caused delays in getting some of those facilities back online. A small percentage of residents were able to use their own generator assets installed before the storms to power their homes and businesses, while many more purchased and installed generators following the storms. Some private generators were installed incorrectly, which resulted in energy being improperly pushed from the private generator back onto the grid, injuring at least one lineman and reinforcing the importance of comprehensive interconnection standards and appropriate enforcement.

FUTURE CHALLENGES RESULTING FROM CLIMATE CHANGE

The USVI has always had to deal with the impacts of hurricanes and tropical storms, which present a particular risk to the Territory’s energy infrastructure. In the past 30 years, the USVI has experienced five major hurricanes, each causing millions of dollars in damage. These risks are already real and significant, even without climate change, and they will only increase as the climate changes and the intensity of extreme events increases. The greatest risks will come from hurricane winds, rainfall, and storm surge, which can damage generation and T&D assets. Lower-impact risks will come from increases in temperature, which will lead to long-term reductions in the efficiency of equipment and change energy consumption patterns, from rising sea levels, which can threaten underground infrastructure and contribute to the effects of hurricane storm surge, and changing precipitation patterns, which will increase the risk of landslides as well as increase energy demand from reverse osmosis plants.
WAPA assets in Charlotte Amalie in and near current flood zones

Storm surge risk for WAPA assets in Red Hook

Storm surge risk for WAPA assets in Cruz Bay

Storm surge risk for WAPA assets in Charlotte Amalie

Sea level rise risks to WAPA assets

WAPA assets in Bovoni (St. Thomas) in and near current flood zones
Hurricane winds, rainfall, and storm surge

High winds and flying debris are the main risks for energy infrastructure. On the generation side, both fossil and solar generation facilities are vulnerable. WAPA’s power plants are designed to withstand approximately 200 MPH winds associated with a Category 5 hurricane; stronger winds can put them at risk. Solar facilities in the Caribbean are generally designed for Category 4 winds; stronger winds will put them at greater risk as well. Solar arrays are also vulnerable to flying debris. On the transmission and distribution side, high winds, downed trees, and flying debris can knock down utility poles and wires just as they did in the latest hurricanes.

Storm surge poses a risk as well. The power plants are located on the coast of each island, and coastal flooding damaged St. Thomas’s Randolph Harley power plant in the 2017 storms. The same risks apply to several substations. The Tutu, East End, and Donoe substations on St. Thomas are in flood hazard zones and were damaged by the 2017 storms. The Donald Francois substation on St. Thomas is also within the Category 5 hurricane SLOSH zone.\(^{12}\)

Another risk involves hurricane damage to the Territory’s ports—at least as long as the Territory depends heavily on fossil fuels for its power generation. If a future storm causes extensive damage to the ports, fuel deliveries may be cut off. Existing storage facilities provide backup capacity of up to 20 days of propane storage on St. Croix and fuel oil storage of up to 65 days on St. Croix and 40 days on St. Thomas. While WAPA did not run out of fuel during Hurricanes Irma and Maria, port damage does present a risk in the future.

Increases in temperature

Higher temperatures may mildly affect aboveground distribution and transmission infrastructure. On hot days, overhead cables are likely to sag. When this occurs, lines can sway further than usual due to the wind and may impact other lines on the same pole. This risk is already being mitigated: during the restoration process after the 2017 hurricanes, linemen installed cross arm bars on power poles to be vertical instead of horizontal, so lines are less likely to collide.

Rising temperatures may also reduce the efficiency of generation and transmission assets. WAPA’s generators and substations are built to operate at temperatures of up to 90 degrees Fahrenheit and are not certified to operate at or above 105 degrees Fahrenheit. During the hottest days when energy demand is likely to peak, the generators and substations could be at risk of overheating, causing brief outages or faster depreciation. The risks can be mitigated: on particularly hot days, WAPA already operates equipment at levels below its maximum thresholds. In addition, most generation equipment includes cooling mechanisms.

Finally, rising temperatures may lead to increased demand for mechanical cooling in residences and businesses, which could lead to higher peak demand on very hot days.

Changes in precipitation

Periods of more intense rainfall will increase the risk of landslides, threatening the T&D system, especially on St. Thomas and St. John, which are already vulnerable to landslides on some of the steeper parts of the islands. Landslide risks should be reviewed in collaboration with other government groups, including the Department of Public Works (DPW) and the Department of Planning and Natural Resources (DPNR).

12 The SLOSH zone is determined by the National Hurricane Center and is the area that they assess from models or from previous hurricanes to be vulnerable to “Sea, Lake and Overland Surges” due to hurricanes (see Climate Analysis section of this report for more details).
Longer dry spells will increase demand for water from reverse osmosis plants, which will, in turn, increase energy demand. The increase is likely to be mild. Reverse osmosis plants, which supply 25 percent of USVI residents with drinking water, currently represent approximately two percent of WAPA’s total electricity sales.

On particularly hot and dry days, the combination of increased demand for air conditioning and the increase in energy used at reverse osmosis facilities is likely to increase peak demand and cause stress to the USVI’s energy system. The current generation capacity on the islands will very likely be able to manage moderate increases in peak load.

The measures will not fully protect the energy system from damage in future strong storms—the cost of fully hardening the system against Category 5 events would be prohibitive—but they will build resilience and redundancy into the system to reduce risks that can be avoided cost-effectively and enable the system to bounce back quickly following any future damage that does occur.

These recommendations are built on much of the research, planning, and implementation that WAPA—with support of federal and local resources—executed in the last decade to address the challenges facing the system. The utility is already in the planning and implementation stages for several key projects that advance these goals; the following initiatives highlight several of these projects already under way, as well as several which are not yet in development.

INITIATIVES FOR INCREASING RESILIENCE IN THE ENERGY SECTOR

Hurricanes Irma and Maria devastated the USVI’s energy infrastructure. Over 90 percent of the transmission and distribution system was destroyed, and more than 20 percent of generation capacity was damaged. At the same time, even before the hurricanes, high costs and unreliable service were already driving customers off the grid. Federal recovery funding provides a once-in-a-generation opportunity to transform the USVI’s energy system to increase the reliability and resilience of the system, stabilize and ultimately reduce costs, stem the tide of grid defections, and attract customers back to WAPA’s grid.

Achieving this transformation requires changes to all aspects of the energy system. The Territory must transform its energy generation portfolio, modernize its grid, fortify infrastructure against climate risks, and strengthen energy planning and governance structures. The changes will require large amounts of funding and coordination, as well as collaboration between all the different bodies that have oversight of the USVI’s energy systems, including the legislature, PSC, WAPA, VIEO, and the Governor’s Office.

TRANSFORM THE GENERATION PORTFOLIO

WAPA’s generation assets are old, inefficient, and predominantly reliant on fossil fuels. All but three of its 12 operational generators are at least 15 years old, and approximately 90 percent of its generation capacity comes from fuel oil or LPG. This contributes to WAPA’s high electricity rates, as more than half of WAPA’s operational costs are for fossil fuel purchases. In addition, only four generators have a generation capacity under 20 MW. The relatively large capacity of WAPA’s other generators makes it more difficult for the utility to use renewables to lower costs, as it must run large fossil fuel units even when it may need only small amounts of additional power to balance system loads.

Replacing aging generation capacity with new, more efficient fossil fuel generators, adding substantial renewables, and capturing energy efficiency will increase the resilience of WAPA’s network and can help stabilize and eventually lower electricity rates. To achieve this transformation, WAPA will use federal funding both to construct utility-scale renewables that it will own and to replace its fossil fuel generators with smaller, more efficient units. Simultaneously, the Governor’s Office will work with the PSC and WAPA to enable the expansion of distributed renewable generation on private property, while the VIEO and WAPA’s viEnergize services unit will expand funding and programs.
KAUAI ISLAND, HAWAII: A RENEWABLE ENERGY TRANSFORMATION

The USVI is not alone in its desire to transition to a greater use of renewables. Other islands are working to increase their use of renewables through new investments, financing mechanisms, and policy changes. Kauai, a part of the Hawaiian archipelago, is one of the most successful examples in the US. On an average clear day, with its renewable projects performing as expected, the Kauai Island Utility Cooperative (KIUC), which provides power to the island, can turn off all but one of its diesel generators and rely on renewables to meet a typical daytime electrical demand of 55-65 MW and an evening peak load of 75 MW.

To achieve this outcome at the utility scale, KIUC primarily relied on PPAs to incorporate PV and battery storage into its generation mix. Storage plays an important role: its significant penetration allows KIUC to manage the intermittent power from solar sources and maintain constant power to the grid. All of the storage relies on lithium ion batteries for the moment, but the utility is also building a pumped hydro system, which will store energy by pumping water from a lower elevation to a higher elevation (when energy is needed, the water is released and turns several turbines as it falls to the lower elevation).

A large part of the transformation also happened on the customer side. Almost 10 percent of the utility’s customers have installed PV systems, and customer-owned rooftop solar provides 26 percent of KIUC’s total renewable assets. As customers primarily use these assets to supply their own power, power sold back to the grid from these systems makes up 4.5 percent of KIUC sales. Unlocking the potential of and getting the economics right for distributed renewables required frequent updates to Kauai’s rate and interconnection policies. KIUC is now focused on the next update to its tariff structure, which will incentivize distributed battery storage and enable the utility to purchase power from solar systems at times of peak demand in the evenings and early mornings, rather than during the midday when solar output is high but demand is low.

Grid management practices had to change, too: to operate the whole grid with a high penetration of renewables, including substantial distributed generation, KIUC implemented comprehensive control systems, installed smart meters, and updated its load schemes and interconnection requirements.

The transformation created a more resilient grid than before: KIUC has led the Hawaiian Islands in grid reliability over the past five years, attaining a 99.96 percent reliability rating. Costs improved as well: renewables, together with lower oil prices, internal cost controls, and customer-oriented energy efficiency, helped KIUC lower the average customer bill by 26 percent between 2013 and 2016 and keep rates flat, even as all other Hawaiian islands have seen rate increases.
for energy efficiency to save customers money and help offset the need for additional capacity in future years. Much work will take place on the island of St. John, which provides an early opportunity to demonstrate that the strategies can be leveraged to dramatically increase the resilience of an island’s energy systems. All of this work will enable WAPA to triple the amount of renewable generation capacity in the USVI by 2025, providing up to 75 percent of the Territory’s peak demand through renewable energy sources such as solar during periods of clear sunshine and relying on fossil fuels and energy storage for the remainder.

Initiative 1

Increase utility-scale renewables

As the costs of renewables and battery storage have dramatically decreased, renewable assets are less expensive in the USVI than fossil fuels assets on a per kWh basis (including capital costs). As a result, they offer a tremendous opportunity to reduce costs for WAPA and lower rates for customers—especially when coupled with battery storage, which can spread the benefits of renewable power to morning and evening peak times as well as help improve reliability.

For 75 percent of the USVI’s peak demand to be met by renewable generation capacity, WAPA must add an additional 50 MW of renewable capacity to its existing 25 MW. WAPA will rely on several funding streams to add at least 50 MW of additional utility-scale renewables with battery storage onto the grid by 2025, with near-term deployment targets of 20 MW. Renewable projects to be initiated in the next year include a 5-10 MW solar microgrid on the South Shore of St. Croix, a 10 MW wind project at the Bovoni Landfill on St. Thomas, and 1-4 MW of solar on St. John. To fund these and other projects, WAPA will explore using FEMA and HUD funding, as well as explore Rural Utility Service (RUS) financing if additional capital is needed.

Initiative 2

Reform power purchase process

Federal funding alone will not meet WAPA’s capital needs for renewables—and the utility’s ability to attract capital in capital markets is severely limited by its credit rating. In this situation, power purchase agreements (PPAs) can be a useful tool with which to attract private capital for utility, scale renewable projects—but the USVI’s current PPA process is inappropriately designed for the size and scope of the USVI’s electricity market and has generally failed to add cost-effective renewables to the grid.

Today, USVI law permits any project developer to advance a project by filling out a simple form with the PSC to become a Qualified Facility (QF). Once a developer is designated as a QF, WAPA must begin negotiating the terms of a PPA and perform due diligence. This takes significant time and effort from WAPA—but as long as the project developer claims that it can deliver power at or below WAPA’s avoided cost, the utility must negotiate a PPA with that developer. Once the PPA is negotiated, the developer must secure financing as well as all necessary environmental and planning permits.

The current QF process has resulted in the installation of few actual renewable energy projects to date. Some have attributed this outcome to WAPA’s reluctance to complete QF contracts. Others point to a lack of sufficient due diligence on vendors that receive QF status. Still others contend that project developers have failed to secure financing due to WAPA’s credit rating and concerns about its ability to make timely payments agreed upon in a PPA.

The process has another disadvantage: it does not allow WAPA to effectively plan for future generation needs, as the utility cannot predict how many QF PPAs it will be required to enter and at what scale—especially because the current regulation allows projects up to 30 MW to qualify, an amount almost equal to 30 percent of the Territory’s peak demand. Thus, even a modest number of unplanned projects could have a disruptive impact on WAPA’s integrated resource planning and create stranded generation assets. Several states, including North Carolina and Michigan, are changing their QF process to address these kinds of issues; the USVI should follow suit.

The Governor’s Office will work with the PSC and WAPA to establish a revised set of regulatory rules for the Qualified Facility PPA process. Working in collaboration with WAPA, the PSC should consider:

14 The Public Utility Regulatory Policies Act of 1978 (PURPA) was implemented to encourage, among other things, conservation and renewables. One of the ways PURPA set out to accomplish its goals was through the establishment of a new class of generating facilities, which would receive special rate and regulatory treatment. Generating facilities in this group are known as qualifying facilities (QFs), and fall into two categories: qualifying small power production facilities and qualifying cogeneration facilities.
• Setting a limit for how many MWs of power can be approved through the QF process over a specified time horizon (e.g., a five year period);

• Permitting WAPA to issue one or more Request for Proposals (RFP) over that time horizon to meet the MW target to drive down costs through a competitive bidding process;

• Requiring WAPA to share draft RFPs and model PPAs with the PSC and public stakeholders for review and comment before being issued to build market interest and public buy-in. RFPs should include transparent scorecards for grading bids so market participants understand how their applications will be judged.

The process of reviewing and updating the QF process should take no more than six months, during which time the PSC should not approve any new qualifying facilities.

Initiative 3
Replace aging fossil fuel generators with smaller, more efficient units

Currently, the majority of WAPA’s fossil fuel assets are very large (more than 20 MW) and close to or beyond their stated lifespan. This makes it difficult for WAPA to efficiently operate these units and rapidly respond to changes in demand. WAPA’s 2016 Integrated Resource Plan (IRP) called for the replacement of these generators with smaller, more efficient units.

WAPA will use federal funding to accelerate the transition described in the IRP and replace 57 MW of generation with new units in the next two years. On St. Thomas, WAPA is in the process of purchasing three new 7 MW generators and is in negotiations for four additional 9 MW units. On St. Croix, WAPA is leasing a 20 MW Aggreko power plant, which is made up of 18 separate, approximately 1.1 MW units to provide the utility with greater flexibility. Due to challenges with permitting at the Estate Richmond Power Plant, WAPA will likely not be able to add additional capacity to the St. Croix grid until 2021.

Beyond these immediate transactions, WAPA should hold off on any additional commitments until it can reevaluate demand and the pace at which renewables are brought onto the grid (see Initiative 12). If additional generation is needed on St. Thomas or St. Croix (and permitting challenges are addressed) during this interim period, WAPA should negotiate contracts that provide it with the flexibility to downsize or cancel parts of an order as needed.

Initiative 4
Update WAPA’s tariff structure to enable grid-tied distributed renewable generation

The amount of solar power that customers in the USVI can install on their properties while remaining connected to the grid is limited to 15 MW within the net metering program established in USVI Legislature’s Act 7075 (10 MW for St. Thomas, St. John, and Water Island and 5 MW for St. Croix). This limit has been reached, and, under current rules, any customers who want to install solar panels on their property would have to go off the grid. As batteries and solar become cheaper, an increasing number of residents will consider doing so—especially the more affluent, who can afford the initial investment more easily.

Such a situation is not sustainable. Without major changes in existing tariffs, customers will continue to leave the grid, and WAPA will be forced to raise rates on the remaining customers to cover its fixed costs. Identifying the appropriate rate structure to incentivize large customers is of particular concern: WAPA’s 10 largest commercial customers made up nearly eight percent of overall electricity sales in Fiscal Year 2016, and at least one, Plaza East, has announced since the hurricanes that it is going off the grid.

Simply expanding net metering is not a viable option: the policy pays those who participate in it full retail rates for electricity, which, considering the fixed costs of T&D, is not sustainable past a small initial amount of generation. Tariff reforms are required to ensure that new distributed generation can be added to the grid to benefit project developers, ratepayers, and WAPA in a way that is sustainable for the system overall. This includes the evaluation and creation of new tariff structures, including a Feed-in Tariff (FiT) and a Stand-By Tariff, as well as phasing out and replacing the existing net metering program. With the appropriate tariff structures in place, distributed renewable
generation can lower energy costs and improve reliability for the grid and the individual customers who own these assets while providing WAPA with enough revenue to maintain the grid.

The Governor’s Office will work with WAPA and the PSC to adopt new tariff structures before the end of 2018. The Governor’s Office will also work with the USVI Legislature to enact legislation that replaces the current net metering policy in Act 7075 with one or more alternative tariffs that support the sustainable deployment of additional distributed generation. Specifically, the options could include:

- **Stand-By Tariff**—Targeted at systems over 500 kW, which are typically commercial or industrial customers. This is a special rate designed to collect only those costs imposed on the grid by a customer that self-supplies its own power but wants to rely on the grid for backup. WAPA included a Stand-By Tariff proposal in its last general base rate case, which was not acted upon by the PSC. WAPA will develop a revised proposal and file it with the PSC for consideration. This should be coordinated with the self-generation tariff for smaller systems described below to ensure the two are aligned.

- **Feed-In Tariff (FiT)**—Targeted at systems between 10 and 500 kW, which are typically small commercial customers. A FiT is a policy that guarantees that customers who own an eligible renewable energy facility can receive a set price from the utility for all electricity they generate and deliver to the grid. In 2014, the Senate passed Act 7586 that authorized the establishment of a FiT for distributed generation systems between 10 kW and 500 kW. To date, the PSC has not acted on two separate proposals from WAPA to create such a charge. The PSC should complete the current open docket filed by WAPA in April 2017, ideally in parallel with an increase in the current cap on distributed renewable generation.

- **Self-Generation Tariff**—Targeted at small power users (systems under 10 kW), which are typically residential customers. As outlined above, the current net metering program has run its course. The Governor’s Office, in consultation with the VIEO Energy Roundtable and WAPA, will work with the Legislature to rewrite the net metering section of Act 7075. Revised legislation should enable the PSC to set a new MW cap for the program while altering the pricing structure to better align incentives between customers and WAPA. Alternatives could include a “self-generation” tariff where customers are paid a rate lower than the retail electric rate for any excess solar generation that they produce and a “self-supply” tariff where customers are only permitted to sell solar power back to WAPA in prescribed situations. Moving forward, the PSC and WAPA should be engaged to jointly develop a new program cap, and the PSC should be authorized to revise this cap in the future without any legislative action. Much can be learned from the approach taken in Hawaii, where it took the Hawaii State Energy Office, the Hawaii Public Utilities Commission (PUC), and the Hawaiian Electric Company several attempts over the course of ten years to put in place an effective and sustainable tariff structure.

Beyond changing the tariff structure itself, it is also important to ensure that permitting, interconnection, and tracking policies and processes can manage the increase in renewable generation that will result. WAPA and DPNR will review these to ensure that they balance the need to be easy for customers with the need to protect the integrity of the grid. WAPA will also create clear guidelines for any customers who want to add renewable generation to their property outside of the net metering program.

**Initiative 5**

**Establish St. John as a global model for energy sustainability and resilience**

St. John’s power resilience needs are particularly urgent. The entire island was without utility power for 49 days after Hurricane Irma, and customers in Coral Bay did not have power restored for 100 days. Given the challenges and opportunities on St. John, the island can serve as an accelerated test bed for the Territory’s broader energy vision, including utility-scale renewables, distributed rooftop solar PV, and hybrid microgrids.

To increase the resilience of the St. John power grid in the event of generation, transmission, or distribution failures on St. Thomas, WAPA will build two hybrid microgrids in Cruz Bay and Coral Bay (see sidebar: Microgrids). These systems will include solar panels to provide power when the sun is shining, batteries to store energy and then provide
it when the sun is not out, and diesel generators to provide emergency baseload power in the event that generation on St. Thomas is interrupted.

The microgrids will be able to meet St. John’s peak demand, currently 8 MW, and prevent the long-term outages experienced after Irma and Maria. Situating microgrids in Cruz Bay and Coral Bay will enable critical facilities on each side of the island to maintain power even if the power lines that connect the two communities along Centerline Road are damaged.

WAPA is in the process of scoping these microgrids to determine the land available for PV panels, the amount of solar energy that could be generated, and sizing of the batteries and diesel generators. This project will include between 1-2 MW of solar power. Pending approval of federal funding, the microgrids will be in operation in 2019.

In addition to the microgrids, WAPA will develop at least 4-6 MW of additional solar PV through utility-scale projects and grid-tied distributed rooftop PV. This energy, combined with the solar energy from the hybrid microgrids, will create installed solar capacity equal to 100 percent of St. John’s peak load.

To strengthen St. John’s T&D network, the USVI has also applied for FEMA funding to install 1,210 composite poles across Centerline Road and underground distribution lines in Cruz Bay up to the Myrah Keating Health Clinic. This will improve reliability for over 5,000 customers. WAPA will also move large overhead transformer banks from poles to pad-mounted banks.

These projects will enable the island to operate independently from St. Thomas in the event of an emergency and establish the island as a global model of sustainability and resilience.

**Initiative 6**

**Expand energy efficiency programs**

The cheapest power projects are those that prevent energy from being used in the first place. Estimates from around the Caribbean suggest that the cost of each kWh saved through energy efficiency programs ranges between 5-10¢/kWh. This is substantially

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**MICROGRIDS**

Microgrids are subsections of larger energy grids that include distributed generation sources and transmission and distribution assets that can be disconnected and operated independently from the broader grid if parts of that grid fail (a practice known as “islanding”). Globally, more than 1,800 microgrid projects, totaling 19 gigawatts (GW) of capacity, are in operation or under development.¹⁵

Microgrids can be powered by a variety of energy sources. Hybrid microgrids include a renewable generation source, battery storage, and fossil fuel generation. The combination of these three power sources takes advantage of the unique characteristics and timing of each source. Renewables provide power during peak supply times (the afternoon for sun and evenings for wind); batteries store and provide renewable energy during off-peak times and help smooth supply; fossil fuels provide power when renewables are not available and batteries are depleted.

Hybrid microgrids can help WAPA increase the reliability and resilience of the USVI’s energy system. By distributing generation capacity throughout the Territory and enabling individual communities to island themselves, WAPA can maintain power to large portions of a grid even after major hurricanes. Smaller scale microgrids can be particularly useful for providing continued power for critical facilities like hospitals or cell phone towers, even in the event of a system-wide outage. Microgrids can also enable faster recovery from extreme events as portions of the grid can be brought online over time without requiring the full grid to be restored first.

¹⁵ Navigant Research, Microgrid Deployment Tracker, 4Q2017.
below WAPA’s current average cost to produce power of 16 ¢/kWh and is competitive with the cost of producing power through renewable resources. As a result, energy efficiency should be evaluated and included as the “first-in” resource in WAPA’s Integrated Resource Plan (see Initiative 12).16 Research from NREL in 2011 suggests that energy efficiency strategies could help the typical USVI household reduce its energy consumption by at least 25 percent. Similarly, NREL’s analysis suggested that USVI government and commercial buildings could reduce energy use by 15-25 percent by addressing inefficient lighting and heating, ventilation, and air conditioning (HVAC) systems.

The VIEO and WAPA’s viEnergize program both provide some mechanisms to help customers fund energy efficiency improvements. The USVI Energy Office runs the Sun Power Loan Fund, which provides loans to finance solar hot water heaters and has multiple rebate programs for Energy Star appliances. WAPA created viEnergize to assist customers in energy efficiency; however, it has not yet been developed into a holistic program.

The Energy Office and viEnergize will develop a coordinated energy efficiency program that takes advantage of the resources and expertise of both offices and maximizes uptake and impact for customers. In the long term, viEnergize should administer most of the USVI’s energy efficiency programs. This will allow the VIEO to focus on policy development and tracking the overall implementation of the Governor’s energy agenda. In the mainland US, a third-party administrator, or TPA, often manages these programs. These TPAs bring specialized expertise in energy increasing efficiency programs and can help fill capacity gaps at smaller utilities. WAPA should evaluate its current capacity and consider hiring a TPA to design and/or administer its energy efficiency portfolio.

Initiative 7
Explore new funding mechanisms for energy efficiency

Increasing the uptake of energy efficiency programs often requires significant financial resources. WAPA will work with the PSC to explore the adoption of funding mechanisms that enable it to invest in energy efficiency programs. Most US utilities finance energy efficiency through a special “system benefit” charge. Under this model, utilities add a small charge to energy bills (typically between 0.2-0.4¢/kWh) that generates revenue that is redirected back to customers through energy efficiency programs. Even a charge as small as 0.2¢/kWh, which would cost the average USVI resident $9 per year, would generate $1.25 million annually for energy efficiency programs. Regulatory rules should require that the system benefits, including energy bill savings to customers, are greater than the costs of the program. Other jurisdictions include a range of services within a system benefit charge, including funding for distributed generation.

Other strategies for promoting energy efficiency include a Lost Revenue Adjustment Mechanism, where a utility can recover the revenue that it lost as a result of its energy efficiency programs, and decoupling, where the utility’s approved rate of return is decoupled from energy sales. Both rate reforms eliminate the utility’s financial disincentive from promoting a reduction in energy demand. This structure incentivizes utilities to invest in lowering customer demand without compromising their ability to recover their fixed costs. In addition, for the short term, VIEO has a $2 million revolving loan fund to support the installation of Energy Star appliances that can fund ad hoc improvements.

Initiative 8
Strengthen building code compliance

The USVI has a history of adopting strong building codes that include requirements for high levels of energy efficiency. However, enforcement of these building codes is relatively weak, which is a challenge in many localities. FEMA has launched a program to hire and train 10 new building inspectors across the Territory. DPNR will ensure that these inspectors are trained on the USVI electric code to ensure its enforcement.

At the same time, the GVI must lead by example. The reconstruction effort presents a great opportunity to do so. All public buildings should be built to comply with the latest USVI energy code and include high-efficiency building systems as cost-effective. This cuts across a number of sectors, including education, health care, public housing, and any other government buildings.

16 Massachusetts, California, and many other US states have energy policies that require that energy efficiency be considered the “first-in” resource in a utility’s integrated resource planning because it is the cheapest resource available.
MODERNIZE THE GRID

WAPA has made intermittent, but impactful, efforts to update the electric grid to keep pace with new technology. This includes the installation of Advanced Metering Infrastructure (AMI) to monitor customer energy usage and of Supervisory Control and Data Acquisition (SCADA) systems that enable different parts of the grid to communicate with each other.

This data provides a comprehensive platform to improve supply-side and demand-side energy efficiency. On the demand side, smart meters installed through the AMI system provide comprehensive data on customer power usage. This allows customers to take more informed steps to reduce their power consumption and WAPA to provide customers with personalized energy efficiency programs. On the supply side, AMI and SCADA help increase the operational efficiency of the system and ensure that energy consumption is appropriately billed to customers. That is important because, of the total power that WAPA generates, it loses five percent on St. Thomas and nine percent on St. Croix in the process of delivering that power to customers.

While AMI and SCADA have been deployed by WAPA, they have not been fully installed and optimized to date.

Initiative 9
Accelerate the deployment of advanced control systems

WAPA will accelerate the deployment of advanced control systems to improve reliability and enhance energy efficiency and distributed generation. This work will primarily occur through the repair and expansion of WAPA’s current SCADA and AMI systems.

On the demand side, WAPA will replace meters damaged by Hurricanes Irma and Maria and finish installing meters in locations that did not have them before the storms. Building on the data provided by the AMI system, WAPA will launch a customer portal that will allow residents to see details about their energy consumption (e.g., time and sources) in comparison to similar customers. The full restoration of smart meters and the expansion of the customer portal will allow WAPA to share personalized energy efficiency programs with customers to enable them to lower their bills while helping WAPA avoid additional capital investments.

DAMAGE AND RECOVERY COSTS

The USVI summarized its funding needs for the energy sector in the Action Plan that was submitted to the US Department of Housing and Urban Development (HUD) Community Development Block Grant Disaster Recovery (CDBG-DR) Program in May 2018. In the plan, WAPA identified $2.3 billion in needs to repair the damage caused by the hurricanes and increase the resilience of the USVI’s energy system in the face of future hazards. This included approximately $600 million for emergency and temporary repairs and $1.7 billion for permanent repairs and resilience enhancements. These funding needs include:

- Ongoing emergency response from mission assignments (e.g., portable generation, 800+ off-island linemen/support personnel);
- Repair and resilience actions needed to restore the power grid, including installing over 20,000 poles, rebuilding over 1,100 miles of transmission and distribution lines, and replacing 5,300 distribution transformers;
- Projects for which engineering estimates are not complete;
- Engineering estimates for repairing four generating units to restore two plants to normal operations.
In addition, WAPA will also explore expanding its program for load management devices. These devices allow customers to reduce energy consumption remotely (for example, by turning on the air conditioner five minutes before a resident arrives home rather than leaving it on all day). If customers are interested, they can also allow WAPA to connect to these devices so that WAPA can reduce one another energy consumption during peak times to reduce stress on the grid.

On the supply side, WAPA will collaborate with Virgin Islands Next Generation Network (viNGN) and FEMA to expand the current fiber and mesh wireless information to improve WAPA’s insight into the feeder system to reduce line losses. In addition, WAPA will rely on both AMI and SCADA capabilities to enable an e-mapping analysis to identify opportunities to reduce supply side losses. Due to dramatic changes in the grid infrastructure, the additions of new distributed renewable systems, and changes in population, WAPA should reassess the needs of each feeder.

The expansion of both the AMI and SCADA systems will enable WAPA to operate the grid more effectively. These investments are necessary to fully leverage new technologies and grid designs such as distributed generation and the hybrid microgrids that WAPA is planning.

**FORTIFY INFRASTRUCTURE AGAINST CLIMATE RISKS**

The USVI energy system is particularly vulnerable to extreme weather events. The recovery effort provides a unique opportunity to harden the entire system both against future storms and chronic stressors related to climate change (e.g., sea level rise). Because it is not economically feasible to build a system that is completely resistant to damage from these risks, the USVI must focus on strategies that reduce risk, enable faster response, and increase the flexibility of the system. WAPA has incorporated many actions to reinforce its generation, transmission, and distribution assets into the rebuilding process. The Authority will continue to identify additional actions to harden the system as the recovery effort moves forward.

**Initiative 10**

**Reinforce all generation, transmission, and distribution assets**

Hurricanes Irma and Maria exposed the extreme vulnerability of WAPA’s system to hurricanes. High winds blew over numerous power lines, high wind speeds and falling tree branches caused utility poles to collapse, and substations and power plants experienced flooding. It is not financially feasible to harden all of the USVI’s energy infrastructure to withstand the strongest possible storms, but it is certainly possible to identify projects that reduce risk at a cost that is acceptable.

To date, WAPA has submitted more than $520 million in projects to FEMA as part of the agency’s Hazard Mitigation program and is already executing many of these projects. Approximately $400 million of this request is for undergrounding transmission and distribution lines in critical locations. WAPA has also submitted approximately $100 million in funding requests to add composite poles in critical locations on St. Croix, St. John, St. Thomas, and Water Island. The remaining projects include improvements to substations (East End, Tutu, and Donald Francois), replacing pole-mounted transformers with pad-mounted transformers, installing a submarine cable from Harley to the East End substation on St. Thomas to provide additional redundancy, and installing emergency generation on St. John.

All the new poles that are being installed in the Territory as part of these efforts will be installed deeper into the ground to provide extra stability.

**Initiative 11**

**Update design and construction standards**

Given the variety of challenges facing the utility in recent years, WAPA has not had the capacity to update its design and construction standards to industry standards. WAPA will work with FEMA and industry associations to update its design and construction standards to better withstand extreme weather events. For renewable assets, WAPA will ensure that privately owned utility-scale renewables are built to the updated standards. DPNR will incorporate up-to-date standards for rooftop PV to reduce the potential damage caused by future storms. Some of these standards will be
ENERGY

STRENGTHEN ENERGY PLANNING AND GOVERNANCE STRUCTURES

Infrastructure investments can improve the reliability and resilience of the USVI energy system and help lower rates; however, a number of significant financial and regulatory issues must be addressed in order to maximize these impacts. These changes cut across all aspects of the system, including operations, governance, and workforce capacity. Specifically, WAPA must review its overall operations and financial planning to reduce its costs and more efficiently operate its assets. The overall energy governance structure must be realigned to increase accountability and better reflect industry best practices in other markets. Finally, workforce development must be enhanced to ensure that there is a local workforce capable of executing the vision outlined in this report and that USVI residents benefit from the influx of investment coming in to the Territory.

Initiative 12
Update WAPA’s Integrated Resource Plan

WAPA’s Integrated Resource Planning (IRP) process guides its capital plans for the next several years. Since the publication of the Territory’s first IRP in 2016, technology has rapidly evolved, especially with respect to battery storage. The current IRP does not appropriately incorporate these advances nor does it include a strong focus on energy efficiency and demand response as strategies for avoiding future capital investments. Additionally, peak demand estimates in the IRP need to be updated to reflect the impacts of the hurricanes, increased deployment of distributed renewables, and rising grid defections.

WAPA will launch an accelerated update to its IRP to develop a new demand forecast, an updated plan for capital investments, and an assessment of the technical, economic, and achievable potential of energy efficiency and demand response as resources. The IRP process should incorporate sufficient opportunities for meaningful stakeholder engagement. The utility will also execute a grid stability analysis to understand which feeders can operate with additional distributed renewable generation capacity (and how much of it) and which, if any, feeders need to be updated to handle additional renewable capacity. This analysis will be completed by the end of the year.

In the future, WAPA should be required to update its IRP at least every four years, with clear guidelines as to what information should be included in the study.

Initiative 13
Update and strengthen maintenance policies and procedures

Maintenance standards are critical to ensure that utility infrastructure operates at maximum efficiency for the full lifetime of the technology and is resilient to damage from climate risks. These standards need to be updated to reflect the damage caused by the storms: in just one example, some of the damage to power lines could have been avoided by better trimming nearby trees.

WAPA will review and update its maintenance policies and procedures and allocate enough staff to carry them out. The utility already plans to cross-train line crews to enable them to manage vegetation in addition to addressing electrical issues. Proactive maintenance can greatly enhance the resilience of WAPA’s system and help lower ongoing operating costs.

Initiative 14
Revise WAPA’s emergency plan

It is not possible to anticipate or prevent all damage. A comprehensive emergency plan is critical to enabling a rapid, coordinated, and successful recovery effort. WAPA will update its emergency plan and operating procedures to incorporate lessons learned from the 2017 hurricanes. This should include a prioritized list of critical facilities to be repowered in any future outages and their distributed or backup generation capacity. The VIEO Distributed Generation project will help support
this effort, as it will inventory all DG and backup generation sources in the Territory. WAPA and VITEMA can use this information to inform planning for the next power restoration effort. VIEO has also launched a project to create a Territorial Energy Assurance Plan, which will further contribute to this effort.

**Initiative 15**

**Restructure financial commitments as needed to improve WAPA’s fiscal solvency**

As previously mentioned, WAPA is facing a substantial decline in revenues, substantial unpaid receivables, a large outstanding debt burden, and a low credit rating. This multi-faceted challenge jeopardizes the utility’s financial health. In the short term, WAPA will focus on deploying federal funding to provide much-needed new generation capacity and reduce ongoing operation costs. Once WAPA has spent the available federal funding and taken advantage of federal low cost financing, the utility will review its debt burden and identify any opportunities to restructure or reduce its long-term commitments to improve its fiscal health.

**Initiative 16**

**Realign energy governance structure**

The USVI’s energy sector has a unique governing structure that inhibits innovation. Typically, public utilities like WAPA are either wholly governed by an independent board or are directly managed by a government agency. Investor-owned utilities are regulated by Public Service Commissions (PSCs), which oversee all utility investments that will be recovered in customer rates. There are a few exceptions (Indiana, Maine, Maryland, Rhode Island, Vermont, and Wisconsin) where PSCs regulate utility rates for public utilities instead.

WAPA is caught between these two structures, as it has both an independent board and a PSC. The Board of Directors is appointed by the Governor; it has fiduciary responsibility for the utility but lacks ratemaking authority. The PSC’s seven voting members are appointed by the Governor as well (with two additional non-voting members appointed by the Legislature); the Commission has the authority to approve or reject changes to WAPA’s rates and to grant QF status to project developers but no other oversight of the utility. Both the PSC and the WAPA governing board lack the authority and capacity to fully and ably execute their respective oversight roles over WAPA. The result has been a fraught relationship where disagreements are brought to court rather than resolved through the regulatory process, and where a lack of agreement on roles and responsibilities prevents the actions needed to drive down rates, increase resilience, and improve the financial health of the utility.

To allow WAPA to function as well as it can, both the Board and the PSC must have clear and distinct roles and responsibilities that are mutually respected. The Governor’s VIEO could play a role, too: in many US states, such offices play a prominent role overseeing and managing energy policy for the state. In New York, for example, the Governor’s Chairman of Energy and Finance is responsible for overseeing multiple government departments and bodies to ensure they are all advancing the Governor’s priorities. While its work on energy efficiency and running the Energy Roundtable are important, the VIEO is not appropriately resourced to hold other government departments accountable.

The Governor’s Office will work with WAPA, the PSC, and the Legislature to enact governance reforms to improve the oversight and health of WAPA. These reforms may include a variety of changes in the structure and oversight of the WAPA Board and of the PSC, but must give one or both of these groups the clear authority and capacity to oversee WAPA.

To elevate the regulatory role of the PSC, its powers should be expanded so that it can provide stronger oversight of the utility in parallel with changes to professionalize the body and ensure any contracts that the PSC signs with consultants are competitively procured. To empower the WAPA Board, its capacity and composition should also be reformed to ensure appropriate utility expertise and provide it with funding to access technical experts as needed.

In the near term, the Governor should assign a working group of WAPA and PSC staff members to
develop specific recommendations for reform by the end of 2018. This working group should engage third-party technical support, such as the National Association of Regulatory Utility Commissioners (NARUC), the American Public Power Association (APPA) and/or the Regulatory Assistance Project (RAP), to bring appropriate industry expertise to bear on utility governance and regulatory oversight.

The Governor’s Office will also explore ways to reconstitute, empower, and appropriately staff the USVI Energy Office. The VIEO should lead implementation of a subset of the recommendations outlined in this report, track and publicly report on the USVI’s progress toward its overall energy strategy, and act as the Governor’s primary advisor on energy issues.

**Initiative 17**

**Support workforce development**

Transforming the USVI’s energy sector will require new jobs, knowledge, and skills. The short-term influx of capital and technical expertise will help launch this transition, but without a robust workforce development program the USVI risks having 21st century infrastructure without a 21st century workforce to maintain it. Critical needs in the Territory include energy auditors to evaluate energy use in buildings, contractors to execute energy efficiency projects, solar installers to meet the increasing demand for solar panels, construction workers to build wind farms, and utility workers to manage and maintain an increasingly complex grid.

Some of these needs can be met with the existing workforce. WAPA will expand its internal training capacity to ensure that its workers are able to operate and maintain new infrastructure, including expanded underground facilities, new composite poles, new high-efficiency generators, and renewable assets. FEMA, in turn, has provided a variety of resources through the Recovery Advisory Reports to inform architects, engineers, and contractors about building more resilient and energy efficient homes up to the current building code and appropriately installing rooftop equipment, including solar panels.

Other needs will require the training of new workers. To prepare the next energy leaders for the Territory, the University of the Virgin Islands (UVI) will expand current programs on renewable energy and energy efficiency in collaboration with WAPA and VIEO. Currently, UVI is developing a net-zero energy home (a home that generates as much energy as it consumes) to use as a hands-on example of energy efficiency and renewable energy strategies. Beyond that, UVI is considering developing a certificate program or elective courses on energy efficiency and renewable energy to expand knowledge on island. In addition, WAPA will explore the feasibility of creating an apprenticeship program with USVI high schools to build skills for key roles and attract young talent to WAPA.

The overall potential for job creation as a result of the energy transformation is substantial: while slightly outdated, a 2012 report estimated that meeting the USVI’s goal of a 60 percent reduction in fossil fuel use by 2025 would create 800 jobs in that timeframe, equivalent to 2,000 “job-years” (for context, total formal civilian employment in all of the USVI stands at around 40,000). Nationally, a study by the National Association of State Energy Officials and the Energy Futures Initiative noted that jobs in energy efficiency alone represented half the total growth of jobs in the energy sector in 2017. In addition, within energy production, the solar industry employs more American workers than coal, nuclear, and wind industries combined and employs slightly fewer than the natural gas industry, where the jobs are primarily in fuel production.

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17 A job year is one full-time job for the period of one year. For example, 10 job years can represent 10 jobs that last for one year, 5 jobs that last for two years, or 2 jobs that last for five years, etc.