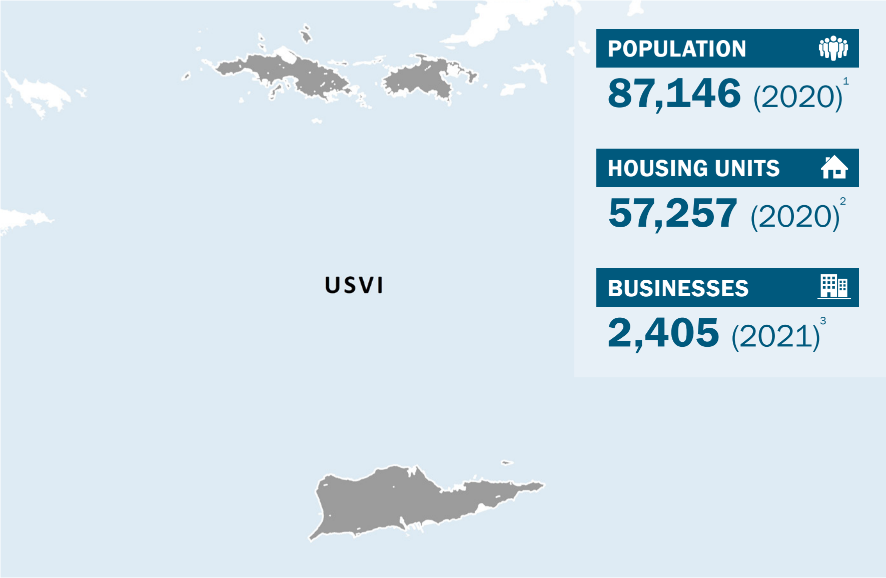
Territory of the U.S. Virgin Islands



POPULATION
87,146 (2020)[1]

HOUSING UNITS
57,257 (2020)[2]

BUSINESSES
2,405 (2021)[3]

QUICK FACTS

ELECTRIC UTILITY
Virgin Islands Water and Power Authority (VIWAPA)[4]

PUBLIC SERVICE COMMISSION
Virgin Islands Public Utilities Commission[5]

TERRITORY ENERGY OFFICE
Virgin Islands Energy Office[6]

EMERGENCY MANAGEMENT AGENCY
Virgin Islands Territorial Emergency Management Agency[7]

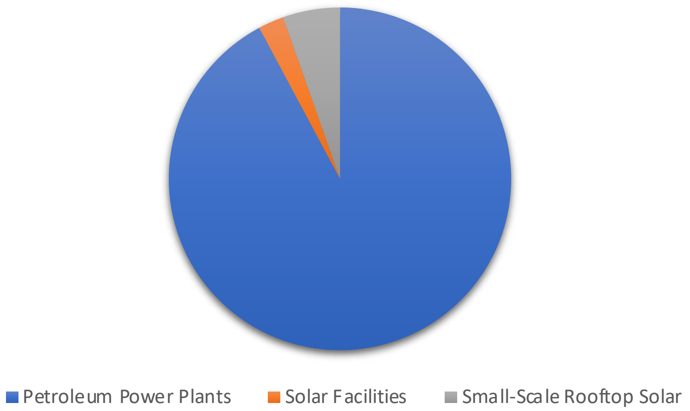
FUSION CENTER
Virgin Islands Fusion Center[8]

AVERAGE RESIDENTIAL ELECTRICITY PRICE
$0.41/kWh (including fuel surcharge of $0.22/kWh) (2022)[9]

This profile examines the relative magnitude of the risks that the Territory of the United States Virgin Islands' (USVI) energy infrastructure routinely encounters in comparison with the probable impacts. Natural and man-made hazards with the potential to cause disruption of the energy infrastructure are identified. Certain natural and adversarial threats, such as cybersecurity, electromagnetic pulse, geomagnetic disturbance, or pandemics are ill-suited to location-based probabilistic risk assessment as they may not adhere to geographic boundaries, have limited occurrence, or have limited historic data. While cybersecurity and kinetic threats are not included in these profiles, they are ever present and should be included in territory energy security planning. Resources for adversarial threat planning include the American Public Power Association's Cybersecurity Resource Guide for Public Power Utilities and Physical Security Resources Page.

The purpose of this profile is to provide USVI energy officials and infrastructure owners and operators with a concise overview of energy sector risks. The charts, graphs, and data points included may support USVI's energy security planning efforts or the development of applications for grid resilience funding opportunities.

ANNUAL ELECTRIC POWER GENERATION (MWh)



ANNUAL ENERGY CONSUMPTION[10]

ELECTRIC POWER
424,608 MWh (2022)

PETROLEUM PRODUCTS
5,949 Mbbl (16,300 bpd) (2021)

- **Motor Gasoline**
  475 Mbbl (1,300 bpd)
- **Distillate Fuel**
  3,212 Mbbl (8,800 bpd)
- **Liquefied Petroleum Gas (LPG)**
  657 Mbbl (1,800 bpd)
- **Jet Fuel**
  657 Mbbl (1,800 bpd)
- **Kerosene**
  73 Mbbl (200 bpd)
- **Residual Fuel**
  876 Mbbl (2,400 bpd)

ANNUAL ENERGY PRODUCTION

ELECTRIC POWER GENERATION
4 plants + Rooftop Solar, 424,608 MWh
285.1 MW total capacity

- **Petroleum (Oil/LPG)**
  2 plants, 391,400 MWh (2022)
  257.7 MW total capacity[11]
- **Solar Facilities**
  2 solar arrays, 10,305 MWh (2022)
  10.4 MW total capacity[12,13]
- **Small-scale Rooftop Solar**
  22,903 MWh (2020)
  17 MW total capacity[14]

OTHER ENERGY PRODUCTION
USVI does not produce any energy beyond electricity (i.e., no production of crude oil, natural gas, or coal).[15]

Energy Sector Risks

As a collection of three Caribbean islands, USVI's energy sector risk is unique compared to the US mainland. The islands' semi-remote location and dependence on imports for energy sector fuel and equipment creates energy security vulnerabilities in the event of disruptive incidents. This section outlines risks of concern for the energy sector of USVI.

Some risks are more significant for one island than others due to geological and physical characteristics, critical infrastructure facilities, or other reasons. These variances were reviewed in the context of building stock, critical facilities, and infrastructure to develop territory-wide overviews of risk.

SUMMARY OF NATURAL HAZARD RISK RANKINGS FOR USVI

	RANKING (BASED ON EXPECTED $ LOSS/YEAR)			
NATURAL HAZARD	St. Thomas	St. Croix	St. John	Composite Score for USVI
Hurricane	1	1	1	**1**
Riverine Flooding	2	2	2	**2**
Earthquake	3	3	4	**3**
Coastal Flooding	5	5	3	**4**
Tsunami	4	4	6	**5**
Rain Induced Landslide	6	6	5	**6**
Wildfire	7	7	7	**7**
Drought	8	8	8	**8**

Summary of Natural Hazard Rankings for USVI. *Derived from USVI's Territorial Hazard Mitigation Plan (2019), Table 2.82, Page 4-154. This ranking is based on an expected loss per year for each hazard, simply calculated as the total expected losses (critical facilities, commercial and residential) divided by the Return Period of the selected event, representing the amount of capital the territory would have to set aside to cover the damages for such an event. (i.e., 1=most concerning hazard, 8 = least concerning hazard).*

RISKS BY HAZARD TO USVI ENERGY SECTOR

Hazard Type		Description of Risk
Natural Hazards[16]	Hurricane	Previous Category 5 hurricanes have seriously damaged power distribution, communication, and wastewater treatment facilities across USVI. Winds are funneled in gullies, leading to intensified damage to structures at higher elevations. Aerial power lines are particularly vulnerable to hurricane winds and flooding.
Natural Hazards[16]	Flooding / Tsunami	Riverine flooding, coastal flooding, and tsunamis pose the risk of inundation and destruction of energy infrastructure. Half of USVI's power plants are located in flood zones.[17] Additionally, maintenance route disruptions caused by floods reduce response capabilities.
Natural Hazards[16]	Earthquake	Intense ground shaking can disrupt all components of a utility system, including water, electric power, wastewater, communications, and liquid fuels.[18] USVI is located on the edge of the Caribbean Plate, with earthquake events primarily characterized by relatively long and far earthquake shocks.
Natural Hazards[16]	Landslides	Due to USVI's natural terrain, many power lines are at risk of damage during a landslide event. Landslides also block roads, potentially limiting access to downed or damaged electric infrastructure.
Natural Hazards[16]	Wildfire	Primarily limited to St. Croix, wildfires in USVI have historically been human-caused and spread over hundreds of acres. Drought conditions can exacerbate wildfire, and wildfire can in turn propagate rain-induced landslides. Past incidents have damaged utility poles.

RISKS BY HAZARD TO USVI ENERGY SECTOR (CONT.)

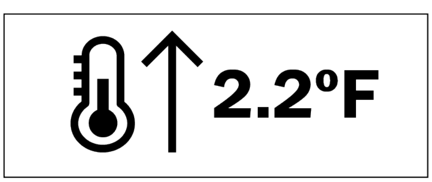
Hazard Type		Description of Risk
Logistics/Human Proceedings	Supply Chain Disruptions	USVI relies entirely on delivery of petroleum products by ship and barge. If a port is damaged or closed, this can severely impede access to petroleum and other goods.
Logistics/Human Proceedings	Market Conditions	Because VIWAPA depends on petroleum-based fuels to generate electricity, they are subject to global petroleum market pricing. Ratepayers are often subject to fuel surcharges on their electric bills, creating affordability and access challenges.
Logistics/Human Proceedings	Limited Access to Rapid Mutal Aid	Although VIWAPA does have mutual aid agreements with public power utilities across the United States for post storm restoration assistance, ransportation logistics limit the rapid deployment of supporting utility personnel and equipment.[19]
Climate Change	Temperature	Increased temperatures increase electricity and fuel demands to provide cooling for buildings. Power generation under warmer temperatures faces potential cooling water shortages, cooling water inefficiencies, and ambient cooling impacts. Extreme heat decreases transmission and distribution capacity because of overloading and the need the need to compensate by derating lines and transformers. Extreme heat also causes power lines to sag.
Climate Change	Precipitation	While significant rain events may increase, overall precipitation will decrease, leading to drought conditions. Rises in extreme rainfall events increases the probability of damage to infrastructure, and changing precipitation patterns may change vegetation growth patterns and increase the likelihood of vegetation disrupting overhead power lines.
Climate Change	Sea Level Rise	Rising sea levels increase the potential severity of tropical storms bringing direct threat to any infrastructure on land. Power plants and other electric infrastructure are sited on the coast, leading to potential impacts to power delivery from sea level rise.
Climate Change	Increased Frequency of Extreme Weather Events	Increased heavy rain events increase flooding potential which can damage power lines and other infrastructure on a more regular basis. They also have the potential to overwhelm storm drainage systems and damage port facilities, delaying petroleum and other necessary goods including medicine.
Adversarial Threats	Although adversarial threats, like cybersecurity and kinetic threats, are not included in this profile, they are ever present and should be included in territory energy security planning efforts. Resources for adversarial threat planning include the American Public Power Association's Cybersecurity Resource Guide for Public Power Utilities and Physical Security Resources Page.	

Climate Change Considerations[20,21]

Future climate change expectations for the USVI include warmer oceans, higher temperatures, an increased frequency in powerful storms, and more inland flooding. These environmental changes create challenges to energy infrastructure, such as storm induced damage or the need to compensate for higher energy demand due to higher temperatures.

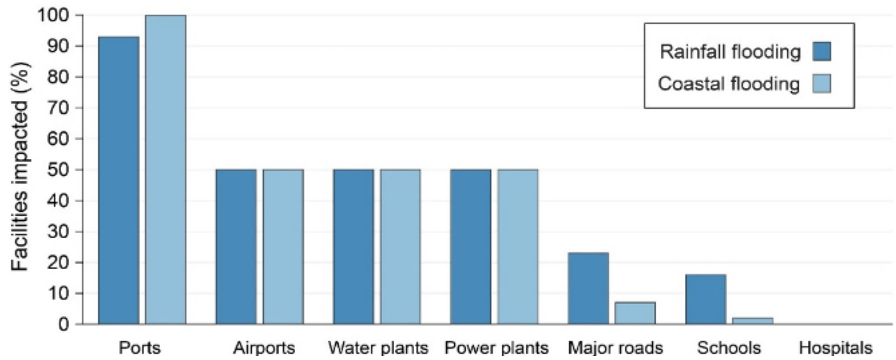
CLIMATE CHANGE RISK TO INFRASTRUCTURE[23]

Climate change is projected to bring significant changes to temperatures, precipitation, and storms to the USVI, threatening the reliability of energy infrastructure. Fewer rainfall events, more intense storms, sea level rise, and increasing temperatures all place an increased burden on energy infrastructure. Energy demand will increase because of the changing climate, particularly cooling demands due to rising temperatures. The risks due to the projected increase in temperature can be contextualized to show the change in energy demands for cooling needs using Cooling Degree Days (CDDs), which is a measure of how many degrees warmer the mean temperature is than 65 degrees on a given day. By the end of the century, assuming a SSP5-8.5 climate pathway, USVI may experience 2,050 additional CDDs (as seen in the plot). The increase in CDDs means energy demands for cooling buildings will be higher throughout the year. This risk is heightened by the difficulty of transmitting energy in high heat conditions.



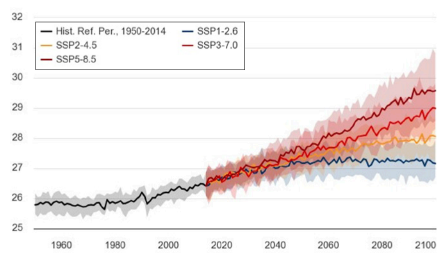
Mean surface air temperature by mid-century.

INFRASTRUCTURE AT RISK OF FLOODING IN THE USVI



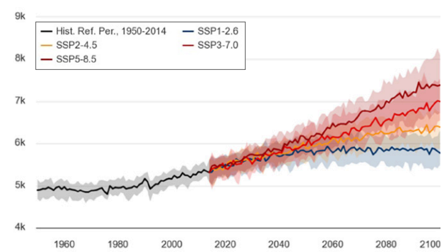
PROJECTED AVERAGE MEAN SURFACE AIR TEMPERATURE (°C) USVI

Ref. Period: 1995–2014; Multi-Model Ensemble



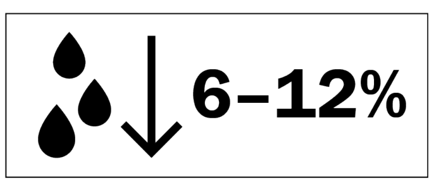
PROJECTED COOLING DEGREE DAYS (REF-65°F) USVI

Ref. Period: 1995–2014; Multi-Model Ensemble



STORMS, IMPACT ON INFRASTRUCTURE

Heavy rainstorms will become more intense, but total rainfall is expected to decrease in the Caribbean region. Mean annual rainfall is projected to decrease by 6-12% for the U.S. Virgin Islands by mid-century along a high emissions pathway.[34] More intense rainfalls can increase flooding by overwhelming storm drainage systems leading to damage of critical infrastructure.

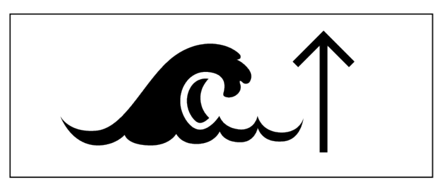


Mean annual rainfall by mid-century. *Fewer, but more intense rainstorms.*

Within the Atlantic basin, the tropical cyclone rain rate is projected to increase by about 15% and the average storm wind intensity around 3% for a global average temperature increase of 3.6°F above present day levels. Additionally, the number of intense tropical cyclones (Categories 4 and 5) are projected to increase.[25]

SEA LEVEL RISE, COASTAL EROSION

Sea level rise is a great concern for any island nation. Waters around the U.S. Virgin Islands have warmed by nearly 2°F since 1901 and sea level is rising by about an inch every decade.[33] Sea level rise increases coastal flooding impacts, placing coastal infrastructure at risk of damage and eroding the shoreline and beachfronts. Storm surge will also become higher as a result of the future higher sea levels, placing more coastal homes and infrastructure at risk of flooding damage during a storm.



Rising sea levels and higher storm surge.

Electric Subsector

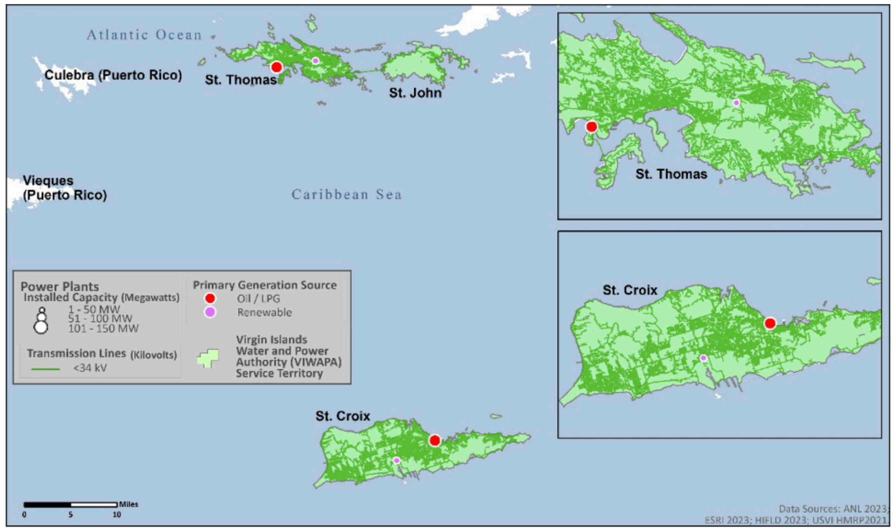
Most electric infrastructure on the U.S. Virgin Islands is owned and operated by the Virgin Islands Water and Power Authority (VIWAPA), a semi-autonomous agency of the Virgin Islands Government which produces and distributes electricity to residential and commercial customers across the territory. There are a few commercial entities within the territory that produce electricity for their own use and are not customers of VIWAPA. VIWAPA generates most electric power at two LPG and oil-fueled power plants on St. Thomas and St. Croix and distributes the generated electricity via <34kv power lines across each island. An undersea power cable from St. Thomas provides electric service to consumers on the less populated island of St. John. Less than 10% of the territory's electricity generating capacity is provided by renewable sources of energy.

Imported petroleum products fuel nearly all the electricity generation on the islands. Fuel costs are highly susceptible to wide market fluctuations, as experienced in December of 2022. In 2019, 65% of the USVI's electricity was generated by fuel oil, about 35% by LPG, and 1% by solar power. However, in 2022, about 40% of the electricity was generated by fuel oil, 57% by LPG, and 3% by solar power. Currently, three of six VIWAPA-owned generating units can operate with LPG as a primary fuel source.[26]

ELECTRIC GENERATING FUEL SUPPLY

The Randolph Harley Generating Station (RHGS), located on St Thomas has LPG storage capacity for approximately 18 days (10 tanks, 84,000 barrels storage capacity). The Richmond Generating Station (RGS), located on St. Croix has LPG storage capacity for approximately 19 days (8 tanks, 65,400 barrels storage capacity). In 2013, VI WAPA maintained approximately 30 days of fuel oil storage capacity on St. Thomas, St. Croix and St. John. The Authority also has two 5,000-gallon storage tanks on the island of St. John to provide No. 2 fuel oil to its 2.5 MW diesel unit.[28]

MAP OF ELECTRIC INFRASTRUCTURE

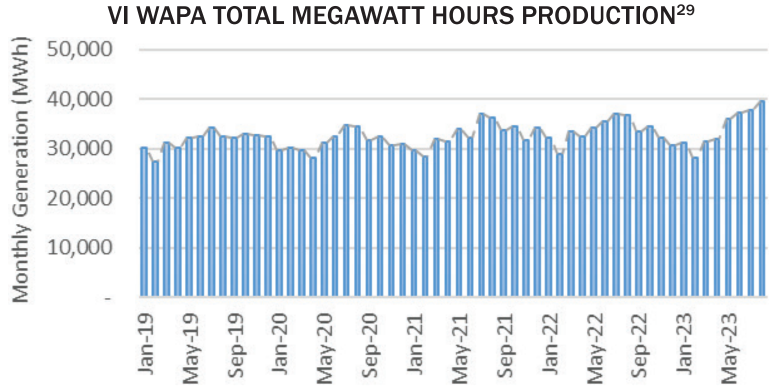


Map of electric infrastructure. *Provided by Argonne National Laboratory, HiFLD Open, ESRI, GIS data layers from the US Virgin Islands Hazard Mitigation & Resilience Plan, and BMR Energy sites for solar arrays on St. Thomas and St. Croix.*

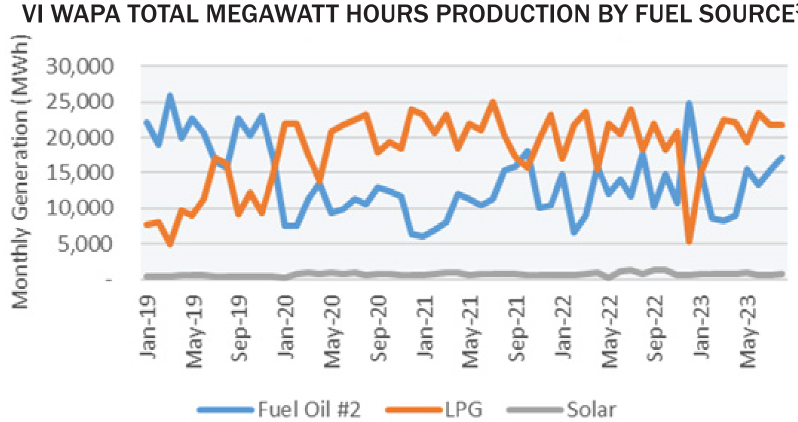
ELECTRIC CUSTOMERS AND CONSUMPTION BY SECTOR, 2022[27]

	CUSTOMERS	CONSUMPTION
Residential	**82%**	**42%**
Commercial	**14%**	**16%**
Industrial	**4%**	**42%**

VI WAPA TOTAL MEGAWATT HOURS PRODUCTION[29]

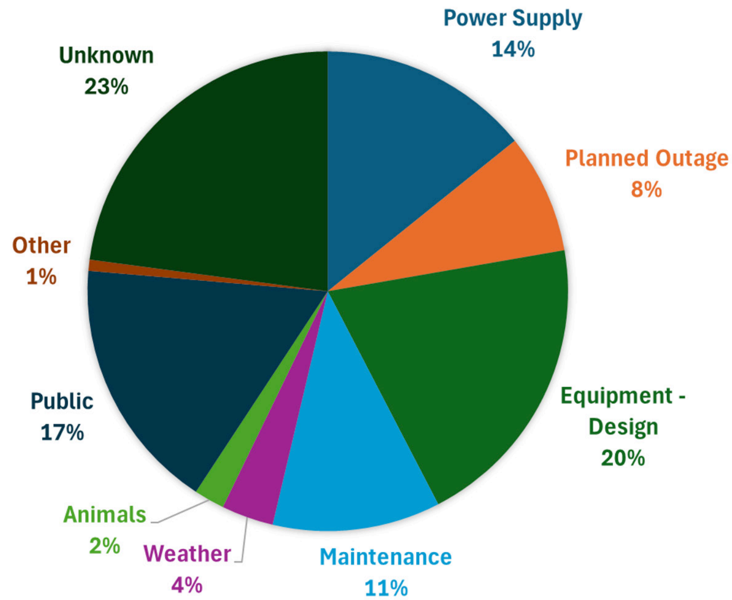


VI WAPA TOTAL MEGAWATT HOURS PRODUCTION BY FUEL SOURCE[30]



USVI WAPA OUTAGES BY CAUSE

January–November 2023



Outages by cause. *Data provided by VI WAPA.*

USVI WAPA OUTAGE CATAGORY EXAMPLES

OUTAGE CATEGORY	EXAMPLE
Power Supply	Lack of power supply
Planned Outage	Construction, Equipment Maintenance
Equipment Install/Design	Installation fault, overload
Maintenance	Decay/age of equipment, corrosion of equipment, tree growth
Weather	Wind, Storm, Lightning, Other Weather
Animals	Small animal/bird, large animal
Public	Customer-caused, motor vehicle collision, fire, other
Other	Miscellaneous
Unknown	Cause Unknown

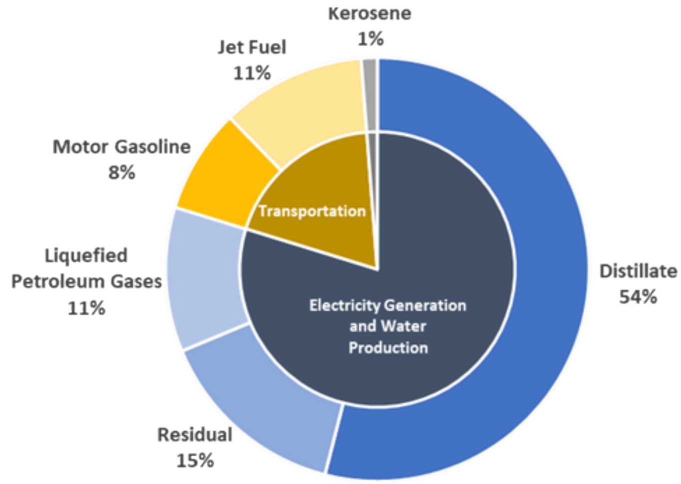
Outage catagories. *Categories provided by VI WAPA. Examples are not comprehensive.*

Petroleum Subsector

The USVI has no fossil energy resources and meets nearly all its energy needs with imported petroleum products. Distillate fuel oil, residual fuel, and LPG account for about 70% of all petroleum products consumed in the USVI, where they are used for electricity generation and the production of drinking water supplies. Jet fuel, motor gasoline, and kerosene make up the remaining 30% of the island's petroleum consumption.

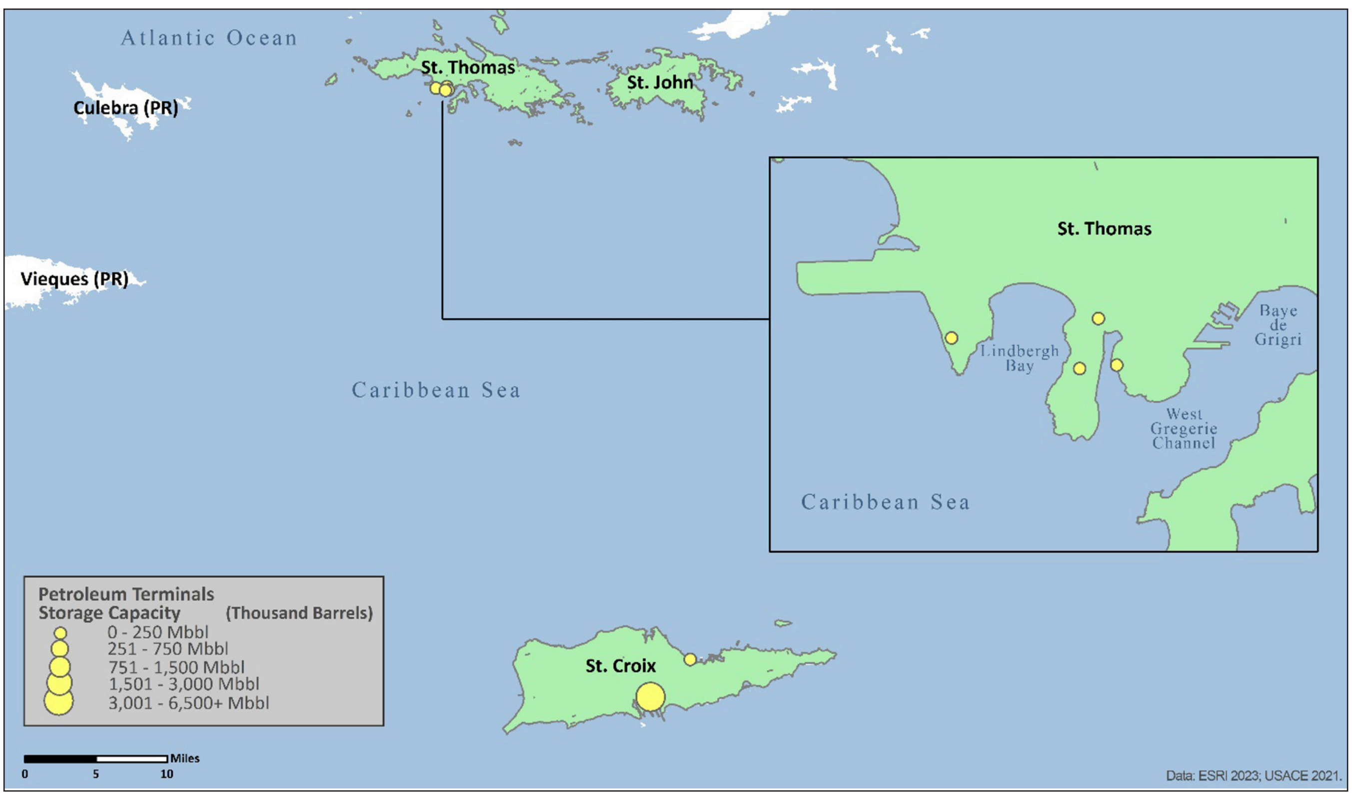
USVI CONSUMPTION OF REFINED PRODUCTS, 2021 (bpd)

Total Consumption: 16,300 bpd



USVI Consumption of Refined Products, 2021 (bpd). [Energy Information Administration—Petroleum Products and Liquids: Virgin Islands (Annual Consumption by Product).]

PETROLEUM TERMINALS[31]



TERMINAL	ISLAND	PETROLEUM FUELS	DOCKS	TANKS	CAPACITY
Puma Energy Terminal	St Thomas	Diesel, Gasoline	Yes	6	N/A
Domino Oil Co Inc	St Thomas	Diesel, Gasoline	Yes	5	N/A
TotalEnergies St. Thomas Terminal	St Thomas	Jet Fuel, Fuel Oil	Yes	5	12,104
VIWAPA STT	St Thomas	LPG (Propane)	Yes	10	88,000
Ocean Point Terminals (formerly Limetree Bay)	St Croix	Distillate, Gasoline, Jet Fuel, LPG, Residual Fuel	Yes	167	34,000,000
VIWAPA STX (formerly Vitol)	St Croix	LPG (Propane)	Yes	8	65,500

Supply Chain

PETROLUEM MOVEMENTS TO USVI[33]

The primary source of imports changes greatly from year to year due to market conditions, as products are obtained from multiple suppliers. In 2022, the USVI imported almost all its residual fuel needs from foreign sources, Colombia (52%), Mexico (37%) and The Bahamas (11%). All other products, such as gasoline and jet fuel likely originate from CONUS and Puerto Rico.

APPLICABILITY OF THE JONES ACT[32]

Under 46 U.S.C. § 501, the Jones Act prohibits vessels from conducting trade in certain U.S. territories and states unless they are U.S.-built, owned, and documented (“coastwise” laws). The Jones Act is **NOT** applicable to the U.S. Virgin Islands unless the President declares otherwise by proclamation.

THE STAFFORD ACT

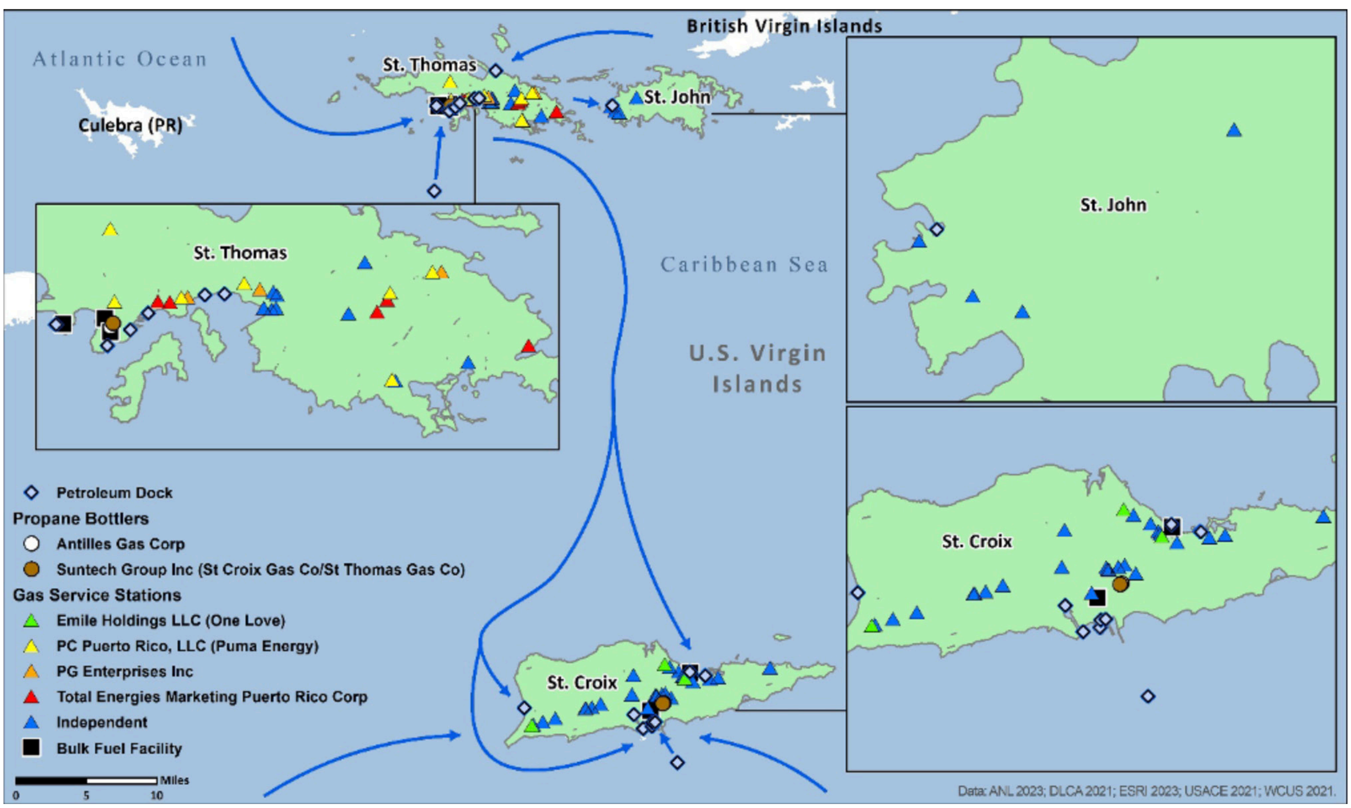
The Stafford Act became law in 1988 and was amended in August 2016, giving the U.S. president authority to grant funds to U.S. states and territories for disaster response and recovery.

DISTRIBUTION AND MOVEMENTS WITHIN ISLANDS[34]

- Within each island, only truck-based distribution of gasoline and diesel fuel originating at the port of entry is available (no pipeline deliveries within the USVI).
- All fuels for the islands are delivered by private haulers from terminals.
- There are about 60 service stations—68% of them are operated by independent retailers.

PRIVATE HAULER	ISLAND
St. Croix Fuel Services Inc.	St. Croix
Bunkers of St. Croix Inc.	St. Croix
Petromax	St. Croix
Caribbean Petroleum Inc.	St. Thomas
Domino Oil Company Inc.	St. Thomas
PC Puerto Rico LLC (Puma)	St. Thomas
Tri Island Energy LLC	St. Thomas

FLOW MAP OF ENERGY FUEL TRANSPORTS & GAS SERVICE STATIONS



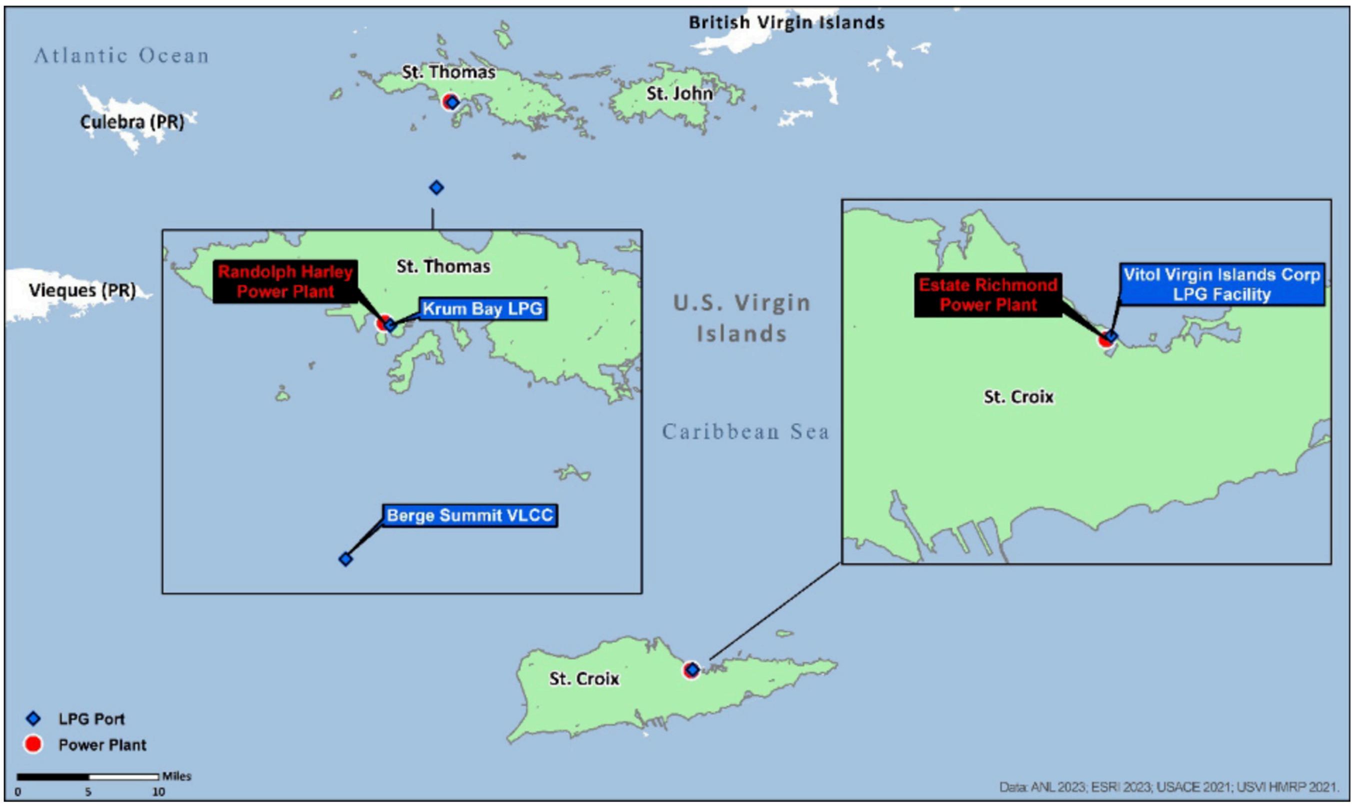
Flow Map of Energy Fuel Transports and Gas Service Stations. *Data points identified in the flow map derived from Argonne National Laboratory, ESRI, U.S. Army Corp of Engineers Waterborne Statistics Center.*

LPG TRANSPORT ON ISLANDS[35,36]

LPG is shipped to two ports at Krum Bay, St Thomas and Christiansted, St Croix.

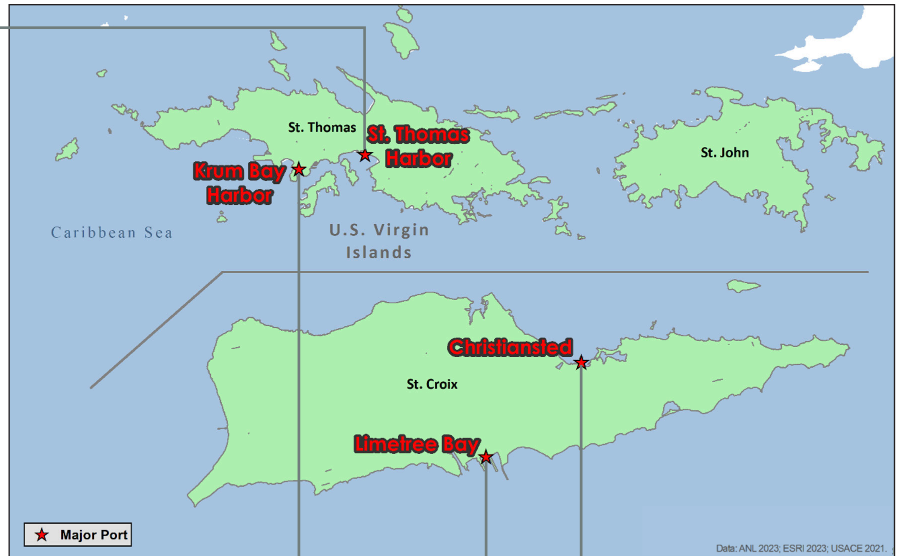
- **Krum Bay, St Thomas:** LPG and diesel fuel deliveries to the WAPA plant on St. Thomas are by sea; ships use the same dock so there are sometimes logistic challenges. There is no option to deliver fuel by truck to the St. Thomas plant due to lack of supply chain to support LPG shipments.
- **Christiansted, St Croix:** LPG deliveries to St. Croix are by boat, called a 'shuttle,' from St. Thomas to St. Croix about six times per month. These smaller shuttle boats are used due to the shallow waters and narrow channel. On St. Croix, the Ocean Point Terminal can supply diesel by truck, but the infrastructure does not exist to receive LPG to the plant.
  - WAPA may procure diesel by truck from Ocean Point Terminal if there is an issue with the LPG system/supply and/or it is needed for blackstart operations. These smaller quantities are delivered by truck—typically bringing in orders of 2,500 to 5,000 barrels, opposed to the smallest quantity purchased by barge being 10,000 barrels. Burning only diesel is not feasible to maintain the necessary burn rate.

LPG PORTS AND PETROLEUM/LPG FIRED POWER PLANTS



LPG Ports and Petroleum/LPG Fired Power Plants. *Map of LPG ports and power plants crafted using data from [ESRI], U.S. Army Corp of Engineers Portsall, and GIS data layers from the [US Virgin Islands Hazard Mitigation & Resilience Plan]. Berge Summit VLCC is an offshore LPG storage facility.*

MAJOR PORT CHARACTERISTICS[37]



ST. THOMAS HARBOR

St. Thomas Harbor, St. Thomas Island, in about the middle of the south coast of St. Thomas Island, is the only sheltered harbor in the Virgin Islands that can be entered by large vessels. Although the oval-shaped harbor is small and open to the south, it is well protected by the high hills surrounding the other sides and provides safe anchorage except during a hurricane. Very large gas carriers (VLGC) are moored approximately 5 miles offshore of St Thomas and act as an LPG Floating Storage Unit, with smaller LPG carrier vessels feeding the two power stations on both the islands.[38]

KRUM BAY

Krum Bay, northwest of Water Island, has depths of 34 feet in the entrance, shoaling to 8 feet near the head. A power plant maintains a lighted T-head pier and a barge dock on the west side of Krum Bay. Channel water depths are 26-30 feet and 11-15 feet at the oil terminal.[39]

Pilotage: The pilots' boathouse (station) is on the waterfront at St. Thomas Old Marine Terminal. St. Thomas Pilots serve the main harbors of Charlotte Amalie, St. John, East and West Gregerie Channels, Crown Bay and Southwest Roads. Pilots board vessels entering St. Thomas Harbors from four points at the entrances.

LIMETREE BAY

Limetree Bay, St. Croix Island. Limetree Bay Harbor is located between Krause lagoon and Canegarden Bay on the S coast of the island of St Croix, US Virgin Islands. It is the site of a private deep draft oil handling facility (formerly Limtree Bay/HOVENSA LLC). Large tankers come here to deliver and load petroleum and petrochemical products.

Limetree Bay Channel, privately dredged, leads from deep water to a large turning basin with east and west basins. In 2012, the reported controlling depth in the channel was 60 feet with a draft limit of 55 feet.

Pilotage: Pilotage is compulsory. Pilots board vessels about 3 miles south-southeast of Limetree Bay Channel Lighted Buoy 1. Vessels are requested to call in advance for clearance on VHF-FM channel 11 for approach procedures and docking instructions. Night entry is limited to vessels not over 100,000 deadweight tons.

Wharves: A total of ten oil-handling docks are in the bay. A sulfur conveyor and a roll-on/roll-off dry cargo dock are on the north side of the east basin. Reported depths alongside are from 38 to 55 feet at the oil docks and 17 feet at the roll-on/roll-off dock.

CHRISTIANSTED

Christiansted, St. Croix Island, on the south shore of the harbor, is the largest town on St. Croix Island. The principal imports include foodstuffs, building materials, petroleum products and clothing. Exports include rum and cattle. In 2022, the controlling depth was 14 feet, with 12 to 17 feet in the basin and lesser depths along the northeast, southeast and southwest limits of the basin. Inside the harbor, a privately dredged channel with private aids leads west of the main channel to facilities in the southwest part of the bay. In 2014, a depth of 16 feet was reported in the channel and alongside the berthing facilities.

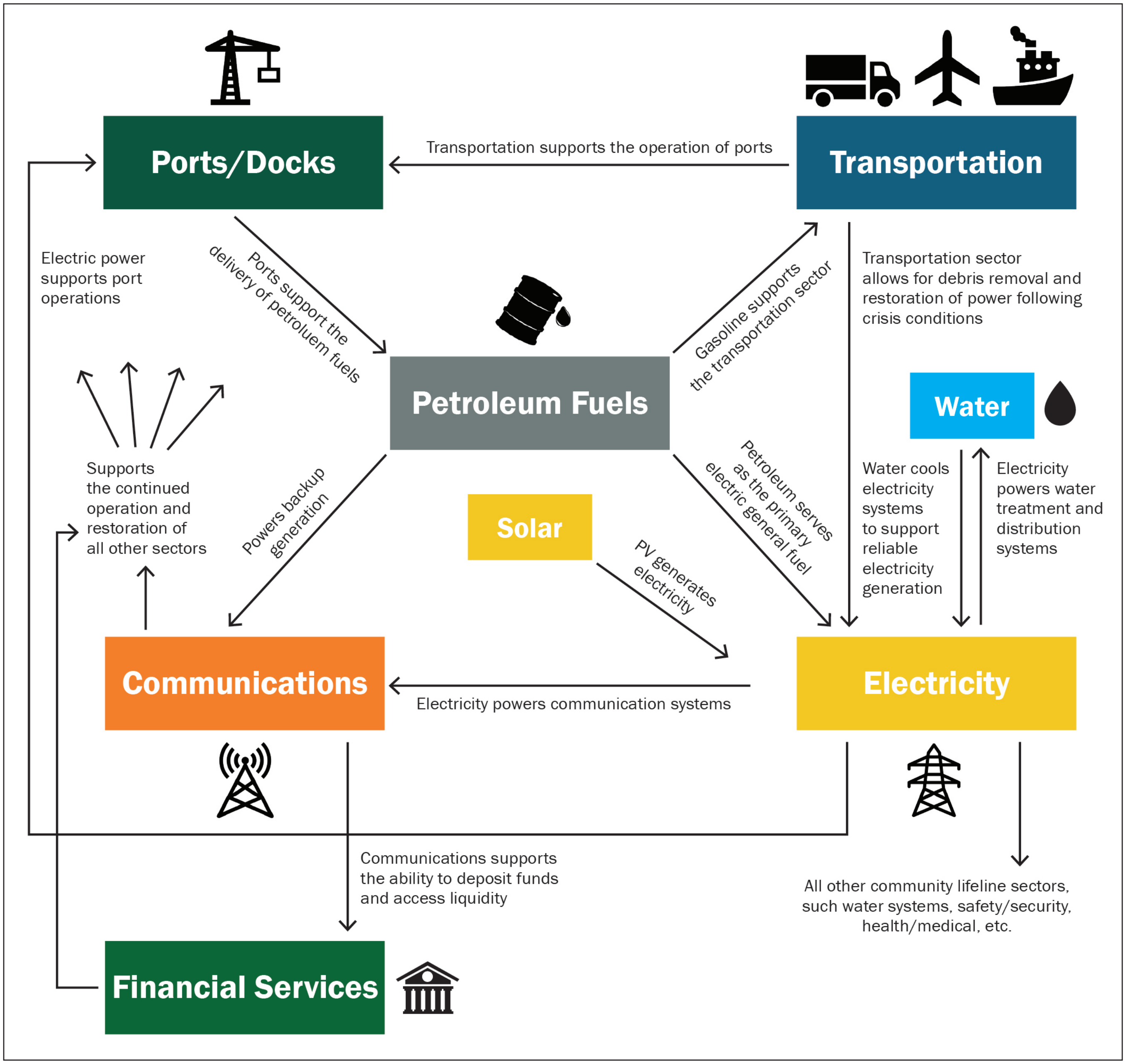
Pilotage: Vessels are boarded from a motorboat just outside Christiansted Harbor Channel Lighted Buoy 1. Strangers are advised to take a pilot and should not attempt to enter at night without one.

Energy Sector Interdependency Analysis

USVI is almost entirely dependent on imported petroleum products for energy generation. This results in a high dependence on port infrastructure to import fuels, which in turn supports the transportation sector and electric generation. The simplified energy sector interdependency graphic below depicts these interdependent relationships. Not pictured are the many sectors supported by the electric grid and back up electric generation, such as water systems, medical services, safety and security, shelter, agriculture, and more.

In the event of disaster scenarios, such as a hurricane or supply chain disruption, these interdependencies are highlighted and disruptions to one may cause loss of energy services in short, medium, or long-term durations. Loss of energy services poses a risk to human health and economic productivity.

ENERGY SECTOR INTERDEPENDENCY



Endnotes

1. US Census Bureau (2020)
2. ETS Region 3 Comprehensive Center (2020)
3. Small Business Administration (2021)
4. VIWAPA Website
5. PSC Website
6. VIEO Website
7. VITEMA Website
8. U.S. Department of Homeland Security, Fusion Center Locations and Contact Information
9. Energy Information Administration—US Virgin Islands Territory Energy Profile. Accessed on 10/27/23.
10. Petroleum data derived from the Energy Information Administration—US Virgin Islands Territory Energy Profile. Accessed on 10/27/23. Annual electric power consumption derived from a variety sources listed in the "Annual Energy Production and Capacity" subsection.
11. VI WAPA, Megawatt Hours Production, November 2023
12. BMR Energy, St. Thomas - Donoe Solar https://bmrenergy.com/projects/st-thomas-solar-project/
13. BMR Energy, St. Croix - Spanish Town Solar Farm, https://bmrenergy.com/projects/st-croix-solar-energy/
14. Virgin Islands Water and Power Authority, VIWAPA Final IRP Report (July 12, 2020), p. 50.
15. Data derived from the Energy Information Administration—US Virgin Islands Territory Energy Profile. Accessed on 10/27/23.
16. USVI Hazard Mitigation Plan, 2019 Update.
17. National Climate Assessment, Volume 5, Chapter 23.
18. Hazus Earthquake Model Technical Manual, Hazus 5.1, July 2022.
19. VIWPA Press Release, June 25, 2020, Governing Board Takes Favorable Action On Electric System Related Items Including Agreements For Off-Island Utilities To Assist Following Storm Events
20. United States. Environmental Protection Agency. What Climate Change Means for the U.S. Virgin Islands, pamphlet, August 2016; United States.
21. Bowden, Jared H.; Terando, Adam J.; Misra, Vasu; Wootten, Adrienne; Bhardwaj, Amit; Boyles, Ryan; Gould, William; Collazo, Jaime A.; Spero, Tanya L. 2020. "High resolution dynamically downscaled rainfall and temperature projections for ecological life zones within Puerto Rico and for the U.S. Virgin Islands." International Journal of Climatology. 104606(3): 1-23. https://doi.org/10.1002/joc.6810
22. United States. Environmental Protection Agency. What Climate Change Means for the U.S. Virgin Islands, pamphlet, August 2016; United States.
23. Climate Change Knowledge Portal, U.S. Virgin Islands Climate Projections, World Bank. Accessed 11/8/2023.
24. Runkle, J., K.E. Kunkel, L.E. Stevens, S.M. Champion, D.R. Easterling, A. Terando, L. Sun, B.C. Stewart, G. Landers, and S. Rayne, 2022: Puerto Rico and the U.S. Virgin Islands State Climate Summary 2022. NOAA Technical Report NESDIS 150-PR. NOAA/NESDIS, Silver Spring, MD, 5 pp.
25. Méndez-Lazaro, P.A., P. Chardón-Maldonado, L. Carrubba, N. Álvarez-Berríos, M. Barreto, J.H. Bowden, W.I. Crespo-Acevedo, E.L. Diaz, L.S. Gardner, G. Gonzalez, G. Guannel, Z. Guido, E.W. Harmsen, A.J. Leinberger, K. McGinley, P.A. Méndez-Lazaro, A.P. Ortiz, R.S. Pulwarty, L.E. Ragster, I.C. Rivera-Collazo, R. Santiago, C. Santos-Burgoa, and I.M. Vila-Biaggi, 2023: Ch. 23. US Caribbean. In: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. https://doi.org/10.7930/NCA5.2023.CH23
26. VIWAPA Final IRP Report (2020), Energy Information Administration—US Virgin Islands Territory Energy Profile, and VIWAPA's "About Us" page.
27. Energy Information Administration—Electric Power Annual (Table 12.8 Virgin Islands)
28. LPG supply reported by Butane-Propane News (2016). Fuel oil supply reported by VIWAPA (2013).
29. VI WAPA, Megawatt Hours Production, November 2023
30. VI WAPA, Megawatt Hours Production, November 2023
31. Petroleum terminal infrastructure provided by ESRI, U.S. Army Corp of Engineers Portsall, and LPGas.
32. Application of US Coastal Laws to Virgin Islands, U.S. Department of the Interior Office of Insular Affairs
34. U.S. Army Corps of Engineers (Portsall and LinkTons, 2021), U.S. Virgin Islands Department of Licensing and Consumer Affairs, U.S. Virgin Islands Department of Planning & Natural Resources (2018), Naval Postgraduate School report on Interdependent Infrastructure Resilience in USVI (2018)
35. Naval Postgraduate School report on Interdependent Infrastructure Resilience in USVI (2018)
36. Discussions and correspondence with VI WAPA, January 12, 2024.
37. United States Coastal Pilot 5, Gulf of Mexico, Puerto Rico and Virgin Islands (2024)
38. Delmar Systems, USVI Power Station Conversion Project.
39. World Port Source, Charlotte Amalie Harbor.

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