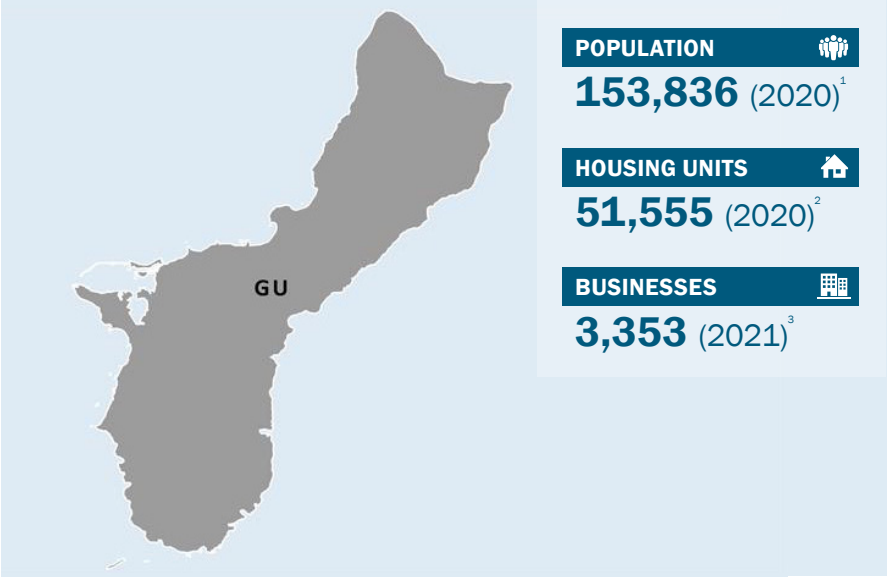
Territory of Guam



POPULATION
153,836 (2020)[1]

HOUSING UNITS
51,555 (2020)[2]

BUSINESSES
3,353 (2021)[3]

QUICK FACTS

ELECTRIC UTILITY
Guam Power Authority (GPA)[4]

PUBLIC SERVICE COMMISSION
Guam Public Utilities Commission (PUC)[5]

TERRITORY ENERGY OFFICE
Guam Energy Office[6]

EMERGENCY MANAGEMENT AGENCY
Guam Homeland Security–Office of Civil Defense[7]

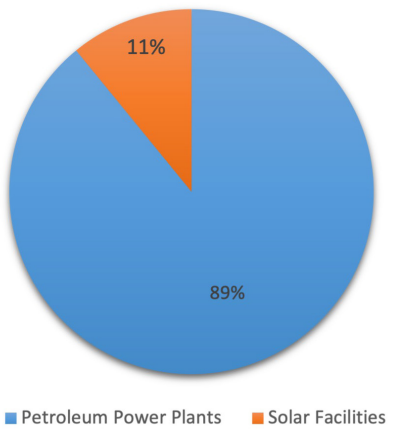
FUSION CENTER
Marianas Regional Fusion Center[8]

AVERAGE RESIDENTIAL ELECTRICITY PRICE
$0.3935/kWh (September 2022)[9]

This Energy Risk Profile examines the relative magnitude of the risks that the Territory of Guam's 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, pandemics, or impacts caused by infrastructure interdependencies 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. Cybersecurity and other threats not included in these profiles 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 Guam energy officials and infrastructure owners and operators with a concise overview of energy sector risks. The charts, graphs, and data points included may support Guam's energy security planning efforts or the development of applications grid resilience funding opportunities.

ANNUAL ELECTRIC POWER GENERATION (MWh)



ANNUAL ENERGY CONSUMPTION[10]

ELECTRIC POWER
1.68 billion kWh (2021)

PETROLEUM PRODUCTS
4,199 Mbbl (11,505 bpd) (2021)

- **Motor Gasoline**
  365 Mbbl (1,000 bpd)
- **Distillate Fuel**
  1,240 Mbbl (3,398 bpd)
- **Jet Fuel**
  767 Mbbl (2,101 bpd)
- **Residual Fuel**
  1,827 Mbbl (5,005 bpd)

ANNUAL ENERGY PRODUCTION[11,12]

ELECTRIC POWER GENERATION
11 plants, 1.8 million MWh
491.8 MW total capacity

- **Petroleum (Oil/LPG)**
  9 plants, 1.6 million MWh
  395.2 MW total capacity[i,ii,iii]
- **Solar Facilities**
  2 solar arrays/plants, 196,000 MWh
  96.6 MW total capacity
- **Other Sources**
  One Small 275 kW Wind Turbine Pilot Project

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

[i] The Cabras 1 & 2 power plant (132 MW) has a planned retirement in 2024, which would bring the total capacity for the remaining 8 power plants to 263.2 MW. Retirement of this plant may be extended until the Ukudu Power Plant comes online.

[ii] The Ukudu Power Plant (198 MW) is scheduled to be operational in 2026 after delays caused by Typhoon Mawar.

[iii] Effective April 1, 2024, Aggreko will provide 20 MW of temporary power to GPA to meet power shortfalls until the Ukudu Power Plant comes online.

Energy Sector Risks

As a small island in the eastern hemisphere 6,000 miles away from the US mainland, Guam's energy sector risk is unique compared to the contiguous US. The island's remote location and dependence on imports for energy sector fuel and equipment makes the territory particularly vulnerable to supply chain disruptions and market conditions impacting the supply and cost of petroleum products. In addition, the island's strategic position in the Indo-Pacific for US military assets makes the island a potential target during geopolitical conflicts.

This section outlines natural hazard risks of concern for the energy sector of Guam, beginning with the below table ranking Guam's vulnerability to specific natural hazards. This ranking is derived from Guam's Hazard Mitigation Plan (2019) but omits manmade hazards such as hazardous materials and wildland fires. The analysis does not include typhoons, but instead evaluates their sub-hazards: severe wind and flooding.

Risks of particular significance to Guam in the evolving landscape of energy and infrastructure are discussed briefly below and in further detail throughout the profile.

SUMMARY OF NATURAL HAZARD RISK RANKINGS FOR GUAM

NATURAL HAZARD	RANKING
Severe Wind	**1**
Earthquake	**2**
Tsunami (water level at 16 feet above mean sea level)	**3**
Flooding (100-year floodplain)	**4**
Slope Failure	**5**

Summary of Natural Hazard Rankings for Guam. *Derived from Guam's Hazard Mitigation Plan, 2019. 1=most vulnerable, 5 = least vulnerable*

RISKS BY HAZARD TO GUAM ENERGY SECTOR

Hazard Type		Description of Risk
Natural Hazards[14]	Tropical Cyclone/Typhoon	Tropical cyclones and typhoons frequently impact Guam. Previous storms have led to seriously damaged power distribution, communication, and wastewater treatment facilities across Guam, most recently during Typhoon Mawar. Winds are funneled in gullies, leading to intensified damage to structures at higher elevations. Aerial power lines are particularly vulnerable to typhoon winds and flooding.
	Tsunami	Tsunamis have likely been underreported because large wave run-up during typhoon events may be more damaging than tsunami inundation. Guam is currently surrounded by coral reefs that abate wave formation, but if those reefs are damaged, significant waves could wash out infrastructure. Lands adjacent to Apra Harbor are likely to be almost completely inundated by a tsunami with 16-foot run-up, including several port and utility facilities.
	Flooding	Riverine flooding, coastal flooding, flash flooding, and stormwater runoff pose the risk of inundation and destruction of energy infrastructure, including substations and inverters. Debris from storm surge has previously impacted power restoration due to road damage.[15]
	Severe Wind	Abrupt changes in Guam's topography can cause approaching winds to speed up as they flow up and over terrain features, resulting in increased pressures on buildings. Incidences of the most extreme severe wind have occurred during typhoons and super typhoons, compounding the typhoons' destructive impact.
	Earthquake	Intense ground shaking can disrupt all components of a utility system, including water, electric power, wastewater, communications, and liquid fuels. All of Guam is susceptible to earthquakes and a large concentration of surface faults exist east of Apra Harbor. Damage to the Harbor because of an earthquake could have significant impacts for fuel and supply reception. 71 Essential Facilities and 83 Major Utilities lie in surface faulting hazard areas. In the areas surrounding Apra Harbor and Piti Power Plant, liquefaction occurred during the August 8, 1993, earthquake. No structural damage to the plant occurred.

RISKS BY HAZARD TO USVI ENERGY SECTOR (CONT.)

Hazard Type		Description of Risk
Natural Hazards (cont.)	Slope Failure	Due to Guam's natural terrain, many power lines are at risk of damage during a slope failure event. These events also block roads, potentially limiting access to downed or damaged electric infrastructure. 31 Essential Facilities and 53 Major Utilities and 23 Transportation Systems are exposed in the slope failure hazard areas.
	Drought	While Guam has a predominantly wet climate it is still susceptible to drought. Drought increases the risk of grass-fed fire which could potentially damages power infrastructure.
Logistics/Human Proceedings	Wildland Fire	According to GPA data, wildland fires cause approximately two small power outages each year. Because there are no natural ignition sources on the island, wildland fires are predominately caused by human activities. A changing climate is increasing the length of the fire season, size of the area burned annually, and the number of wildfires. Drought conditions can exacerbate wildfire, and in turn, propagate rain-induced landslides. According to the 2019 Hazard Mitigation Plan, 239 major utility assets (electric, water, and wastewater assets) are exposed to "high" or "very high" fire hazard.
	Supply Chain Disruptions	GPA relies almost entirely on delivery of petroleum products by ship and barge. With Apra Harbor serving as its only deep-water port, any damage or closure can severely impede access to petroleum and other goods.
	Market Conditions	Because Guam relies heavily on petroleum-based fuels to generate electricity it is subject to global petroleum market pricing. Ratepayers are often subject to fuel surcharges on their electric bills—creating affordability and access challenges.
	Limited Access to Rapid Mutal Aid	Although GPA does have mutual aid agreements with public power utilities across the United States and neighboring islands for post-storm restoration assistance, transportation logistics limit the rapid deployment of supporting utility personnel and equipment. Guam also lacks adequate housing for supporting personnel necessary during a post-disaster event.
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.
	Precipitation	Increased temperatures will lead to more rainfall. Related changing vegetation growth patterns may disrupt overhead power lines. Rises in extreme rainfall events increase the probability of damage to infrastructure.
	Sea Level Rise	Rising sea levels increase the potential severity of storms bringing direct threat to any infrastructure on land. A portion of Piti between Naval Base Guam and Cabras Power Plant are projected to be most impacted by sea level rise for scenarios of 1-6 feet above mean higher water levels. Some power plants and other electric infrastructure are located on the coast, leading to potential impacts to power delivery from sea level rise.
	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 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. Guam's energy sector should be particularly cognizant of nation-state threat actors attempting to disrupt critical infrastructure services to the US military bases and should collaborate with the US Department of Defense and US Department of Energy to mitigate threats to the defense industrial base sector.	

Climate Change Considerations[18]

As is the case with many island nations, warming ocean and air temperatures, sea level rise, and strengthening tropical storms are key climate change concerns for Guam. The combination of these impacts creates a significant amount of stress on infrastructure systems and human life in the region. High temperatures combined with other potential natural hazards such as flooding create a need for resilient infrastructure to survive potential future impacts.

CLIMATE CHANGE RISK TO INFRASTRUCTURE

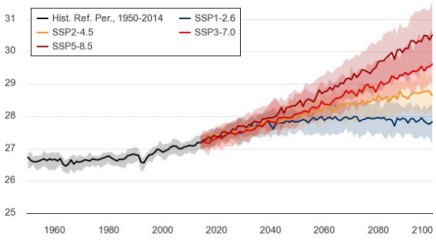
Climate change is projected to bring significant changes to temperatures, precipitation, and storms to Guam, threatening the reliability of energy infrastructure. Fewer rainfall events, more intense storms, sea level rise, and increasing temperatures all place an increased burden on energy infrastructure. Energy demand will increase because of the changing climate, particularly cooling demands due to increased 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 are a measure of how many degrees warmer the mean temperature is than 65°F on a given day. Guam currently has about 6,000 Cooling Degree Days (CDDs) per year, which will increase to around 8,000 CDDs by the end of the century assuming an SSP5-8.5 climate pathway, as seen in the plot at top right.[19] 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.

HEAT, HUMAN HEALTH

The annual number of hot days (at or above 88°F) in Guam has increased from an average of 5 days in the 1950s to an average of 36 days in the 1990s. According to high emission climate scenario projections, Guam is projected to experience over 257 days per year by the end of the century under high warming scenarios.

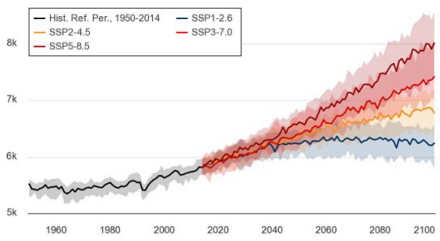
PROJECTED AVERAGE MEAN SURFACE AIR TEMPERATURE GUAM (U.S.)

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

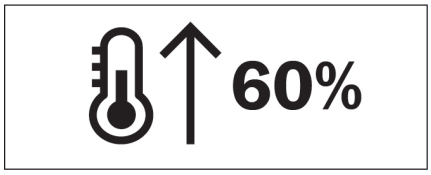


PROJECTED COOLING DEGREE DAYS (REF-65°F) GUAM (U.S.)

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



Additionally, the number of cool nights (at or below 74°F) has decreased from an average of 40 per year in the 1950s to an average of zero since 2005.



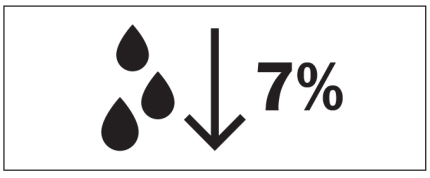
Increase in annual number of days above 88°F

Rising temperatures present a direct threat to human health, especially the most vulnerable populations, due to the reduced ability to remain cool. Prolonged exposure to high temperatures has significant human health impacts, including heat stroke and related conditions. Increased heat also creates a more suitable climate for disease-carrying species, such as mosquitoes. Invasive species that are better suited to warming climates may also threaten native flora and fauna, possibly impacting local diets and livelihoods.

Higher temperatures also increase the rate of evapotranspiration, which dries soils and plants, and reduces both surface water availability and groundwater recharge. These changes increase the risk of drought, which can cause drinking water shortages and reduce the quality of available drinking water. Additionally, higher temperatures increase the population's energy demands to maintain cool conditions in homes. The heightened energy demand increases the load for energy providers and the risk of service disruptions can be life-threatening to the population.

STORMS, IMPACT ON INFRASTRUCTURE

Currently, annual precipitation rates in Guam have not significantly changed. Rainfall patterns for Guam are highly variable and reliant on the El Niño-Southern Oscillation. Under high emissions scenarios, average island-wide annual rainfall is projected to decrease by about 7% by the end of the century. Under lower warming scenarios, Guam is expected to see no statistically significant changes in annual rainfall. Additionally, the frequency of extreme rainfall days has increased slightly, although by no significant amount. However, projections indicate that Guam will experience an increase in both frequency and intensity of extreme rainfall events.[20] Increased heavy rainfall heightens the risk of flooding and erosion due to the excess runoff from extreme rainfall. Drought conditions are uncertain, but some downscaled climate projections indicate the probability of a drought year (a year with 20% or more below mean rainfall) will increase fourfold from the historic decadal drought rate by 2080-2099 (16% to 40%).



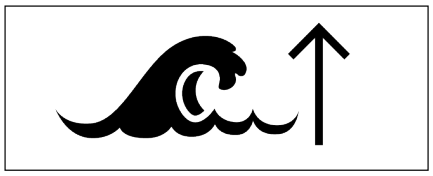
Mean annual rainfall by mid-century. *Fewer, but more intense rainstorms.*

Historically, Guam has experienced 2 to 8 tropical cyclones in any given year. The overall frequency of tropical cyclones has decreased by 15% from 1980 to 2013. There is no definite determination that either tropical

cyclone intensity or frequency will change in a warmer climate, although future occurrence is projected to decrease to about 1 to 6 tropical cyclones per year. Fewer, but stronger storms are expected as climate change effects continue to be realized.

SEA LEVEL RISE, COASTAL EROSION

Sea level rise is a growing threat to Guam. A result of sea level rise is the increase in frequent and extreme coastal erosion, coastal flooding, and saltwater intrusion into coastal aquifers. Small changes in the average sea level can have large effects on high water frequency and coastal erosion. Approximately 3 feet of sea level rise is projected to affect at least 58% of Guam's built environment.[21] High water days have increased in Guam, from an average of 2 days per year in the 1960s to an average of 21 days per year for the decade 2005-2014. This consistent high water can cause erosion and flooding, damaging coastal infrastructure.



Rising sea levels and higher storm surge.

CLIMATE RISK SUMMARY

HEAT

- Increase in temperatures could cause power line sagging and ampacity derating.
- Higher temperatures may increase the risk of extreme weather events.
- Rising temperatures will increase electricity and fuel demand.
  - Power generation under warmer temperatures face potential cooling water shortages and cooling water inefficiencies, and ambient cooling impacts.
  - Extreme heat decreases transmission and distribution capacity. Transmission lines become at risk of sagging and ampacity derating. Distribution lines become at risk of sagging, ampacity derating, and overloading.
  - Extreme heat places transformers at risk of derating, loss of asset life, and overloading.

SEVERE STORM AND FLOODING

- Heavy rains increase flooding potential which can damage power lines, and other infrastructure, disrupting operations.
- Flooding raises the risk of destruction and damage to most assets. Additionally, maintenance route disruptions caused by floods reduce response capabilities.

Electric Subsector

The electric grid on Guam is owned and operated by the Guam Power Authority (GPA), a public corporation overseen by the elected Consolidated Commission on Utilities (CCU) and regulated by the Guam Public Utilities Commission (PUC), which produces and distributes electricity to residential, commercial, and public sector customers across the territory.

GPA generates most electric power with diesel- and residual fuel oil (RFO)-fueled power plants, with most of the electricity generated by four base-load steam turbine generators burning RFO. GPA distributes electricity via 1,800 miles of 34-115 kV power lines across the island. A small portion (11%) of the territory's electricity generating capacity is currently provided by renewable sources of energy. Guam's renewable energy capacity is growing, with an additional 60 MW of solar power generating capacity coming online in 2022. Additionally, the 198 MW Ukudu Ultra-Low Sulfur Diesel (ULSD)/natural gas plant is expected to come online in 2026. The new plant's generating capacity will offset the reduction in capacity caused by an explosion at the Cabras Plant in 2015.

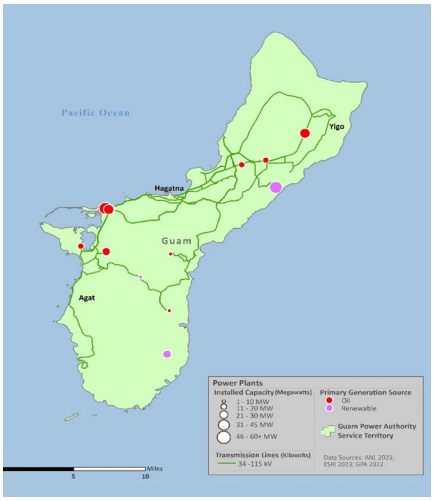
Guam's electrical power system is a combination of above-ground and below-ground distribution and transmission lines.

- 190 miles of transmission ("backbone" 115kV) power lines; 22% of those are buried, primarily servicing the Tumon area.[22]
- 1,638 miles of distribution lines (34 kV or less), with 19% buried.[23]

The below-ground system is concentrated in Tumon Bay (a major tourist area) and the areas surrounding the Guam Memorial Hospital, A.B. Won Pat International Airport, and the Port of Guam.[24] Once online, the Ukudu power plant will supply the 60 percent of GPA customers who currently get their power through underground lines.[25]

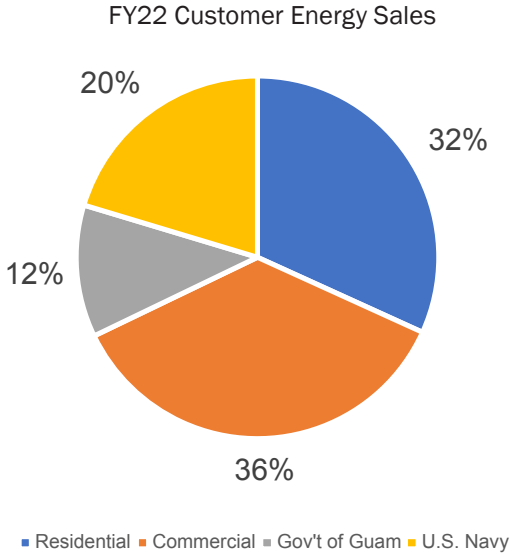
Imported petroleum products fuel nearly all the electricity generation on the island. Fuel costs are highly susceptible to wide market fluctuations and GPA imposes a fuel surcharge for electricity that can be adjusted every six months to reflect changes in petroleum costs.[26]

MAP OF ELECTRIC INFRASTRUCTURE

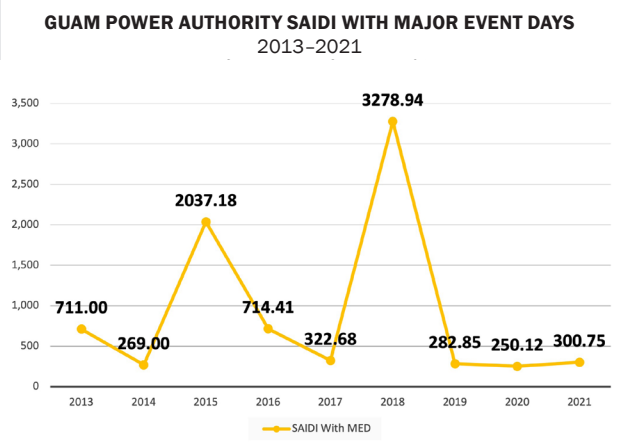


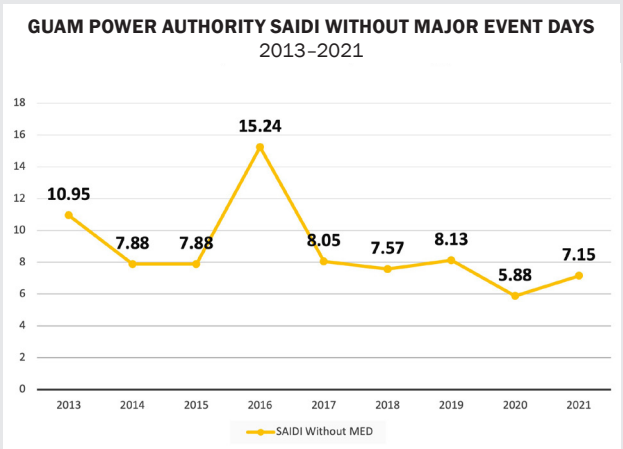
Map of electric infrastructure. *Provided by Argonne National Laboratory, HiFLD Open, ESRI, and GPA.*

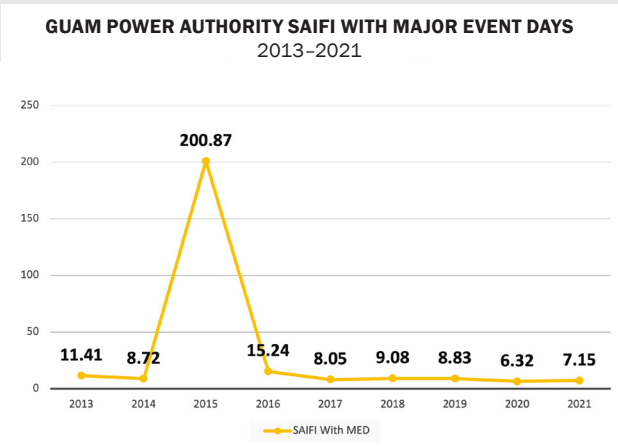
ELECTRIC CUSTOMER ENERGY SALES BY SECTOR[27]

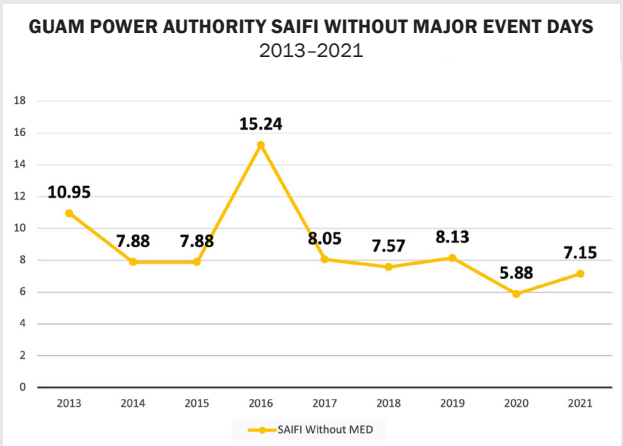


ENERGY SYSTEM RELIABILITY METRICS









SAIDI–The System Average Interruption Duration Index is the minutes of non-momentary electric interruptions, per year, the average customer experiencedHigher temperatures may increase the risk of extreme weather events.

SAIFI–The System Average Interruption Frequency Index is the number of non-momentary electric interruptions, per year, the average customer experienced.

MED–A major event day is defined by IEEE Standard 1366 as a day in which the daily SAIDI exceeds a threshold value, TMED. To calculate daily SAIDI, any interruption that spans multiple calendar days is accrued to the day on which the interruption began. Statistically, days having a daily system SAIDI greater than TMED are days when the energy delivery system experiences stresses beyond those normally expected, such as severe weather. Activities that occur on major event days should be analyzed and reported separately

Petroleum Subsector

Guam has no fossil energy resources and meets nearly all its energy needs with imported petroleum products. In 2021, Guam purchased 123,936,000 gallons of petroleum, roughly 39% of which was motor gasoline, 38% diesel fuel, 20% jet fuel, and 2% propane.[29] Diesel is mostly used to generate electricity. Guam consumed 8,085 barrels per day in 2021, down from 12,550 barrels per day in 2020.[30]

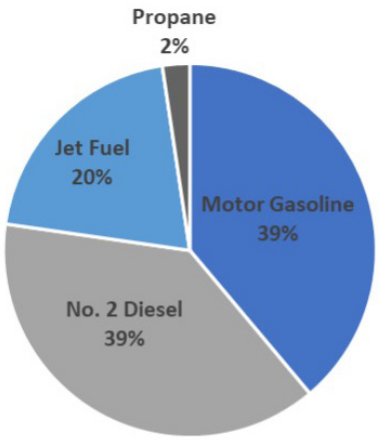
CONSUMPTION OF REFINED PETROLEUM PRODUCTS IN GUAM, 2018–2021

Barrels per Day (bpd)

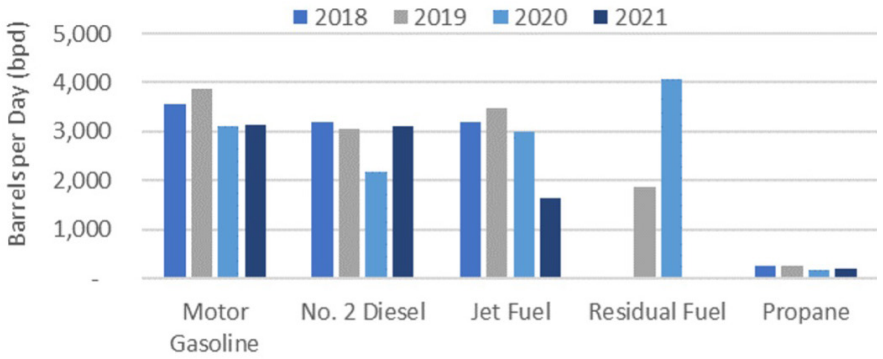
PETROLEUM PRODUCT	2018	2019	2020	2021
Motor Gasoline	3,550	3,864	3,115	3,143
No. 2 Diesel	3,186	3,041	2,175	3,104
Jet Fuel	3,191	3,489	3,004	1,646
Residual Fuel	–	1,870	4,071	–
Propane	265	262	185	191
Total	**10,192**	**12,526**	**12,550**	**8,085**

PETROLEUM CONSUMPTION IN GUAM, 2021

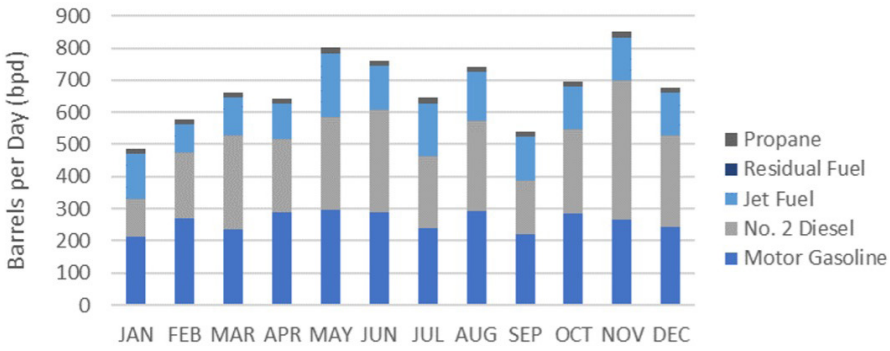
Percentage of Total Barrels per day



GUAM CONSUMPTION OF REFINED PRODUCTS, 2018–2021



MONTHLY CONSUMPTION OF REFINED PRODUCTS IN GUAM, 2021



PETROLEUM CONSUMPTION: ELECTRIC SECTOR

GPA's electricity is generated mainly from burning USLD and RFO. Guam transitioned from diesel fuel to USLD in 2011,[31] and GPA is moving away from using RFO at its petroleum-fired power plants and towards using ULSD. The last remaining RFO Plant, Cabras 1 & 2, is scheduled for retirement in 2024, although delays in the operationalization of Ukudu may delay its retirement.

GPA resupplies its Bulk Fuel Storage Facility using fuel stored at the Tristar Agat Terminal. The Agat Terminal has a total capacity of 422,150 barrels for the storage of fuel oil. GPA sells the excess fuel stored at the Agat Terminal to third parties for fuel oil bunkering purposes.

Electric Generating Fuel Supply: GPA has approximately 60 days of fuel storage for power plant operations at the GPA Bulk Storage Facility in Piti. GPA also maintains diesel storage at

GPA PETROLEUM-FIRED POWER PLANTS[32]

POWER PLANT	CITY	NAMEPLATE CAPACITY (MW)	PRIMARY FUEL	NOTES
Cabras 1 & 2	Piti	132	RFO	2024 Retirement
Piti 8 & 9	Piti	88	ULSD	Converted in 2021
Piti 7	Piti	40	ULSD	
Dededo CT 1 & 2	Dededo	46	ULSD	
Macheche CT	Dededo	22	ULSD	
Yigo CT	Yigo	22	ULSD	
Talofofo 1 & 2	Talofofo	8.8	ULSD	
Manengon (MDI) 1 & 2	Yona	10	ULSD	
Tenjo #1, 2, 3, 4, 5, 6	Santa Rita	26.4	ULSD	
Ukudu Power Plant	Dededo	198	ULSD	2024/2026*
KEPCO Diesel Power Plant	Piti	41	ULSD	Canceled*

GPA Petroluem-Fired Power Plants. *ULSD–Ultra Low Sulfur Diesel; RFO–Residual Fuel Oil*
**New commission date expected to be 2026 due to delays from damage to fuel oil and water tanks caused by Typhoon Mawar[33]; **Project canceled due to rising construction costs[34]*

each of its petroleum fueled generating stations. Each generator has 3 days of onsite storage without refuel and tanks are topped off each day.[35]

After the Ukudu Power Plant is online, GPA will no longer use RFO and the Bulk Fuel Storage Facility tanks will store up to 80 days of ULSD specifically for the Ukudu facility. The Ukudu facility will also have storage capacity for 30-days ULSD supply.

PETROLEUM STORAGE AT GPA PETROLEUM-FIRED POWER PLANTS[36]

POWER PLANT	CITY	PRIMARY FUEL	WORKING CAPACITY (BARRELS)			TOTAL CAPACITY
			DIESEL	LSFO	HSFO	
Cabras 1 & 2	Piti	RFO	1,029	8,000	8,000	17,029
Piti 8 & 9	Piti	ULSD	800	8,800	8,800	18,400
Piti 7	Piti	ULSD	3,102			3,102
Dededo CT 1 & 2	Dededo	ULSD	6,310			6,310
Macheche CT	Dededo	ULSD	4,174			4,174
Yigo CT	Yigo	ULSD	1,954			1,954
Talofofo 1 & 2	Talofofo	ULSD	556			556
Manengon (MDI) 1 & 2	Yona	ULSD	2,945			2,945
Tenjo #1, 2, 3, 4, 5, 6	Santa Rita	ULSD	3,525			3,525
Total			**24,395**	**16,800**	**16,800**	**57,995**

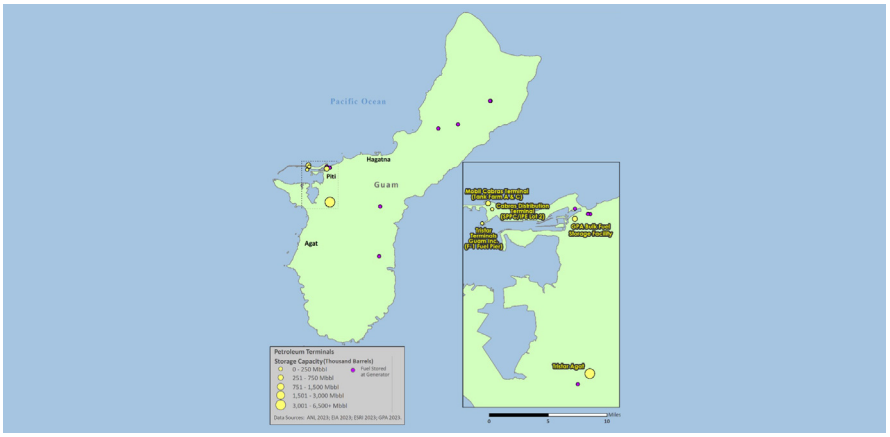
GPA officials say the Ukudu plant will cut Guam's fuel imports and consumption by at least 500,000 barrels per year (1,340 bpd) due to its high thermal efficiency.[37]

PETROLEUM TERMINALS[38]

There are five bulk fuel storage facilities in Guam, located near Apra port

TERMINAL	OWNER	CITY	TANKS	CAPACITY (BARRELS)	PETROLEUM FUELS
Tristar Agat Terminal	Tristar Guam	Agat	25	4,200,000	Gasoline, Diesel, Jet, LPG
GPA Bulk Fuel Storage*	GPA, Operated by IP&E	Piti	2	536,000	Residual Fuel Oil
Cabras Distribution Terminal (SPPC/IP&E Lot 2)	IP&E	Piti	6	165,150	Gasoline, Diesel, Jet
Mobile Cabras Terminal (Tank Farm A & C)	Mobil Oil Guam	Piti	12	251,600	Gasoline, Diesel, Jet
Tristar Terminals Guam Inc. (F-1 Fuel Pier)	Tristar Guam	Piti	2	80,000	Gasoline, Diesel, Jet, LPG

***Petroleum Terminals**. *After the Ukudu Power Plant is online, GPA will no longer use Residual Fuel Oil (RFO) and the Bulk Fuel Storage Facility tanks will store up to 80 days of ULSD for the Ukudu facility. The Ukudu facility will have storage capacity for an additional 30 days of ULSD supply*



Supply Chain

PETROLUEM MOVEMENTS TO GUAM

In 2022, Guam imported almost all its gasoline, jet fuel, distillate, and kerosene fuel needs from two foreign sources: South Korea (97%) and Japan (3%). Previously, in 2021, Singapore had provided the majority, 37%, of Guam's petroleum, while South Korea and Japan supplied 36% and 33%, respectively.[39]

DISTRIBUTION AND MOVEMENTS ON ISLANDS[41]

Typically, liquid bulk products are delivered to the Marine Industrial Terminal via tanker vessels every 20 days. These products are then distributed by pipeline from their storage tanks to their loading racks, where the products are loaded into tank trucks and distributed to service stations, as well as commercial and government accounts throughout Guam. A portion of the bulk fuels is reloaded at the pier onto coastal tankers for distribution to the Federated States of Micronesia and the Commonwealth of the Northern Mariana Islands.[42] The terminal is the trans-shipment hub for cargo, supporting an estimated total population of 500,000 persons in 37 countries and areas in the western Pacific.[43]

Two additional berths are managed by private companies involved in fuel service and four berths regularly used for commercial traffic. The Fl and Golf Piers berths are Government of Guam-owned bulk fuel, jet fuel, and LP gas unloading facilities.

The F-1 and Golf Piers are managed and operated by TriStar Terminals Guam Inc. and Mobil Oil Guam Inc., respectively. Two other petroleum companies unload their products at F-1 Pier: South Pacific Petroleum Corporation (SPPC) distributing the 76 brand and Isla Petroleum & Energy Holdings, LLC (IP&E) representing the Shell brand.[44]

On the island, only truck-based distribution of gasoline and diesel fuel originating at the port of entry, Apra, is available. Transmission pipeline deliveries are not made within Guam. The only pipelines are short-range steel pipelines from port to power plants delivered via the GPA Delivery Pump Station.

- The GPA Delivery Pump Station delivers residual fuel oil going out of the GPA Bulk Fuel Storage Facility to two GPA power generation units via a combination of underground and supported aboveground pipelines:
  - Cabras 1&2 (6-inch steel pipeline)
  - Piti 8&9 (6-inch steel pipeline)
- GPA is building a new ULSD and natural gas pipeline from the Bulk Fuel Storage Facility to the Ukudu Power Plant in mostly the same rights-of-way as the pipeline to Tanguisson.

APPLICABILITY OF THE JONES ACT[40]

Under 46 U.S.C. § 501, the Jones Act prohibits vessels conducting trade in certain U.S. territories and states unless they are U.S.-built, owned, and documented ("coastwise" laws). The Jones Act is applicable to Guam, but waivers can be issued in the 'interests of national defense'.

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.

APRA HARBOR

Apra Harbor, situated midway along the west coast of Guam, is the main berthing facility on the island, consisting of a commercial harbor, a naval complex, and a repair facility. The harbor comprises two main areas: Apra Inner Harbor and Apra Outer Harbor.

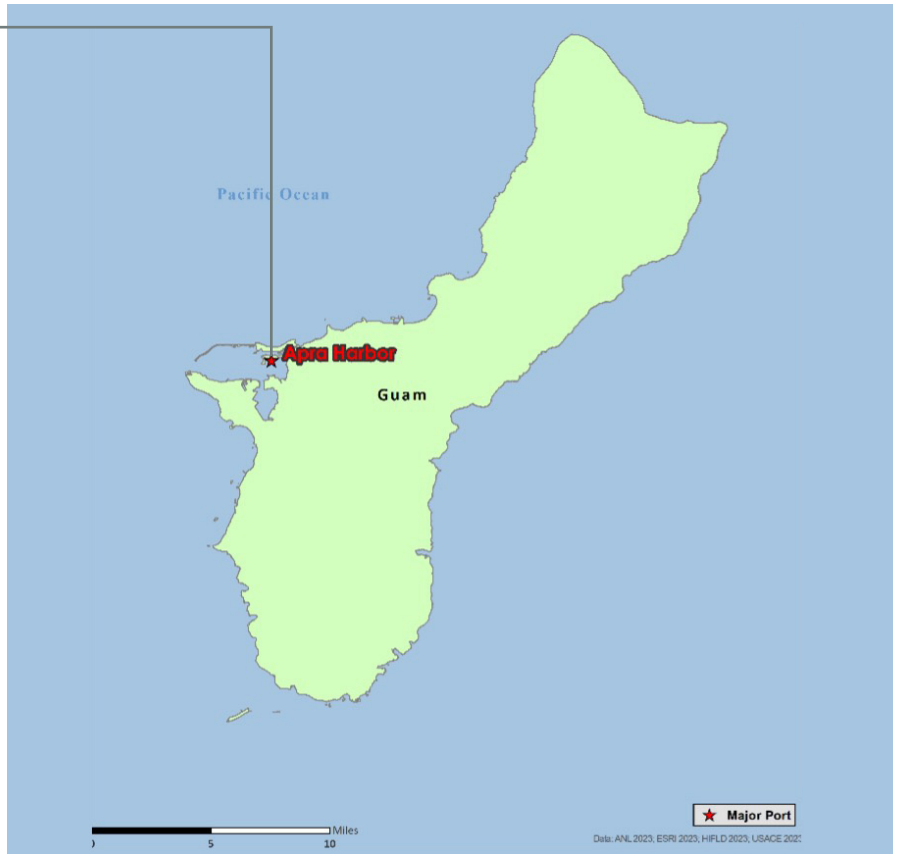
- **Apra Inner Harbor (South Apra)** houses the U.S. Naval facility and a commercial ship repair facility.
- **Apra Outer Harbor (North Apra)** is the principal commercial port for the island.

Glass Breakwater forms the north and northwest sides of Apra Outer Harbor and acts as a barrier against most ocean swells from the north and west. The harbor is extensive and safe, except during typhoon season.

Anchorages: Anchorage outside Apra Harbor is impossible due to the great depths and rapid shoaling of the bottom. Naval, explosive, special and general anchorages are in Apra Outer Harbor. The approaches to the harbor are free and deep, as is the channel between the breakwaters.

Pilotage: Pilotage is compulsory for vessels over 500 gross tons and all vessels entering the port for the first time and after daylight hours. Pilots are required to board inbound vessels and leave outbound vessels at Alpha Hotel Pilot Station, about 2 miles west of Orote Point, to ensure that the vessel is properly aligned on the entrance range.

MAJOR PORT CHARACTERISTICS[45]



Wharves: Guam's commercial port is situated on **Cabras Island** in Outer Harbor. The Port Authority of Guam (PAG), an autonomous agency of the Government of Guam, is responsible for the management of the port's 33-acre site. The facility offers 0.15 mile of docking space for container, break-bulk, fishing and passenger vessels. The Guam Economic and Development Authority administers the **Cabras Island Industrial Park** adjacent to the Commercial Port, which includes a fuel wharf and a floating dry dock. The commercial port offers alongside depths of 5.3 to 10.8 fathoms (64.8 ft).

Tank vessels discharge at the Mobil Pier (Wharf G) and at the GIROCO Pier (Wharf F-1). The Mobil Pier has a length of 223 feet and an alongside depth of 9.6 fathoms (57.6 ft) and is situated about 0.2 miles west of the root of Glass Breakwater. The GIROCO Pier has a length of 797 feet and an alongside depth of 10.8 fathoms (64.8 ft) and is positioned about 0.3 miles southeast of the Mobil Pier.

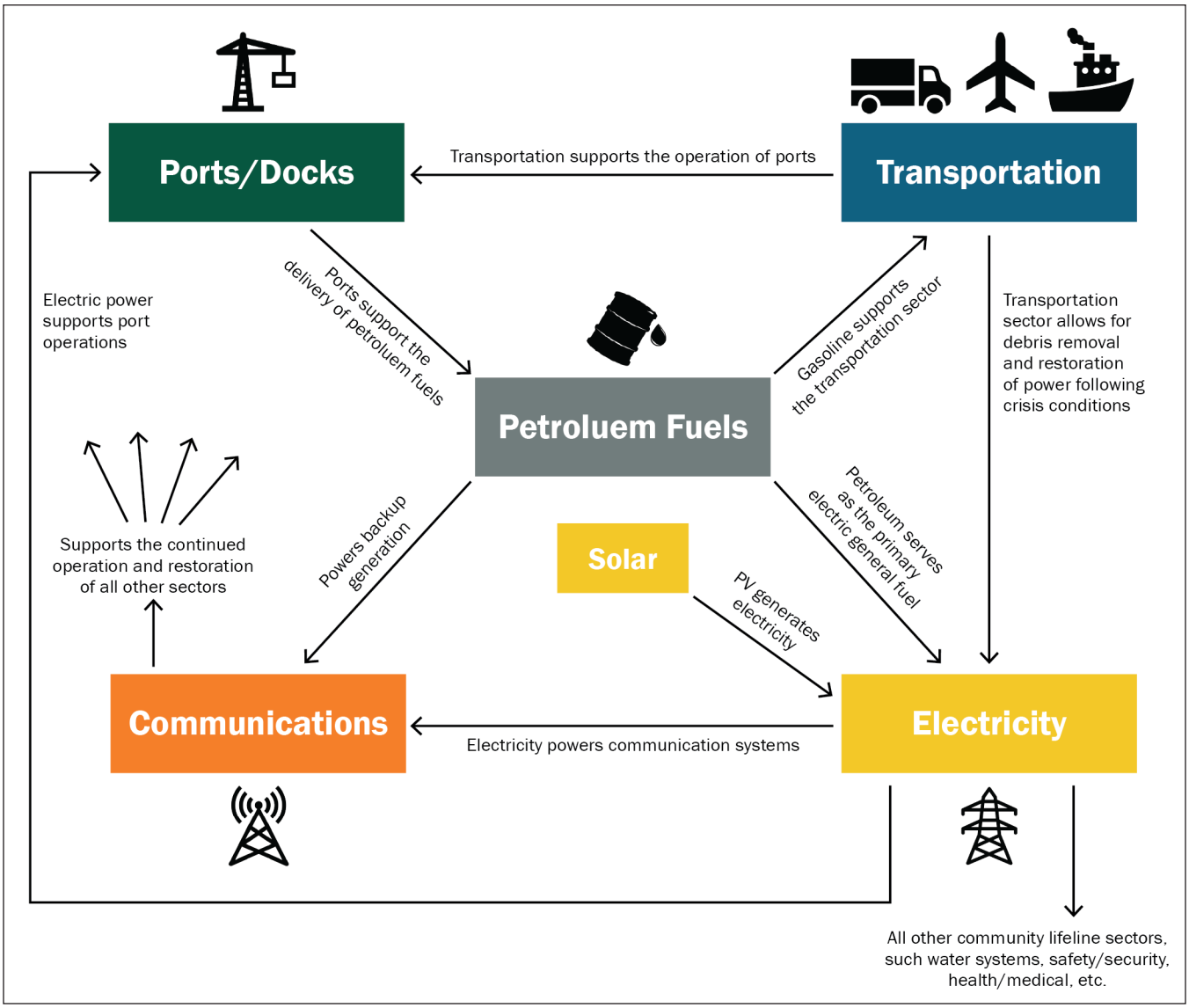
Supplies: Apra Harbor is the principal supply center for the region. Water is available at most wharves. Bunker fuel is available at Golf Pier, Berths F-1 and F-3 and by tanker truck.

Energy Sector Interdependency Analysis

Guam is very 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 typhoon 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, economic productivity, and military operations.

ENERGY SECTOR INTERDEPENDENCY



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