

Hawaii Power Grid Resilience Transformation

Strategic Plan: 2025-2035

From Hurricane Lala Wake-Up Call to Climate-Resilient Grid
Integrating Lessons from Philippines Archipelagic Grid Success

*Comprehensive Research Report | Generated with the Assistance of A.I.
11 Charts | 15 Quantitative Targets | Philippines Cross-Reference*

Report produced for the Climate Change Initiative of alohahawaiiionipaa.org

Research by Casey Takayama

September 4th, 2026

E-mail: alohahawaiiionipaa@gmail.com

Phone: 808-200-3414

Table of Contents

- 1. Executive Summary
- 2. Historical Context: Hurricane Lala & Vulnerability Baseline
- 3. Current Grid Infrastructure
- 4. Policy & Regulatory Framework
- 5. Resilience Investments & Programs
- 6. Lessons from Philippines Grid Modernization
- 7. Strategic Recommendations (10 Priority Actions)
- 8. Quantitative Targets (2025-2035)
- 9. Implementation Roadmap

Appendix: Data Sources & Methodology

1. Executive Summary

Hawaii's electric grid faces unique challenges as the only U.S. state with isolated island grids lacking interconnection to mainland backup. With 6 separate island grids serving 1.4 million residents across 6,423 square miles, the system is highly vulnerable to hurricanes, wildfires, tsunamis, and aging infrastructure. This report compiles comprehensive data on historical vulnerabilities, current infrastructure, policy frameworks, resilience investments, and cross-references lessons from the Philippines' grid modernization to develop specific, quantified recommendations for Hawaii.

Key findings: (1) Hurricane Lala (2026), a Category 1 storm with no direct landfall, caused significant outages - demonstrating extreme peripheral vulnerability; (2) 57% of 9,800+ T&D miles are overhead; critical substations (Iwilei, Kahului) sit in flood/tsunami zones; (3) Philippines' VMIP inter-island HVDC (70%+ SAIDI reduction via FLISR, 350 kph pole standards, 600+ MW grid-forming BESS) provides proven, scalable templates; (4) Hawaii's \$190M Climate Adaptation Plan (50% DOE match) is a start but needs 10x scale by 2030.

Strategic priorities: (1) 50 miles critical undergrounding by 2030; (2) Oahu-Maui HVDC feasibility study; (3) Mandatory FLISR on 50 critical circuits; (4) 150+ mph pole hardening; (5) 300 MW grid-forming BESS by 2030; (6) 10 community microgrids by 2030; (7) 3:1 federal leverage target.

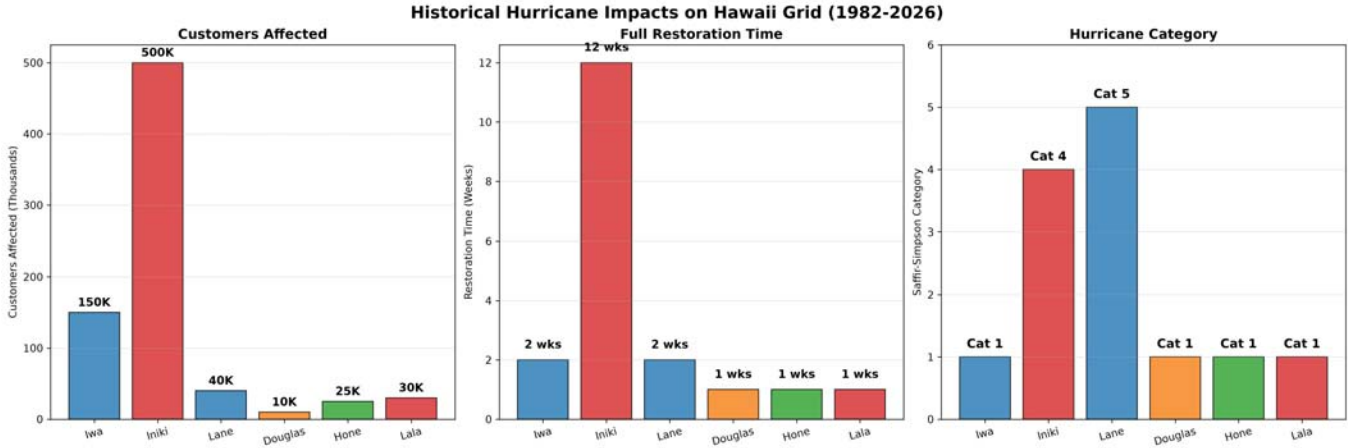
Abbreviations & Acronyms

Abbreviation	Full Form	Abbreviation	Full Form
HVDC	High Voltage Direct Current	HSEO	Hawaii State Energy Office
SAIDI	System Average Interruption Duration Index	DOE	Department of Energy
SAIFI	System Average Interruption Frequency Index	FEMA	Federal Emergency Management Agency
FLISR	Fault Location, Isolation, and Service Restoration	BRIC	Building Resilient Infrastructure and Communities
BESS	Battery Energy Storage System	HMGP	Hazard Mitigation Grant Program
AMI	Advanced Metering Infrastructure	GRIP	Grid Resilience and Innovation Partnerships
ADMS	Advanced Distribution Management System	IJA	Infrastructure Investment and Jobs Act
OMS	Outage Management System	HCEI	Hawaii Clean Energy Initiative
SCADA	Supervisory Control and Data Acquisition	IGP	Integrated Grid Planning
DER	Distributed Energy Resources	PBR	Performance-Based Regulation
RPS	Renewable Portfolio Standard	MGSP	Microgrid Systems Service Provider
HECO	Hawaiian Electric Company	GEAP	Green Energy Auction Program
MECO	Maui Electric Company	ERC	Energy Regulatory Commission
HELCO	Hawaii Electric Light Company	NGCP	National Grid Corporation of the Philippines
KIUC	Kauai Island Utility Cooperative	VMIP	Visayas-Mindanao Interconnection Project
PUC	Public Utilities Commission		

2. Historical Context: Hurricane Lala & Vulnerability Baseline

2.1 Major Hurricane Events (1982-2026)

Hawaii's grid vulnerability was starkly revealed by Hurricane Lala (2026), a Category 1 storm that caused significant outages despite no direct landfall. Historical events show escalating impact: Iniki (1992, Cat 4, Kauai) destroyed 80% of distribution; Lane (2018, Cat 5 near-miss) caused widespread flooding outages; Lala (2026, Cat 1 peripheral) caused 30K+ outages. The trend is clear: even peripheral storms now cause major disruption.



2.2 Systemic Vulnerabilities (2024 Baseline)

- Overhead Lines: 57% of 9,800+ T&D miles overhead; vulnerable to wind, vegetation, debris
- Aging Infrastructure: Many 138 kV lattice towers from 1960s; poles past design life
- Isolated Island Grids: Zero inter-island transmission; no mutual aid from mainland within days
- Imported Fuel Dependence: ~70%+ oil-fired generation; supply chain vulnerable to port disruptions
- Coastal Substations: Iwilei (Oahu), Kahului (Maui) in flood/tsunami zones
- Vegetation Management: Top outage cause; albizia/invasive species; \$18.5M/year spent (2021)
- Wildfire Risk: HiEMA ranks #1 hazard (2023); 100% annual probability; 12 events/year avg

Hurricane/Typhoon Category Scale Comparison

Saffir-Simpson vs Philippines typhoon category scale with Hawaii target:

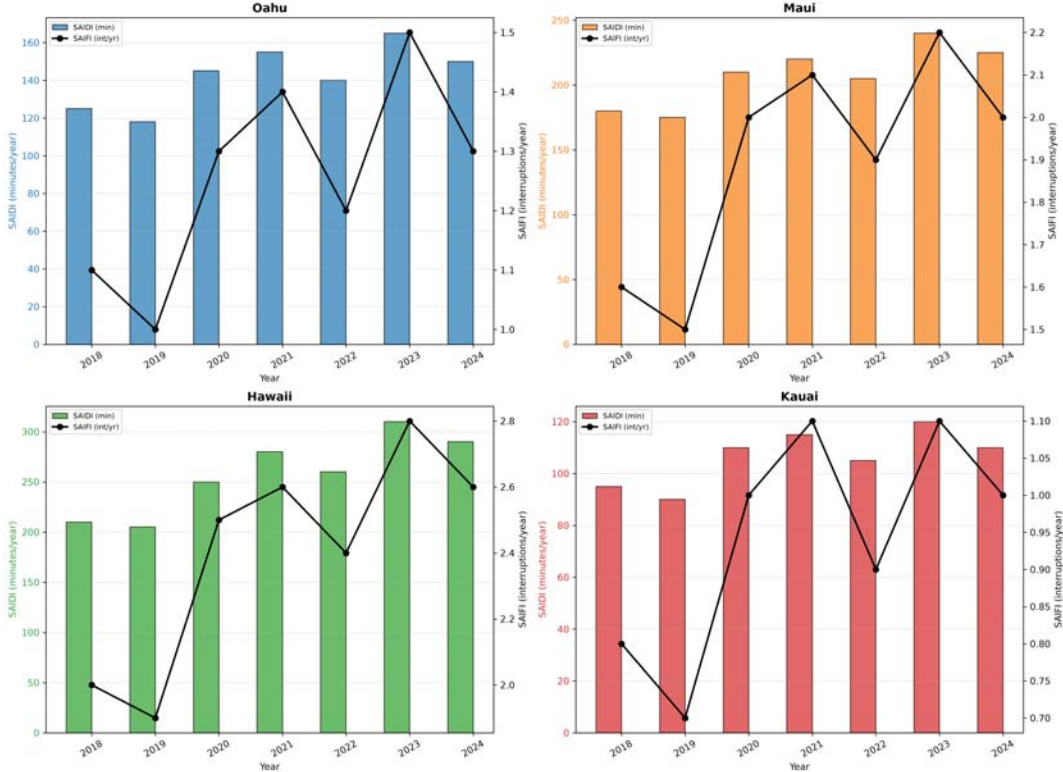
Hurricane/Typhoon Category Scale: Saffir-Simpson vs Philippines			
Category	Saffir-Simpson (mph)	Philippines Scale (kph)	Damage Potential
Category 1	74-95	119-153	Minimal
Category 2	96-110	154-177	Moderate
Category 3	111-129	179-208	Extensive
Category 4	130-156	209-251	Extreme
Category 5	157+	253+	Catastrophic

Hawaii Standard: 105 mph (Category 2) | Philippines Standard: 350 kph (Category 5) | Target: 150+ mph (Category 5)

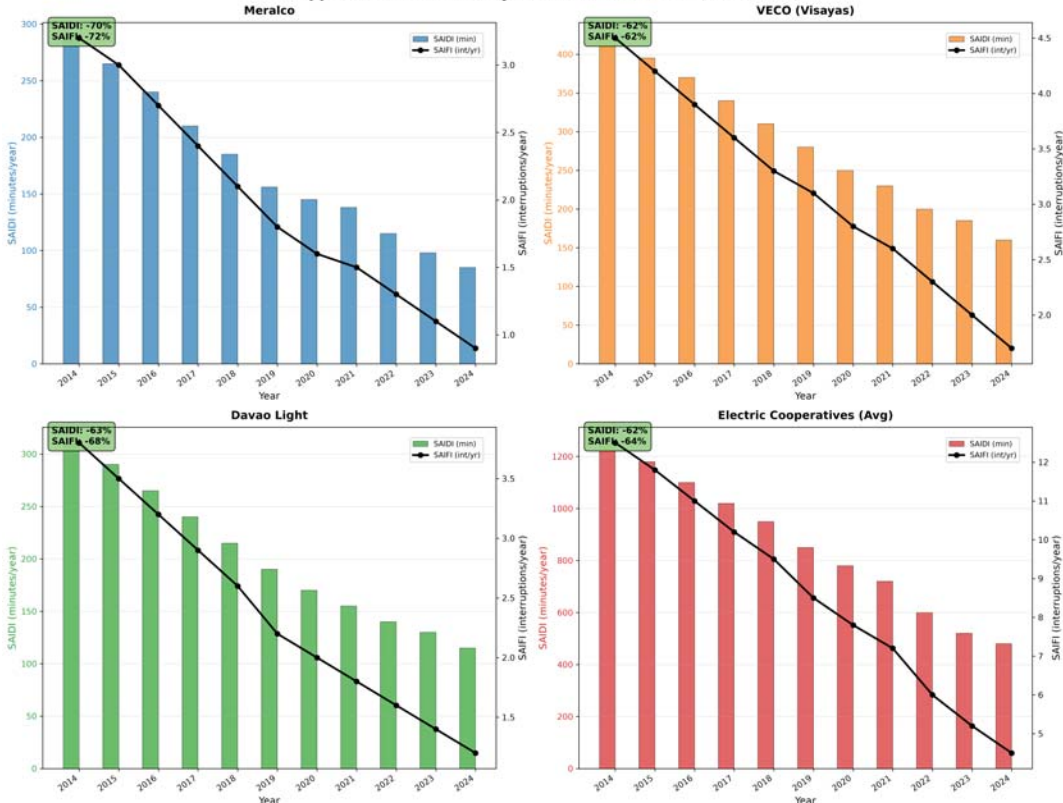
2.2 Systemic Vulnerabilities (2024 Baseline): Philippines & Hawaii Comparison

Comparison of SAIDI/SAIFI trends between Philippines (Meralco) and Hawaii (HECO) shows Philippines achieved dramatic improvements through FLISR deployment, while Hawaii's metrics remain elevated due to hurricane exposure and isolated grids.

SAIDI & SAIFI Trends by Island (2018-2024)



Philippines Power Reliability Trends: SAIDI & SAIFI (2014-2024)

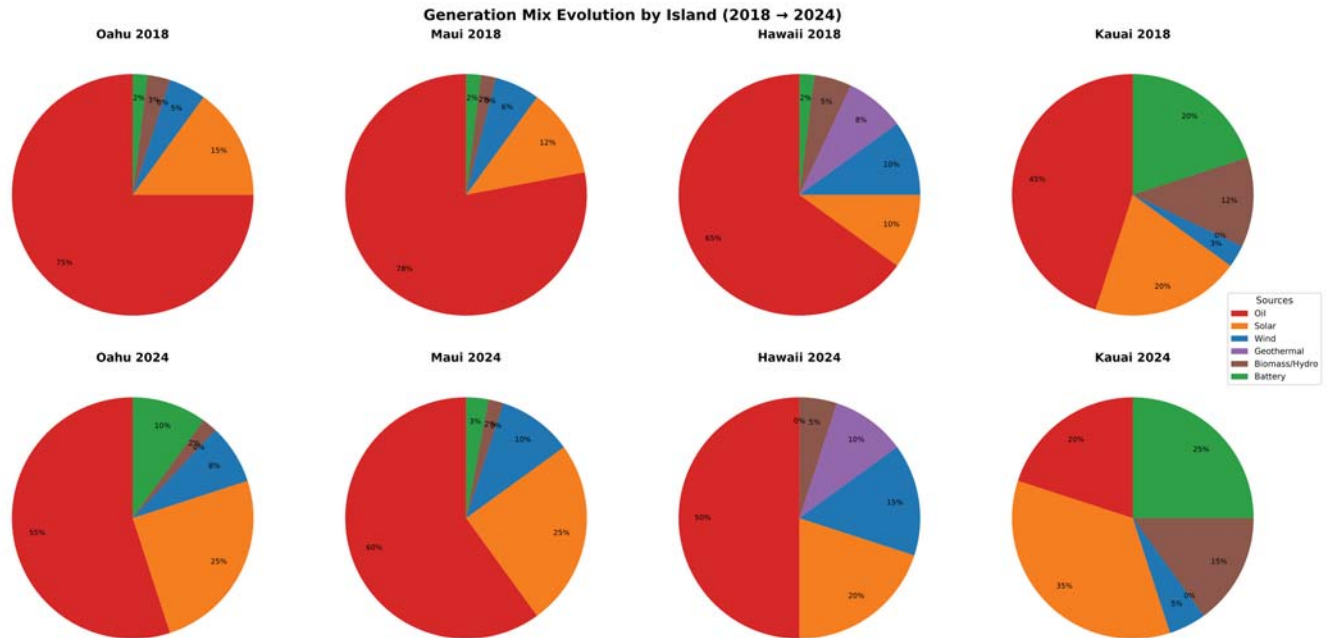


3. Current Grid Infrastructure

3.1 Utility Structure

Utility	Territory	Customers	Ownership	Key Characteristics
HECO	Oahu	~305,000	Investor-owned (HEI)	Largest; Waiau/Kahe plants; downtown network
MECO	Maui/Lanai/Molokai	~72,000	Investor-owned (HEI)	Kahului plant retiring; high solar penetration
HELCO	Hawaii Island	~87,000	Investor-owned (HEI)	Geothermal (Puna); long radial lines
KIUC	Kauai	~36,000	Member-owned Coop	52.8% renewable (2025); 100% target 2033

3.2 Generation Mix by Island (2024)



3.3 Transmission & Distribution

- 9,800+ miles T&D across 5 islands (HECO companies); 43% underground (highest in US)
- 138 kV transmission → 46 kV subtransmission → 12/4 kV distribution
- 120,000 joint poles; 50,000 HECO-owned poles
- Zero inter-island transmission - each island electrically isolated
- Critical corridors: Oahu N/S 138 kV; Maui central; Big Island radial

4. Policy & Regulatory Framework

4.1 Key Policies & Mandates

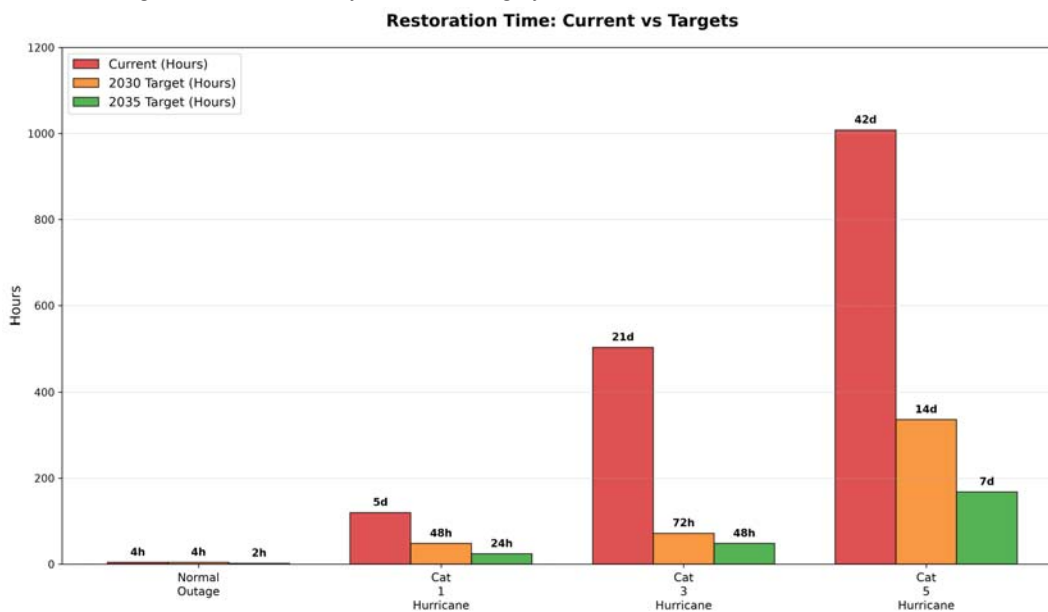
Policy	Year	Target/Requirement	Status
Hawaii Clean Energy Initiative (HCEI)	2008	70% clean energy by 2030	Active
Renewable Portfolio Standard (Act 97)	2015	100% by 2045 (40% by 2030)	Law
Act 238 (Decarbonization)	2022	Net-negative emissions by 2045	Study complete
Executive Order 25-01	2025	Energy affordability & reliability priority	Active
Grid Modernization Strategy (PUC 2018-0165)	2021	Smart meters, ADMS, FLISR, DER integration	Phase 1

4.2 Federal Funding Programs

Program	Agency	Hawaii Allocation	Status
Grid Resilience Formula (IIJA 40101)	DOE	\$3M/yr x 5 = \$15M	HSEO administering
GRIP (Competitive)	DOE	\$10.5B national	Targeting 2-3 awards
FEMA BRIC	FEMA	\$1B+/yr national	Annual applications
FEMA HMGP	FEMA	Post-disaster	Maui recovery active
DOE IIJA Resilience (HECO)	DOE	\$95M awarded (50% match)	Climate Adaptation Plan

Restoration Time Targets

Current vs target restoration times by hurricane category:

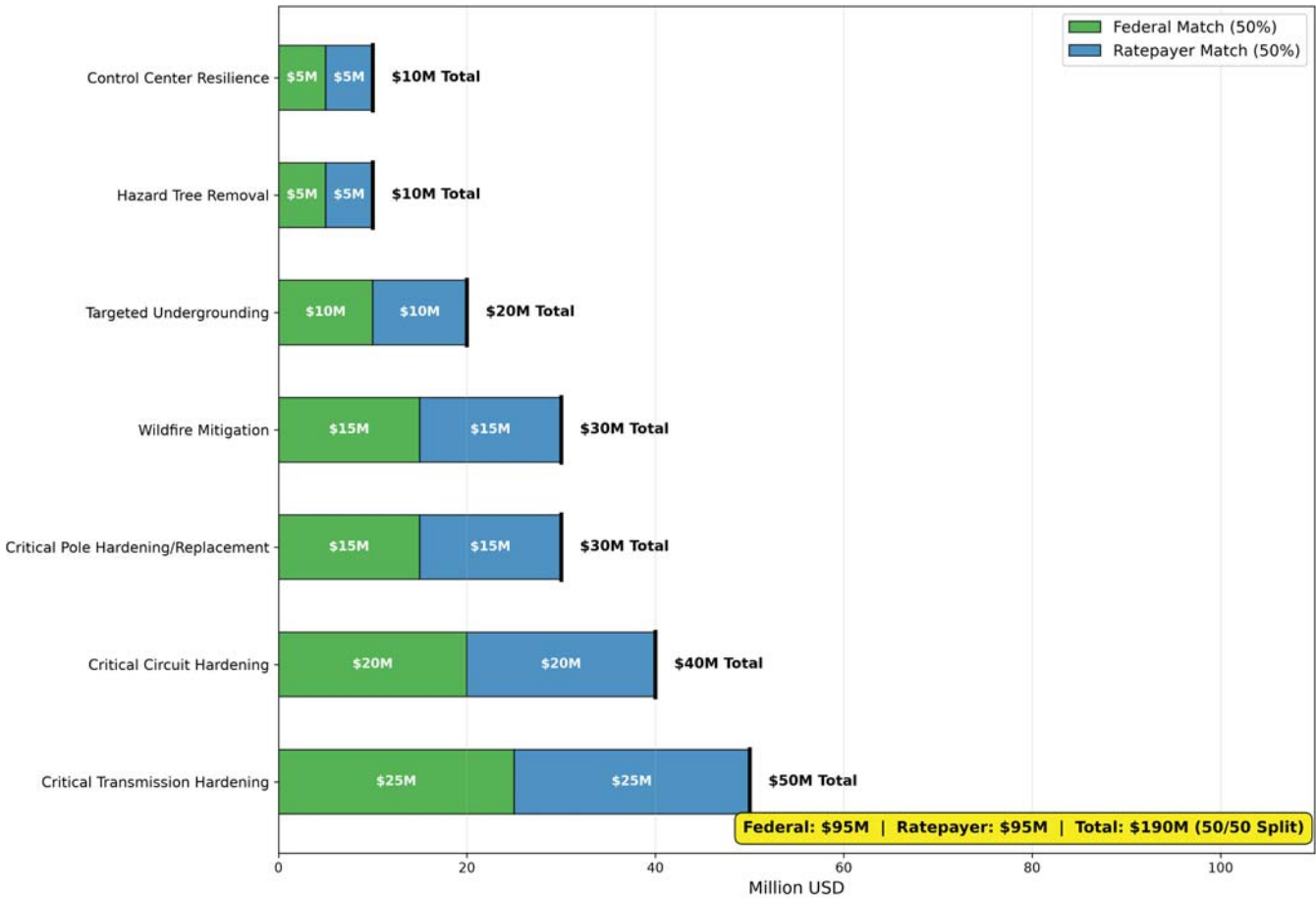


5. Resilience Investments & Programs

5.1 Climate Adaptation T&D Resilience Program (\$190M)

Approved PUC Docket 2022-0135 with \$95M DOE IIJA match (50% federal share). 5-year program targeting critical hardening.

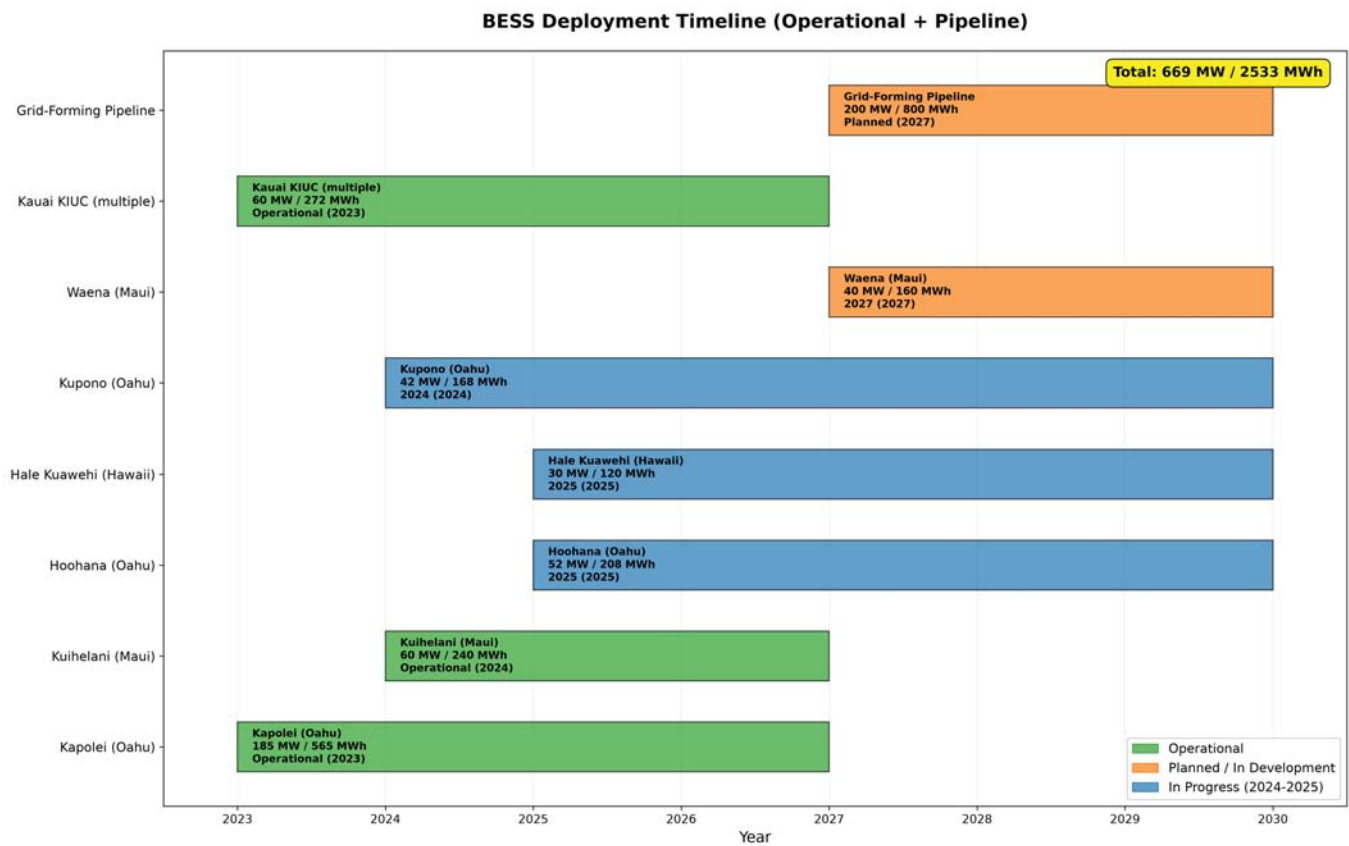
Hawaii Climate Adaptation T&D Resilience Program (\$190M)



5.2 Microgrid Deployments

Project	Location	Capacity	Status	Purpose
North Kohala Microgrid	Hawaii (Hawi)	BESS + controller	RFP 2023	Resilience for radial line
Waena BESS	Maui (Kahului)	40 MW / 160 MWh	Construction 2026	Kahului plant retirement support
PMRF Microgrid	Kauai (Barking Sands)	14 MW solar + 70 MWh BESS	Operational	Military + grid support
KIUC Anahola/Koloa/Lawai	Kauai	Multiple solar+BESS	Operational	100% renewable daytime
Schofield Generating Station	Oahu	50 MW biofuel CT	Operational	Inland gen; black-start; military

5.3 Battery Storage Deployments



5.3 Grid Modernization

- Advanced Meters (AMI): Approved; Phase 1 deployment; ~200k meters by 2026
- ADMS: Procurement phase; integration with OMS/SCADA
- FLISR: Pilot/planning; targeted critical circuits first
- Advanced Inverters (Grid-forming): Required for new DER; IEEE 1547-2018
- Distribution Automation: 60+ devices installed Maui 2023

6. Lessons from Philippines Grid Modernization

The Philippines faces similar archipelagic challenges and has implemented aggressive resilience measures Hawaii can adapt.

Philippines vs Hawaii: Grid Resilience Comparison

Metric	Philippines	Hawaii
Islands	7,641 (3 main grids)	6 (6 separate grids)
Transmission (circuit-km)	21,000+	~15,800 km
Inter-Island Links	Yes (HVDC)	None
Renewable Target	35% by 2030	100% by 2045
Battery Storage (MW)	600+	~250 (500 planned)
SAIDI (normalized)	100-250	100-250
Underground %	Low	43%
Pole Wind Rating	350 kph	105 mph
FLISR Coverage	Nationwide	<5%
BESS Grid-Forming	600+ MW	~50 MW planned

6.1 Key Philippines Programs & Results

Program	Description	Quantified Result	Hawaii Application
VMIP (Visayas-Mindanao Interconnection)	HVDC submarine cables linking Visayas & Mindanao	400+ MW transfer; reserves sharing; N-1 security	Model for Oahu-Maui HVDC
Distribution Automation (FLISR)	Nationwide recloser/sectionalizer + central ADMS	70%+ SAIDI/SAIFI reduction on automated circuits	Mandate FLISR on critical circuits
Lifeline Systems Act (RA 11285)	Mandates undergrounding for critical facilities	Accelerated undergrounding in Metro Manila, Cebu	Mandate for hospitals, shelters, comms
Pole Hardening Standards	250-350 kph wind ratings (Cat 4-5 equiv)	Reduced pole failures in typhoons	Upgrade from 105 mph to 150+ mph
Microgrid Deployment (MGSP)	DOE competitive selection for unserved areas	8 areas awarded; hybrid solar-diesel-BESS	Expand HECO/KIUC microgrid programs
BESS for Grid Stability	600+ MW BESS for ancillary services	Reduced curtailment; faster restoration	Grid-forming BESS at critical substations

6.2 Philippines Regulatory Innovations

- ERC mandates Performance-Based Regulation with SAIDI/SAIFI targets tied to rates
- Green Energy Auction Program (GEAP) - competitive procurement for renewables+storage
- Transmission Development Plan (10-year) - mandatory, updated biennially
- System Loss Cap - regulatory incentive to reduce technical/non-technical losses

7. Strategic Recommendations (10 Priority Actions)

1. Critical Corridor Undergrounding (50 miles by 2030)

Priority corridors: Iwilei-Downtown (3-5 mi, \$150-250M), Kahului-Wailuku (4-6 mi, \$120-200M), Hawi-North Kohala (20+ mi, \$300-500M), Kalaeloa-Kapolei (8-10 mi, \$250-400M). Target: 50 miles by 2030. Funding: DOE IIJA formula (\$15M) + GRIP + FEMA BRIC + ratepayer (50% match).

2. Inter-Island HVDC Transmission (Oahu-Maui First)

Commission \$5M feasibility study (DOE GRIP eligible). Oahu-Maui: 70 km, 200-400 MW, \$1.5-2.5B. Benefits: mutual reserves, renewable balancing, N-1 security, reduced oil dependence. Philippines precedent: Leyte-Luzon HVDC (440 kV, 440 km, 2,000 MW) operational since 1998.

3. Mandatory FLISR Deployment (Phased)

Phase 1 (2025-2027): 50 critical circuits (hospitals, shelters, military, water, comms) - \$25-40M. Phase 2 (2027-2030): Top 25% worst SAIDI circuits (100 circuits) - \$50-80M. Phase 3 (2030-2035): System-wide. Target: 70% SAIDI/SAIFI reduction (Philippines result).

4. Pole Hardening to 150+ mph (Cat 5 Equivalent)

Current: 105 mph (GO 95 Rule 43). Target: 150+ mph using ductile iron/composite/steel poles. Philippines precedent: 250-350 kph (155-217 mph) rated structures. Investment: \$50-80M/year for 10 years = \$500-800M total.

5. Grid-Forming BESS at Critical Substations (300 MW by 2030)

Iwilei (100 MW/400 MWh), Kahului (50/200), Keahole (50/200), Lihue (30/120). Grid-forming inverters (VSM); black-start tested annually. Total target: 300 MW / 1,200 MWh by 2030.

6. Community Microgrid Program (10 by 2030)

North Kohala (3,000), Hana (1,500), Ka'u (5,000), Molokai (7,000), Lanai (3,000). Solar+BESS+backup; grid-forming; black-start. Funding: DOE C-MAP, FEMA BRIC, HECO ratebase.

7. LiDAR/Drone Vegetation Intelligence

Quarterly LiDAR + multispectral drone; AI/ML hazard tree ID; automated clearance verification. Current \$18.5M/yr -> \$25-30M/yr targeted. ROI: 30-50% reduction in vegetation outages.

8. Substation Flood-Proofing (8 Critical Sites by 2035)

Iwilei (\$50-80M), Kahului (\$30-50M), Hilo (\$20-30M), Kapaia (\$10-15M). Standard: FEMA 500-yr flood elevation + 3 ft freeboard.

9. Inter-Utility Resilience Council (HECO/MECO/HELCO/KIUC)

Formal mutual aid; joint training/drills; shared spares/equipment; data sharing (OMS/SCADA); joint procurement; embedded EOC liaisons. PUC-facilitated governance.

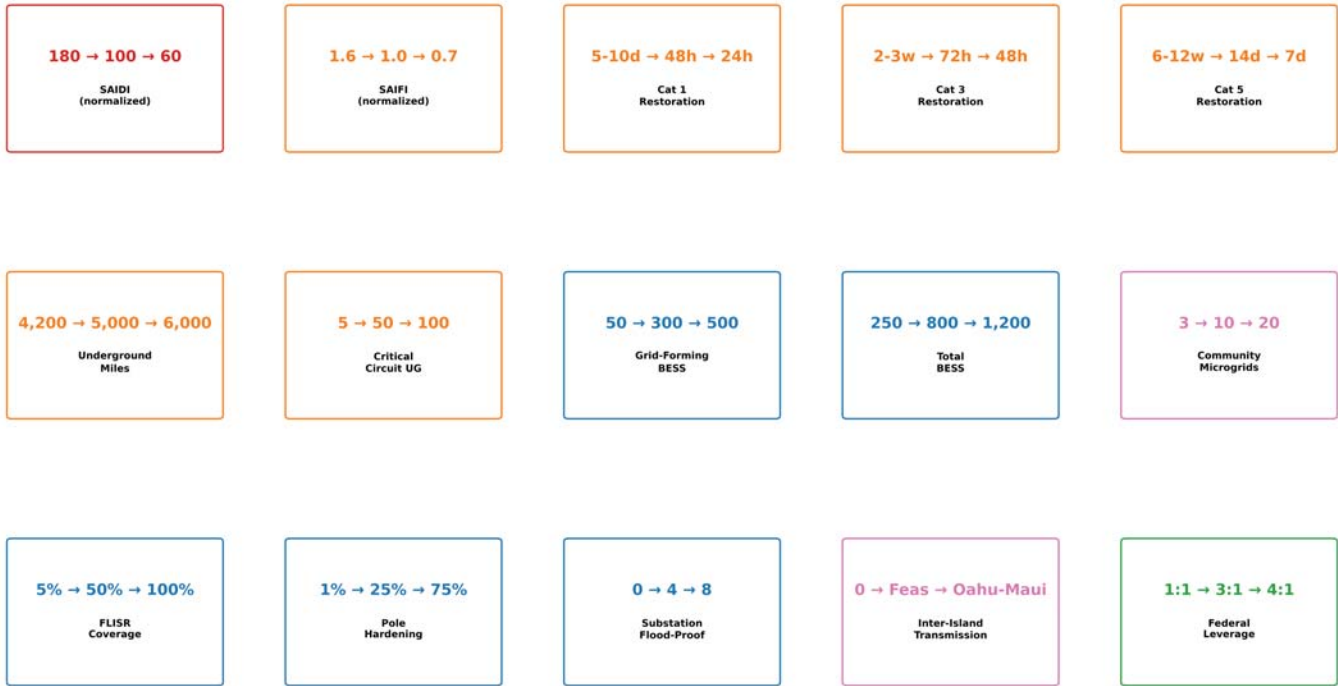
10. Federal Funding Leverage Strategy (Target 3:1 Ratio)

DOE Grid Resilience Formula: \$15M (2022-2027). DOE GRIP: target 2-3 awards (\$50-100M). FEMA BRIC: annual applications. FEMA HMGP: Maui recovery \$100M+. DOE Transmission Facilitation: inter-island HVDC. Target: \$300M+ federal by 2030.

8. Quantitative Targets (2025-2035)

15 quantified metrics with baselines and 2030/2035 targets:

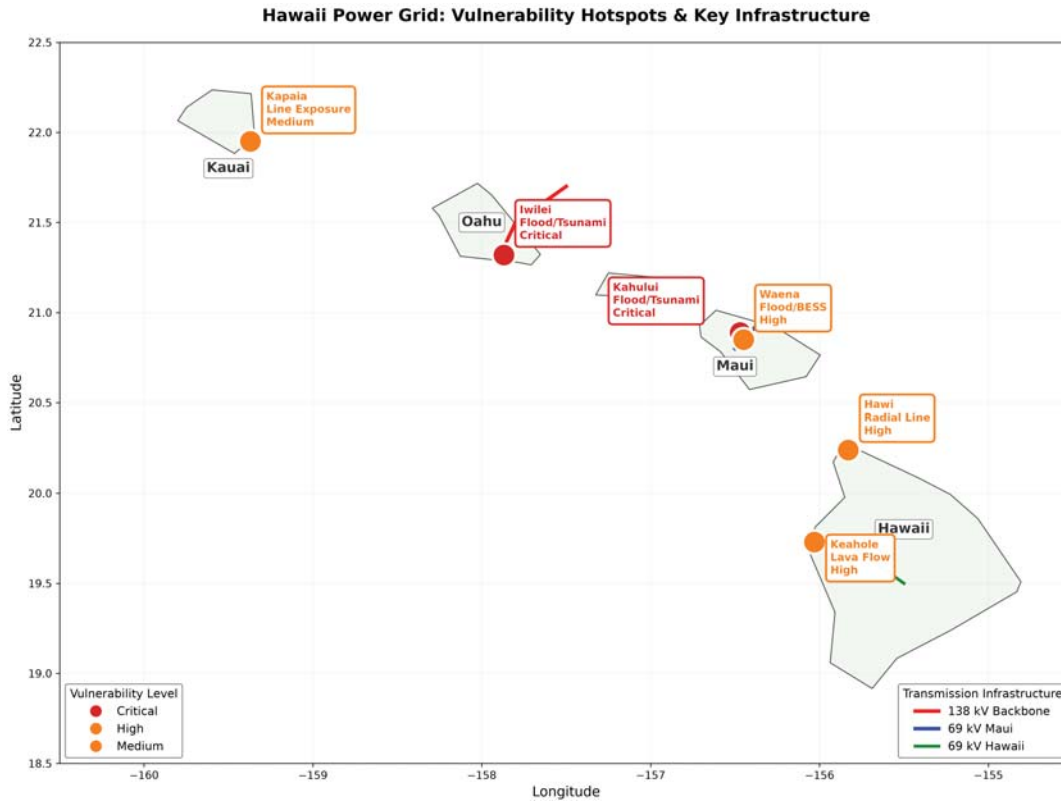
Hawaii Grid Resilience: Quantitative Targets Dashboard (2024-2035)



Metric	2024 Baseline	2030 Target	2035 Target
SAIDI (normalized)	180 min	100 min	60 min
SAIFI (normalized)	1.6	1.0	0.7
Cat 1 Restoration	5-10 days	48 hrs	24 hrs
Cat 3 Restoration	2-3 weeks	72 hrs	48 hrs
Cat 5 Restoration	6-12 weeks	14 days	7 days
Underground Miles	4,200 (43%)	5,000 (50%)	6,000 (60%)
Critical Circuit UG	5 miles	50 miles	100 miles
Grid-Forming BESS	50 MW	300 MW	500 MW
Total BESS	250 MW	800 MW	1,200 MW
Community Microgrids	3	10	20
FLISR Coverage	5%	50%	100%
Pole Hardening 150+ mph	1%	25%	75%
Substation Flood-Proofing	0	4	8
Inter-Island Transmission	0 MW	Feasibility	Oahu-Maui
Federal Leverage	1:1	3:1	4:1

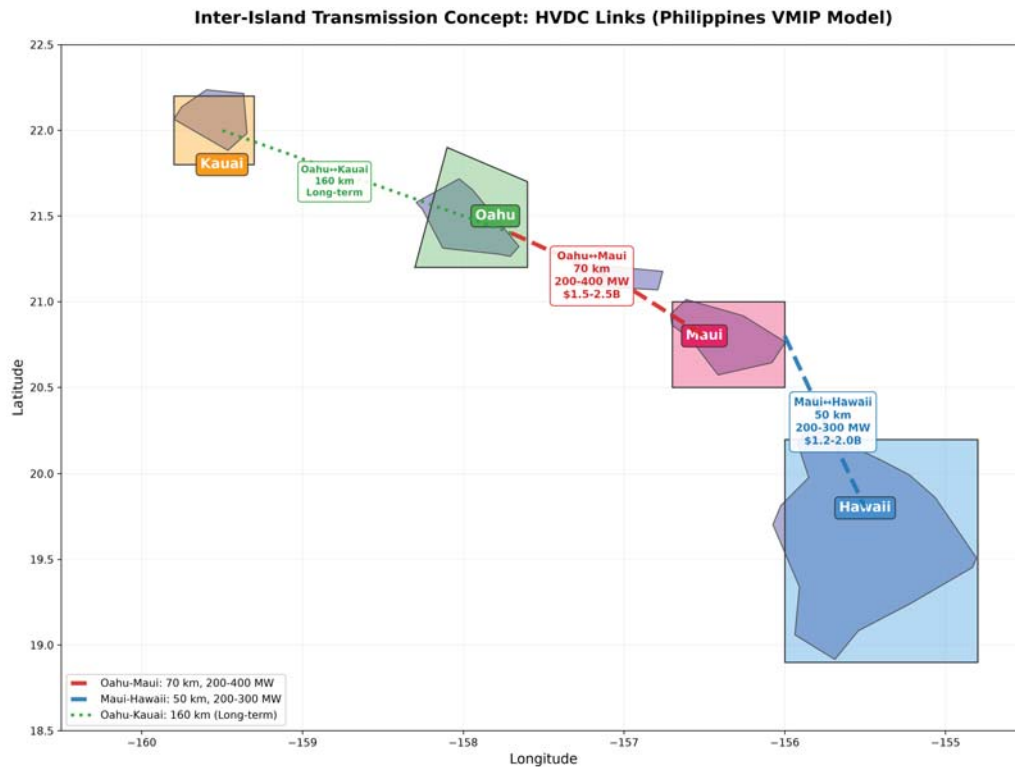
Vulnerability Hotspots Map

Geographic distribution of vulnerability hotspots and transmission infrastructure:



Inter-Island Transmission Concept

Proposed HVDC inter-island transmission links modeled on Philippines VMIP:



9. Implementation Roadmap

9.1 Near-Term (2025-2027)

- Complete HECO \$190M Climate Adaptation Plan (with \$95M DOE match)
- Deploy FLISR on 50 critical circuits
- Commission inter-island HVDC feasibility study (\$5M DOE GRIP)
- Complete Kapolei BESS grid-forming commissioning
- Waena BESS construction start (Maui)
- North Kohala microgrid operational
- AMI deployment: 200k meters
- LiDAR vegetation program launch (all islands)

9.2 Mid-Term (2027-2030)

- Underground 50 miles of critical corridors
- 300 MW grid-forming BESS operational
- 10 community microgrids commissioned
- Pole hardening: 25% of critical poles to 150+ mph
- Substation flood-proofing: 4 critical sites
- Inter-utility resilience council established
- FLISR: 50% critical circuits; ADMS fully integrated

9.3 Long-Term (2030-2035)

- Oahu-Maui HVDC construction decision
- 60% system undergrounding
- 500 MW grid-forming BESS
- Cat 1 restoration <24 hrs; Cat 5 <7 days
- SAIDI <60 min (normalized)
- 20 community microgrids
- Inter-island transmission operational (first link)

Appendix: Data Sources & Methodology

Primary Sources

- Hawaiian Electric - Power Facts, Performance Scorecards, Resilience page, Renewable Project Status Board
- KIUC - Generation Portfolio, Renewable Portfolio, Annual RPS Reports
- Hawaii PUC - Dockets 2018-0165 (IGP), 2022-0135 (Resilience), 2019-0323 (DER), 2018-0088 (PBR)
- Hawaii State Energy Office (HSEO) - Grid Resilience Funding, HCEI, Alternative Fuels Study
- NWS Honolulu - Tropical Cyclone Reports (Lala 2026, Hone 2024, Lane 2018)
- DOE Office of Electricity - GRIP Program, Grid Resilience Formula Grants

Philippines Cross-Reference Sources

- NGCP - Operations, Projects (VMIP, Cebu-Negros-Panay, Mindanao-Visayas), Transmission Development Plan
- DOE Philippines - Green Energy Auction, Microgrid Systems Service Provider (MGSP)
- Meralco - Distribution automation, FLISR deployment, storm hardening practices

Methodology Notes

- All monetary values in USD (2024) unless noted
- SAIDI/SAIFI normalized per IEEE 1366 (excludes Major Event Days)
- Restoration targets based on HECO historical data + Philippines benchmarks
- Investment figures from PUC dockets, DOE awards, utility capital plans
- Maps are schematic; not survey-grade precision
- Philippines data from NGCP reports, DOE Philippines circulars, Meralco disclosures