Hawaii State Energy Office Advanced Assistance Project

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Advance Assistance Project Overview

- Funded by FEMA Hazard Mitigation Advance Assistance funding
  - AA projects used to collect data
- Develop a Common Operating Picture (COP) for energy
  - Use for emergency response
  - Fulfill energy security planning requirements
  - Prioritize energy resilience investments
- Develop a visualization of COP
  - Geospatial Decision Support System (GDSS)
  - Geospatial
  - Interdependencies

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Inventory Critical Energy Infrastructure (CEI) and Community Lifeline Key Customers (CLKC)

- Interview CEI owners on Oahu to collect key data
- Survey CLKC to inventory and collect back-up generation data
- Define energy system interdependencies and CLKCs dependencies on energy systems
- Prioritize CEI and CLKC, considering population served and disadvantaged populations

Conduct a Risk Assessment on Energy Assets

- Overlay identified threat layers with CEI locations to assess the likelihood of threat exposure
- Rate CEI sensitivity, degree and likelihood of adverse impact, for each hazard type
- Assess the consequences of a CEI outage, exploring the relationship between CEI and CLKC
- Calculate risk and identify trends and key conclusions

Create a Geospatial Decision Support System

- Display Oahu's CEI and CLKC on an ArcGIS map platform with the ability to view with hazard layers
- View system linkages in complementary dashboard to understand upstream and downstream dependencies

Develop Risk Mitigation Approach

- Identify risk mitigation measures and existing resources
- Develop measure evaluation and prioritization tool
- Develop implementation plan

Inventory and Map Interdependencies

Develop Inventory of Critical Energy Infrastructure (CEI) and Collect Data

Power plants
Transmission lines
Substations
Refinery
SNG Plant
Terminals
Pipeline pumping stations
Pipelines
Etc.

Develop Inventory of Critical Lifeline and Key Customers (CLKC) and Collect Data

Emergency operation centers
Fire stations
Police stations
Shelters
Hospitals and other medical centers
Communication Assets
Water and wastewater systems
Etc.

Characterize Interdependencies

How is CEI dependent on other Energy Infrastructure? Map upstream and downstream linkages

How are Critical facilities dependent on CEI?

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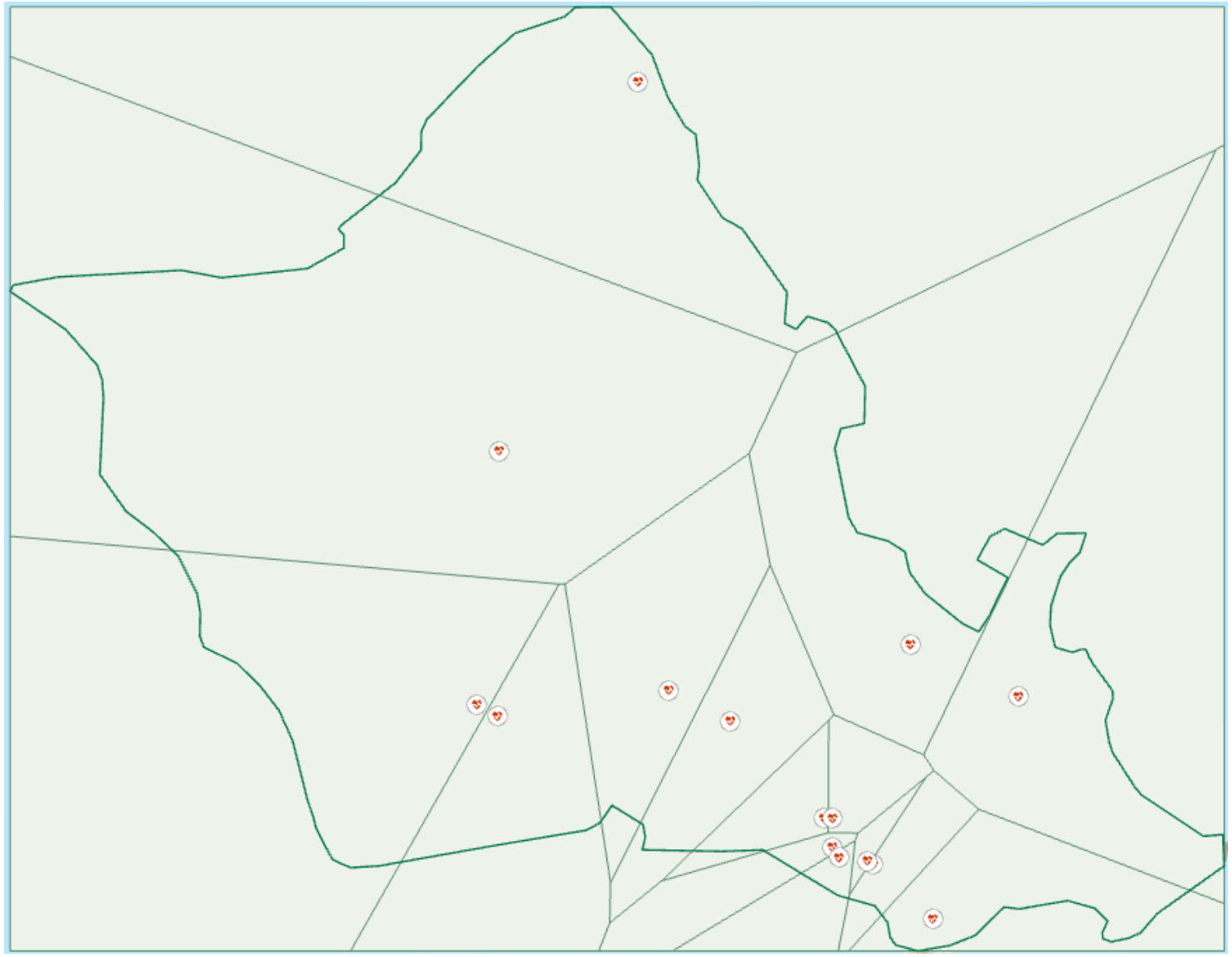
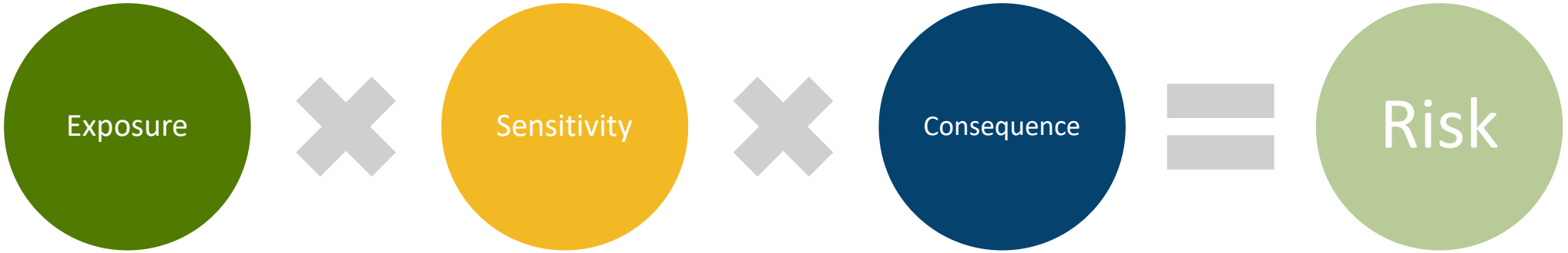
CLKC Prioritization

ArcGIS tools were used to assign many of the CLKC assets (hospitals, police, fire) a Thiessen polygon area that represents the most likely service territory of each CLKC. This was based on proximity of each census tract to the associated CLKC point vs. to any other CLKC point.

These layers were then intersected with population and disadvantage community datasets to estimate the population and disadvantaged community served by the CLKC.



Risk Assessment Methodology



- Specific to location
- Probability of occurrence on an annual basis, assigned to buckets
- Informed by historic climate data (NOAA, NWS, etc.) in collaboration with the State Hazard Mitigation Plan and probabilistic models

- Specific to asset type
- Can be interpreted as the expected outage duration from exposure to a given threat, bucketed 1-3
- Informed by subject matter experts

- Specific to asset
- Primary consequence represented as lost energy supply from asset outage
- Secondary consequence represented by cost to society of lost supply– our focus with the CLKC dependency analysis
- Informed by analysis of asset and interdependency relation

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Hazards Studied in Assessment

Quantitative Risk Assessment


Coastal Flooding/Erosion


Tsunami


High Winds


Earthquake


Inland and Coastal Flooding (100- and 500-Year Floodplains


Landslide and Rockfall


Wildfire

Qualitative Risk Assessment

- Cyberattack
- Fuel Disruption
- Human Error or Accident
- Equipment Malfunction
- Pandemic

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Sensitivity

- Sensitivity scores, assessment of the likelihood and extent of damage and duration of infrastructure outage, were assigned into buckets of 1 through 3 based on subject matter expertise, including a utility and oil sector SMEs.
- A matrix of energy asset types vs. each natural hazard was created.

	Coastal Flooding and Erosion	High Winds	Flooding (inland and storm surge)	Tsunami	Earthquake	Landslide and Rockfall	Wildfire
Solar	2	1	2	3	2	2	2
Wind	2	3	2	2	2	2	1
Batteries	2	1	2	3	3	3	2
All Other Generation	2	1	2	3	3	3	2
Substations	2	1	2	3	3	3	2
Transmission Lines (overhead)	2	3	1	2	3	3	3
Transmission Lines (under)	2	1	1	1	2	2	1
Refinery	2	2	3	3	3	2	3
Liquid Pipelines	2	1	1	1	3	2	1
Ports	2	2	2	2	3	2	2
Terminals	2	2	3	3	2	2	3
Gas Production Facilities	2	2	3	3	3	2	3
Gas Pipelines	2	1	1	1	2	2	1

Consequence

- This risk assessment has a particular focus on exploring the relationships between CEI and community lifeline key customers (CLKC). Therefore, the dependency of CLKC on the CEI is an important factor in consequence scoring, especially for the electric system.
- Consequence was then scored on a scale of 1 to 6 with the following approach:

Table 2: Consequence Scoring Table

Consequence Score	Substations and Transmission Lines		Other Infrastructure Types
	Voltage	CLKC Weighted Dependency	Priority Score
6	138kV	≥20*	High
5	138kV	0-20	
4	138kV	0	Medium
3	69kV or below	≥20	
2	69kV or below	0-20	Low
1	69kV or below	0	

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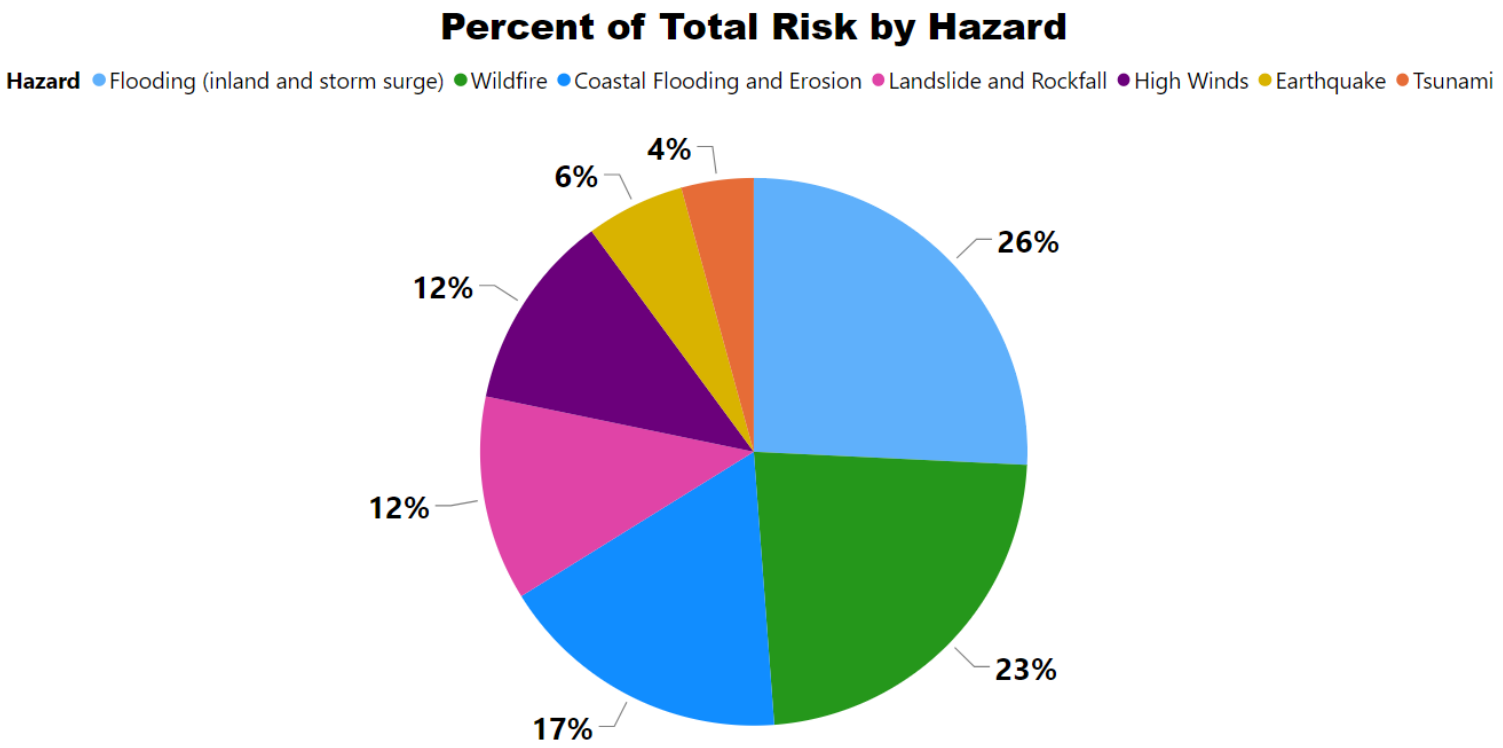
Risk Assessment Results

- Top assets by total risk score:
  - Three key pipelines that move petroleum products from Kapolei to terminals and power plants near Honolulu
  - Several higher voltage transmission lines that stem out from the one of the largest Oahu power plants
  - Key marine import terminal and a key jet fuel terminal



Risk Mitigation Approach

Final Risk Mitigation Goals & Objectives for O'ahu's Energy Systems

Goal 1: Reduce occurrence and duration of energy service disruptions by reducing system vulnerability to hazards	Goal 2: Promote actions to prepare O'ahu's energy systems for the impacts of climate change	Goal 3: Mitigate risks to energy systems and assets that serve critical community lifelines.	Goal 4: Support Hawaii's clean energy structure and transition to renewable energy through modernized grid infrastructure.
• ***Objective 1.1***: Identify and address interdependencies that could result in significant energy service disruption across critical facilities and assets. • ***Objective 1.2***: Protect or consider relocating fuel storage facilities, energy generation facilities, and energy distribution networks against high-priority hazards. • ***Objective 1.3***: Reduce flood risk to critical facilities and systems that are vulnerable to flooding.	• ***Objective 2.1***: Strengthen understanding of risks to critical energy systems due to changing climate hazards. • ***Objective 2.2***: Ensure protective measures adequately address changes in risk across time horizons. • ***Objective 2.3***: Promote actions that reduce recovery time after a natural hazard event.	• ***Objective 3.1***: Ensure critical community facilities (such as shelters, healthcare facilities, emergency management facilities, gas/charging stations) can operate with minimal interruption during an incident. • ***Objective 3.2***: Promote projects and actions that improve energy self-sufficiency for critical community facilities. • ***Objective 3.3***: Prioritize mitigation for energy assets that benefit locally identified disadvantaged communities, aligned with the Justice40 initiative. • ***Objective 3.4***: Partner with Community Lifeline Key Customers (CLKC), local communities and community organizations, and key sectors to prioritize energy mitigation actions equitably.	• ***Objective 4.1***: Maximize electricity generation, transmission, and distribution efficiency. • ***Objective 4.2***: Identify and implement resilient and transformative technologies for the electric grid, including assets that should be replaced to support a clean energy transition. • ***Objective 4.3***: Integrate alternative energy methods and clean energy technologies to accelerate decarbonization and a clean energy transition.

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Mitigation Measures

The project identified 28 proposed mitigation measures for Oahu's energy system. Measures are grouped in a three-part framework that is broadly common to energy resilience:

Strengthen Against and Resist Potential Hazards

This category reflects the ability of the energy system to withstand impacts from extreme events. Example adaptations include strengthening poles and undergrounding lines.

Absorb Impacts When Hazards Strike

This category represents mitigation measures that allow the energy system to continue providing some level of service, despite damage. Example adaptations include feeder sectionalizing, microgrids, and backup generation.

Advance Resilience Through Planning and Policy

The portfolio of actions that improve planning processes, engineering, design, and operations as well as emergency response and stakeholder engagement, all of which can help improve energy resilience

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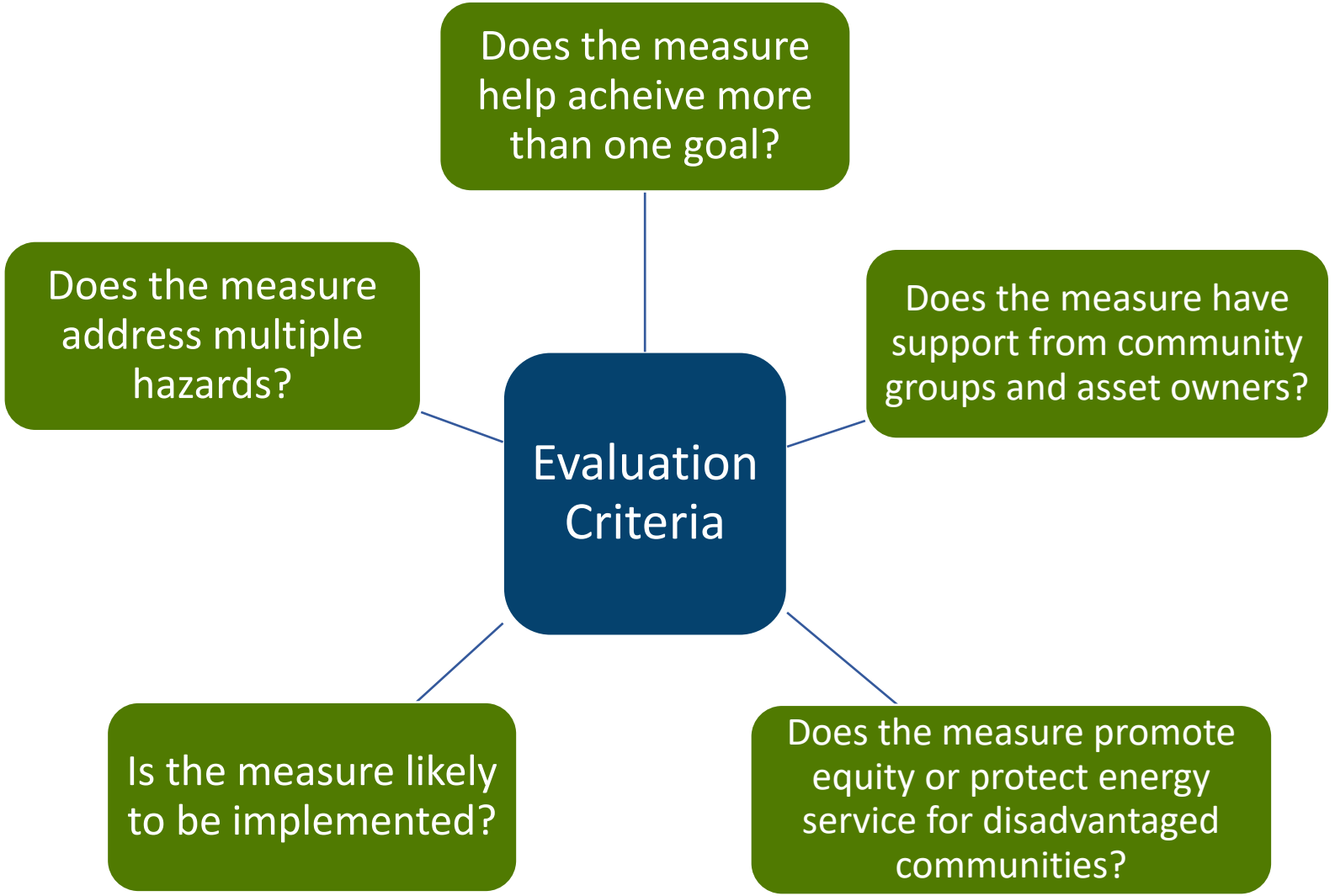
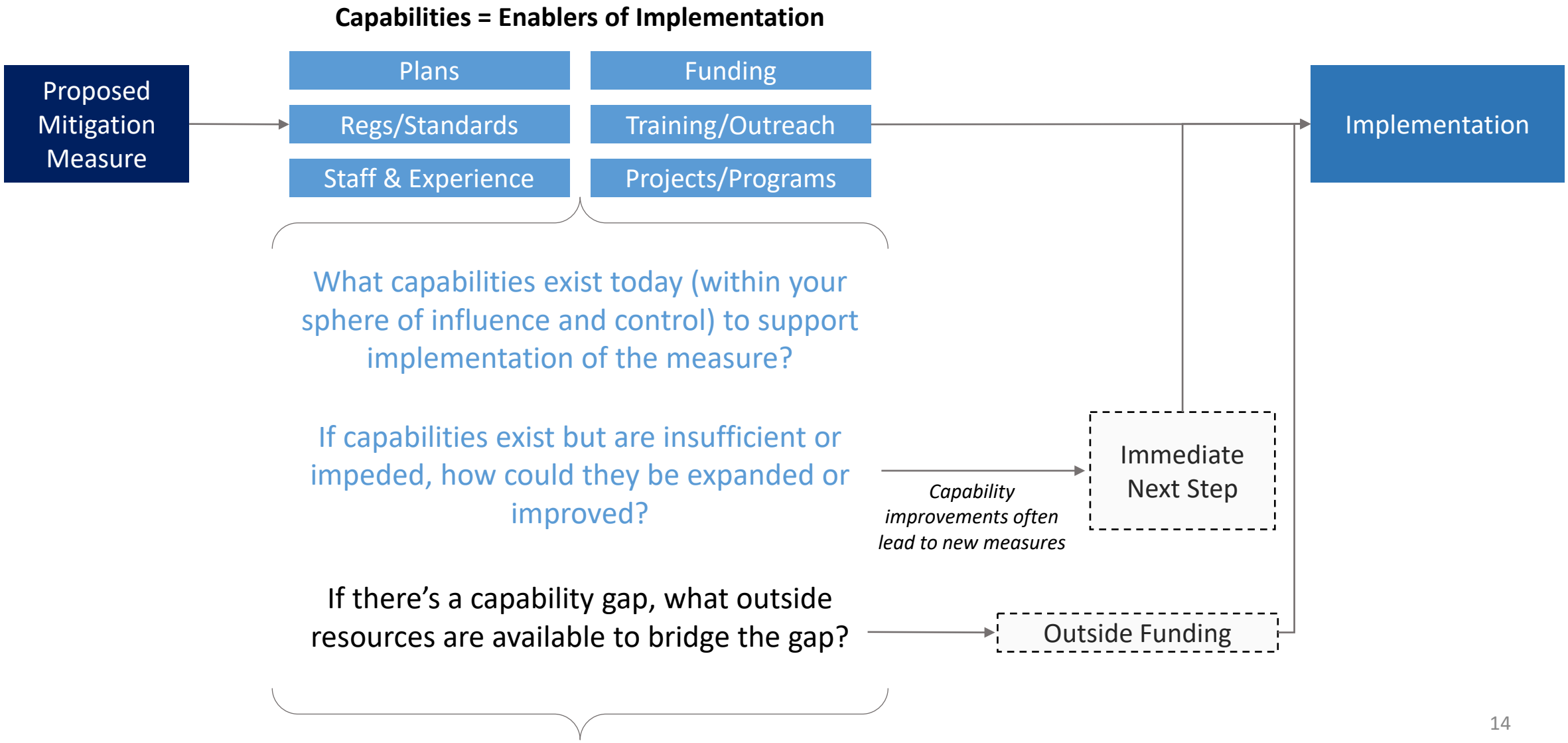
Evaluation Criteria



Capabilities Assessment



Implementation Plan Approach

Action Worksheet	
Proposed Action 1 Description	
Lead Implementation Partner	
Partner Agencies	
HSEO Support Role	
Timeline	
Cost	
Potential Funding Resources	
Priority	
Benefits	
Status	
Next implementation steps	
Benefits	
Potential Funding Resources	

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Geospatial Decision Support System (GDSS)

- The GDSS is a web-based tool that provides end users the ability to explore and understand complex geospatial data such as energy infrastructure networks alongside complimentary analyses of vulnerabilities and capabilities.
  - Visualize dependencies across CEI and CLKC infrastructure networks and allow users to flexibly visualize these dependencies
  - Assess downstream impacts stemming from node loss
  - Understand the risks to the system
- End users include HSEO, OHS, and HI-EMA. Uses include energy security planning; emergency response; hazard mitigation grant and funding applications and prioritization; CI protection, etc.
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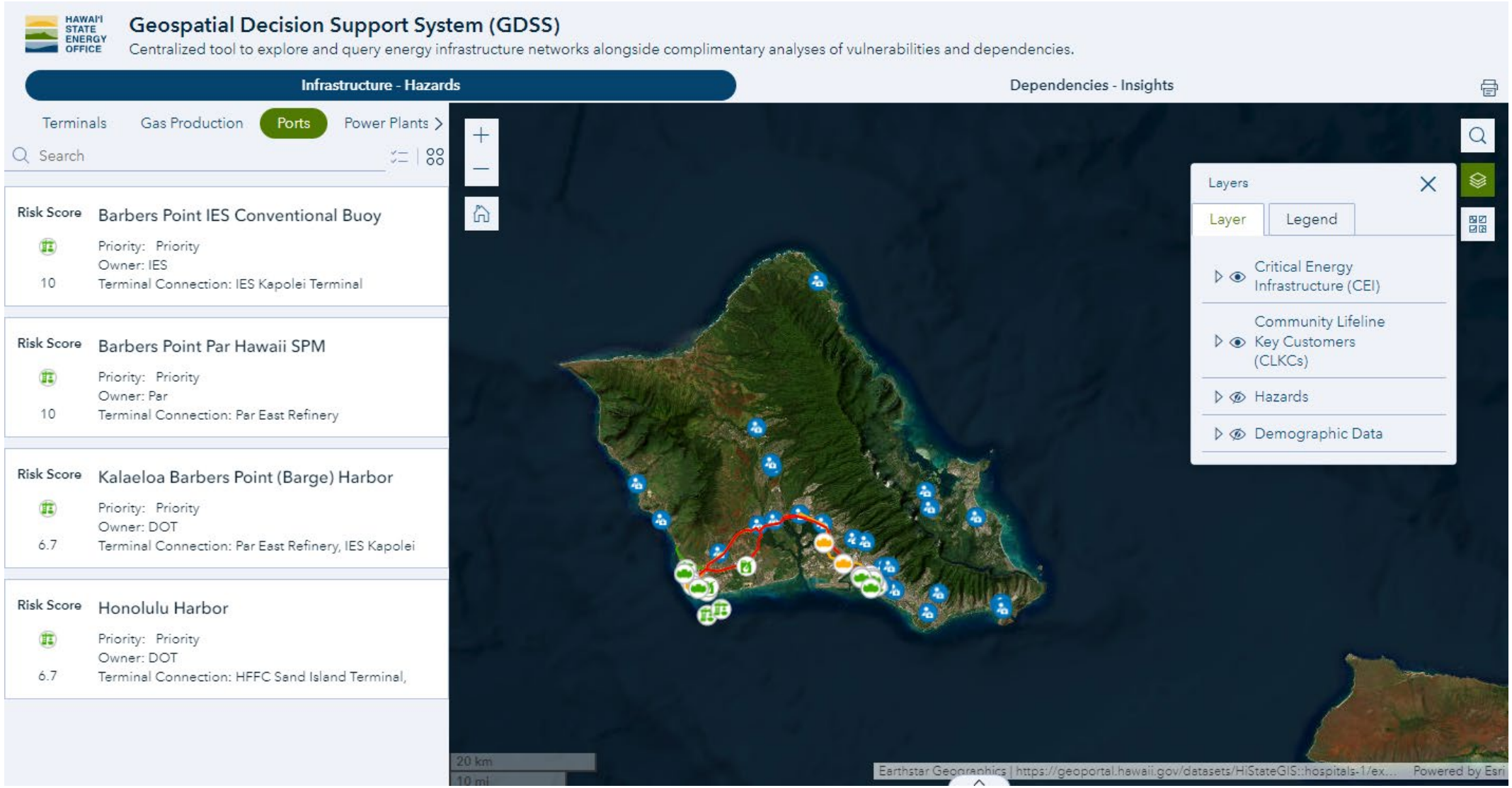
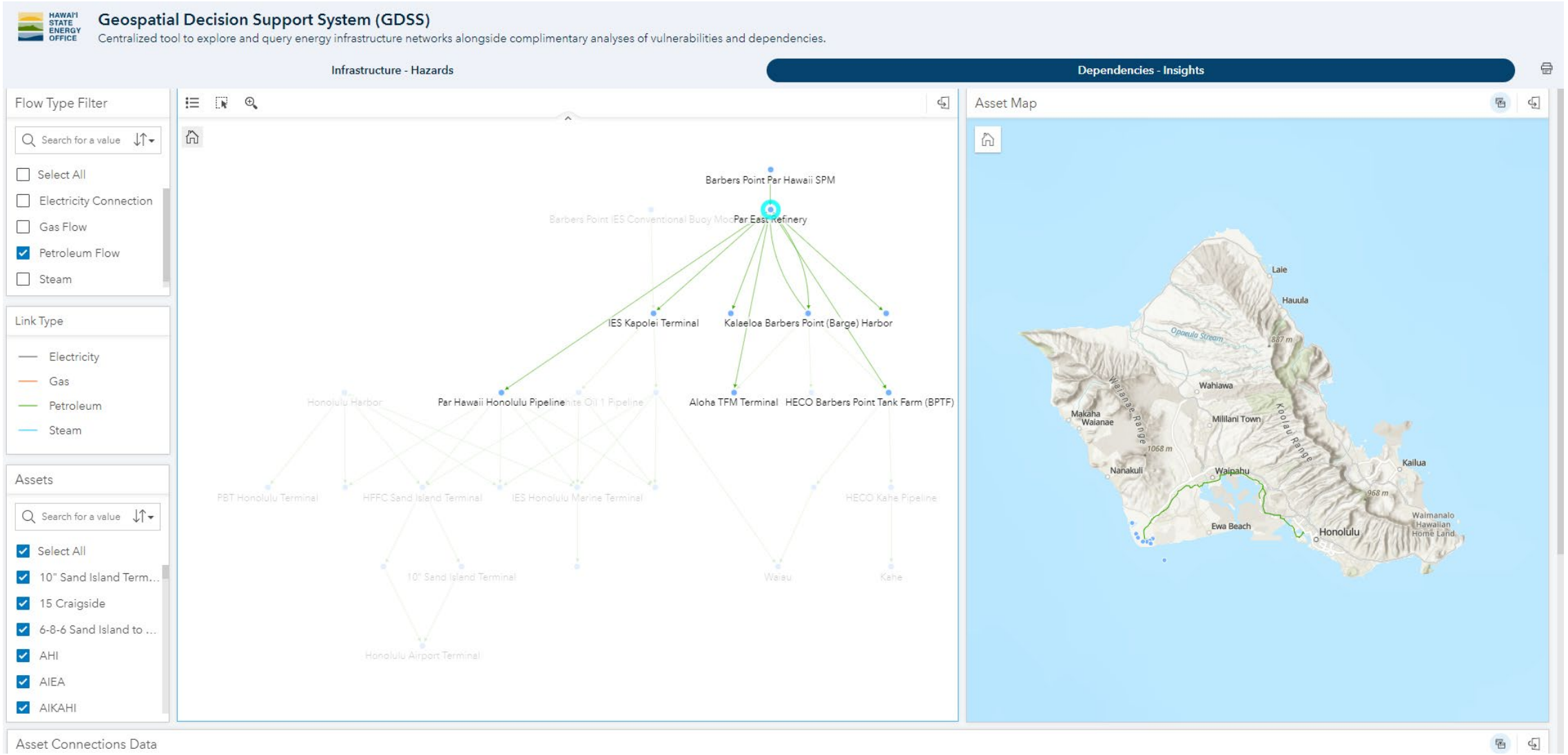
Geospatial Decision Support System (GDSS)

- The GDSS is hosted in the OHS enterprise Esri GIS environment.
- It can house sensitive data with the ability to fine-tune data access control to only authorized user groups.
  - PCII
  - NDA
- The GDSS application has two sides: (1) The Infrastructure/Hazards tab and (2) The Dependency Insights tab
- For (2), Used ArcGIS Insights and the Link Analysis tool to visualize the relationships between nodes and ultimately the dependencies of CLKC on CEI.

Dynamically explore CEI, CLKC, and hazards



Visualize CEI dependencies



Next Steps

- AA 2.0 - Statewide energy COP (Kauai, Maui, Hawaii counties)
- GDSS as platform for Critical Infrastructure Protection program by OHS

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Questions?