UNDERSEA CABLE

Prepared for the:
State of Hawai‘i
Department of Business, Economic Development and Tourism

Under Supplemental Contract No. 1 for Contract #60514
for the NETL Grant Project

Task 1, Subtask 5, Undersea Cable Element

Submitted by the:
Hawai‘i Natural Energy Institute

July 2013
UNDERSEA CABLE

Prepared for the:

Hawai‘i Renewable Energy Grid Project

Prepared by the:

State of Hawai‘i
Department of Business, Economic Development and Tourism

June 2013
# Table of Contents

## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Summary</td>
<td>1</td>
</tr>
<tr>
<td>Hawaii Energy Geography</td>
<td>2</td>
</tr>
<tr>
<td>Resources</td>
<td>2</td>
</tr>
<tr>
<td>Demand</td>
<td>2</td>
</tr>
<tr>
<td>Reconciling Demand and Economic Viability</td>
<td>3</td>
</tr>
<tr>
<td>Summary of Findings from Cable Studies</td>
<td>4</td>
</tr>
<tr>
<td>Navigant Cable Study</td>
<td>4</td>
</tr>
<tr>
<td>AECOM HIREP</td>
<td>5</td>
</tr>
<tr>
<td>Air Quality and Climate Change</td>
<td>6</td>
</tr>
<tr>
<td>Cultural Resources</td>
<td>6</td>
</tr>
<tr>
<td>Land Transportation</td>
<td>8</td>
</tr>
<tr>
<td>Land Use</td>
<td>9</td>
</tr>
<tr>
<td>Marine Transportation</td>
<td>10</td>
</tr>
<tr>
<td>Marine Biological Resources</td>
<td>10</td>
</tr>
<tr>
<td>Natural Hazards, Hazardous Materials and Munitions and Explosives of Concern</td>
<td>13</td>
</tr>
<tr>
<td>Noise and Vibration</td>
<td>16</td>
</tr>
<tr>
<td>Public Health and Safety</td>
<td>17</td>
</tr>
<tr>
<td>Public Services and Infrastructure</td>
<td>18</td>
</tr>
<tr>
<td>Recreation</td>
<td>18</td>
</tr>
<tr>
<td>SOEST</td>
<td>18</td>
</tr>
<tr>
<td>Hawaii Deep Water Cable Study</td>
<td>20</td>
</tr>
<tr>
<td>Case for Cable</td>
<td>20</td>
</tr>
<tr>
<td>Capacity to Deliver Energy</td>
<td>20</td>
</tr>
<tr>
<td>Load Balancing Opportunities &amp; Efficiencies</td>
<td>21</td>
</tr>
<tr>
<td>Economics</td>
<td>21</td>
</tr>
<tr>
<td>Construction Phase</td>
<td>21</td>
</tr>
</tbody>
</table>
Analytical Assumptions............................................................................................................................. 21
Estimated Economic Impacts.......................................................................................................................... 22
Converter Station Operations and Maintenance............................................................................................ 23
   Analytical Assumptions............................................................................................................................. 23
   Estimated Economic Impacts....................................................................................................................... 23
Other Considerations...................................................................................................................................... 24
Energy Security .............................................................................................................................................. 24
Environmental Trade-offs (Alignment with HCEI)...................................................................................... 24
   Emission Reductions................................................................................................................................. 24
   Reduced Dependence on Oil ..................................................................................................................... 25
   Net Energy Savings............................................................................................................................... 25
   Construction Damage............................................................................................................................. 26
Description of Cable ................................................................................................................................. 26
Background on Cables Currently in Operation (State of Commercialization)................................. 26
Sizing and Capacity....................................................................................................................................... 27
Routing.......................................................................................................................................................... 28
Financial Structure......................................................................................................................................... 28
Agreement Terms.......................................................................................................................................... 29
Risk ............................................................................................................................................................. 30
Risks and Uncertainties ................................................................................................................................. 31
Executive Summary

In an effort to diversify the renewable energy capacity in the State of Hawaii, and with the support of the U.S. Department of Energy ("USDOE"), the primary stakeholders in Hawaii’s energy future, the State of Hawaii Department of Business, Economic Development and Tourism ("DBEDT") and the Hawaiian Electric entities, decided that there was a need to investigate the possibility of connecting the islands through an inter-island cable system, which would allow the development of larger scale renewable projects to meet Oahu’s demand as well as increase grid stability for all connected islands.

Several key reports have been commissioned, including an overarching report by Navigant, an environmental impact study by AECOM; technical reports by the University of Hawaii School of Ocean and Earth Science and Technology ("SOEST"); and the 1989 Hawaii Deep Water Cable Study ("HDWCS") which assessed the feasibility of transmitting geothermal electricity via a submarine cable system from the Island of Hawaii to Oahu and Maui and contains valuable information that can be used for the Cable Project.

The AECOM review was prepared at a programmatic level, meaning that it reflects the environmental consequences attendant upon a wide-ranging program. The report is a comprehensive study of the project’s potential environmental impacts vis-à-vis several resource areas, including:

- air quality and climate change;
- cultural resources;
- geology and soils;
- land transportation;
- land use;
- marine transportation;
- marine/benthic species and habitat;
- natural hazards, hazardous waste, and munitions and explosives of concern;
- noise and vibration;
- public health and safety;
- public services/infrastructure;
- recreation;
- socioeconomics and environmental justice;
- terrestrial/coastal biological resources, species and habitat;
The report identifies all assumptions relied upon when determining the potential impacts, as well as measures that can be taken to mitigate any negative effects.

The SOEST reports discuss the results of ocean floor surveys conducted by SOEST for the purpose of ascertaining the feasibility of laying a power transmission cable on the ocean floor to transport renewable energy generated on Lanai and Molokai to Oahu.

Hawaii Energy Geography

Resources
Hawaii’s economy is not energy intensive. The state is geographically isolated from major natural gas and coal resources, yet depends heavily on fossil fuels to meet energy demand. Indeed, it is the most petroleum-dependent state in the nation.\(^1\) In 2009, close to nine-tenths of Hawaii’s energy came from imported petroleum.\(^2\) In 2010, Hawaii imported 94 percent of its energy.\(^3\)

While Hawaii’s location presents challenges in supplying the fossil fuels needed to meet all of its energy demands, the state is also uniquely situated for innovation in the renewable energy sector. Generally, renewable energy is not cost-competitive in other parts of the country where energy produced from natural gas and coal is less expensive. However, because of the geographic isolation of Hawaii, and the high price of importing fossil fuels, Hawaii is uniquely positioned to produce renewable energy at a competitive cost with energy from fossil fuels.

Moreover, Hawaii’s unique geography makes the natural renewable resources available in Hawaii, particularly wind, solar, and geothermal resources readily available in abundance.

Demand
Among the islands, Oahu is by far the dominant consumer. In June 2012, Honolulu consumed 571,895,959 kilowatt hours of electricity. The same month, the County of Maui (including the islands of Molokai and Lanai) consumed 92,635,449 kilowatt hours, Hawaii County consumed 87,471,902 kilowatt hours, and the County of Kauai consumed 37,416,623 kilowatt hours of electricity.

---


Oahu’s energy demands are almost three times the demand of the other counties combined. Honolulu is also the most densely populated county. Thus, there is limited availability of land upon which renewable energy projects may be constructed to meet the county’s needs.

Reconciling Demand and Economic Viability

The availability of land and demand for energy on Oahu leads to the unique problem facing the State and the Hawaiian Electric entities – Hawaiian Electric Company (“HECO”), Maui Electric Company (“MECO”), and Hawaii Electric Light Company (“HELCO”) – in meeting the RPS. The vast majority of energy demand is on Oahu, but the existing population density and higher cost of land and development results in Oahu not being the optimal location to develop all the commercial-scale renewable energy projects needed to meet Oahu’s RPS requirements.

Meanwhile, the comparatively larger undeveloped areas available on the neighbor islands allow for such development of a larger scale project. However, as the grids of the respective islands are not currently connected, there is currently no ability to develop such a large scale project on another island for the purpose of assisting in meeting Oahu’s energy demand and thus reducing its dependence on fossil fuels. Along with the support of the U.S. Department of Energy ("USDOE"), therefore, the primary stakeholders in Hawaii’s energy future, the State of Hawaii Department of Business, Economic Development and Tourism
(“DBEDT”) and the Hawaiian Electric entities, decided that there was a need to investigate the possibility of connecting the islands through an inter-island cable system, which would allow the development of larger scale renewable projects to meet Oahu’s demand as well as increase grid stability for all connected islands.

**Summary of Findings from Cable Studies**

**Navigant Cable Study**

DBEDT retained Navigant Consulting Inc. (“Navigant”) to act as a subject matter expert to assist the state with matters relating to the undersea cable, including development, design, regulation, financing, ownership, procurement, and analyses related to an inter-island undersea power cable.

The Navigant Report focused on the optimal business structure for the project, with an emphasis on burden-sharing and economic risk-taking. Under Navigant’s recommended structure, the project should be developed by a private developer selected through a competitive procurement process. Navigant found that neither the State nor HECO is well-situated to accept project development risk, particularly in light of the downgrade of HECO’s credit rating to BBB-.

Under the recommended structure, the private developer would develop, own, and maintain the project for a period of at least ten years. Thereafter, HECO would have the option to purchase the cable. If the option to purchase is exercised, HECO would seek a rate recovery of its purchase price through a Hawaii Public Utility Commission (“PUC”) order.

The report further discusses legislation Navigant developed for implementation of the proposed business structure. Briefly, the legislation would authorize the PUC (i) to approve the creation of a transmission utility (ii) to approve a transmission tariff and mechanism for a surcharge to be collected by the existing electric utility for transfer to the certified cable company; and (iii) to approve investments made by the existing electric utility in on-island infrastructure. Navigant determined that the enactment of such authorizing legislation was a necessary pre-condition for further material progress on the project.4

Navigant ultimately concluded that under the proper business structure, the project is both technically and economically feasible. Moreover, it will produce savings for retail ratepayers as of the date of first commercial operation and continuously thereafter.

---

4 The legislation proposed by Navigant was, with modifications, signed into law by Governor Neil Abercrombie on June 27, 2012 (Act 165, Session Laws of Hawaii 2012).
AECOM HIREP

The State retained the consulting firm AECOM to prepare an environmental review of the potential impacts resulting from the undersea cable project.

AECOM’s review was prepared at a programmatic level, meaning that it reflects the environmental consequences attendant upon a wide-ranging program. Programmatic analyses look at broad issues relevant to the overarching program design. As a result of the programmatic nature of AECOM’s analysis, the analysis itself will continue to provide valuable insight on the project’s impacts even if particular segments of the project are altered in the future. Segment-specific analyses will still need to be conducted at a later date.

The report is a comprehensive study of the project’s potential environmental impacts vis-à-vis several resource areas, including:

- air quality and climate change;
- cultural resources;
- geology and soils;
- land transportation;
- land use;
- marine transportation;
- marine/benthic species and habitat;
- natural hazards, hazardous waste, and munitions and explosives of concern;
- noise and vibration;
- public health and safety;
- public services/infrastructure;
- recreation;
- socioeconomics and environmental justice;
- terrestrial/coastal biological resources, species and habitat;
- visual resources; and
- water resources.

The report identifies all assumptions relied upon when determining the potential impacts, as well as measures that can be taken to mitigate any negative effects.

---

The following is a brief summary of AECOM’s analysis of each of the 17 resource areas considered:

**Air Quality and Climate Change**

The undersea cable project will likely have temporary, construction-related impacts and long-term, operations-related impacts on air quality. Construction of the converter stations will potentially produce fugitive dust and construction vehicle emissions, while at sea the operation of the cable-laying vessels and related machinery will produce similar emissions.

To minimize these adverse effects on air quality, the study recommends that conservation and construction measures (“CCMs”) be implemented during construction. Dust control measures, such as a dust control (watering) program and covering of soil stockpiles during transport or storage, will be developed and implemented by the construction contractor. Construction vehicles will either remain on-site or be scheduled to arrive and depart the landing site area during nonpeak traffic hours, to reduce vehicle emissions.

Over the long term, the converter stations could result in emissions – both from the converter equipment and from the vehicle travel required to operate and maintain the stations. However, by their nature, converter stations emit little to no air emissions, and the stations themselves would not be considered a “major source” as defined by Haw. Rev. Stat. §342B-1.6

It is anticipated that emissions during construction will be temporary and relatively minor, can be minimized through implementation of CCMs, and will not significantly affect air quality. Further, the use of a cable system to transmit renewable energy for use in lieu of fossil fuels will result in the reduction of greenhouse gas emissions.

**Cultural Resources**

Many of the proposed landing sites lie in areas which are largely undeveloped, and it is expected that these areas will have archaeological significance upon further subsurface testing. The particular impacts will be largely dependent upon the landing sites ultimately selected and the further investigation of the locations. The impacts will arise almost entirely during the construction phase of the project, rather than during operations.

---

6 The state’s air pollution control laws, set forth in Haw. Rev. Stat. Chapter 342B, define “Major source” as “any stationary source, or any group of stationary sources that are located on one or more contiguous properties, and are under common control, belonging to a single major industrial grouping and that emits or has the potential to emit, considering controls: (1) Any hazardous air pollutant, except radionuclides, in the aggregate of ten tons per year or more, twenty-five tons per year or more of any combination, or such lesser quantity as the director may establish by rule; (2) One hundred tons per year or more of any regulated air pollutant, including fugitive emissions of any such regulated air pollutant as the director may establish by rule; and (3) For radionuclides, “major source” shall have the meaning specified by the director by rule.”
Although cultural resources are not recoverable, certain measures can be taken to ensure that areas of cultural significance are left intact as much as possible. These include selecting lands which have already been developed or otherwise disturbed, using existing roads and minimizing the creation of new roads, having cultural and archaeological personnel on hand during construction when there is a likelihood of encountering cultural resources (especially Native Hawaiian burials), and ensuring compliance with the state’s historic preservation laws (Haw. Rev. Stat. Chapter 6E).

The report also recommends the creation of cultural resources management plans to address the discovery of cultural resources at a site or where there is a high potential of such discovery. Such plans would address mitigation activities to be taken for cultural resources found at particular sites. While avoidance is always the preferred mitigation option, the plans will also identify the steps to be taken in the case that avoidance is not possible. Such steps will include the establishment of monitoring programs, identification of measures to prevent looting, vandalism and the impacts of erosion, education of workers and the public, and the proper handling of discovered artifacts.

Among the conservation measures identified by AECOM, many can be implemented early on in the planning process. For instance, it is noted that developers must consult with the State Historic Preservation Division (“SHPD”) and Native Hawaiian organizations to identify culturally sensitive sites and resources – a process which is required by the National Historic Preservation Act. The report also recommends that developers conduct a comprehensive review of archival archeological literature to identify culturally sensitive sites and potential lineal and cultural descendants from the proposed landing site area.

*Geology and Soils*

The sites on every island will almost certainly require clearing, grading, excavating, engineering and re-contouring of soils, both on the land upon which the converter stations will be constructed as well as for the access roads to the sites. This activity will primarily impact the soils. Construction activities may result in the clearing of vegetation, leaving the underlying soils prone to erosion. The threat of erosion will be greater at sites with greater slopes. However, most of the contemplated landing sites are located in flat, coastal plains which will be less vulnerable to erosion.

AECOM’s report sets forth seven recommendations for measures which can be taken in order to minimize the impact of the project on geology and soils. The starting point of the recommendations, which are summarized below, is the avoidance of sites with particular geologic traits. The recommendations further provide guidelines as to what measures should be taken, if any, in the event that avoidance is impossible or not practicable.
1) Avoidance of steeply sloping landing sites. Where avoidance is not possible, a geotechnical survey should be prepared to provide design and construction recommendations to ensure stability.

2) Dewatering of coastal sites.

3) Avoidance of lands designated as “prime” under the Agricultural Lands of Importance to the State of Hawaii rating system. If avoidance of such lands is impracticable or impossible, the developer will have to petition the county and the state department of agriculture for reclassification or rezoning of the site pursuant to Haw. Rev. Stat. § 205-50.

4) Avoidance of landing sites on or near wetlands or surface water/drainage ways. If avoidance is not possible, development must comply with the requirements of the Clean Water Act (33 U.S.C. §1251 et seq.), Section 10 of the Rivers and Harbors Act of 1899 (33 USC § 401), the Safe Water Drinking Act (42 U.S.C. §300f et seq.), the federal Coastal Zone Management Act (16 U.S.C. §§ 1451–1464) and the state Coastal Zone Management Program (Haw. Rev. Stat. Chapter 205A, the Hawaii Water Plan (Haw. Rev. Stat. Chapter 174C), and county water use and development plans.

5) If more than one acre of land is disturbed by the project, obtaining a Water Quality Certification pursuant to Section 401 of the Clean Water Act (33 USC § 1341) and, potentially, a grading/grubbing permit from the county in which the development occurs. The developer may further be required to undertake permanent erosion control measures upon completion of construction.

6) Control of potential impacts to water quality and quantity during grading and construction by obtaining a National Pollutant Discharge Elimination System permit pursuant to Section 403 of the Clean Water Act(33 USC § 1343) and a grading/grubbing permit from the pertinent county.

**Land Transportation**

Impacts to land transportation from project activities likely will be unavoidable. The use of heavy-load trucks to deliver equipment and materials will probably result in the deterioration of roadway conditions, the alteration of existing roadways (either by widening narrow roads to accommodate oversized vehicles or the surfacing of unpaved

---

7 Haw. Rev. Stat. §§205-41 through 205-52 provide for the enactment of state and county “agricultural policies, tax policies, land use plans, ordinances, and roles” to promote the preservation of lands designated as “important agricultural lands.” There are three classes of important agricultural lands – prime, unique and “other important agricultural lands.” “Prime” land refers to land whose soil has, among other characteristics, proper moisture, temperature, and acidity. See Agricultural Lands of Importance to the State of Hawaii, Classification System, available at [http://hawaii.gov/dbedt/gis/data/alish.pdf](http://hawaii.gov/dbedt/gis/data/alish.pdf) (last visited December 14, 2012).
roadways), and increased traffic congestion from heavy-load trucks moving at slow speeds. Further, new roads may need to be constructed in order to reach certain landing sites. However, these impacts will occur primarily during the construction phase of the project, with only minimal post-development impacts resulting from ongoing maintenance and operations.

To minimize the potential impacts, AECOM’s report recommends the identification of efficient routes which avoid highly congested roadways and/or roadways that do not have the capacity to handle oversize and overweight vehicles. In conjunction with this recommendation, a transportation management plan should be developed to ensure the safe flow of traffic during construction operations.

**Land Use**

The report discusses impacts to land use, defined as the allowable uses of land as prescribed by the governing entity with jurisdiction over the land. Land use encompasses zoning, which is used to regulate activities permissible on land and implement land use plans.

Pursuant to Haw. Rev. Stat. Chapter 205, all state lands are placed in one of four land use districts: urban, rural, agricultural, and conservation. Jurisdiction varies by district. Urban districts lie primarily within the jurisdiction of their respective counties. Jurisdiction over rural districts is shared by the Land Use Commission and county governments. Agricultural lands are further divided into sub-categories depending upon their productivity. The use of land within the highest categories of productivity is governed by statute, while the Land Use Commission establishes the permissible uses of lower-productivity agricultural lands. Finally, conservation districts fall within the jurisdiction of the Hawaii Board of Land and Natural Resources.

The report recommends that development is sited to minimize the displacement of existing uses. To the extent that avoidance of such displacement is not possible, the developer will be required to obtain the requisite permits and variances and/or apply for re-categorization of the land in compliance with the applicable law.

In addition to the restrictions placed on land use based upon a land's categorization under Haw. Rev. Stat. Chapter 205, lands located within the shoreline must follow the guidelines and permitting procedures set forth in the Coastal Zone Management Act (Haw. Rev. Stat. Chapter 205A). The act establishes minimal guidelines and permitting procedures for the counties to follow, but the counties are responsible for designating the lands which shall constitute special management areas subject to the act. All prospective landing sites fall

---

within special management areas, and developers will necessarily have to comply with the Coastal Zone Management Act’s guidelines and permitting processes.

**Marine Transportation**
The resource of marine transportation refers to the transportation of people or goods by watercraft. As a remote island state, Hawaii is dependent upon marine transportation for the bulk of its goods. Use of watercraft for the transportation of people, however, is minimal. After the suspension of the Hawaii Superferry services in 2009, the only regularly scheduled interisland passenger ferry services run between Maui and Lanai and Lanai and Molokai.\(^9\)

The transportation of food, fuel, building materials, and other consumer products to the islands will be impacted by the cable project, particularly during the construction phase. However, as the in-flow of goods must remain uninterrupted, it will be necessary for the cable developer to work with cargo carriers to ensure that transportation corridors remain open throughout construction. This may be achieved by publishing notice of cable laying in the USCG District 14 Local Notice to Mariners one week prior to commencement. Likewise, the cargo ships must be able to dock and unload at the various harbors and facilities. Notice should also be provided to harbormasters when cable routes terminate at or near a state harbor.

This section of AECOM’s report also covers the activities of the United States Coast Guard and Navy. The developer must consult with the Navy to ensure that defense facilities, movements, or security procedures are not impacted or compromised by the construction or operation of the cable facilities.

**Marine Biological Resources**
AECOM’s report on the potential impacts to marine biological resources is based on data collected by the University of Hawaii School of Ocean and Earth Science Technology (“SOEST”). SOEST focused primarily on the southern route from Pearl Harbor on Oahu to northwest Molokai and the northern route between Kaneohe and Molokai. Numerous mustard gas bombs were detected along the southern route, as documented in SOEST’s report. Accordingly, SOEST was unable to recommend a safe passage for the cable along the southern route.

While the northern route did not have similar hazards, it is likely that there are several areas of sensitive habitats containing deep water coral along the route. The ocean floor was studied using a towed camera sled (“TowCam”) or remotely operated vehicles (ROVs). The ROV coverage was good, but only covered 10 percent of routes surveyed. The TowCam

was inconsistent, and produced only vague images that give an idea of seafloor topography and bottom type. It occasionally caught fish or mega-fauna that remained in the field of view for a sufficient amount of time. The TowCam footage’s primary value was its indication of areas where sensitive coral habitat communities may be present, thus warranting further study.

The ROVs observed a large number of fish and mega-fauna. Among those most frequently observed by the ROV are sponges, anemone, coral, spider craps, shrimp, starfish, urchin, dogfish shark and butterfly fish. The waters around Hawaii also have a large number of endangered or threatened species protected by the Endangered Species Act. These include turtles, humpback whales, sperm whales, blue fin whales, sei whales, and monk seals. Further, large swaths of the ocean between Oahu, Molokai, Lanai and Maui are within the National Marine Whale Sanctuary, which falls under NOAA’s jurisdiction.

---

10 A detailed list of the fish and megafauna observed in the ROV videos is contained in the report.
The project will impact marine biological resources during construction and operations. The trenching required to bury the cable will bury and destroy such adjacent organisms as coral. Sediment plumes (i.e. sediment disturbed from the ground floor during construction) will affect benthic communities and particularly sensitive filter feeding organisms. These plumes will affect not only those organisms adjacent to construction activities, but could potentially affect other organisms at great distances depending on currents.

The report recommends avoidance of reef habitats that would be irreversibly damaged by laying cable. Further surveys should be taken in areas where there is the potential for sensitive habitats as determined from the ROV footage.

The electromagnetic field emitted by the cable will interfere with life functions of organisms – particularly marine mammals and turtles – when the organisms are within sensory range of the cable. Marine mammals’ orientation, homing, navigation, predation, social and reproductive behaviors may be impacted. However, based on a study conducted
on the effect of DC cables on bottlenose dolphin orientation, it is expected that marine mammals will correct their orientation once outside the cable's electromagnetic field. And, while the cable could have severe impacts on sea turtles at a critical life stage, such as adults and hatchlings traversing shallow waters at natal beaches, the likelihood of exposure is likely low assuming the cables are sited carefully.

The report recommends that observers be employed to watch for marine mammals and turtles during cable laying activities, and the development of a plan in the event that marine mammals are encountered. Sensitive deep-water coral habitats must be identified before construction so that they can be avoided. Locating such habitats will require further study with improved visual recording. Avoidance of sensitive habitats is the primary objective. Cable routes must also be analyzed to determine the composition of the sediment which will be disturbed during the cable laying process.

**Natural Hazards, Hazardous Materials and Munitions and Explosives of Concern**

While the cable will not make natural disasters more likely, natural hazards could damage the cable itself, thereby affecting the human environment due to electrical disruptions.

Natural hazards affecting the marine environment in the areas of analysis would be associated with damage to a potential undersea cable from tsunami, off-shore earthquakes, undersea landslides, or underwater volcanic activity.

The greatest potential natural hazard pertaining to the marine environment would be seismic events and associated tsunami. The undersea power cable system could be impacted by the shaking force, underwater landslides, or wave energy generated by these two types of events. Potential damage from natural disasters would depend on the location of the cables; the type of benthic and geological surface upon which cables are laid; terrestrial connection of cables via directional drilling; and cable design and engineering.

Hawaii’s flood dangers are primarily related to flash flooding of streams and flooding related to storm-generated coastal surges. Those potential landing areas most affected by flooding are those areas located in an official FEMA flood zone.

Tsunamis, which can affect all shorelines in Hawaii, are typically generated in the waters off South America, Japan, Alaska, and the west coast of the United States.

The Hawaiian Islands are seasonally affected by Pacific hurricanes and tropical storms from the late summer to early winter months when ocean waters around the state are at their warmest. These storms generally travel toward the islands from a southerly or southeasterly direction and can deposit large amounts of rain with high winds on all the islands. The storms generally exacerbate localized stream flooding and coastal storm surges. Landing area sites in tsunami evacuation zones or official FEMA flood zones would
be most impacted by these events, although areas outside these zones could be impacted based on severity of the event, elevation, shoreline topography, and near shore geology.

In Hawaii, most earthquakes are related to volcanic activity. Each year, thousands of earthquakes occur due to volcanic activity. Most of these events are so small as to be detectible by only the most sensitive of seismic instruments.

Because Oahu is an older Hawaiian Island, it is not considered particularly prone to major seismic activity. Generally, the risk and intensity of earthquakes increases moving east along the Hawaiian Island chain, toward younger islands. Violent earthquakes can occur anywhere in the state, along with associated liquefaction events on low-lying and fill areas.

Smaller landslides pose a continual concern in Hawaii. These landslides are activated by storms, earthquakes, volcanic eruption, and fires. Related to landslides, debris, and mud flows are rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground during heavy rains. While frequently the result of natural events, landslides also can be the result of land mismanagement or dam failure particularly in mountain, canyon, and coastal regions.

Wildfire occurs on all of the major Hawaiian Islands, with human activity as the primary cause. Because Hawaii’s native ecosystems are not adaptive to wildfires, wildfires can result in extinction of native species and increased coverage of nonnative, invasive species. Other results of wildfires include soil erosion, increased runoff, and decreased water quality. Wildfires can occur on all the islands. Generally, dry, windier leeward sides of islands are more prone to risk of wildfire.

Haleakala volcano on the island of Maui is considered dormant, since it last erupted sometime between 1500 and 1800, but it is not yet considered extinct. The islands of Oahu, Lanai, and Molokai do not have any active volcanoes. There are numerous active volcanoes on the Big Island, including Mauna Loa, Mauna Kea, and the offshore underwater volcano known as Loihi. These volcanoes are associated with seismic activity that can, in turn, affect the site study area. However, none of the landing site areas are located on islands with active volcanoes, so there would be no risk from lava flows.

When the exact locations of land-based facilities within the landing site areas are determined, it may be necessary to perform detailed investigations, including a site-specific Environmental Site Assessment in conformance with the American Society for Testing and Materials Method E 1527-05, which would provide for review of accessible public records and require site inspections to identify classes of land uses and/or hazardous materials that may be present at the project-specific locations and along possible cable alignments.
Since the early 1900s, the state has been home to military bases for all branches of the U.S. military. The military has disposed of munitions and explosives of concern (“MECs”) on land and in the surrounding waters. As noted in the summary of the SOEST report in Section 3(b)(ii)(3) herein, some of the routes originally proposed – specifically, those to the south of Oahu - intersect with a four-mile swath of disposed munitions.

AECOM recommended the following general criteria and measures that should be taken to minimize risks in the event of a natural disaster.

- Project locations shall be outside of FEMA flood zones, where possible and practicable.
- Projects located on Oahu shall be required to comply with Revised Ordinances of Honolulu Section 21-9.10 (“Flood hazard districts”).
- Projects located in Maui County shall be required to comply with Maui County Code, Title 19 Chapter 19.62 (“Flood hazard districts”).
- For any project seeking Federal Emergency Management Agency (“FEMA”) flood insurance, the project shall also be required to comply with provisions of FEMA’s National Flood Insurance Program (NFIP) administered by the City and County of Honolulu Department of Planning and Permitting or the Maui County Department of Planning and in conjunction with DLNR under provisions of Haw. Rev. Stat. Chapter 179.
- For military sites, future project development shall comply with location, siting, and construction requirements as outlined by the Department of Defense.
- Projects shall be located outside of designated tsunami inundation/evacuation zones where possible and practicable.
- Projects shall be designed to comply with seismic regulations applicable to the relevant zones of the Uniform Building Code and any other applicable county seismic regulations.
- Landing site areas shall be developed in areas with minimal slope and no known geological hazards.
- Projects located on Oahu shall comply with ROH Sections 14-14.2 and 18-4.1 (relating to grading). Maui County does not have ordinances that specifically address the siting.
- The project developer shall comply with all design, fire safety, and emergency response requirements of respective counties, the Department of Defense or military fire departments having jurisdiction over the specific landing site area.

---

11 Both the Revised Ordinances of Honolulu and the Maui County Code relate to the management of development in areas designated as flood hazard districts.
Upon completion of construction, developers shall plant native, fire-resistant vegetation; remove all dry grass, brush, and trees within at least 100 feet from buildings; and locate fuel tanks at least 30 feet from any structure.

Developer shall avoid placement of an undersea cable in or near marine areas of known geologic instability, including seismic faults.

Developer shall conduct an environmental assessment prior to obtaining property for the converter stations in order to assess the presence of any environmental contamination, hazardous substances, or MECs on the property.

Developer shall create a disposal and recycling plan to deal with construction and demolition waste.

Developer shall ensure that hazardous materials used during construction are handled and stored properly, and there are procedures in place to handle inadvertent spills.

Site construction and demolition shall be performed in accordance with a site-specific safety and health plan. The plan shall identify safe working conditions for construction areas. Safety measures shall include proper techniques for personal protective equipment, use of allowable tools, and mechanical measures as appropriate.

Developer shall avoid siting the cable across areas known to contain hazardous materials.

Developer shall require the contractor to repair site-specific mitigation measures to minimize the potential for accidental release of hazardous materials into the environment, including procedures for hazardous material storage, handling, and staging; spill prevention and response and waste disposal; and good housekeeping.

Although military munitions could be present on the seafloor throughout the Hawaiian Islands, of the most concern are areas of dense concentrations where it would be difficult for cable installers and maintenance workers to completely avoid the munitions. The main construction and mitigation measure for the MEC areas shall be avoidance. The SOEST report suggests that the greatest concentration of MEC is present off the south shore of Oahu.

**Noise and Vibration**

Elevated noise levels from project-related construction activities are inevitable, but are expected to be minor and short-term, i.e. limited to the construction phase. Noises generated from the construction equipment would need to comply with Hawaii Occupational Safety and Health Division regulations for temporary construction. Once the facility is operational, noise levels at the property lines would need to comply with HRS Chapter 342F, HAR Title 11 Chapter 46, and HAR Title 12 Chapter 200.1.
Potential noise impacts associated with undersea cables would occur during the construction phase and in connection with maintenance or repair. Noise may arise from operation of vessels or machinery during the cable-laying process, but the impacts would be temporary. If High Voltage Alternate Current (HVAC) cables are used as part of future developments, possible long-term vibration and noise emission from the cable would be taken into account. Potential impacts from HVAC cables on marine habitats and species are summarized above in the section entitled "Marine Biological Resources."

To minimize impacts, AECOM’s report recommends that the public be given timely notice of upcoming construction activities. Newer equipment should be used as much as possible to reduce noise (as compared to older equipment), and all equipment with internal combustible engines should be equipped with a properly maintained muffler. Construction equipment and the equipment of the facilities themselves should be operated according to manufacturer’s instructions and routinely maintained.

**Public Health and Safety**

Public health and safety may be impacted during the construction phase (from construction and material transportation-related accidents) and during operations. The presence of electrical generating equipment, cables and various oils create a potential for fire. The project may also generate electromagnetic fields. Numerous reviews of epidemiological and biological research studies have generally concluded that there is no scientific basis to support a finding of adverse human health effects from electromagnetic frequencies ("EMF") although others have found that there may be an association between EMF and certain diseases.

To minimize the potential adverse effects to public health, AECOM’s report recommends the development of a health and safety program during construction, operation, and decommissioning of a project. The program should identify all applicable federal and state occupational safety standards; establish safe work practices for each task; and establish fire safety evacuation procedures; and define safety performance standards. All Occupational Safety and Health Administration ("OSHA") laws and standards should be followed.

Electrical systems should be designed to meet all applicable safety standards (e.g., National Electrical Code and International Electrical Code). Moreover, the project should be planned to minimize electromagnetic interference (such as interference with radar, microwave, television, and radio transmissions) and comply with Federal Communications Commission regulations. Signal strength studies should be conducted when proposed locations have the potential to impact communications transmission – particularly where a converter station and transmission lines would travel on or near a military base.

To minimize potential impacts from EMF, the submarine cable should be designed with the proper electrical shielding and burial (as appropriate) in the ocean floor.
Public Services and Infrastructure
During construction and operation, there may be interruption of various public services, including electrical services, potable water supply, wastewater and solid waste disposal, and gas supply. In addition, the project may require police, fire and emergency medical response service, and thus detract from the availability of these services to respond to other calls.

To avoid and mitigate these impacts, the project developer should consult with government agencies (county, state and federal) in regard to safety and emergency supports. In addition, a public facilities assessment should be conducted before construction commences to determine the adequacy of police, fire control, hospital, and emergency medical response.

The developer should also consult with public and private utility entities to minimize and avoid conflicts with existing utility infrastructures.

Recreation
Popular recreational activities in the state include water-related activities (boating, kayaking, diving, surfing, swimming, and fishing), land-based activities (hiking, camping, hunting), and sports (baseball/softball, volleyball, soccer, football). Generally, impacts to these activities would be short-term and limited to the construction phase of the project.

To minimize impacts, it is recommended that there is adequate continuous access to significant natural resources in public ownership, and that public beaches be protected for public use and recreation.

SOEST
Between November 2009 and November 2010, the University of Hawaii School of Ocean and Earth Science and Technology (“SOEST”) prepared four technical reports. The reports discuss the results of ocean floor surveys conducted by SOEST for the purpose of ascertaining the feasibility of laying a power transmission cable on the ocean floor to transport renewable energy generated on Lanai and Molokai to Oahu.

SOEST’s studies uncovered certain physical obstacles along the proposed cable routes. In particular, SOEST identified the need to modify proposed routes in order to avoid an extensive disposed munitions field along one four-mile section of the route south of Oahu.
Video camera footage recorded by SOEST revealed a number of small aerial bombs, believed to be mustard gas bombs disposed of south of Oahu in 1945-46.\textsuperscript{12} SOEST was also tasked with identifying technically feasible routes given legal restrictions and the desires of major stakeholders, including HECO. Specifically, DBEDT asked SOEST to identify potential routes which do not enter federal waters of the Hawaiian Islands Humpback Whale National Marine Sanctuary.\textsuperscript{13} SOEST was further informed that HECO favored a south Oahu landing site near Honolulu Harbor and the Iwilei sub-station instead of Pearl Harbor.

SOEST identified a number of potential routes for the cable, including routes between: (i) Pearl Harbor/Honolulu Harbor and Lanai; (ii) Kaneohe to northwest Molokai; (iii) Northwest Molokai to Lanai; (iv) Oahu to Molokai and (v) Lanai to Maui.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{soest_routes.png}
\caption{Preferred (black) and alternate (dashed) cable routes, other routes surveyed (white dashed), on sunlit bathymetry (gray) and seafloor acoustic imagery (red = strong, green = weak). Pink = existing telecom cable, red dot = observed cable crossing, blue box = bottom fish refuge, red box/circle = dump areas, ruled area = humpback whale sanctuary}
\end{figure}

SOEST’s report exclusively addresses the physical feasibility of the interisland cable given the seafloor bathymetry and existence of physical obstacles (both manmade and natural).

\textsuperscript{12} The Hawaii Undersea Military Munitions Assessment Project assisted in identification of these obstacles. Additional information is available at \url{http://hummaproject.com/index.php} (last visited October 30, 2012).

\textsuperscript{13} Under the National Marine Sanctuaries Act, codified in 16 U.S.C. §§ 1431-1445, the Secretary of Commerce has the authority to designate certain marine areas designated as “sanctuaries.” It is unlawful for any person to “destroy, cause the loss of, or injure any sanctuary resource.” See 16 U.S.C. § 1436(a). However, the Secretary of Commerce may issue “special use permits” authorizing the conduct of specific activities in a national marine sanctuary if the Secretary determines such authorization is necessary “to establish conditions of access to and use of any sanctuary resource.” See 16 U.S.C. § 1441(c)(3). The Secretary of Commerce has delegated responsibility for overseeing the national marine sanctuaries program to the National Oceanic and Atmospheric Administration (“NOAA”). NOAA designated the Whale Sanctuary as National Marine Sanctuary on November 4, 1992. See 15 CFR § 922.180.
The acceptability of certain risks, such as the exposure of cable in shallower locations to damage from anchoring fishing and pleasure boats, would need to be further examined by DBEDT and the Cable Project developer. Issues of where the cable may be buried or covered, and at what cost, were left to be examined in greater detail in subsequent environmental analyses.

**Hawaii Deep Water Cable Study**

The 1989 Hawaii Deep Water Cable Study (“HDWCS”) assessed the feasibility of transmitting geothermal electricity via a submarine cable system from the Island of Hawaii to Oahu and Maui. The study identified the high-voltage, direct-current cables linking Norway and Denmark (the “Skagerrak” system) as representing then-state-of-the-art submarine cable technology. While the Skagerrak system traverses a distance of 78 miles at a maximum depth of 1,800 feet, interconnection of Hawaii and Oahu would require a submarine cable operating in depths of up to 6,300 feet and traversing 150 miles.

The HDWCS addressed the use of geothermal energy, rather than wind, and the feasibility of cable routes between Hawaii and Oahu rather than routes between Oahu and Molokai and Oahu and Lanai. Nevertheless, the study contains valuable information that can be used for the Cable Project.

**Case for Cable**

**Capacity to Deliver Energy**

The cable project originally investigated by DBEDT and the HECO companies, based on proposals submitted in response to Hawaiian Electric Company’s 2008 Request for Proposals under the Competitive Bidding Framework, was for 400 MW of intermittent generation to be produced by wind farms located on Lanai and/or Molokai and transmitted to Oahu via an undersea cable system. Oahu’s total electricity consumption in 2011 was approximately 10 terawatt hours. After taking capacity utilization factors into account, this would have had the potential to deliver roughly twenty percent of the island’s energy demands via renewable energy. Additionally, by connecting more than just Oahu to either Lanai or Molokai (or both), an inter-island cable would allow for the development of other renewable projects, including solar and geothermal projects.

---

Load Balancing Opportunities & Efficiencies

One of the primary problems with the original scope of limiting the project to solely a wind project is the variability of the wind. A major downturn in wind power generation or a peak in demand that is not met by wind power could have significant consequences for the energy grid, particularly for the outer islands. To respond to these fluctuations, HECO has partnered with Honeywell to implement automated demand response technology in a wind power-based pilot program.\(^{15}\) During the two-year pilot, HECO will connect with commercial and industrial customers to temporarily reduce the need for electricity — critical to maintaining grid reliability as Hawaii reduces fossil fuel dependence.

HECO will conduct a test of “fast demand response” technology, which will give HECO the ability to reduce demand within ten minutes of being notified of an imbalance between supply and demand. Consumers will receive an incentive to participate. In exchange for reducing their demand during a fast demand response event, the consumers will receive an additional per-kilowatt-hour incentive credit.

Fast demand response, managing reserves and generation regulation is discussed in the Smart Grid section of this HREGP report.

Economics

The consulting firm AECOM analyzed changes in regional economic output and employment which would result from the construction and operations/maintenance phases of the cable system. AECOM’s analysis was conducted using IMPLAN software.\(^{16}\)

The IMPLAN model utilizes existing economic conditions for the geographic area analyzed and provides an estimate of the direct, indirect, and induced impacts on the Hawaii economy from the cable system.

Using the IMPLAN model, AECOM determined that the project would have a temporary, positive economic impact on the State’s economy.

Construction Phase

Analytical Assumptions

Construction employment wages and salaries would provide additional income to the area, as would expenditures within the state for construction materials and services during the


two year construction period. Payroll for the work required on the project (including trenching and facility construction) would add approximately $8.3 million annually to payroll. Capital expenditures on construction materials and equipment would be approximately $22.8 million annually over a two-year period.

Project construction is expected to directly create an average of 139 annual full-time employees for 24 months. This direct employment will create both indirect and induced secondary employment in the region. Indirect employment is defined as employment that will be generated by the purchase of goods and services required by the project. Induced employment is defined as employment that will be generated by the purchase of goods and services by businesses that are indirectly supported by the cable system.

**Estimated Economic Impacts**

Based on the aforementioned employment, payroll, and capital expenditure assumptions, AECOM estimated that the total annual beneficial economic impacts from the two-year construction phase would be as follows (rounded values):

- Direct economic output: $24,800,000
- Indirect economic output: $5,400,000
- Induced economic output: $7,900,000
- Total economic impact: $38,100,000

The top 10 industries that would benefit the most are construction, rental housing, real estate establishments, architectural and engineering services, petroleum refineries, food service, physicians and other medical professionals, banks, wholesale trade businesses, and insurance carriers.

Also, using the assumptions above during the construction phase, the cable system’s estimated annual number of jobs created would be as follows:

- Direct (project) employment: 139.0
- Indirect employment: 35.7
- Induced employment: 63.2
- Total employment creation: 237.9

This additional employment would result from the cable system’s local construction expenditures as well as from spending by local construction workers. This indirect and induced employment is anticipated to be filled without immigration of new workers, and the increased employment would result in beneficial economic impacts during the construction phase.
Converter Station Operations and Maintenance

Analytical Assumptions
Staff needs for operations and maintenance of the converter stations is anticipated to be 34 fulltime employees. The 34 employees would include various technicians, skilled personnel, operators, and engineers. It is expected that all 34 employees would be hired locally.\(^{17}\)

Based on the employment estimate and established ratios of employment to payroll and capital expenditures present in the state of Hawaii, the annual expenditures of the project were assumed to be $16.8 million for materials, equipment, and supplies, and $3.7 million in payroll annually.

Estimated Economic Impacts
Based on the foregoing assumptions, the annual estimated economic impacts from the operation of the converter stations would be as follows (rounded values):

- Direct economic output: $16,800,000
- Indirect economic output: $600,000
- Induced economic output: $2,700,000
- Total economic impact: $20,100,000

Also, using the assumptions above, the ongoing operations and maintenance phase of the cable system would create the following estimated number of jobs:

Direct (project) employment: 33.6
- Indirect employment: 4.5
- Induced employment: 22.2
- Total employment creation: 60.2

This total employment is anticipated to be filled without substantial immigration of new workers, and the increased employment would result in beneficial economic impacts during the operations and maintenance phase.

\(^{17}\) The study does not address the impact of employing maintenance personnel, and assumes that upon installation, the cable will be relatively maintenance free, and personnel will be needed only in the event of unexpected damage to the cable.
Other Considerations

It is also important to note that the cable has the potential of reducing electricity cost fluctuations caused by changes in oil prices. Hawaii heavily depends on imported oil for electricity generation, and it follows that changes in oil prices affect the state’s electricity prices. Hawaii’s electricity prices per kilowatt-hour are currently about three times the national average. To the extent that an interisland undersea cable system facilitates the delivery of power not linked to the price of oil and increases the overall efficiency of the energy system, energy costs and economic dislocations caused by oil price volatility would be reduced.

Energy Security

Energy security generally refers to the uninterrupted availability of energy resources at an affordable price.\(^{18}\) Due to Hawaii’s extreme reliance on imported petroleum, the state’s energy security is extremely low. Residents are extremely vulnerable to energy price spikes and energy shortages.

Hawaii has the nation’s highest energy costs. This high price burden is matched by the equally problematic lack of fuel security inherent in such overwhelming dependence upon outside sources.

Hawaii is moving to enhance its energy security through the Hawaii Clean Energy Initiative (“HCEI”). HCEI is essentially a two-pronged approach. It aims to increase energy efficiency and conservation, while at the same time increasing the use of locally available, renewable energy resources. The ultimate goal of the initiative is to meet 70% of Hawaii’s energy needs through efficiency and energy resources by the year 2030. A large part of meeting this goal is implementation of the undersea cable project. If a 600 MW cable were utilized at a 60% capacity factor, it would deliver enough electricity to satisfy approximately 30% of Hawaii’s annual electricity demand. DBEDT’s State Energy Office leads the State government’s effort to ensure a robust, secure, and reliable energy infrastructure in the contemporary energy environment. As the sector specific agency for energy, DBEDT works closely with State Civil Defense and dozens of government and industry emergency management and security partners to lower vulnerabilities, deter threats, minimize the consequences of energy disruptions, and enhance recovery of Hawaii’s energy systems.

Environmental Trade-offs (Alignment with HCEI)

Emission Reductions

The project is expected to have a beneficial impact on climate change by decreasing fossil fuel consumption. The burning of fossil fuels results in the emission of greenhouse gasses -

primarily carbon dioxide, methane, and nitrous oxide. All of these greenhouse gasses contribute to climate change. Renewable electricity generated by wind, solar, geothermal and other renewable resources on the other hand, substantially reduces the creation of greenhouse gasses relative to that of burning fossil fuels. Replacing fossil fuel use with such energy would result in the reduction of greenhouse gas emissions into the atmosphere, and would be associated with a concurrent reduction in climate change impacts.

Reduced Dependence on Oil
As detailed in other sections, Hawaii is extremely dependent on imported petroleum liquids. In fact, it is the most petroleum-dependent state in the nation. Because of this, state energy prices are extremely susceptible to fluctuations in energy prices. The state is also vulnerable to energy shortages in the event that there is a disruption to imports.

A major goal of the project is to reduce Hawaii’s dependence on oil, and its accompanying vulnerabilities, by migrating toward renewable energy sources such as wind, solar, and geothermal energy. The use of renewable, locally available energy sources will stabilize Hawaii’s energy prices and will guard against energy shortages resulting from oil shortages.

Net Energy Savings
Hawaii’s renewable energy portfolio standard (Haw. Rev. Stat. §269-91 et seq.) requires that the State achieves 40% renewable energy generation by 2030. Until January 1, 2015, “renewable electrical energy” includes electrical energy savings brought about by the use of displacement or off-set technologies, such as solar water heating systems or the use of energy efficiency technologies. While the undersea cable project will greatly contribute to reaching the renewable portfolio standards mandated by Haw. Rev. Stat. Chapter 269, other avenues must be pursued to fully reach these standards.

In January 2008, the U.S. Department of Energy (“DOE”) and the State of Hawaii signed a Memorandum of Understanding (“MOU”) establishing the Hawaii Clean Energy Initiative. This agreement established an aggressive goal to help Hawaii greatly increase its renewable and clean energy production capabilities, and to transition exclusively to renewable energy use on the smaller islands. Although the MOU is not legally binding, it has the potential to help reduce oil consumption in Hawaii by 72% if implementation is successful.19

---

19 The text of the Memorandum of Understanding between the State of Hawaii and the U.S. Department of Energy is available on the DOE’s Database of State Incentives for Renewables & Efficiency Website, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=HI06R&re=0&ee=0 (last visited December 27, 2012).
Construction Damage
As set forth in the summary of AECOM’s report, any construction damages resulting from the project are expected to be short-term and limited to the actual construction phase. Once construction is completed, it is expected that damages caused by ongoing operations and maintenance will be minimal. Efforts will be made to select less sensitive sites and take all available steps to mitigate the consequences of infrastructure construction (as recommended by AECOM) so as to head off damages at the outset to the extent possible.

Description of Cable
Background on Cables Currently in Operation (State of Commercialization)

There are currently several undersea cables under construction and in operation throughout the world. The following is a list of cables in operation.

Table 1: Underwater Cables in Current Operation

<table>
<thead>
<tr>
<th>Name</th>
<th>Connecting Locations</th>
<th>Body of Water</th>
<th>Length of Cable (Submarine portion)</th>
<th>MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baltic Cable</td>
<td>Germany and Sweden</td>
<td>Baltic Sea</td>
<td>160 miles</td>
<td>600</td>
</tr>
<tr>
<td>Basslink</td>
<td>Australia and Tasmania</td>
<td>Bass Strait</td>
<td>230 miles</td>
<td>500</td>
</tr>
<tr>
<td>Britned</td>
<td>Netherlands and Great Britain</td>
<td>North Sea</td>
<td>160 miles</td>
<td>1,000</td>
</tr>
<tr>
<td>Cross-Skagerrak</td>
<td>Denmark and Norway</td>
<td>Skagerrak Strait</td>
<td>79 miles</td>
<td>1,050</td>
</tr>
<tr>
<td>Cross Sound Cable</td>
<td>New York (Long Island) and Connecticut</td>
<td>Long Island Sound</td>
<td>25 miles</td>
<td>330</td>
</tr>
<tr>
<td>Estlink</td>
<td>Estonia and Finland</td>
<td>Gulf of Finland</td>
<td>65 miles</td>
<td>350</td>
</tr>
<tr>
<td>Fenno-Skan</td>
<td>Finland and Sweden</td>
<td>Gulf of Bothnia</td>
<td>145 miles</td>
<td>550</td>
</tr>
<tr>
<td>HBDC Cross-Channel</td>
<td>France and England</td>
<td>English Channel</td>
<td>45 miles</td>
<td>2,000 (two bipoles)</td>
</tr>
<tr>
<td>HDVC Gotland</td>
<td>Sweden (mainland and island of Gotland)</td>
<td>Baltic Sea</td>
<td>58 miles</td>
<td>130</td>
</tr>
<tr>
<td>Name</td>
<td>Connecting Locations</td>
<td>Body of Water</td>
<td>Length of Cable (Submarine portion)</td>
<td>MW</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------------------------------</td>
<td>---------------------</td>
<td>-------------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>HDVC Inter-Island</td>
<td>New Zealand (North and South Islands)</td>
<td>Cook Strait</td>
<td>25 miles</td>
<td>700</td>
</tr>
<tr>
<td>HDVC Italy-Corsica-Sardinia</td>
<td>Sardinia, mainland Italy, and Corsica</td>
<td>Mediterranean Sea</td>
<td>239 miles</td>
<td>300</td>
</tr>
<tr>
<td>HVDC Italy-Greece</td>
<td>Italy and Greece</td>
<td>Ionian Sea</td>
<td>194 miles</td>
<td>500</td>
</tr>
<tr>
<td>HVDC Leyte-Luzon</td>
<td>Philippines (island of Leyte and mainland)</td>
<td>Pacific Ocean</td>
<td>280 miles</td>
<td>440</td>
</tr>
<tr>
<td>HVDC Moyle</td>
<td>Scotland and Ireland</td>
<td>North Channel</td>
<td>40 miles</td>
<td>500</td>
</tr>
<tr>
<td>HVDC Vancouver Island</td>
<td>Canada (Vancouver Island and mainland)</td>
<td>Strait of Georgia</td>
<td>21 miles</td>
<td>370</td>
</tr>
<tr>
<td>Kii Channel HVDC System</td>
<td>Japan (Honshu and Shikoku)</td>
<td>Kii Channel</td>
<td>31 miles</td>
<td>1,400</td>
</tr>
<tr>
<td>Kontek</td>
<td>Germany and Denmark</td>
<td>Baltic Sea</td>
<td>106 miles</td>
<td>600</td>
</tr>
<tr>
<td>Konti-Skan</td>
<td>Sweden and Denmark</td>
<td>Baltic Sea</td>
<td>93 miles</td>
<td>300</td>
</tr>
<tr>
<td>Neptune Cable</td>
<td>New Jersey and New York (Long Island)</td>
<td>Atlantic Ocean</td>
<td>64 miles</td>
<td>660</td>
</tr>
<tr>
<td>NorNed</td>
<td>Netherlands and Norway</td>
<td>North Sea</td>
<td>360 miles</td>
<td>700</td>
</tr>
<tr>
<td>SwePol</td>
<td>Poland and Sweden</td>
<td>Baltic Sea</td>
<td>158 miles</td>
<td>600</td>
</tr>
<tr>
<td>Trans Bay Cable</td>
<td>United States (Pittsburgh, CA and San Francisco, CA)</td>
<td>San Francisco Bay</td>
<td>53 miles</td>
<td>660</td>
</tr>
</tbody>
</table>

**Sizing and Capacity**

The original proposed project was planned to consist of an undersea cable connecting the site of the proposed 400 MW wind farms (to be located on Moloka‘i, Lana‘i or both) with HECO’s integrated grid on Oahu. Upon completion, this project would have had the capacity to deliver approximately 14% of Hawaii’s overall energy needs.\(^{20}\) However, the opportunity to link the islands, including Maui could allow for greater

---

\(^{20}\) See n. 24.
production. Specifically, the High-voltage, Direct Current (HVDC) cables that the industry has preferred for cabling over the distances required are capable of transmitting great amounts of electricity. One of the most recent HVDC cables proposed in Brazil will connect Porto Velho to Sao Paulo. The line will be in excess of 1600 miles long and consist of two bipoles of ±600 kV, 3150 MW each. The current longest cable in existence is a ±800 kV, 6400 MW link connecting the Xiangjiaba Dam to Shanghai, in the People’s Republic of China, which is 1287 miles long. The distance between Honolulu and the Big Island is approximately 165 miles. Thus, the current state of the technology is such that, subject to finding sufficient renewable resources on the neighbor islands, the majority of Oahu’s energy consumption could be from renewable resources, which would greatly increase Hawaii’s energy security.

Routing

As stated in the summary of SOEST’s technical study, a number of potential routes have been mapped for the cable, including routes between: (i) Pearl Harbor/Honolulu Harbor and Lanai; (ii) Kaneohe to northwest Molokai; (iii) Northwest Molokai to Lanai; (iv) Oahu to Molokai and (v) Lanai to Maui.

SOEST used a prescreening approach to define potential suitable cable corridors, and considered bottom type, hazards, slope, and geologic features before routes were defined and mapping activities commenced.

The preferred route for the cable is identified in a map prepared by SOEST.21 This route was deemed feasible by SOEST in that no major physical obstacles exist and the route does not enter federal waters of the Hawaiian Islands Humpback Whale National Marine Sanctuary. As stated in the AECOM report, additional studies will be needed (and additional ROV footage shot) before the final route is confirmed.

Financial Structure

The project is expected to cost between $750 million and $1 billion. The state and HECO elected to put the project out to bid for a private developer to both provide expertise in the development of cables as well as to participate in shouldering the risk. Finding a developer to finance the cable would transfer the development risk prior to the commercial operation of the cable from the State, HECO, and rate-payers by having the selected developer bear such risk. The obvious tradeoff is that the developer will price the project assuming the bearing of such risk, which would necessarily result in increased pricing.

While the project could entail significant risks for a developer, it has attracted the interest of major companies that specialize in undersea cable projects. Executives from two prominent firms have indicated an interest in responding to a request for proposals.

21 See Section **, infra at p. **.
On September 28, 2012, HECO drafted a revised RFP for the delivery of renewable energy to Oahu.

The current financial structure for the project is not definite inasmuch as the structure of the project itself will not be solidified until bids are submitted in response to HECO’s RFP. The September, 2012 draft RFP contemplates four types of responsive bids:

1. An “On-Oahu Generator Bid”, which is a bid for a renewable energy generation located on the island of Oahu, or within three (3) nautical miles from the coast line offshore of Oahu that will connect directly to the HECO system;

2. An “Off-Oahu Generator Bid”, which is a bid for a renewable energy generation resource not located on Oahu but could reasonably reach the island of Oahu via an inter-island transmission cable. The inter-island transmission cable would not be included in this bid.

3. An “Undersea Cable System Bid”, which is a bid by an undersea cable system developer to build a stand-alone inter-island transmission cable system to connect energy produced by one or more off-Oahu generators to the HECO system; and

4. A “Combined Resource Bid”, which is a Bid for an Off-Oahu generator combined with an inter-island transmission cable and associated facilities from the island on which such resource is located to the HECO system.

Agreement Terms

If HECO selects an on-Oahu renewable energy generation bid, the selected renewable energy generator(s) will provide energy to HECO pursuant to a power purchase agreement ("PPA"). The terms of the PPA will be negotiated between HHECO and the Bidder, and will then be subject to PUC approval. The form PPA (Addendum D to the RFP) sets forth various construction milestones and energy output requirements for a renewable energy generator over a twenty-year term. At the end of the term, HECO shall have the right to purchase the facility.

Clearly, HECO will not consider off-Oahu generator bids without a bid for undersea cable capacity from the same island. If the renewable energy is being generated off Oahu, additional terms (contained in Appendix E to the RFP) will be added to the PPA to account for coordination with the undersea cable developer. HECO will also enter into a Transmission Development and Control Agreement (“TDCA”) (Addendum G to the RFP) with an undersea cable developer. The terms generally provide for project development

---

22 See note 26.
milestones and specifications of the cable. The TDCA provides for the transfer of operational control of the cable to HECO upon achieving preliminary commercial operations and successful completion of control system acceptance tests. There are also stringent financing requirements, including prohibiting the developer from using the agreement or any portion of the project to secure project debt without the prior consent of an independent project engineer to be selected by the PUC.

Finally, the successful bidder of a combined resource will negotiate a PPA based on the model PPA (Appendix D to the RFP) as modified by terms and conditions identified in the term sheet specific to off-Oahu renewable energy generation (Appendix F).

**Risk**
HECO will evaluate bids based, in part, on the level of “project on project risk,” or “the risk involved when mutually dependent projects, whose risk of completion, and therefore, financing, are dependent on each other, such as in the case of a high-voltage electric transmission cable system intended to connect a renewable energy generation facility to an electric utility system where the uncertainty as to whether the renewable energy generation facility can be financed or built results in increased risk for the high-voltage electric transmission cable system project because it is not viable without a source of energy to transmit, and vice versa.”

The RFP includes a number of measures to help mitigate project-on-project financing risk for HECO and its consumers. Specifically, HECO consumers will not be responsible for paying for undersea cable capacity provided by the certified cable company ("CCC") unless and until energy is available to be transmitted through the cable. Therefore, the CCC will be expected to assume all responsibility, including financial responsibility, for the system until the date of preliminary commercial operations.

Further, in order to ensure that all components proceed in a like fashion and in order to mitigate project-on-project financing risk, critical permits will have to be obtained before any one component project is allowed to proceed to the next stage of development. Once the critical permits have been obtained, the CCC and each off-Oahu generator will be financially responsible for any delay in its specific project completion date so that HECO and its customers do not have to pay for project capacity before electric energy is available to be transmitted.

Bids will be evaluated, in part, based on the specific measures proposed to mitigate risk. It is expected that the developers of the various projects may need to contract with each other regarding common ownership arrangements, the rights to proceed, liquidated damages, termination rights, step-in rights and other related rights and obligations in order to reduce and appropriately allocate the project-on-project financing risk inherent in these projects.
**Risks and Uncertainties**

Risks and uncertainties are inherent in such a large-scale project. As set forth above, there is financial risk involved in the project, including project-on-project financing risk.

There are also uncertainties as to whether developers will be willing to accept the risk inherent in the financing structure required under the HECO RFP. There are technical uncertainties, including the particular route the cable will take (if an off-Oahu generator bid is selected) and whether the route is feasible. There is also uncertainty as to how the projects will be received by the public. Currently, the majority of Hawaii residents support the project, although a good portion remains undecided.

Most of these risks and uncertainties, however, can be minimized through careful planning, continuous cooperation between the developer, government and private entities, and maintaining transparency across the board. Moreover, the risks and uncertainties that the state faces should it not transition to renewable energy are far greater. This includes continued vulnerability to fluctuating oil prices and continued dependence on imported energy, which renders the state extremely energy insecure.

As discussed herein, HECO developed an initial draft RFP for the undersea cable in October, 2011. Due to the number of comments received, HECO issued revised RFP documents on September 28, 2012. The next step will be the filing of proposed final RFP documents with the PUC. HECO had originally intended the submission by the 4th quarter of 2012, but that has not occurred. By its own terms, the HECO RFP will not result in the submission of a proposed agreement between HECO and the selected cable developer until approximately two and one half years after the issuance of the Final RFP. Thus, the earliest to reasonably expect commission approval of the agreement would be in mid-2015. At that point, the necessary permitting process would need to occur, which would be followed by construction to be completed with a project completion date. Because HECO has not yet received the proposals, there is no certain project completion date (particularly because the specific projects will have their own timetables). However, due to the nature of the cost of the cable and the expense of securing its manufacture, it is assumed that developers will want to ensure their ability to obtain all discretionary permits prior to incurring that obligation. As the permitting process will likely take several years, a conservative estimate would have the construction of the cable system completed within a decade. It should be noted that there are many potential barriers which could delay such a timetable, but cautious planning will help to mitigate such obstacles.