# HAWAI‘I CLEAN ENERGY

## FINAL

## PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

## SUMMARY

**U.S. DEPARTMENT OF ENERGY**

Office of Electricity Delivery and Energy Reliability
Office of Energy Efficiency and Renewable Energy

(DOE/EIS-0459)

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# COVER SHEET

**TITLE:** Hawai‘i Clean Energy Final Programmatic Environmental Impact Statement (Final PEIS)

**RESPONSIBLE FEDERAL AGENCY:** U.S. Department of Energy (DOE), Offices of Electricity Delivery and Energy Reliability (OE) and Energy Efficiency and Renewable Energy (EERE)

**COOPERATING AGENCIES:** State of Hawai‘i (Department of Business, Economic Development, and Tourism), U.S. Environmental Protection Agency, Bureau of Ocean Energy Management, National Park Service, Natural Resources Conservation Service, U.S. Marine Corps, U.S. Navy, and Federal Aviation Administration

**LOCATION:** State of Hawai‘i (Islands of O‘ahu, Hawai‘i, Kaua‘i, Lāna‘i, Maui, and Molokai)

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**ABSTRACT:** DOE decided to prepare this PEIS, which is not required under NEPA, to evaluate DOE's proposed action to develop guidance that can be used to support the State of Hawai‘i in achieving the Hawai‘i Clean Energy Initiative (HCEI) goal of meeting 70 percent of the State’s energy needs by 2030 through clean energy (the preferred alternative). For the PEIS, DOE and the State of Hawai‘i grouped 31 clean energy technologies and activities into five categories: (1) Energy Efficiency, (2) Distributed Renewable Energy Technologies, (3) Utility-Scale Renewable Energy Technologies, (4) Alternative Transportation Fuels and Modes, and (5) Electrical Transmission and Distribution. For each activity or technology, the PEIS identifies potential impacts to 17 environmental resource areas and potential best management practices that could be used to minimize or prevent those potential environmental impacts. The PEIS is available from the Hawai‘i Clean Energy PEIS and DOE NEPA websites: http://hawaiicleanenergypeis.com and http://energy.gov/nepa/nepa-documents.

**PUBLIC COMMENTS:** The Final PEIS considers comments submitted during the 90-day public comment period on the Draft PEIS and from eight public hearings held on six islands in Hawai‘i between May 12 and 22, 2014. A Comment-Response Document, which includes all comments received on the Draft PEIS and DOE’s responses to those comments, is included as Chapter 9 of the Final PEIS. Written and oral comments were given equal weight, and all comments submitted after the comment period closed were considered. The Final PEIS contains revisions and new information based in part on comments received on the Draft PEIS. Vertical bars in the margins marking changed text indicate the locations of these revisions and new information. Deletions are not indicated.

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# ACRONYMS

| | |
|---|---|
| BOEM | U.S. Bureau of Ocean Energy Management |
| CEQ | Council on Environmental Quality |
| CFR | *Code of Federal Regulations* |
| DBEDT | Hawai‘i Department of Business, Economic Development and Tourism |
| DoD | U.S. Department of Defense |
| DOE | U.S. Department of Energy |
| EPA | U.S. Environmental Protection Agency |
| EPAct 2005 | *Energy Policy Act of 2005* |
| FR | *Federal Register* |
| HCEI | Hawai‘i Clean Energy Initiative |
| HIREP | Hawai‘i Interisland Renewable Energy Program |
| MOU | Memorandum of Understanding |
| NEPA | *National Environmental Policy Act of 1969* |
| NOI | Notice of Intent |
| NPS | U.S. National Park Service |
| NRCS | U.S. Natural Resources Conservation Service |
| PEIS | Programmatic Environmental Impact Statement |
| PV | photovoltaic |
| RPS | Renewable Portfolio Standard |
| U.S.C. | *United States Code* |

# S.1 Introduction

The *Hawaiʻi Clean Energy Programmatic Environmental Impact Statement* (PEIS) analyzes the potential environmental impacts, and best management practices that could minimize or prevent those potential environmental impacts, associated with 31 clean energy technologies and activities grouped into five categories: (1) Energy Efficiency, (2) Distributed Renewable Energy Technologies, (3) Utility-Scale Renewable Energy Technologies, (4) Alternative Transportation Fuels and Modes, and (5) Electrical Transmission and Distribution. The information in the PEIS could help DOE, the public, other Federal and State agencies, Native Hawaiian and other organizations, and future energy developers better understand and plan for greater use of renewable energy and energy efficiency in Hawaiʻi.

With about 85 percent of its energy derived from imported petroleum and petroleum products, the State of Hawaiʻi remains the most oil-dependent State in the Nation. Roughly equal amounts of petroleum are used for electricity generation, ground transportation, and commercial aviation (about 28 percent each), with the rest used for marine transport, military, and other uses. Unlike other states, Hawaiʻi relies heavily on imported oil to meet its electricity generation needs. Whereas less than 1 percent of electricity on the U.S. mainland is generated using oil, in Hawaiʻi, the figure is 74 percent. Furthermore, electricity prices in the State are three times higher than the United States national average. Section 355 of the Energy Policy Act of 2005 (EPAct 2005) directs the U.S. Department of Energy (DOE) to assess the economic implications of Hawaiʻi's dependence on imported oil as the principal source of energy and to explore the technical and economic feasibility of increasing the contribution of renewable energy resources for both electricity generation and fuel for various modes of transportation.

In furtherance of the provisions of Section 355 of EPAct 2005, DOE and the State of Hawaiʻi entered into a Memorandum of Understanding (MOU) in January 2008[1]. This MOU established a long-term partnership known as the Hawaiʻi Clean Energy Initiative (HCEI) to transform the way in which energy efficiency and renewable energy resources are planned and used in the State. When it was established, HCEI set a goal of meeting 70 percent of Hawaiʻi's energy needs by 2030 through clean energy, which refers to a combination of 40 percent from renewable energy generation and 30 percent from energy efficiency and conservation measures. In addition to State-mandated renewable energy and energy efficiency goals, the HCEI set a goal to reduce oil used for ground transportation by 70 percent by 2030, and a goal to meet as much of in-State demand for transportation fuels with renewables as feasible by 2030[2]. In support of HCEI goals, the Hawaiʻi State Legislature passed and the Governor signed into law House Bill (HB) 1464 in 2009, establishing the Renewable Portfolio Standard (RPS) and Energy Efficiency Portfolio Standard in the State of Hawaiʻi. In the 2015 Legislative Session, the Hawaiʻi State Legislature amended the State's RPS by passing HB 623, which increases the RPS to 30 percent by December 31, 2020; 70 percent by December 31, 2040, and 100 percent by December 31, 2045. Governor David Ige signed the nation's first 100 percent RPS into law on June 8, 2015; Act 97 (Session Laws of Hawaii, 2015).

[1] In September 2014, DOE and the State of Hawaiʻi signed another MOU to reaffirm their commitment to the HCEI (http://dbedt.hawaii.gov/blog/hawaii-and-u-s-department-of-energy-reaffirm-commitment-to-clean-energy-initiative/).

[2] Unlike the electricity generation sector, the transportation sector does not currently have statute-mandated goals. With this in mind, the State of Hawaiʻi is reestablishing goals and timelines to reduce petroleum-based fuels for transportation as a priority of the next phase of the HCEI. The Hawaiʻi State Energy Office completed a series of stakeholder consultations in June 2015, culminating with a final report offering a set of actionable tactics (see http://www.hawaiicleanenergyinitiative.org/). The Hawaiʻi State Energy Office intends to re-engage stakeholders to create a new energy-in-transportation road map, using the new report as a guide.

## S.2 Purpose and Need

The purpose and need for DOE action is based on the 2008 MOU (reaffirmed in the 2014 MOU) with the State of Hawai‘i that established the long-term HCEI partnership. Consistent with this MOU, DOE’s purpose and need is to support the State of Hawai‘i in its efforts to meet 70 percent of the State’s energy needs by 2030 through clean energy.

DOE’s primary purpose in preparing this PEIS, which is not required under NEPA, is to provide information to the public, Federal and State agencies, Native Hawaiian and other organizations, and future energy developers on the potential environmental impacts of a wide range of energy efficiency activities and renewable energy technologies that could be used to support the HCEI. This environmental information could be used by decision-makers, developers, and regulators in determining the best activities and technologies to meet future energy needs. The public could use this PEIS to better understand the types of potential impacts associated with the various technologies and activities.

The State of Hawai‘i’s intent regarding the Clean Energy PEIS is for the Federal, State, and county governments, the general public, and private developers to use the PEIS as a reference document when project-specific environmental impact statements (EISs) are prepared. The PEIS can support the environmental review of future clean energy initiatives in Hawai‘i by identifying common impacts from a variety of clean energy technologies, local resources that could be potentially impacted, local entities that should be consulted, regulatory processes in place, and available best management practices to minimize foreseen environmental impacts. The State of Hawai‘i acknowledges that the PEIS does not serve to recommend or prioritize any specific clean energy technology or policy.

DOE prepared this PEIS pursuant to the *National Environmental Policy Act of 1969* (NEPA), as implemented by the Council on Environmental Quality (CEQ) NEPA regulations (40 CFR Parts 1500 through 1508) and DOE NEPA implementing procedures (10 CFR Part 1021).

## S.3 Proposed Action

DOE’s proposed action is to develop guidance that can be used in making decisions to support the State of Hawai‘i in achieving the goal established in the HCEI to meet 70 percent of the State’s energy needs by 2030 through energy efficiency activities and renewable energy technologies.

Most clean energy projects have the potential to cause environmental impacts, especially if not implemented properly. However, careful adherence to Federal, State, and county laws, regulations, and permitting requirements; implementation of well-planned best management practices and mitigation measures; along with early consideration of local community concerns about the projects could alleviate or mitigate many of the potential environmental impacts.

Early consideration of such guidance, especially in project planning and development, could substantially streamline the project-specific environmental review, permitting processes, and community interactions, as well as lessen the potential for controversy over specific projects. DOE application of this guidance would be limited to those actions where DOE has authority for a Federal decision-making role; however, the information in this PEIS and in any forthcoming guidance could be potentially useful for any proposed project whether Federal, State, or private.

For this PEIS, DOE and the State of Hawai‘i identified 31 clean energy technologies and activities associated with potential future actions and grouped them into five clean energy categories. These are listed in Table S-1 and briefly described below. Activities and technologies were selected for clean energy categories based on their ability to make a timely contribution to the reduction of Hawai‘i’s reliance on fossil fuels and their stage of technical development, which makes the technology more likely to advance to the implementation or commercialization stage. Four of these technologies or activities are only described in Chapter 2 and not carried forward for detailed impacts analyses. The reasoning for this treatment is provided in the descriptions below.

This PEIS analyzes each of these technologies and activities at a programmatic level for the islands of Kaua‘i, O‘ahu, Molokai, Lāna‘i, Maui, and Hawai‘i. Potential impacts are analyzed on an island-by-island basis when feasible. DOE is not proposing to develop any specific project, activity, or technology at this time and, therefore, cannot and does not analyze impacts of specific projects.

In the absence of specific, proposed projects, DOE defined “representative projects” for each activity and technology to allow the PEIS to evaluate and present the typical impacts (beneficial and adverse) associated with the respective activity or technology at the scale of a hypothetical project. The representative projects for each activity and technology characterize projects that could be implemented in Hawai‘i by 2030 based on realistic capacity factors and feasibility. The representative projects are hypothetical and not intended to represent any real or proposed project and are provided for analytical purposes only.

**Table S-1. Clean Energy Categories and Associated Technologies or Activities**

| Clean Energy Category | Technology or Activity |
|---|---|
| Energy Efficiency | Energy Efficient Buildings |
| | Energy Conservation |
| | Ground Source Heat Pumps |
| | Initiatives and Programs |
| | Sea Water Air Conditioning |
| | Solar Water Heating |
| Distributed Renewables | Biomass |
| | Hydroelectric |
| | Hydrogen Fuel Cells |
| | Photovoltaic |
| | Wind |
| Utility-Scale Renewables | Biomass |
| | Geothermal |
| | Hydroelectric |
| | Municipal Solid Waste |
| | Marine Hydrokinetic Energy |
| | Ocean Thermal Energy Conversion |
| | Photovoltaic |
| | Solar Thermal |
| | Wind (Land-based) |
| | Wind (Offshore) |
| Alternative Transportation Fuels and Modes | Biofuels |
| | Electric Vehicles |
| | Hybrid Electric Vehicles |
| | Hydrogen |
| | Compressed and Liquefied Natural Gas and Liquefied Petroleum Gas |
| | Multi-Modal Transportation |
| Electrical Transmission and Distribution | On-Island Transmission |
| | Undersea Cables |
| | Smart Grid |
| | Energy Storage |

## Clean Energy Categories

### *Energy Efficiency*

Energy efficiency refers to reducing the energy used for a given purpose or service while maintaining the same results; for example, replacing an incandescent light bulb with a different type of lighting technology that uses less energy to produce the same amount of light. Energy efficient technologies reduce the need for energy while energy efficient activities require less energy or save energy. This PEIS addresses the following energy efficient technologies and activities:

***Energy Efficient Buildings***

Residential and commercial buildings use energy for many purposes such as cooling, lighting, water heating, and use of appliances and electronics. Today's buildings consume more energy than any other sector of the U.S. economy including the transportation industry. In an effort to decrease energy consumption, energy efficiency measures are incorporated into building construction and retrofits.

***Energy Conservation***

Energy conservation is the act of reducing or going without a service or task in order to save energy; for example, turning off a light. Using less energy generally has positive potential environmental consequences. There would be no adverse environmental impacts associated with energy conservation; therefore, this activity is not carried forward for detailed impacts analyses.

***Ground Source Heat Pumps***

Underground temperatures are less variable than air temperatures. A ground source heat pump is an electrical-powered heating and cooling system that takes advantage of the relatively constant ground or groundwater temperature to transfer energy for space heating/cooling and water heating. Because of the moderate climate, ground source heat pumps are not currently deployed widely in Hawai‘i and would be unlikely by 2030; therefore, this technology is not carried forward for detailed impacts analyses. Heat pump water heaters are an efficient heat transfer method used in construction. The PEIS addresses heat pump water heaters under *Energy Efficient Buildings*.

***Initiatives and Programs***

Utility- and government-sponsored clean energy initiatives and programs can help to make renewable energy, energy efficiency, and conservation practices attractive to consumers and communities. There are several ways to provide incentives to individuals, businesses, and communities that could result in a reduced overall demand for imported fossil fuels. These range from education and training to financial incentives for using energy efficient appliances and equipment at home and in commercial operations. The State of Hawai‘i, island utilities, counties, and the Federal Government have employed several energy efficiency and renewable energy initiatives and programs for specific State-, island-, and community-level projects. There would be no adverse environmental impacts associated with initiatives and programs; therefore, this activity is not carried forward for detailed impacts analyses.

***Sea Water Air Conditioning***

Sea water air conditioning, also known as deep water cooling, uses the temperature differences (gradients) between deep and surface water to chill water for individual buildings or for use in larger (district) cooling air conditioning systems. This energy efficiency technology replaces the conventional electric chiller component of a cooling system with a deep, cold sea water cooling station or heat exchanger to cool a closed-loop air conditioning system that is significantly less energy-intensive.

***Solar Water Heating***

Solar water heating is a technology that uses the sun to heat water. It is generally considered for use in residential rooftop applications. This PEIS focuses on its use in single-family homes; however, it is scalable to multi-family residences. Solar water heating technology has the potential to reduce household energy consumption by up to 40 percent.

## Distributed Renewables

Distributed renewables refer to the use of renewable energy resources for an electricity generator that is located close to the end user or even onsite. The generating capacity of a distributed generation source can range from generation at a single residence to larger installations for commercial or multi-unit housing applications. This PEIS addresses the following distributed renewable technologies and activities:

### *Biomass*

Biomass energy encompasses multiple energy production technologies that use organic matter from trees, agricultural crops, and animal waste as well as biogenic material in urban waste streams to produce a variety of potential energy end products. Biomass energy to produce electricity and heat is discussed under both distributed renewable and utility-scale renewable energy. Biomass energy used for transportation fuels is discussed under Alternative Transportation Fuels and Modes.

### *Hydroelectric*

Hydroelectric power, or hydropower, utilizes the energy in flowing water to spin a turbine attached to a generator to produce electricity. Hydropower plants require a water source in a geographic area generally characterized by uneven terrain such as hills or mountains to have sufficient power-generation potential. There are three common types of hydropower plant designs: impoundment, diversion, and pumped storage hydropower (the latter is discussed in the context of Energy Storage technology in the clean energy category of Electrical Transmission and Distribution).

### *Hydrogen Fuel Cells*

A fuel cell is a device that converts the chemical energy from a fuel into electricity through a chemical reaction with oxygen or another oxidizing agent. A hydrogen fuel cell uses the chemical energy of hydrogen to react with oxygen to produce electricity. Fuel cells can be used for almost any application typically powered by batteries or internal combustion engines, and they can scale to provide energy to a laptop computer or to a utility power station. Fuel cells produce no criteria air pollutants or greenhouse gas emissions at the point of operation. However, they are heavily dependent on a cost-efficient supply of hydrogen.

### *Photovoltaics*

Photovoltaic (PV) cells convert sunlight to electricity. Photovoltaic cells are assembled into a solar module or group of PV cells. Solar modules are placed in an area or added to a larger system to generate and supply electricity for homes and businesses. A system typically includes one or more solar modules (sometimes referred to as an array), equipment to convert direct current electricity to alternating current electricity (i.e., inverters), and connecting wiring. Some systems are designed with batteries to store the generated electricity for later use and/or sun tracking devices to increase the amount of solar energy collected.

### *Wind*

Wind turbines convert the kinetic energy of the wind to mechanical power. The wind turbine blades are designed to act like an airplane wing. The wind causes a pocket of low-pressure air on one side of the blade, which generates “lift” and pulls the blade toward it, causing the blade to move and the rotor to turn. The rotor turns a shaft and, through a gearbox, spins a generator to make electricity. Small wind turbines generally are those with capacities ranging from 20 watts to 100 kilowatts. At the low end of this range, units with capacities of 20 to 500 watts are often referred to as micro-turbines. At the high end of the range, small wind turbines can have a similar configuration and appearance to utility-sized wind turbines.

### Utility-Scale Renewables

Utility-scale renewables refer to the use of renewable energy resources from a centrally located regional power plant. Utility-scale renewable technologies include the same kinds of renewable energy resources as distributed renewables, as well as other resources whose use at the distributed scale is impractical. The generating capacities for utility-scale technologies are typically at least an order of magnitude larger than for distributed applications. This PEIS addresses the following utility-scale technologies and activities:

#### *Biomass*

Biomass energy sources for utility-scale projects are the same as those for distributed renewable energy projects. Some types of biomass resources are more or less suited for utility-scale projects. The cost-effective acquisition (i.e., collecting, processing, and transportation) of biomass resources is a key component to implementing a utility-scale biomass energy system.

#### *Geothermal*

Geothermal energy recovery systems use heat that radiates naturally from the earth. These geothermal systems can be used directly for heating buildings or in industrial processes, or they can be used to generate electricity. Because it is difficult to transport heat over any large distance, both direct use and electricity production must take place at, or very near, the geothermal system. Once converted to electricity, the energy can be transported great distances over transmission lines.

#### *Hydroelectric*

Utility-scale hydroelectric, or hydropower, is the same technology as described in Distributed Renewables but on a larger scale. According to a U.S. Army Corps of Engineers evaluation, the State of Hawaiʻi has limited potential for large-scale, river-based hydropower projects; therefore, this utility-scale technology is considered to have a low feasibility and is not carried forward for detailed impacts analyses.

#### *Municipal Solid Waste*

Municipal solid waste, more commonly known as trash or garbage, consists of everyday items used and then thrown away. This technology includes options available for converting municipal solid waste and other forms of waste to energy. Municipal solid waste-to-energy projects use similar technologies as those described for biomass facilities but also include the collection and use of methane gas released from existing landfills.

#### *Marine Hydrokinetic Energy*

Marine hydrokinetic technologies use the kinetic energy from moving water (such as waves, tides, and ocean currents) to generate electricity. The amount of energy that can be extracted from a wave is a function of the wave's height and frequency. That is, the higher and more frequent the waves, the more power that can be extracted. Marine hydrokinetic devices can be situated on the shoreline or offshore depending on the technology. This technology is in the early stages of development; consequently, there are numerous designs in various stages of viability for commercial deployment or product testing.

#### *Ocean Thermal Energy Conversion*

Ocean thermal energy conversion is a technology that relies on temperature gradients in the ocean to generate electricity. By utilizing colder deep water and warmer surface waters, it is possible to alternately condense and evaporate a fluid to drive a turbine. In general, the larger the temperature difference between the shallow and deep water, the more power a system will be able to produce.

#### *Photovoltaics*

As discussed in Distributed Renewables, PV modules convert the sun's energy directly into electricity. This technology also is currently applied to larger, utility-scale generating facilities as arrays of solar modules.

***Solar Thermal***
Solar thermal energy systems convert solar energy into thermal energy (heat) that can be used for the production of electricity. One big difference from solar PV technology is that solar thermal power plants generate electricity indirectly. Heat from the sun's rays is collected and used to heat a fluid. The steam produced from the heated fluid powers a generator that produces electricity.

***Land-Based Wind***
As discussed above for distributed wind, wind turbines convert the kinetic energy of the wind to mechanical power. Utility-scale wind projects include multiple, larger turbines in an array to maximize the available wind resource. Typical land-based wind turbines for utility-scale applications range from 1.5 to 3.5 megawatts with rotor diameters of 200-300 feet on towers about 250 feet to over 350 feet tall, dependent on the particular installation.

***Offshore Wind***
Offshore, utility-scale wind turbines function in the same manner as land-based wind turbines. That is, they convert the kinetic energy of the wind to mechanical power and the turning rotor spins a generator to make electricity. Most manufacturers of offshore wind turbines are currently testing prototypes with capacities of 5 to 7 megawatts with rotor diameters roughly 400 to 500 feet or larger. A primary difference between land-based and offshore wind turbine technology is the substructure upon which the wind turbine and tower is mounted. Depending on the depth of the water, offshore turbines are mounted on either shallow-water substructures (less than about 100 feet), transitional technology substructures (100 to 200 feet), or floating platforms (greater than 200 feet).

## *Alternative Transportation Fuels and Modes*
Alternative transportation fuels and modes encompass those fuel types and methods of transportation that are different than conventional gasoline-powered automobiles. This PEIS addresses the following alternative transportation fuels, alternative transportation modes, and alternative types and methods of transportation:

***Biofuels***
Biofuels are fuels derived from biomass or waste feedstocks. Biomass includes wood, agricultural crops, herbaceous and woody energy crops, and municipal organic wastes such as manure. Biofuels from waste feedstocks can also be derived from food wastes, including fats, oils, and grease (FOG). Converting restaurants' recycled fats, oils, and grease into biodiesel diverts waste, reduces pollution, and supports local businesses. These feedstocks can be transformed using a variety of conversion technologies into conventional biofuel products (such as ethanol and biodiesel), and advanced biofuel products (such as cellulosic ethanol, biobutanol, Green Diesel, synthetic gasoline, and renewable jet fuel).

***Electric Vehicles***
Electric vehicles operate with an electric motor (or motors) powered by rechargeable battery packs. Some electric vehicles run solely on electrical power from the grid while others use a combination of gasoline and electricity.

***Hybrid Electric Vehicles***
Hybrid-electric vehicle powertrains combine a conventional combustion engine (either gasoline or diesel), a battery, and an electric motor. The wheels are driven by the internal combustion engine, the electric motor, or a combination of the two.

***Hydrogen***
Hydrogen is the simplest and most abundant element in the universe and can be produced from fossil fuels including oil, coal, or natural gas as well as biomass, organic waste, water, or salt water. As a

transportation fuel, the energy content in 2.2 pounds of hydrogen gas is about the same as the energy content in 1 gallon of gasoline. Hydrogen can be used in internal combustion engines or in combination with hydrogen fuel cells to power electric motors.

***Compressed and Liquefied Natural Gas and Liquefied Petroleum Gas***

Natural gas as an alternative transportation fuel for vehicles comes in two forms: compressed natural gas and liquefied natural gas. The fuel is used in natural gas vehicles and more commonly in compressed natural gas-powered vehicles. These vehicles are similar to gasoline or diesel vehicles with regard to power, acceleration, and cruising speed.

***Multi-Modal Transportation***

Multi-modal transportation options reduce the number of miles traveled by personal vehicles for work commuting and personal trips. Multi-modal transportation options include public transportation (e.g., bus, rail, and marine), ridesharing, car sharing, bike sharing, active transit (walking and biking), telecommuting/teleworking, and alternative work schedules. A comprehensive, well-connected multi-modal transportation system allows tourists and residents to easily access multiple transportation options so that they can get to where they need to go quickly and without as much dependence on single occupancy vehicles.

## *Electrical Transmission and Distribution*

Electrical transmission and distribution refers to the transmission of electrical power from a point of generation and the means by which it is stored and distributed to electricity users. Electricity transmission and distribution systems form an electrical grid or network that is used to manage and distribute electricity in a geographic region. While electrical transmission and distribution is not specifically addressed in the HCEI, implementation of new renewable energy technologies and/or improving the existing electrical network in Hawai‘i would directly affect transmission of such electricity and is therefore analyzed in this PEIS. This PEIS addresses the following electrical transmission and distribution technologies and activities:

***On-Island Transmission***

On-island transmission of electricity includes connections from the power generation source, transmission over a short or long distance, and connection to the power user. This system is often referred as the island electrical grid or simply “power grid.” The power grid is how the majority of people and companies get their electricity.

***Undersea Cable***

Undersea power cables, also called submarine cables, transmit power across large bodies of water; whether from one island to another or from an offshore energy facility (e.g., an offshore wind turbine platform) to an on-island electrical network. Undersea cables lie on the sea bed and connect to on-island power grids via a land-sea cable transition site. Any type of electrical power can transmit across undersea cables including that from renewable energy sources such as solar, wind, and biomass.

***Smart Grid***

A smart grid is a modernized electrical grid that uses analog or digital information and communications technology to gather and act on information, such as information about the behaviors of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity. DOE describes the smart grid as an integration of five fundamental technologies: (1) integrated communications, (2) advanced components, (3) advanced control methods, (4) sensing and measurement, and (5) improved interfaces and decision support.

***Energy Storage***

Energy storage can take electricity that is generated at one point in time and store it for use at a different time. Incorporating energy storage in the electricity distribution chain allows utilities to decouple generation from demand which has several benefits including improved use of generated energy. The primary uses for energy storage include energy management, bridging power, and power quality and reliability.

# S.4 Public Participation and Agency Coordination

## S.4.1 PUBLIC PARTICIPATION

### S.4.1.1 PEIS Scoping Process

In 2010, DOE announced its intent to prepare a PEIS for the wind phase of the now-defunct Hawai‘i Interisland Renewable Energy Program (HIREP). The Notice of Intent (NOI) appeared on December 14, 2010, in the *Federal Register* (75 FR 77859), and it referred to the PEIS as the HIREP: Wind PEIS (DOE/EIS-0459). The NOI identified the State of Hawai‘i as a joint lead agency.

In February 2011, DOE held scoping meetings in Honolulu, Kahului, Kaunakakai, and Lāna‘i City. In meetings and submitted comments, commenters expressed concern that DOE and the State of Hawai‘i would not analyze energy efficiency measures, distributed renewable energy assets, or the full range of potential renewable energy technologies. Commenters also expressed concern about the construction of interisland electricity transmission connections and cables; the potential disparity of impacts on islands that could host wind development projects versus those that would use the electricity; and potential impacts to cultural resources, among other issues. In response to public scoping comments received on the HIREP: Wind PEIS, DOE consulted with the State of Hawai‘i and broadened the range of energy efficiency and renewable energy activities and technologies to be analyzed as well as the number of islands to be evaluated. The result was a more comprehensive programmatic EIS renamed the Hawai‘i Clean Energy PEIS.

A new scoping process began with DOE’s publication of an Amended NOI in the *Federal Register* (77 FR 47828, August 10, 2012), with the State of Hawai‘i as a cooperating agency instead of a joint lead agency. The Amended NOI identified the five clean energy categories under the expanded range of activities and technologies to be analyzed. DOE held eight public scoping meetings in September 2012 on six islands in the cities of Honolulu, Līhu‘e, Kailua-Kona, Hilo, Kahului, Lāna‘i City, Kaunakakai, and Kāne‘ohe.

In addition to the Amended NOI, DOE announced the scoping meetings to encourage public participation in the PEIS process through publishing notices in six local newspapers, issuing a press release, sending postcards or emails to individuals and groups that had previously shown interest in the HIREP: Wind PEIS, and creating the Hawai‘i Clean Energy PEIS Website (www.hawaiicleanenergypeis.com).

DOE received and reviewed more than 700 comment documents as part of the Hawai‘i Clean Energy PEIS scoping process. Issues raised most often were related to island energy independence and self-sufficiency (e.g., opposition to generating electricity on other islands for transmission to O‘ahu); Native Hawaiian issues (e.g., to avoid impacts on subsistence lifestyle, spirituality, and traditions); cultural and historic resources; socioeconomics and communities; land use; biological resources; utility-scale land-based wind and geothermal renewables; undersea cable corridors; and concerns about health effects of smart meters. DOE prepared the *Scoping Summary Report for the Hawai‘i Clean Energy Programmatic Environmental Impact Statement* that contains a five-page summary of these comments (available online from http://hawaiicleanenergypeis.com/eis-documents/). DOE also considered these comments during the preparation of the Draft PEIS.

### S.4.1.2 Areas of Controversy

Through discussions with the cooperating agencies, other agency coordination efforts, and the public involvement process— DOE solicited input, including the identification of any potential areas of controversy. This input came both during the public scoping process and the comments received during the public review of the Draft PEIS. The following potential areas of controversy were identified in the Draft PEIS and remain unchanged after review of public comments received on the Draft EIS. Changes to the PEIS that resulted from comments are addressed in Section S.4.1.3:

- Island energy independence and self-sufficiency – Concerns were raised about islands being self-sufficient and energy-independent versus using local resources to generate energy for use on other islands.
- Native Hawaiian issues – Concerns, based on traditional beliefs, were raised about the use of island resources, such as using geothermal energy, to generate energy.
- Land use – Concerns were raised about the use of this finite resource for energy generation.
- Transmission lines including undersea cable – In addition to island energy dependence and self-sufficiency, concerns were raised about the overall cost and relative benefit of an interisland transmission grid.
- Analysis was too limiting – Concerns were raised about the proposal for a major project using a single technology (e.g., wind power) without adequate study of all the options and their appropriateness for use in specific locations.

As a result of considering all scoping comments and comments received on the Draft PEIS, the PEIS is a programmatic evaluation of the energy efficiency activities and renewable energy technologies that could reasonably be implemented in Hawai‘i. The scope includes an assessment of the viability of implementation in the State of Hawai‘i and the associated potential environmental impacts. As discussed in Section S.3 above, the PEIS does not evaluate any specific or proposed project. Implementation of these activities and technologies and the ultimate ability to achieve the goals established by the HCEI should include input from all stakeholders.

### S.4.1.3 Draft PEIS Public Review and Comment Period

On April 18, 2014, DOE published in the *Federal Register* its Notice of Availability for the *Hawai‘i Clean Energy Draft Programmatic Environmental Impact Statement* (DOE/EIS-0407D) (79 FR 21909). DOE's Notice of Availability invited the public to comment on the Draft PEIS during a 90-day public comment period that ended on July 17, 2014, and described how the public could submit oral and written comments on the Draft PEIS. DOE's Notice also announced that it would hold a total of eight public hearings from May 12 through May 22, 2014, in Lihue on Kaua‘i, Kailua-Kona and Hilo on Hawai‘i Island, Kahului on Maui, Kaunakakai on Molokai, Lāna‘i City on Lāna‘i Island, and in Honolulu and Kāne‘ohe on O‘ahu.

DOE used notification methods similar to those used during the scoping period to notify the public and applicable Federal, State, and county agencies of the public review and comment period for the Draft PEIS. These notification methods included posting advertisements soliciting comments on the Draft PEIS and announcing the public hearings in local newspapers both one week and then two days (as possible) prior to the hearing dates; sending an email to individuals who had signed up on the PEIS website to receive email notifications related to the development of the PEIS as well as to scoping meeting attendees who had signed up to receive such notification; and mailing postcards through the U.S. postal service to those interested individuals who had not provided an email addresses.

DOE made the Draft PEIS available on the Internet at the Hawaiʻi Clean Energy PEIS Website (www.hawaiicleanenergypeis.com) and on the DOE NEPA Website (www.energy.gov/nepa) and provided a CD or bound copy of the Draft PEIS upon request. The State of Hawaiʻi DBEDT distributed bound copies of the Draft PEIS to eight public libraries throughout Hawaiʻi.

DOE received 151 comment documents (emails, letters, hearing transcripts, etc.) consisting of 582 comments on the Draft PEIS from Federal, State, and local government agencies, Native Hawaiian and other organizations, and members of the public. Examples of some changes in the Final PEIS that were driven by public or agency comments include the following:

- Expansion on the programmatic nature of the Hawaii Clean Energy PEIS
- Expansion of the background of the HCEI goals
- Expansion of the roles and responsibilities of various Hawaiʻi state agencies
- Addition of heat pump water heaters as an element within energy-efficient buildings
- Addition of information related to interconnection standards; primarily as they relate to distributed solar PV generation
- Update of renewable portfolio standards based on recent legislation
- Additional permitting details for OTEC and sea water air conditioning
- Expansion of the discussion on multi-modal transportation
- Clarification of permitting and potential impacts associated with an undersea cable
- Enhancement of the discussion of cultural resources impacts, and
- Update of the National Marine Fisheries listing of candidate marine species.

DOE considered all comments on the Draft PEIS received or postmarked during the public comment period in preparing this Final PEIS. Comments received after the close of the public review and comment period were also considered in the preparation of the Final PEIS.

### S.4.2 AGENCY COORDINATION

When implementing NEPA, a lead agency is strongly encouraged to involve Federal, State, and local government agencies. DOE benefitted in the preparation of the PEIS from the contributions of several cooperating and participating agencies.

The CEQ regulations define a lead agency as the agency or agencies preparing or having taken primary responsibility for preparing the environmental impact statement (40 CFR 1501.5 and 40 CFR 1508.16) and a cooperating agency as any other Federal agency having jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or a reasonable alternative) for legislation or other major Federal action significantly affecting the quality of the human environment (40 CFR 1501.6 and 40 CFR 1508.5). A State or local governmental agency may also become a cooperating agency. Participating (or consulting) agencies are those with an interest in defining the scope of an impact assessment and collaborating with lead and cooperating agencies in determining the methodologies and level of detail to be used in analyzing the alternatives.

DOE sent invitations to various Federal agencies and the State of Hawai‘i Department of Business, Economic Development and Tourism (DBEDT) to be cooperating agencies for this PEIS. DBEDT agreed to represent the State of Hawai‘i as the sole cooperating agency for the State. Table S-2 lists the Federal and State agencies that agreed to be a cooperating agency or participating agency for this PEIS, followed by brief descriptions of the expertise, permitting authority, and responsibilities of each cooperating agency.

**Table S-2. Cooperating and Participating Agencies**

| Agency | Department/Office |
|---|---|
| **Cooperating Status** | |
| U.S. Department of the Interior | National Park Service |
| | Bureau of Ocean Energy Management |
| U.S. Department of Agriculture | Natural Resources Conservation Service |
| U.S. Environmental Protection Agency | Region 9 |
| U.S. Department of Defense | U.S. Marine Corps |
| | U.S. Navy |
| U.S. Department of Transportation | Federal Aviation Administration |
| State of Hawai‘i | DBEDT |
| **Participating Status** | |
| U.S. Department of the Interior | U.S. Geological Survey |
| | U.S. Fish and Wildlife Service |
| Advisory Council on Historic Preservation | N/A |
| U.S. Department of Agriculture | Farm Services Agency |
| U.S. Department of Commerce | National Marine Fisheries Service |
| | National Oceanic and Atmospheric Administration, National Ocean Service – Office of National Marine Sanctuaries |
| U.S. Department of Transportation | Federal Highway Administration |
| U.S. Department of Homeland Security | U.S. Coast Guard |
| U.S. Department of Defense | U.S. Army Corps of Engineers |

Several of the listed agencies submitted comments on the Draft PEIS, which were resolved as documented in the Comment Response-Document. The agencies were all contacted relative to release of the Final PEIS and raised no additional concerns.

## National Park Service

The U.S. National Park Service (NPS) has expertise in natural and cultural resources and is charged with protecting the U.S. National Park System including resources for future generations. In addition, the NPS monitors the condition of National Historic Trails and Landmarks and National Natural Landmarks outside of the park system, and it may provide technical preservation assistance to owners of landmarks. NPS also maintains the *National Register of Historic Places*.

## S.4.2.1 Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) has expertise in and the responsibility for permitting leases and rights-of-way for renewable energy development activities on the Outer Continental Shelf and other offshore Federal waters. It also has expertise in coastal and marine biological and physical sciences, as well as marine archaeological and cultural resources. Under EPAct 2005, BOEM was granted (through its predecessor agency) the authority for regulating the production, transportation, and transmission of renewable energy resources on the Outer Continental Shelf and other offshore Federal waters. Pursuant to the *Outer Continental Shelf Lands Act* (43 U.S.C. §§ 1331–1356, Public Law 113-212), BOEM has been vested with jurisdictional authority for submerged lands greater than 3 miles seaward of the Hawaiian coastline. BOEM has no jurisdictional authority in Hawaiian waters from the coastline out to the 3-mile State/Federal boundary. This authority does not apply to any area on the OCS within the boundaries of any unit of the National Park System, National Wildlife Refuge system, National Marine Sanctuary system, or any National Monument.

### S.4.2.2 Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) has expertise in conservation planning assistance to private landowners and in the soil sciences. NRCS derives its regulatory and permitting authority under the *Soil Conservation and Domestic Allotment Act* (16 U.S.C. § 590a *et seq.*) and the *Food, Conservation, and Energy Act of 2008* (Public Law 110–234; known as the "Farm Bill"), as well as subsequent Farm Bills using programs such as the Conservation Stewardship Program (7 CFR Part 1470); *Environmental Quality Incentives Program in the Food, Conservation, and Energy Act of 2008* (Public Law 110–246); and the Wildlife Habitat Incentive Program (7 CFR Part 636).

### S.4.2.3 U.S. Environmental Protection Agency

The EPA administers the programmatic and regulatory aspects of 11 pollution control statutes including the *Clean Air Act* (42 U.S.C. § 7401 *et seq.*) and *Clean Water Act* (33 U.S.C. § 1251 *et seq.*). EPA has interest in all environmental resource areas, activities, and technologies. As a cooperating agency, EPA assisted in the independent review of both the Draft and Final PEISs.

### S.4.2.4 Federal Aviation Administration

The Federal Aviation Administration has expertise in airport land and airspace issues and permitting authority for matters related to hazards to air navigation.

### S.4.2.5 U.S. Marine Corps and U.S. Navy

The U.S. Marine Corps and the Department of the Navy both have expertise related to U.S. military installations and training, including radar, restricted areas, airspace, and training areas. All branches of the military are present on O‘ahu. The branches of the military coordinate with the U.S. Department of Defense (DoD) on renewable energy project compatibility through the DoD Siting Clearinghouse in the Office of the Deputy Undersecretary of Defense for Installations and Environment. The Clearinghouse formal review process applies to projects filed with the U.S. Secretary of Transportation under 49 U.S.C. § 44718 as well as other projects proposed for construction within military training routes or special use airspace, whether on private, State, or Federal property.

### S.4.2.6 State of Hawai‘i

State of Hawai‘i agencies have expertise in all matters related to State energy policy, land use, Native Hawaiian culture, aquatic resources, ocean recreation, forestry and wildlife, land and coastal land management and conservation, historic preservation, and parklands. On behalf of all State of Hawai‘i agencies, DBEDT is serving as a cooperating agency for this PEIS. The State agencies have permitting authority and will serve as information sources for many entities, including but not limited to the public and developers of future projects in Hawai‘i.

## S.5 Permitting and Regulatory Requirements

DOE prepared this PEIS pursuant to NEPA, as implemented by the CEQ NEPA regulations (40 CFR Parts 1500 through 1508) and DOE NEPA implementing procedures (10 CFR Part 1021). This PEIS considers, among other regulatory items, the requirements of the *Hawai'i Environmental Policy Act* (Chapter 343, Hawai'i Revised Statutes). This PEIS does not eliminate the need for project-specific environmental review of individual projects or activities that might be eligible for funding or other forms of support by DOE or other Federal agencies. To the extent that DOE proposes to fund or undertake particular projects or activities that may fall within the scope of this PEIS, project-specific NEPA reviews for such projects and activities are expected to build on, or tier from, this PEIS. Moreover, any such projects and activities would be subject to compliance with obligations under other environmental laws such as the *Endangered Species Act of 1973* (16 U.S.C. § 1531–1544 *et seq*.) and the *National Historic Preservation Act of 1966* (54 U.S.C. § 300101 *et seq*.). For those projects that do not have any connection to Federal actions, State-level environmental reviews would still have to occur as required under Hawai'i Revised Statutes, such as the *Hawai'i Environmental Policy Act* and other statutes and administrative rules.

The Hawai'i State Energy Office has developed and made available online a comprehensive list of Federal, State, and county-specific permits that are generally required for the activities that typically accompany clean energy projects. These include permits related to siting, construction, operation, and other phases. This information is available at https://energy.Hawaii.gov and includes a link to a single downloadable document called the *Guide to Renewable Energy Facility Permits in the State of Hawai'i*. Permit packets associated with each permit also are available for download at the above website. In addition, many Federal, State, and county permitting agencies in Hawai'i have developed their own guidance materials describing various permitting processes, procedures, and requirements. The links to these agency websites are included in Section 2.2 of the PEIS.

To supplement these tools, a free interactive online permitting tool, the Hawai'i Renewable Energy Permitting Wizard, is also available from the Hawai'i State Energy Office (http://wizard.hawaiicleanenergyinitiative.org/). The Wizard allows users (such as a would-be renewable energy developer) to identify the Federal, State, and county permits that may be required for a specific renewable energy project in Hawai'i based on input provided by the user. Designed for renewable energy projects, the Wizard can create a permit plan for a proposed project based on the type of renewable energy technology proposed. The permit plan also includes the recommended sequence—with estimated timelines—in which the permits may be obtained.

## S.6 Structure of the Hawai'i Clean Energy PEIS

This PEIS is arranged into a summary; nine chapters, each containing a separate, chapter-specific reference list; and three appendices:

- This Summary summarizes the contents of the PEIS. In accordance with 40 CFR 1502.12, the Summary stresses the major conclusions and areas of controversy (including issues raised by agencies and the public). Title 40 CFR 1502.12 also requires that a summary stress the issues to be resolved (including the choice among alternatives). However, since this PEIS focuses on a range of technologies and activities and analyzes their potential impacts rather than setting up a choice from among them, neither the body of the PEIS nor this Summary present issues to be resolved.

- Chapter 1, "Introduction," provides background information on the HCEI, an overview of the NEPA process, the purpose and need for agency action, and information on public and agency coordination.

- Chapter 2, "Proposed Action," describes each of the five clean energy categories and the associated 31 technologies and activities. The chapter discusses, from a programmatic perspective, the permitting and regulatory requirements needed to implement the technologies and activities associated with the different clean energy categories. It provides a brief primer of each activity/technology that includes a description of a representative project. The chapter includes a discussion of a no-action alternative and tables that summarize potential environmental impacts associated with the technologies and activities in each clean energy category. The chapter concludes with brief explanations of the PEIS's treatment of cumulative impacts, irreversible and irretrievable commitment of resources, the relationship between short-term uses and long-term productivity, unavoidable adverse impacts, and DOE's preferred alternative. This chapter also contains the glossary.

- Chapter 3, "Affected Environment," provides the existing conditions for each of the potentially affected environmental resource areas. It considers these resource areas at the State level and on an island-by-island basis for six islands (Kaua'i, O'ahu, Molokai, Lāna'i, Maui, and Hawai'i). In order to avoid redundancy in later chapters focused on technology-specific impacts, this chapter includes a discussion of the environmental impacts most often associated with construction and operation activities regardless of the clean energy activity or technology. The chapter organizes and discusses these impacts and associated best management practices in relation to the impacted resource, not the particular activity or technology. The environmental resource areas addressed in Chapter 3 include:

  - Geology and Soils – The geologic characteristics of the area at and below the ground surface, the frequency and severity of seismic activity, and the kinds and quality of soils.

  - Climate and Air Quality – Climatic conditions such as temperature and precipitation, ambient air quality, and criteria pollutant and greenhouse gas emissions.

  - Water Resources – Marine, surface-water, and groundwater features, water quality and availability, floodplains, and wetlands.

  - Biological Resources – Flora and fauna of the region and the occurrence and protection of special-status species.

  - Land and Submerged Land Use – Land and submerged land use practices and land ownership information.

  - Cultural and Historic Resources – Cultural, historic, and archaeological resources and the importance of those resources.

  - Coastal Zone Management – The existing regulatory process for consistency with coastal zone management plans, special management areas, and shoreline setbacks.

  - Scenic and Visual Resources – Scenic and visual resources in terms of land formations, vegetation, and color, and the occurrence of unique natural views.

- Recreation Resources – Existing recreation areas and uses, both on land and in the marine environment.

- Land and Marine Transportation – The existing transportation systems in the area.

- Airspace Management – Existing airport systems and military air bases and operation as well as the processes for managing the safe utilization of the airspace for intended uses.

- Noise and Vibration – Ambient noise and vibration levels, analytical techniques, and the identification of sensitive receptors.

- Utilities and Infrastructure – Existing electric utilities and electrical transmission and distribution services.

- Hazardous Materials and Waste Management – Solid and hazardous waste generation and management practices, wastewater services, the types of waste from current activities, the means by which waste is disposed, and pollution prevention practices.

- Socioeconomics – The labor market, population, housing, public services, and personal income.

- Environmental Justice – The identification of low-income and minority populations that could be subject to disproportionately high and adverse environmental impacts.

- Health and Safety (including Accidents and Intentional Destructive Acts) – The existing public and occupational safety conditions, including information on health and safety regulations and worker safety and injury data. The impacts chapters also provide a perspective of potential impacts from accidents and intentional destructive acts.

- Chapters 4 through 8 present the environmental impact analyses, by environmental resource, for the activities/technologies carried forward for detailed analysis. Energy Conservation and Initiatives and Programs are not associated with adverse environmental impacts, and Utility-Scale Hydroelectric is considered to have low feasibility; these are not analyzed in detail.) The analyses are based on the potential programmatic-level impacts from the representative projects (Chapter 2) on the affected environment (Chapter 3) to provide potential impact perspectives. Each section within each chapter also presents best management practices and mitigation measures specific to an activity or technology.

  - Chapter 4, "Environmental Impacts from Energy Efficiency"
  - Chapter 5, "Environmental Impacts from Distributed Renewables"
  - Chapter 6, "Environmental Impacts from Utility-Scale Renewables"
  - Chapter 7, "Environmental Impacts from Alternative Transportation Fuels and Modes"
  - Chapter 8, "Environmental Impacts from Electrical Transmission and Distribution"

- Chapter 9, "Comment-Response Document," presents a description of the comment-response process, the comments received, and DOE's responses to those comments.

This PEIS includes three appendixes:

- Appendix A, "Public Notices"
- Appendix B, "Distribution List"

- Appendix C, "List of Preparers"

## S.7 Potential Environmental Impacts and Best Management Practices

As identified in Section S.3, DOE is not proposing any specific projects associated with this PEIS. Therefore, this PEIS uses representative projects to evaluate the potential environmental impacts from the various activities and technologies that could be implemented to assist the State in meeting the Renewable Portfolio Standard and Energy Efficiency Portfolio Standard established as part of the HCEI. This PEIS also describes best management practices that could be implemented to keep those impacts to a minimum or prevent them altogether.

Additionally, because of its programmatic nature, the PEIS cannot present the same comparative analyses of each activity or technology as an evaluation of a specific project at a known location. The criteria used for such a specific analysis could include reliability, schedule-ability, economic feasibility, lifecycle analysis, potential for and scale of emergency/disaster impacts, and relative ease of integration onto each island's grid. These criteria could be included in a future project-specific environmental review.

Chapter 2 presents several summary tables that provide an overview of the potential environmental impacts for the energy efficiency activities and renewable energy technologies associated with each of the five clean energy categories. Each table presents the following:

- A reference to specific sections in Chapter 3 for those impacts that would be common among most construction and operation activities. (These impacts are set forth in one place in Chapter 3 to avoid repeating them for each distinct activity or technology in later chapters.)

- The potential environmental impacts specific to the stated activity/technology.

Accompanying each summary table is a chart that illustrates the resource areas that could be affected by each activity/technology. The clear circles indicate that no potential impacts would be expected for the activity/technology in that resource area. The light-gray circles indicate that the activity/technology would be expected to result in impacts similar to those common among most construction and operation activities (described in Chapter 3). The black circles indicate that there could be potential impacts specific to an activity or technology for that resource area. These charts are also presented below as Tables S-3 through S-7.

Best management practices and mitigation measures are identified in several places in the PEIS. For those potential impacts common among construction and operation activities, and not technology-specific, best management practices are presented in Chapter 3 for each resource area. For the activity/technology-specific impacts, the best management practices and mitigation measures are presented in Chapters 4 through 8 with the impacts analysis for that activity/technology. Implementation of these best management practices and mitigation measures are important to prevent or minimize the potential environmental impacts to that resource.

**Table S-3. Characterization of the Potential for Environmental Impacts – Energy Efficiency**

| Activity/Technology | Resource Areas | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Geology and Soils | Climate and Air Quality | Water Resources | Biological Resources | Land and Submerged Land Use | Cultural and Historic Resources | Coastal Zone Management | Scenic and Visual Resources | Recreation Resources | Land and Marine Transportation | Airspace Management | Noise and Vibration | Utilities and Infrastructure | Hazardous Materials and Waste Management | Socioeconomics | Environmental Justice | Health and Safety |
| Energy Efficient Buildings | ○ | ● | ○ | ○ | ○ | ● | ○ | ● | ○ | ○ | ○ | ● | ● | ● | ● | ● | ● |
| Sea Water Air Conditioning | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● | ● | ● | ● |
| Solar Water Heating | ○ | ● | ○ | ○ | ○ | ● | ○ | ● | ○ | ○ | ○ | ● | ● | ● | ● | ● | ● |

○ = No potential impacts.

● = Potential impacts are common among most construction and operation activities.

● = Potential impacts are specific to an activity or technology.

**Table S-4. Characterization of the Potential for Environmental Impacts – Distributed Renewables**

| Activity/Technology | Resource Areas | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Geology and Soils | Climate and Air Quality | Water Resources | Biological Resources | Land and Submerged Land Use | Cultural and Historic Resources | Coastal Zone Management | Scenic and Visual Resources | Recreation Resources | Land and Marine Transportation | Airspace Management | Noise and Vibration | Utilities and Infrastructure | Hazardous Materials and Waste Management | Socioeconomics | Environmental Justice | Health and Safety |
| Biomass | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● | ● | ● | ● |
| Hydroelectric | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ○ | ○ | ● | ● | ● | ● | ● | ● |
| Hydrogen Fuel Cells | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ● |
| Photovoltaics | ○ | ● | ○ | ○ | ○ | ● | ○ | ● | ○ | ○ | ○ | ○ | ● | ● | ○ | ○ | ● |
| Wind | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● | ● | ○ | ○ | ● |

○ = No potential impacts.

● = Potential impacts are common among most construction and operation activities.

● = Potential impacts are specific to an activity or technology.

**Table S-5. Characterization of the Potential for Environmental Impacts – Utility-Scale Renewables**

| Activity/Technology | | Resource Areas | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Geology and Soils | Climate and Air Quality | Water Resources | Biological Resources | Land and Submerged Land Use | Cultural and Historic Resources | Coastal Zone Management | Scenic and Visual Resources | Recreation Resources | Land and Marine Transportation | Airspace Management | Noise and Vibration | Utilities and Infrastructure | Hazardous Materials and Waste Management | Socioeconomics | Environmental Justice | Health and Safety |
| Biomass | Direct Combustion – Steam Turbine | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| | Biodiesel Plant/ Electric Plant | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Geothermal | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● | ● | ● | ● |
| Municipal Solid Waste | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Marine Hydrokinetic Energy | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● | ● | ● | ● |
| Ocean Thermal Energy | | ○ | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Photovoltaic Systems | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Solar Thermal Systems | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Wind (Land-Based) | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Wind (Offshore) | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |

○ = No potential impacts.

● = Potential impacts are common among most construction and operation activities.

● = Potential impacts are specific to an activity or technology.

**Table S-6. Characterization of the Potential for Environmental Impacts – Alternative Transportation Fuels and Modes**

| Activity/Technology | Resource Areas | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Geology and Soils | Climate and Air Quality | Water Resources | Biological Resources | Land and Submerged Land Use | Cultural and Historic Resources | Coastal Zone Management | Scenic and Visual Resources | Recreation Resources | Land and Marine Transportation | Airspace Management | Noise and Vibration | Utilities and Infrastructure | Hazardous Materials and Waste Management | Socioeconomics | Environmental Justice | Health and Safety |
| Biofuels | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● | ● | ○ | ○ |
| Plug-In Electric Vehicles | ● | ● | ○ | ○ | ● | ○ | ○ | ○ | ○ | ● | ○ | ● | ● | ● | ● | ○ | ○ |
| Hybrid Electric Vehicles | ○ | ● | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ● | ○ | ○ | ○ | ● | ○ | ○ | ○ |
| Hydrogen | ● | ● | ● | ○ | ● | ● | ○ | ● | ● | ● | ○ | ● | ● | ● | ● | ○ | ○ |
| Compressed and Liquefied Natural Gas and Liquefied Petroleum Gas | ● | ● | ○ | ● | ● | ● | ○ | ○ | ○ | ● | ○ | ○ | ● | ● | ○ | ○ | ● |
| Multi-Modal Transportation | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● | ○ | ● | ○ | ● | ● | ○ | ○ |

○ = No potential impacts.

● = Potential impacts are common among most construction and operation activities.

● = Potential impacts are specific to an activity or technology.

**Table S-7. Characterization of the Potential for Environmental Impacts – Electrical Transmission and Distribution**

| Activity/Technology | Resource Areas | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Geology and Soils | Climate and Air Quality | Water Resources | Biological Resources | Land and Submerged Land Use | Cultural and Historic Resources | Coastal Zone Management | Scenic and Visual Resources | Recreation Resources | Land and Marine Transportation | Airspace Management | Noise and Vibration | Utilities and Infrastructure | Hazardous Materials and Waste Management | Socioeconomics | Environmental Justice | Health and Safety |
| On-Island Transmission | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ● |
| Undersea Cables | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● | ● | ○ | ● |
| Smart Grid | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ● | ● | ● | ○ | ● |
| Energy Storage | ○ | ○ | ● | ○ | ○ | ● | ● | ○ | ○ | ○ | ○ | ○ | ● | ● | ● | ○ | ● |

○ = No potential impacts.

● = Potential impacts are common among most construction and operation activities.

● = Potential impacts are specific to an activity or technology.

# S.8 Overview of Potential Environmental Impacts from Technologies and Activities in the Clean Energy Categories

This section (1) provides an overview of the major conclusions about potential impacts from the five clean energy categories and (2) presents tables that summarize the potential environmental impacts associated with the clean energy technologies with the highest potential for adverse environmental impacts (based on the representative projects analyzed in this PEIS). Table S-8 summarizes impacts for On-Island Transmission, Undersea Cables, and Sea Water Air Conditioning. Potential environmental impacts for Utility-Scale Renewable technologies are summarized for Biomass-Fueled Steam Turbine Generation, Biodiesel Plant and Electric Power Plant, Geothermal, Municipal Solid Waste-to-Energy Facility, and Marine Hydrokinetic Energy in Table S-9a, and for Ocean Thermal Energy Conversion, Photovoltaic Systems, Solar Thermal Systems, Land-based Wind, and Offshore Wind in Table S9b. The other activities and technologies (generally the energy efficiency activities, distributed renewable technologies, and the alternative transportation fuels and modes) are not listed in these tables because they have the smallest potential for adverse environmental impacts. Chapter 2 contains a complete set of the tables that summarize potential impacts from all renewable energy technologies and energy efficiency activities for all resource areas (see Tables 2-37 through 2-46).

## Major Conclusions

Many of the technologies and activities evaluated in this PEIS have the potential benefit of reducing greenhouse gas and other criteria pollutant emissions due to the reduced need for and use of fossil fuels as an energy source. The potential for other environmental impacts varies across the different energy categories depending on the technology, size, and location of the analyzed projects, but generally can be characterized as follows:

- Activities and technologies in the Energy Efficiency category would have the smallest potential for notable environmental impacts. The small size and, in most cases, minimally disruptive nature of these activities and technologies would result in no or minimal potential impacts across the resource areas. However, sea water air conditioning could potentially impact water quality and biological resources, due to the return of warmer water for discharge. These potential impacts can be minimized or eliminated through the consideration and implementation of the various best management practices identified and discussed in this PEIS.

- Activities and technologies in the Distributed Renewables category typically would involve small projects; therefore, potential impacts from these technologies are not likely to be significant. Implementation of renewable energy projects at the residential scale (particularly solar photovoltaic, which can be deployed quickly in multiple locations) can exceed the capacity of a local power grid or utility. This can cause delays in bringing new energy sources to the electrical grid, require system upgrades, and have other consequences on local circuits. These and other potential adverse impacts can be minimized or eliminated through the implementation of interconnection standards and the use of best management practices identified and discussed in the PEIS.

- Among the technologies and activities analyzed in this PEIS, the greatest potential for environmental impacts is associated with the Utility-Scale Renewables category since it would include those technologies with the largest physical footprint and generation of the largest amount of electricity. All of these technologies would have the potential to impact numerous resource areas. Such potential impacts generally would be highest during construction and include noise, increased air emissions, changes to scenic and visual landscapes, and potential impacts to biological and cultural resources. The most common potential long-term impacts associated with these technologies would include changes to land and submerged land use and scenic and visual resources. These potential impacts would be location-dependent and could be minimized or eliminated through the use of the location-specific best management practices identified and discussed in the PEIS.

- Activities and technologies in the Alternative Transportation Fuels and Modes category would have a moderate potential for notable environmental impacts. Increased use of the alternative fuels would result in a reduction of criteria pollutants and greenhouse gas emissions as well as a reduction in the use of fossil fuels. The development of certain biofuels, however, could have adverse impacts related to using large land areas for the production of feedstock, the application of herbicides and fertilizers, and the introduction of invasive species. These and other potential adverse impacts can be minimized or eliminated through the use of best management practices such as proper handling, storage, and use of chemicals and the screening of plant species for invasive characteristics. A comprehensive, connected multi-modal transportation system in Hawai‘i likely would result in reductions in petroleum used for ground transportation, reductions in nonpoint source pollution, and improved air quality.

- In the Electrical Transmission and Distribution category, the two technologies with the greatest potential for environmental impacts on valuable resources are on-island transmission and undersea cables. These projects are long and linear, and the potential impacts are predominantly associated with construction activities and the route of the transmission lines/cables. Potential construction and routing impacts can be minimized or eliminated through the use of construction- and location-specific best management practices.

In addition, during project siting, all of these activities—but especially the Electrical Transmission and Distribution and the Utility-Scale Renewables categories—share the characteristic of encountering one or more host communities that could be impacted in numerous ways. In Hawaiʻi, this almost always includes the potential to impact Native Hawaiian communities, lifestyles, and values. The potential for project acceptance and success can be greatly enhanced by early and sincere involvement of the various communities in project planning and concern for "fairness" in project definition.

In addition to impacts from a technology standpoint, the State of Hawaiʻi has indicated particular interest in the potential impacts to four environmental resource areas.

- Biological resources due to the large number of threatened and endangered species and unique island habitat;
- Land and submerged land use based on the finite characteristics of this resource to the islands' environments;
- Cultural and historic resources because of the strong and long standing beliefs of the native population and their relationship with the islands' physical environment; and
- Scenic and visual resources because of both the cultural and historic aspects, as well as the importance to the tourism appeal of the islands.

**Table S-8. Summary of Impacts for Selected Technologies and Activities**

| Resource Area | On-Island Transmission | Undersea Cables | Sea Water Air Conditioning |
|---|---|---|---|
| **Geology and Soils** | | | |
| | General impacts during construction. | **Onshore**<br>General impacts during construction.<br><br>**Offshore**<br>Potential disturbance of marine sediments during construction (short-term) with minor impacts:<br>• Sediment disturbance at the horizontal directional drilling breakout point<br>• Drilling mud/slurry release at the horizontal directional drilling breakout point<br>• Sediment disturbance at trenching locations.<br><br>No impacts to geology and soils during operation. | **Onshore**<br>Potential soil erosion and contamination during construction (short-term).<br><br>**Offshore**<br>Potential disturbance of marine sediments during construction (short-term) and operations. |
| **Climate and Air Quality** | | | |
| Air Quality | General impacts during construction | General impacts during construction.<br><br>Beneficial impacts resulting from higher penetration of renewable generation on each connected island grid. | General impacts during construction (short-term).<br><br>The use of a sea water air conditioning system would require 75 percent less electricity than a standard cooling system; therefore, there would be a beneficial impact to air quality from a reduction of criteria pollutants resulting from electricity generated by fossil fuels. |
| Climate Change | General impacts during construction | General impacts during construction. | Minor impacts during construction. Reductions in greenhouse gas emissions as a result of reduction of electricity generation using fossil fuels. |

Table S-8. Summary of Impacts for Selected Technologies and Activities (continued)

| Resource Area | On-Island Transmission | Undersea Cables | Sea Water Air Conditioning |
|---|---|---|---|
| **Water Resources** | | | |
| Surface Water | General impacts during construction.<br><br>Operation impacts include possible alteration of stormwater runoff along transmission corridor as vegetation is reestablished. Any single drainage path expected to experience minimal alteration.<br><br>Potential application of herbicides to maintain transmission corridor could produce negative environmental impacts if they reach surface waters. | **Onshore**<br>General impacts during construction.<br><br>Potential impacts if increase in impermeable surfaces at built up land-sea transition sites.<br><br>**Offshore**<br>Sediment disturbance/dispersal and increased turbidity during horizontal directional drilling.<br><br>Potential site-specific impacts may occur to habitats or communities of concern.<br><br>No operation impacts. | **Onshore**<br>General impacts during construction (short-term).<br><br>No operation impacts.<br><br>**Offshore**<br>Sediment disturbance/ dispersal and increased turbidity.<br><br>Potential site-specific impacts may occur to habitats or communities of concern.<br><br>Potential increase in nutrient levels (nitrate and phosphates).<br><br>Potential for sea water temperature variability impact. |
| Groundwater | General impacts during construction.<br><br>No adverse operation impacts unless herbicides applied to maintain transmission corridor. | General impacts during construction. | General construction impacts.<br><br>No adverse operation impacts.<br><br>Potential fresh water (groundwater) savings if wastewater is used as the cooling medium.<br><br>Potentially beneficial; fresh water savings compared to a facility with an open cooling system. |

**Table S-8. Summary of Impacts for Selected Technologies and Activities (continued)**

| Resource Area | On-Island Transmission | Undersea Cables | Sea Water Air Conditioning |
|---|---|---|---|
| **Biological Resources** | | | |
| | General impacts to terrestrial ecosystems during construction, including potential access roads.<br><br>Operational maintenance of cleared areas around towers and vegetation height along transmission corridor.<br><br>Potential bird and bat collisions with towers and lines, especially nocturnal flying species. | General impacts to terrestrial and marine ecosystems during construction (short-term impacts to benthic communities and marine mammals if construction occurred in the Hawaiian Islands Humpback Whale National Marine Sanctuary).<br><br>Potential localized disturbance impacts to benthic communities at the horizontal directional drilling breakout point and along cable route during construction due to direct displacement or indirect sedimentation.<br><br>Potential operation impacts on sensitive species by electromagnetic fields along undersea cable route. | General impacts to terrestrial and marine ecosystems during construction (short-term impacts to benthic communities and marine mammals if construction occurred in the Hawaiian Islands Humpback Whale National Marine Sanctuary).<br><br>Minimal and localized impacts to marine organisms from water discharge temperature.<br><br>Potential increase in nutrient levels resulting in increased marine productivity and possible creation of unusual algal blooms.<br><br>Potential localized disturbance impacts to benthic communities at discharge point.<br><br>Potential entrainment of smaller organisms at the intake pipe. |
| **Land and Submerged Land Use** | | | |
| Land Use | Transmission line corridors and location of substations and switching yards could result in changes of land ownership patterns and land use. | General impacts during construction and operation. | Short-term land disturbance impacts at the cooling station locations and along distribution line routes during construction. |
| Submerged Land Use | None; the on-island transmission project would not extend offshore. | Short-term submerged land disturbance impacts along the undersea cable corridor during construction.<br><br>Potential temporary impacts during maintenance/ expansion activities.<br><br>Potential land use impacts along undersea cable corridor. | Potential land use impacts related to expansions/maintenance of the cooling stations and/or distribution network. |

**Table S-8. Summary of Impacts for Selected Technologies and Activities (continued)**

| Resource Area | On-Island Transmission | Undersea Cables | Sea Water Air Conditioning |
|---|---|---|---|
| **Cultural and Historic Resources** | | | |
| | General impacts during construction and operation.<br><br>Potential direct impacts from construction activities to archaeological and historic properties, including burial sites and protected traditional and customary activities.<br><br>Increased likelihood of unauthorized access to culturally sensitive areas by worker presence during operations.<br><br>Potential for visual, noise, or restricted access effects on sensitive cultural and historic resources and activities.<br><br>Potential impact on a historical building, structure, or district by facilities being incompatible with the historic context of a structure or area. | Potential direct impacts from onshore and offshore construction activities to archaeological and historic properties, including burial sites and protected traditional and customary activities.<br><br>Increased likelihood of unauthorized access to culturally sensitive areas by worker presence during operations.<br><br>Potential for visual, noise, or restricted access effects on sensitive cultural and historic resources and activities.<br><br>Potential impact on a historical building, structure, or district by facilities being incompatible with the historic context of a structure or area. | General construction and operation impacts to cultural resources.<br><br>Potential adverse impacts to cultural, historic, and related natural resources during construction and operation (both on and offshore). |
| **Coastal Zone Management** | | | |
| | General impacts during construction and operation.<br><br>Potential impacts to coastal zone resources (site-specific). | Potential effects to special management areas established to protect specific coastline resources and limit shorefront access (project/site-specific). | Potential effects to special management areas established to protect specific coastline resources and limit shorefront access (project- and/or site-specific). |

**Table S-8. Summary of Impacts for Selected Technologies and Activities (continued)**

| Resource Area | On-Island Transmission | Undersea Cables | Sea Water Air Conditioning |
|---|---|---|---|
| **Scenic and Visual Resources** | | | |
| | General impacts during construction.<br><br>Long-term visual impacts associated with towers, transmission lines, cleared transmission corridors, substations, and switching yards. | Short-term impacts to visual resources during construction.<br><br>Short-term visibility of cable-laying ships.<br><br>Long-term visual impacts associated with the new transition sites. | Short-term impacts to visual resources during construction.<br><br>Long-term visual impacts associated with the new cooling station. |
| **Recreation Resources** | | | |
| | General impacts during construction.<br><br>Long-term obstruction to some recreational activities; conversely, some activities could be enhanced by improved access (e.g., from access roads for installed transmission infrastructure). | General impacts during construction.<br><br>Short-term impacts during construction; limited to no impacts during operations. | General impacts during construction. Potential short-term impacts to offshore recreation during installation of the subsurface piping.<br><br>The short-term impacts could include: (1) restricted access to recreation areas near the area of installation of the underwater piping and on-shore facility, and (2) possible visual impairment from areas near the construction of the facilities that could have a negative effect on the ongoing recreational activities. |

**Table S-8. Summary of Impacts for Selected Technologies and Activities (continued)**

| Resource Area | On-Island Transmission | Undersea Cables | Sea Water Air Conditioning |
|---|---|---|---|
| **Land and Marine Transportation** | | | |
| Land Transporta-tion | Potential traffic congestion during construction from wide-load hauling of transmission line components (e.g., towers and tower foundations).<br><br>Short-term impacts during line stringing.<br><br>Impacts during construction if transmission line installation required road crossings. | Potential traffic congestion during construction from wide-load hauling of transmission line components (e.g., cables and installation equipment).<br><br>General impacts during construction of the land-sea transition sites | General impacts including localized short-term traffic impacts during construction and/or if road crossings are needed. |
| Marine Transporta-tion | None; the on-island transmission project would not extend offshore. | Potential short-term impacts on harbor operations, local marine transportation, and military marine (including submarine) operations. | Potential short-term (temporary) impacts on harbor operation, local marine transportation, and military marine operations<br><br>Potential impacts to military submarine operations. |
| **Airspace Management** | | | |
| | Potential air traffic impacts during construction if helicopters are used to transport supplies or for line stringing.<br><br>Potential construction and operation impacts and hazards to civilian and military aviation due to topography and high presence of low-altitude aviation.<br><br>Potential long-term impacts from radio frequency interference. | None; construction and operation of undersea cable and land-sea transition sites would not require any tall structures and therefore would not impact airspace management. | None; construction and operation of sea water air conditioning would not require any tall structures and therefore would not impact airspace management. |

**Table S-8. Summary of Impacts for Selected Technologies and Activities (continued)**

| Resource Area | On-Island Transmission | Undersea Cables | Sea Water Air Conditioning |
|---|---|---|---|
| **Noise and Vibration** | | | |
| | Short-term noise and vibration impacts during construction.<br><br>Potential vibration and humming noise during operation from loose hardware.<br><br>Sizzles, crackles, hissing noises possible, especially during periods of higher humidity. | Short-term noise and vibration impacts to sensitive noise receptors, including potential impacts to marine mammals and sea turtles.<br><br>Long-term noise and vibration impacts from operation of undersea cables would be negligible.<br><br>Noise and vibration impacts from land-based converter stations would be dependent on the location and compatibility with the existing noise levels and land uses. | Short-term noise and vibration impacts during construction. Noise levels could temporarily exceed regulatory levels. Exposure to elevated noise and vibration levels may result in temporary impacts to marine & mammal behavior and marine mammal prey species.<br>No long-term ambient noise or vibration impacts are expected during operation.<br><br>A positive benefit could be the elimination of noise currently generated from cooling towers as buildings convert to sea water air conditioning systems. |
| **Utilities and Infrastructure** | | | |
| | Potential impacts related to adding electricity capacity to the grid. | Potential impacts related to adding electricity capacity to the local power grid.<br><br>Connecting the electrical grids of two or more islands would:<br>• Enable the transmission of power and ancillary services in both directions and allow the two networks to operate in a coordinated fashion;<br>• Improve the power system economics and reliability on each island;<br>• Increase system flexibility in resource planning, operations, and reliability;<br>• Add flexibility in siting and interconnection of renewable energy generation;<br>• Reduce renewable energy curtailments; and<br>• Reduce oil usage for electricity generation. | Potential reduction in energy consumption (may require modification of the utility structure to meet the Renewable Portfolio Standard). |

**Table S-8. Summary of Impacts for Selected Technologies and Activities (continued)**

| Resource Area | On-Island Transmission | Undersea Cables | Sea Water Air Conditioning |
|---|---|---|---|
| **Hazardous Materials and Waste Management** | | | |
| Hazardous Materials | General impacts from exposure to hazardous materials during construction.<br><br>Potential impacts from exposure to hazardous materials during operation and maintenance from use of herbicides to maintain transmission corridor. | General impacts during construction and operation, particularly during development of converter stations. | General impacts from exposure to hazardous materials during construction.<br><br>No adverse operation impacts. |
| Waste Management | None; any vegetation cleared likely would be composted or reused. | Any waste generated onboard the construction vessels and barges would be disposed of at the appropriate landfill. | General waste management impacts during construction. |
| Wastewater | General impacts during construction. | General impacts during construction and operation, particularly during development of converter stations. | General wastewater impacts during construction.<br><br>No adverse operation impacts.<br><br>Potential beneficial impacts may occur if wastewater were utilized in place of sea water. This would minimize the amount of wastewater from other sources that would have to be treated by the local municipality. |
| **Socioeconomics** | | | |
| | Minimal beneficial impacts during construction and operation. | Minimal beneficial impacts during construction and operation. | Beneficial – few jobs created. |
| **Environmental Justice** | | | |
| | Small environmental justice impacts.<br><br>Site-specific evaluation of impacted populations required. | Small environmental justice impacts.<br><br>Site-specific evaluation of impacted populations required. | Depending on siting, impacts to visual and scenic resources could have the potential to be disproportionately high and adverse with respect to environmental justice communities. |

**Table S-8. Summary of Impacts for Selected Technologies and Activities (continued)**

**Table S-8. Summary of Impacts for Selected Technologies and Activities (continued)**
Resource Area | On-Island Transmission | Undersea Cables | Sea Water Air Conditioning

| Resource Area | On-Island Transmission | Undersea Cables | Sea Water Air Conditioning |
|---|---|---|---|
| **Health and Safety** | | | |
| | Potential health and safety impacts to workers during installation, maintenance, and repairs of the transmission lines. Typical industrial hazards.<br><br>Additional health and safety risks specific to electrical generation, transmission, and distribution industry.<br><br>Potential minor health and safety impacts to the public during operation of the transmission lines as a result of electromagnetic fields generated. Limited to areas immediately adjacent to transmission lines. | General construction and operation impacts.<br><br>Potential health and safety impacts to workers during installation, maintenance, and repairs of the undersea cables and transition sites, including increased safety risks associated with the marine environment.<br><br>Additional health and safety risks specific to electrical generation, transmission, and distribution industry. | General waste management impacts during construction. |

**Table S-9a. Summary of Impacts for Utility-Scale Renewable Technologies and Activities**

| Resource Area | Biomass: Direct Combustion Biomass-Fueled Steam Turbine Generating Project | Biomass: Biodiesel Plant and Electric Power Plant Project | Geothermal | Municipal Solid Waste-to-Energy Facility | Marine Hydrokinetic Energy |
|---|---|---|---|---|---|
| **Geology and Soils** | | | | | |
| | General construction impacts.<br><br>Potential soil erosion and degradation from agricultural activities. | General construction impacts.<br><br>Potential soil erosion and degradation from agricultural activities. | General construction impacts including land disturbance.<br><br>Potential well blowouts during drilling.<br><br>Potential for increased risk to personnel and equipment from hot fluids and steam and geothermal gases such as hydrogen sulfide.<br><br>Potential lava flow hazards and risks during operation associated with active volcanoes. | General construction impacts.<br><br>No operation impacts. | General construction impacts including soil disturbance.<br><br>Potential impacts associated with on-island electrical transmission lines.<br><br>Potential impacts to marine sediments and marine communities.<br><br>No operation impacts. |
| **Climate and Air Quality** | | | | | |
| Air Quality | General construction impacts.<br><br>Potential increase in criteria pollutant emissions (including nitrogen dioxide, particulate matter, carbon monoxides, and sulfur dioxide, as well as carbon dioxide) during combustion.<br><br>Potential increase in criteria pollutant emissions (including carbon dioxide) from biomass production (equipment, fertilizer/ pesticide application, harvest, and transport). | General construction impacts.<br><br>Additional criteria pollutant emissions during construction of the biodiesel plant.<br><br>Increased criteria pollutant emissions (nitrogen dioxide, particulate matter, carbon monoxides, and sulfur dioxide, as well as carbon dioxide) from combustion.<br><br>Increased criteria pollutant emissions (including carbon dioxide) emissions from biomass production | General construction impacts.<br><br>Potential emission of the non-condensable gases during operations.<br><br>Potential for trace amounts of nitrogen oxides, negligible amounts of sulfur dioxide or particulate matter, and small amounts of carbon dioxide.<br><br>Potential health impacts from naturally present hydrogen sulfide. | General construction impacts.<br><br>Increased criteria pollutant emissions (nitrogen dioxide, particulate matter, carbon monoxide, and sulfur dioxide, as well as carbon dioxide) from combustion.<br><br>Potential increase in pollutant emissions (including cadmium, carbon monoxide, dioxins/furans, hydrogen chloride, lead, mercury, nitrogen oxides, particulate matter, and sulfur dioxide) during project operations. | General construction impacts.<br><br>Potential land disturbance and associated fugitive dust at nearby onshore construction related areas.<br><br>Potential short-term, minor increase in criteria pollutant emissions from construction equipment and marine vessels.<br><br>Typically, no air quality impacts during operations. |

**Table S-9a. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Biomass: Direct Combustion Biomass-Fueled Steam Turbine Generating Project | Biomass: Biodiesel Plant and Electric Power Plant Project | Geothermal | Municipal Solid Waste-to-Energy Facility | Marine Hydrokinetic Energy |
|---|---|---|---|---|---|
| Climate Change | Potential impacts from increased biogenic carbon dioxide greenhouse gas emissions.<br><br>Decreased greenhouse gas emissions from electricity production using fossil fuels. | Potential increase in carbon dioxide emissions would result in increased greenhouse gas.<br><br>Decreased greenhouse gas emissions from electricity production using fossil fuels. | Potential greenhouse gas emissions reduction from a mix of cleaner technologies used to produce electricity. | Decreased greenhouse gas emissions from electricity production using fossil fuels. | Potential increase in greenhouse gas emissions from construction equipment and marine vessels.<br><br>Potentially beneficial impacts from greenhouse gas reduction associated with less electricity production using fossil fuels. |
| **Water Resources** | | | | | |
| Surface Water | General construction impacts.<br><br>Potential for increased stormwater runoff.<br><br>Increased water demand for crop irrigation (ex: sugarcane crop – more water/acre).<br><br>Potential adverse impacts from runoff contamination associated with fertilizer/ pesticide applications. | General construction impacts.<br><br>Potential for increased stormwater runoff.<br><br>Increased water supply demand for crop irrigation.<br><br>Potential adverse impacts from runoff contamination associated with fertilizer/ pesticide applications. | General construction impacts.<br><br>Potential for minor impacts to surface waters from runoff contaminated with geothermal fluids ("drift") during ops.<br><br>Potential impacts to surface waters from leaks or releases of low-boiling point organic working fluids (e.g., isobutene or isopentane) during operations. | General construction impacts.<br><br>Potential water resource discharge impacts from blowdown chemicals.<br><br>Potential stormwater contamination from solid waste activities, such as stockpiling, dumping, and moving. | **Onshore**<br>General construction impacts.<br><br>Potential for increased stormwater runoff from new building sites (site-specific).<br><br>**Offshore**<br>Potential ocean sediment disturbance. Potential increased turbidity to communities of concern (site-specific) in marine waters. |
| Groundwater | General construction impacts.<br><br>Potential for long-term increased runoff.<br><br>Potential decrease in groundwater recharge.<br><br>Potential for groundwater contamination from fertilizer/ pesticide applications via runoff or local recharge. | General construction impacts.<br><br>Potential for long-term increased runoff.<br><br>Potential decrease in groundwater recharge.<br><br>Potential for groundwater contamination from fertilizer/ pesticide applications via runoff or local recharge. | General construction impacts.<br><br>Potential for groundwater contamination/ drinking water supplies from drilling mud used.<br><br>Potential for increased impacts to water resources from increased water demand (site-specific; i.e., particularly to Maui's Central aquifer sector). | General construction impacts.<br><br>Potential for long-term increased runoff.<br><br>Potential decrease in groundwater recharge. Potential increase in water demand. | **Onshore**<br>General construction impacts.<br><br>Limited water supply impacts for facility operations.<br><br>**Offshore**<br>No groundwater impacts. |

## Table S-9a. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)

| Resource Area | Biomass | | Geothermal | Municipal Solid Waste-to-Energy Facility | Marine Hydrokinetic Energy |
|---|---|---|---|---|---|
| | **Direct Combustion Biomass-Fueled Steam Turbine Generating Project** | **Biodiesel Plant and Electric Power Plant Project** | | | |
| | | | Potential groundwater impacts from geothermal fluids removed from the subsurface. | | |
| **Biological Resources** | | | | | |
| | Potential for general construction impacts.<br><br>Potential impacts to vegetation or wildlife (including to the wide-ranging Hawaiian hawk and the Hawaiian hoary bat) species (site-specific).<br><br>Potential beneficial impacts – may create a market for selective harvesting of invasive woody species, such as albizia trees.<br><br>Potential impacts from the introduction of new, invasive plant species.<br><br>Potential impacts associated with use of genetically modified plants. | General construction impacts.<br><br>Potential for loss of wildlife habitat.<br><br>Potential impacts from the introduction of new, invasive plant species from commercial feedstock production.<br><br>Potential impacts associated with use of genetically modified plants. | General construction impacts.<br><br>Potential impacts to biological resources including land disturbance and disturbance by human activity.<br><br>Potential increase in invasive species establishment in disturbed sites.<br><br>Potential biological impacts on flights of marine birds (such as shearwaters and petrels) from facility lighting (site-specific). | General construction impacts.<br><br>Potential for construction impacts including land disturbance to wildlife in adjacent habitats, particularly near important nesting and feeding areas, wetlands, or roost sites (site-specific).<br><br>Potential for impacts to biological resources during operations (site-specific). | Potential construction impacts include displacement of marine mammals, reptiles, and fish both from physical activity and noise transmission through ocean waters.<br><br>Potential marine habitat impacts including to marine pools, beaches (both rocky and sand), coral reefs, and essential fish habitat.<br><br>Potential loss of beach nesting habitat for sea turtles and marine birds; and resting sites for the Hawaiian monk seal.<br><br>Potential collision hazards to marine mammals and reptiles during anchor cabling.<br><br>Potential localized noise (sound waves) impacts (potential auditory injury), avoidance, physical injury to marine mammals, fish, or other species, and alteration of water dynamics from submerged oscillating or rotating components. |

**Table S-9a. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| | Biomass | | | | |
|---|---|---|---|---|---|
| **Resource Area** | **Direct Combustion Biomass-Fueled Steam Turbine Generating Project** | **Biodiesel Plant and Electric Power Plant Project** | **Geothermal** | **Municipal Solid Waste-to-Energy Facility** | **Marine Hydrokinetic Energy** |
| | | | | | Potential electromagnetic field impacts from the undersea power cable. |
| **Land and Submerged Land Use** | | | | | |
| Land Use | Potential change in landownership patterns if the site is acquired by purchase or land use easement.<br><br>Potential conversion of undeveloped land or land under current land uses. | Potential change in landownership patterns if the site is acquired by purchase or land use easement.<br><br>Undeveloped land or land under current land uses could be converted to energy uses. | Potential change in land use or ownership by purchase or through land leases.<br><br>Potential impacts to undeveloped land or land with current uses from conversion to an energy facility.<br>Potential land use easement impacts. | Potential change in landownership patterns if the site is acquired by purchase or land use easement.<br><br>Potential land use conversion impacts (i.e., the creation of transmission corridors). | Potential land disturbance impacts during construction. |
| Submerged Land use | Biomass projects would be land-based and not impact submerged land uses. | Biomass projects would be land-based and not impact submerged land uses. | Geothermal projects would be land-based and not impact submerged land uses. | Because the representative project would be entirely land-based, there would be no impacts to submerged land use. | Potential localized impacts to the ocean floor from tethering and power cable installation, including obstruction of local marine habitats. |
| **Cultural and Historic Resources** | | | | | |
| | General construction and operation impacts.<br><br>Potential direct impacts from construction activities to archaeological and historic properties, including burial sites and protected traditional and customary activities.<br><br>Increased likelihood of unauthorized access to culturally sensitive areas by worker presence during operations. | General construction and operation impacts.<br><br>Potential direct impacts from construction activities to archaeological and historic properties, including burial sites and protected traditional and customary activities.<br><br>Increased likelihood of unauthorized access to culturally sensitive areas by worker presence during operations. | General construction and operation impacts.<br><br>Potential direct impacts from construction activities to archaeological and historic properties, including burial sites and protected traditional and customary activities.<br><br>Increased likelihood of unauthorized access to culturally sensitive areas by worker presence during operations. | General construction and operation impacts.<br><br>Potential direct impacts from construction activities to archaeological and historic properties, including burial sites and protected traditional and customary activities.<br><br>Increased likelihood of unauthorized access to culturally sensitive areas by worker presence during operations. | General construction and operation impacts.<br><br>Potential direct impacts from onshore and offshore construction activities to archaeological and historic properties, including burial sites and protected traditional and customary activities.<br><br>Increased likelihood of unauthorized access to culturally sensitive areas by worker presence during operations. |

**Table S-9a. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Biomass: Direct Combustion Biomass-Fueled Steam Turbine Generating Project | Biomass: Biodiesel Plant and Electric Power Plant Project | Geothermal | Municipal Solid Waste-to-Energy Facility | Marine Hydrokinetic Energy |
|---|---|---|---|---|---|
| | Potential for visual, noise, or restricted access effects on sensitive cultural and historic resources and activities.<br><br>Potential impact on a historical building, structure, or district by facilities being incompatible with the historic context of a structure or area. | Potential for visual, noise, or restricted access effects on sensitive cultural and historic resources and activities.<br><br>Potential impact on a historical building, structure, or district by facilities being incompatible with the historic context of a structure or area. | Potential for visual, noise, or restricted access effects on sensitive cultural and historic resources and activities.<br><br>Potential impact on a historical building, structure, or district by facilities being incompatible with the historic context of a structure or area.<br><br>Potential adverse impacts to ethnographic resources as active volcanoes and rift zones are considered sacred by Native Hawaiians.<br><br>Potential for adverse viewshed impacts from facility development, transmission lines, and other ancillary facilities; particularly to geothermal resources located within and adjacent to the Hawai‘i Volcanoes National Park. | Potential for visual, noise, or restricted access effects on sensitive cultural and historic resources and activities.<br><br>Potential impact on a historical building, structure, or district by facilities being incompatible with the historic context of a structure or area. | Potential for visual, noise, or restricted access effects on sensitive cultural and historic resources and activities.<br><br>Potential impact on a historical building, structure, or district by facilities being incompatible with the historic context of a structure or area. |
| **Coastal Zone Management** | | | | | |
| | Potential impacts to special management areas, shorefront access, and shoreline erosion (site-specific) through water runoff and sedimentation. | Potential impacts to special management areas, shorefront access, and shoreline erosion through water runoff and sedimentation (site-specific). | Potential impacts to designated special management areas, shorefront access, and shoreline erosion (site-specific). | Potential impacts to special management areas, shorefront access, and shoreline erosion (site-specific). | Potential impacts including land disturbances, structural developments, lighting, and other impacts to special management areas, shorefront access.<br><br>Potential alteration of shorefront access (site-specific) and alteration of ocean currents. |

**Table S-9a. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Biomass: Direct Combustion Biomass-Fueled Steam Turbine Generating Project | Biomass: Biodiesel Plant and Electric Power Plant Project | Geothermal | Municipal Solid Waste-to-Energy Facility | Marine Hydrokinetic Energy |
|---|---|---|---|---|---|
| **Scenic and Visual Resources** | | | | | |
| | Short-term visual impacts during construction.<br><br>Long-term visual impacts from introduction of a new facility.<br><br>Potential impacts from harvest of biomass.<br><br>Potential visual impacts from truck traffic during delivery. | Short-term visual impacts during construction.<br><br>Long-term visual impacts from introduction of a new facility.<br><br>Potential impacts during crop harvest.<br><br>Potential visual impacts from truck traffic delivery. | Potential short-term construction impacts.<br><br>Potential long-term visual impacts from the power plant, night lighting, visibility of the transmission line, and the presence of steam plumes at facilities using water-cooled systems. | General visual impacts during construction.<br><br>Long-term visual impacts from the municipal solid waste combustion facility (site-specific).<br><br>Long-term visual impacts from truck traffic delivery of municipal solid waste (site-specific). | General visual impacts during construction.<br><br>Long-term visual impacts (i.e., onshore/ offshore—marine hydrokinetic energy technology and location specific).<br><br>Long-term visual impacts from navigation lighting for devices. |
| **Recreation Resources** | | | | | |
| | General construction impacts.<br><br>Potential long-term recreation resource impacts from visual and noise effects.<br><br>Potential recreational resource impacts from truck traffic. | General construction impacts.<br><br>Potential long-term recreation resource impacts from visual and noise effects.<br><br>Potential recreational resource impacts from truck traffic. | General construction impacts.<br><br>Potential long-term recreational resource impacts including access restrictions, noise, and visual impacts from the new facilities.<br><br>Potential permanent loss of recreational values (site-specific).<br><br>Potential lighting impacts to nearby recreation resources such as campgrounds where dark night sky is valued. | General construction impacts.<br><br>Potential long-term recreation resource impacts including from visual and noise impacts (site-specific).<br><br>Potential recreational resource impacts from truck traffic.<br><br>Potential impacts to recreation resources (i.e., nearby campgrounds or areas where a dark night sky is valued) from facility lighting. | General construction impacts.<br><br>Potential long-term recreation resource impacts from visual impacts (site-specific).<br><br>Potential effects to water-based recreation activities (i.e., swimming, surfing, boating, and fishing) resulting from access restrictions or use alterations to promote recreation user safety and prevent collisions or malfunctions to offshore technologies.<br>Potential wave attenuation impacts at the shore (technology and site-specific; i.e., dependent on the array of devices and location). |

**Table S-9a. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

**Table S-9a. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Biomass | | Geothermal | Municipal Solid Waste-to-Energy Facility | Marine Hydrokinetic Energy |
|---|---|---|---|---|---|
| | Direct Combustion Biomass-Fueled Steam Turbine Generating Project | Biodiesel Plant and Electric Power Plant Project | | | |
| **Land and Marine Transportation** | | | | | |
| Land Transportation | Potential increase in truck traffic for biomass delivery.<br><br>Potential increased wear on paved roads and road maintenance. | Potential increase in truck traffic for biomass delivery.<br><br>Potential increased wear on paved roads and road maintenance. | Potential short-term impacts on roadway traffic during project construction. | Potential for localized transportation impacts from transporting municipal solid waste. | None. |
| Marine Transportation | None; it is unlikely that bulk biomass would be shipped between islands. | None; it is unlikely that bulk biomass would be shipped between islands. | None identified. | Because the representative project would be entirely land-based, there would be no impacts to marine transportation. Transfer of municipal solid waste between islands is not anticipated. | Potential obstruction impacts to marine navigation including to tourist cruises, passenger ferries, fishing vessels (recreational and commercial), and large commercial cargo ships.<br><br>Potential impacts to military marine operations, surface and subsurface navigation from both floating and submerged structures. |
| **Airspace Management** | | | | | |
| | Potential hazards to aircrafts from emission stacks for those project locations nearby airports. | Minimal potential hazards to aircrafts from emission stacks for those project locations nearby airports. | None; the development and operation of a geothermal facility would not result in any tall structures or steam exhausts that would require further consultation on airspace management impacts. | Potential impacts if emission stacks are less than 200 feet. | None; the marine hydrokinetic energy representative project would not include any tall structures and therefore would not impact airspace management. |

**Table S-9a. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Biomass: Direct Combustion Biomass-Fueled Steam Turbine Generating Project | Biomass: Biodiesel Plant and Electric Power Plant Project | Geothermal | Municipal Solid Waste-to-Energy Facility | Marine Hydrokinetic Energy |
|---|---|---|---|---|---|
| **Noise and Vibration** | | | | | |
| | Short-term noise and vibration construction impacts.<br><br>Potential long-term impacts to existing noise and vibration levels, depending on the location of facilities and compatibility with existing noise levels and land uses.<br><br>Noise impacts from truck traffic delivery (site-specific). | Short-term noise and vibration construction impacts.<br><br>Long-term noise and vibration operation impacts (site-specific).<br><br>Noise impacts from truck traffic delivery (site-specific). | Short-term and long-term noise and vibration impacts would result from exploration, construction, and operation. Potential impacts from noise and vibration would be wholly dependent on sound levels and the proximity of sensitive receptors to the source. Noise and vibration levels would be reduced with implementation of best management practices. | General impacts during construction and operation. | Short-term noise and vibration impacts to sensitive noise receptors, including potential impacts to marine mammals and sea turtles. Unless deployed in large arrays of generators, long-term noise and vibration impacts from marine hydrokinetic energy technologies would be minimal with implementation of best management practices. |
| **Utilities and Infrastructure** | | | | | |
| | General construction and operation impacts.<br><br>Varying impacts to utilities (site/island-specific i.e., small effects to O'ahu, larger effects to Lāna'i), requiring potential adjustment/ management of power grids and overall power production. | General construction and operation impacts.<br><br>Varying impacts to utilities (site/island-specific i.e., small effects to O'ahu, large effects to Lāna'i), requiring potential adjustment/ management of power grids and overall power production. | General construction impacts.<br><br>Potential for minor to moderate impacts to electric utilities (site-specific, i.e., moderate effects to Maui and minor effects to Hawaii's utilities). | General construction and operation impacts.<br><br>Varying impacts to utilities (site/island-specific i.e., small effects to O'ahu, larger effects to Lāna'i), requiring potential adjustment/ management of power grids and overall power production. | General construction impacts. |

**Table S-9a. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Biomass: Direct Combustion Biomass-Fueled Steam Turbine Generating Project | Biomass: Biodiesel Plant and Electric Power Plant Project | Geothermal | Municipal Solid Waste-to-Energy Facility | Marine Hydrokinetic Energy |
|---|---|---|---|---|---|
| **Hazardous Materials and Waste** | | | | | |
| Management Hazardous Materials | General construction impacts.<br><br>Potential exposure to high quantities of fertilizers (primarily nitrogen), herbicides, and pesticides. | General construction impacts.<br><br>Potential exposure to high quantities of fertilizers, herbicides, and pesticides.<br><br>Potential hazardous materials exposure impacts from biodiesel leaks or accidents. | General construction impacts.<br><br>Potential impact from exposure to hazardous materials if chemicals used during exploration/flow testing or from drilling fluids that were improperly handled or released into the environment.<br><br>Potential impact from exposure to hazardous materials if an accidental spill or chemical release were to occur during operations from lubricating oils, hydraulic fluids, coolants, solvents, and/or cleaning agents.<br><br>Potential impact from exposure associated with naturally occurring hydrogen sulfide. | General construction impacts.<br><br>Potential exposure to hazardous materials from municipal solid waste delivered to the site.<br><br>Potential impact from exposure to hazardous materials associated with the flammability of syngas production. | General construction impacts.<br><br>Potential exposure to hazardous materials including fuels from boats, marine vessels, barges, lubricants and hydraulic fluids contained in the wave or tidal energy devices during operations and maintenance. |
| Waste Management | General construction impacts. | General construction impacts.<br><br>Potential increase in byproduct waste generated | General construction impacts.<br><br>Potentially adverse impacts if additional waste were generated on the island of Hawai‘i.<br>Minor amounts of hazardous waste may be generated including paints, coatings, and spent solvents. | General construction impacts.<br><br>Potential exposure to hazardous waste (i.e., infectious waste, electronics, lead acid batteries, firearms, propane tanks, sludge, agricultural wastes, soil, and some noncombustible inorganic materials (such as concrete, stone). | Potential landfill impacts to O‘ahu and Hawai‘i (pending the resolution of existing landfill capacity constraints) if non-recyclable materials add to existing landfill capacity constraints. |

## Table S-9a. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)

| Resource Area | Biomass: Direct Combustion Biomass-Fueled Steam Turbine Generating Project | Biomass: Biodiesel Plant and Electric Power Plant Project | Geothermal | Municipal Solid Waste-to-Energy Facility | Marine Hydrokinetic Energy |
|---|---|---|---|---|---|
| | | | | Potential waste management impacts from ash waste byproducts.<br><br>Potentially beneficial impacts resulting from decreased municipal solid waste in landfills. | |
| Wastewater | Potential impacts to wastewater services from trace amounts of chemicals and elevated temperatures during blowdown from the steam cycle and cooling system. | General construction impacts.<br><br>Potential impacts to wastewater services from trace amounts of chemicals and elevated temperatures during the blowdown from the steam cycle and cooling system. | General construction impacts.<br><br>Potential wastewater impacts in the event of a leak containing geothermal waste fluids. | General construction impacts.<br><br>Potential impacts to wastewater services from blowdown. | Potential impacts to wastewater services from vessel effluent during construction.<br><br>No operation impacts. |
| **Socioeconomics** | | | | | |
| | Very small population and economic benefits (i.e., few net new jobs) during construction and operation. | Very small population and economic benefits (i.e., few net new jobs) during construction and operation. | Very small population and economic benefits (i.e., few net new jobs) during construction and operation. | Very small population and economic benefits (i.e., few net new jobs) during construction and operation. | Very small population and economic benefits (i.e., few net new jobs) during construction and operation. |
| **Environmental Justice** | | | | | |
| | Small potential impacts to the general population.<br><br>Site-specific evaluation of impacted populations required. | Small potential impacts to the general population.<br><br>Site-specific evaluation of impacted populations required. | Small environmental justice impacts.<br><br>Site-specific evaluation of impacted populations required. | Small potential impacts to the general population.<br><br>Site-specific evaluation of impacted populations required. | No effects identified. Because of the uncertainty of the marine hydrokinetic energy designs and the low potential for adverse impacts, there would be no disproportionately high and adverse impacts to minority or low-income populations. There would be no environmental justice impacts from the marine hydrokinetic energy representative project. |

**Table S-9a. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Biomass: Direct Combustion Biomass-Fueled Steam Turbine Generating Project | Biomass: Biodiesel Plant and Electric Power Plant Project | Geothermal | Municipal Solid Waste-to-Energy Facility | Marine Hydrokinetic Energy |
|---|---|---|---|---|---|
| **Health and Safety** | | | | | |
| | General construction and operation impacts. | General construction and operation impacts.<br><br>Health risks from the use of pesticides, herbicides, and fertilizers.<br><br>Additional risks of traffic accidents associated with the transport of biomass materials. | General construction and operation impacts.<br><br>Potential health and safety effects from drilling including hydrogen sulfide worker exposure.<br><br>Potential health and safety impacts from physical, thermal, and chemical hazards such as hydrogen sulfide exposure. | General construction and operation impacts. | General construction and operation impacts.<br><br>Potential for public health and safety effects including to boats, both civilian and military marine vessels, and to the public onshore in the event the device were destroyed, damaged or if the loss of mooring/ spatial stabilization were to occur. |

**Table S-9b. Summary of Impacts for Utility-Scale Renewable Technologies and Activities**

| Resource Area | Ocean Thermal Energy Conversion | Photovoltaic Systems | Solar Thermal Systems | Wind (Land-Based) | Wind (Offshore) |
|---|---|---|---|---|---|
| **Geology and Soils** | | | | | |
| | None; the only potential impacts to geology and soils would be the interface of the undersea cable to connect the ocean thermal energy conversion facilities with the grid. | General construction impacts from land disturbance/soil erosion.<br><br>No operation impacts. | General construction impacts from land disturbance.<br><br>Potential for soil contamination in the event of a leak or accidental release of the heat transfer fluids (such as synthetic oil or even molten salt) used in the system. | General construction impacts from land disturbance/soil erosion.<br><br>No operation impacts. | General onshore construction impacts from land disturbance/soil erosion.<br><br>Potential impacts to marine sediments (e.g., natural migration of sand) from anchor/mooring devices, undersea cables, and land/sea transition zones.<br><br>No operation impacts. |
| **Climate and Air Quality** | | | | | |
| Air Quality | General construction impacts.<br><br>Limited, intermittent, and short-term air quality impacts during construction.<br><br>Potential land disturbance and related fugitive dust at nearby onshore construction related areas, including areas where offshore electrical lines connect with the onshore regional electric grid. | General construction impacts.<br><br>No operation impacts. | General construction impacts.<br><br>No operation impacts. | General construction impacts.<br><br>No operation impacts. | General construction impacts.<br><br>Potential increased criteria pollutants from construction equipment including marine vessels (powered by fossil fuels, e.g., diesel, or gasoline) during construction.<br><br>Potential for fugitive dust at nearby onshore construction-related areas. |

**Table S-9b. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Ocean Thermal Energy Conversion | Photovoltaic Systems | Solar Thermal Systems | Wind (Land-Based) | Wind (Offshore) |
|---|---|---|---|---|---|
| | Potential increase in criteria pollutant emissions during construction from equipment or marine vessels powered by fossil fuels.<br><br>Potential operational emissions from auxiliary diesel generators on the platform. | | | | |
| Climate Change | Potential increase in greenhouse gas emissions from construction equipment and operation of diesel generators on the platform.<br><br>Potential greenhouse gas emissions reduction from a mix of technologies used to produce electricity using fossil fuels. | Potential greenhouse gas emissions reduction from a mix of cleaner technologies used to produce electricity using fossil fuels. | Potential greenhouse gas emissions reduction from a mix of different technologies used to produce electricity using fossil fuels. | Potential greenhouse gas emissions reduction from a mix of cleaner technologies used to produce electricity using fossil fuels. | Potential greenhouse gas emissions reduction from a mix of cleaner technologies used to produce electricity using fossil fuels. |
| **Water Resources** | | | | | |
| Surface Water | Potential ocean sediment disturbance resulting in increased turbidity and impacts to coral or other bottom communities of concern.<br><br>Potential water quality impacts from discharge not meeting water quality criteria for marine waters (i.e., nutrient levels such as nitrite plus nitrate, phosphate, and phosphorous.). | General construction impacts.<br><br>Potential stormwater runoff from the site (dependent on the amount of impermeable surface/nature of the preconstruction site). | General construction impacts.<br><br>Potential stormwater runoff contamination in the event of leaks or accidental releases of the heat transfer fluids (such as synthetic oil or even molten salt) used in the system. | General construction impacts.<br><br>Potential for increased stormwater runoff as a result of increased impermeable surfaces (wind turbine foundations, electrical support buildings, and paved roads or parking areas) – (site-specific). | General construction impacts including horizontal directional drilling for electrical cables and for the construction of a substation.<br><br>No potential onshore effects during operations.<br><br>Potential for increased turbidity at breakout point from drilling mud or slurries used during horizontal directional drilling. |

**Table S-9b. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Ocean Thermal Energy Conversion | Photovoltaic Systems | Solar Thermal Systems | Wind (Land-Based) | Wind (Offshore) |
|---|---|---|---|---|---|
| | Potential increased algal bloom impacts from increased nutrient levels.<br><br>Potential impacts from temperature variation and elevated chlorine levels of discharge. | | | | Potential impacts to coral or other bottom communities of concern from high turbidity (site-specific). |
| Groundwater | Minimal groundwater impacts during construction and operation. | General construction impacts.<br><br>Potential changes in runoff to the site and potential associated change in groundwater recharge. | Minor groundwater impacts during construction.<br><br>Potential changes in runoff to the site and potential associated change in groundwater recharge. | General construction impacts. | General construction impacts.<br><br>No operation impacts. |
| Floodplains and Wetlands | None identified. | Potential impacts during construction and operation (site-specific). | Potential impacts during construction and operation (site-specific). | Potential impacts during construction and operation (site-specific). | Potential impacts during construction (site-specific). |
| **Biological Resources** | | | | | |
| | Potential for short-term and small disturbances during placement of the cabling lines, moors, and anchors.<br><br>Potential disturbance to deep and shallow marine habitats and shorelines (including marine pools, sandy and rocky beaches, seagrass habitat, shallow benthic communities, and coral reefs at multiple depths) during construction (site-specific). | General construction impacts.<br><br>Potential impacts to biological resources including migratory birds, threatened and endangered plants and animals, critical habitat, protected land areas, and wetlands from habitat loss during site development (site-specific). For locations near the ocean, potential impacts may occur to marine anchialine pools. | General construction impacts.<br><br>Potential impacts to biological resources including migratory birds, threatened and endangered plants and animals, critical habitat, protected land areas, and wetlands) from habitat loss during site development (site-specific). For locations near the ocean, potential impacts may occur to marine anchialine pools. | General construction and operation impacts.<br><br>Potential impacts to biological resources including loss of vegetation and wildlife (migratory birds, threatened and endangered plants and animals, critical habitat, and other high value areas such as wetlands and native plant communities) from site development (site-specific).<br><br>Potential for mortality of avian species and bats (site-specific). | General construction and operation impacts.<br><br>Potential disturbance impacts to the ocean floor and marine communities/ habitats (i.e., coral reefs, shallow benthic communities, seagrass habitat, beaches, and possibly marine pools) during installation of anchors, undersea cables (site-specific).<br><br>Potential impacts to marine animals from temporary construction noise impacts. |

**Table S-9b. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Ocean Thermal Energy Conversion | Photovoltaic Systems | Solar Thermal Systems | Wind (Land-Based) | Wind (Offshore) |
|---|---|---|---|---|---|
| | | | | | |
| | Potential impacts to the marine environment from introduction of an electromagnetic field along the undersea cable.<br><br>Potential attraction of marine fish, mammals, and seabirds to structures and for biofouling organisms.<br><br>Potential impacts to marine communities from nutrient rich discharge waters.<br><br>Potential impacts to marine organisms due to intake pipes.<br><br>Potential collision hazards to marine mammals from mooring lines. | | | Potential impacts to seabirds by attracting/disorienting them from onsite lighting. | Potential for increase in marine mammal collisions from ships and boats during construction.<br><br>Potential increase for hazards to marine mammals congregating in marine subsurface structures.<br><br>Potential for increased collision hazard for large marine mammals (i.e., whales) from mooring cables.<br><br>Potential hazards (increased risk for mortalities by rotor blade collision) to seabirds in areas surrounding wind turbines due to potential aggregation of forage fish near submarine structures, tower safety lighting, and potential use of aboveground platform structures as resting areas.<br>Potential introduction of an electromagnetic field into the marine environment along the cable resulting in potential impacts to marine mammals with electrosensory systems. |

**Table S-9b. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Ocean Thermal Energy Conversion | Photovoltaic Systems | Solar Thermal Systems | Wind (Land-Based) | Wind (Offshore) |
|---|---|---|---|---|---|
| **Land and Submerged Land Use** | | | | | |
| Land Use | Typical land use impacts associated with the interface of an undersea cable and the electrical grid. | Potential land use impacts including land disturbance and possible conversion of undeveloped land and land in other current use to an energy generating facility.<br><br>Potential change in land ownership patterns and/or easements required for the project (i.e., project site, access roads, corridors to the nearest electrical grid).<br><br>Potential impacts to adjacent land uses (roads, residential/ commercial areas, historic sites, scenic locations, and airports) from the glint and glare of the solar panels. | Potential change in land ownership patterns through purchase and or land use leases for both the solar thermal project site and any linear corridors required to tie-in to the existing electrical grid.<br><br>Potential impacts to undeveloped land or land currently used for other uses could be converted to energy uses. | Potential land use impacts including land disturbance during site preparation and turbine installation, as well as access road construction and support structures.<br><br>Potential conversion of undeveloped land or land with other current land uses for energy use.<br><br>Potential landownership changes and obtainment of land use easements. | Potential change in local landownership patterns.<br><br>Potential land disturbance during construction of the tie-in to the existing transmission grid. |
| Submerged Land Use | Potential for large obstructions in the ocean floor from structures. | None; PV projects would be land-based and not impact submerged land uses. | None; solar thermal projects would be land-based and not impact submerged land uses. | None; land-based wind turbines would have no potential effects to submerged land use. | Potential impacts to sea floor requiring a submerged lands lease. |
| **Cultural and Historic Resources** | | | | | |
| | General construction and operation impacts.<br><br>Potential direct impacts from onshore and offshore construction activities to archaeological and historic properties, including burial sites and protected traditional and customary activities. | General construction and operation impacts.<br><br>Potential direct impacts from construction activities to archaeological and historic properties, including burial sites and protected traditional and customary activities. | General construction and operation impacts.<br><br>Potential direct impacts from construction activities to archaeological and historic properties, including burial sites and protected traditional and customary activities. | General construction and operation impacts.<br><br>The visual impact of wind turbines may be unacceptable near cultural and historic areas. | General construction and operation impacts.<br><br>The visual impact of wind turbines may be unacceptable near cultural and historic areas. |

**Table S-9b. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Ocean Thermal Energy Conversion | Photovoltaic Systems | Solar Thermal Systems | Wind (Land-Based) | Wind (Offshore) |
|---|---|---|---|---|---|
| | Increased likelihood of unauthorized access to culturally sensitive areas by worker presence during operations.<br><br>Potential for visual, noise, or restricted access effects on sensitive cultural and historic resources and activities.<br><br>Potential impact on a historical building, structure, or district by facilities being incompatible with the historic context of a structure or area. | Increased likelihood of unauthorized access to culturally sensitive areas by worker presence during operations.<br><br>Potential for visual, noise, or restricted access effects on sensitive cultural and historic resources and activities.<br><br>Potential impact on a historical building, structure, or district by facilities being incompatible with the historic context of a structure or area. | Increased likelihood of unauthorized access to culturally sensitive areas by worker presence during operations.<br><br>Potential for visual, noise, or restricted access effects on sensitive cultural and historic resources and activities.<br><br>Potential impact on a historical building, structure, or district by facilities being incompatible with the historic context of a structure or area. | Potential direct impacts from construction activities to archaeological and historic properties, including burial sites and protected traditional and customary activities.<br><br>Increased likelihood of unauthorized access to culturally sensitive areas by worker presence during operations.<br><br>Potential for visual, noise, or restricted access effects on sensitive cultural and historic resources and activities.<br><br>Potential impact on a historical building, structure, or district by facilities being incompatible with the historic context of a structure or area.<br><br>The visual impact of wind turbines may be unacceptable near cultural and historic areas where the historic integrity (setting, feeling, association, viewsheds) plays an important role in the value of the resource. | Potential direct impacts from onshore and offshore construction activities to archaeological and historic properties, including burial sites and protected traditional and customary activities.<br><br>Increased likelihood of unauthorized access to culturally sensitive areas by worker presence during operations.<br><br>Potential for visual, noise, or restricted access effects on sensitive cultural and historic resources and activities.<br><br>Potential impact on a historical building, structure, or district by facilities being incompatible with the historic context of a structure or area.<br><br>The visual impact of wind turbines may be unacceptable near cultural and historic areas where the historic integrity (setting, feeling, association, viewsheds) plays an important role in the value of the resource. |

**Table S-9b. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Ocean Thermal Energy Conversion | Photovoltaic Systems | Solar Thermal Systems | Wind (Land-Based) | Wind (Offshore) |
|---|---|---|---|---|---|
| **Coastal Zone Management** | | | | | |
| | Potential impacts to designated special management areas from the cable crossing the shoreline (site-specific).<br><br>Potential shorefront access impacts from the cable crossing the shoreline (site-specific).<br><br>Potential shoreline erosion impacts from the cable crossing the shoreline (site-specific). | Potential impacts to designated special management areas, shorefront access, and shoreline erosion (site-specific). | Potential impacts to designated special management areas, shorefront access, and shoreline erosion (site-specific);<br><br>Potential for adverse impacts to those locations near the shoreline.<br><br>Potential for increase in runoff and sedimentation and impacts to coastal water habitats from land clearing. | Potential impacts to designated special management areas, shorefront access, and shoreline erosion (site-specific). | Potential impacts to designated special management areas, shorefront access, and shoreline erosion (site-specific). |
| **Scenic and Visual Resources** | | | | | |
| | General visual impacts during construction.<br><br>Potential long-term visual impacts onshore from the introduction of a transition site. | General visual impacts during construction.<br><br>Potential long-term visual impacts from solar panels, including in association with new facilities and associated buildings.<br><br>Potential glinting, glare, and visual effects depending on the panel orientation, sun angle, viewing angle, viewer distance, and other visibility factors; may also be dependent on individual viewer sensitivity.<br><br>Potential long-term visual effects from routine maintenance activities. | General visual impacts during construction.<br><br>Potential long-term dynamic visual impacts from parabolic troughs/mirrors (glare/ reflected light), thermal storage tanks, steam condenser, cooling towers (plumes) and generator as well as road access, parking, maintenance facilities, and transmission line tie-in.<br><br>Potential for individual discomfort from glare effects, depending on viewer sensitivity, viewer location, viewer movement, and time of day. | General short-term visual impacts during construction including site preparation activities such as clearing, construction of access and onsite roads, equipment laydown areas, installation of turbine foundations, erection of turbines, and connection to the grid.<br><br>Potential long-term visual impacts from wind turbine operations including the presence of the wind turbines, movement of the rotor blades, shadow flicker, blade glinting, flashing aviation warning lights (nighttime in particular), roads, vehicles, and workers conducting maintenance activities. | Potential long-term visual impacts from wind turbine operations including the presence of the wind turbines, the sweeping movement of the blades, lighting for the marine and aviation navigation, and the land/sea transition site.<br><br>Depending on viewer sensitivity, potential for long-term impacts to viewers due to the strong vertical lines/ large sweep of turbines/ moving blades that can dominate views or command visual attention. |

**Table S-9b. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Ocean Thermal Energy Conversion | Photovoltaic Systems | Solar Thermal Systems | Wind (Land-Based) | Wind (Offshore) |
|---|---|---|---|---|---|
| | | | Potential increase in light pollution impacts (skyglow, light trespass, and glare) from security lighting and other exterior lighting around buildings, parking areas, work areas and during maintenance activities (vehicle-mounted lights). | Depending on viewer sensitivity, potential for long-term impacts to viewers nearby due to the strong vertical lines/ large sweep of turbines/ moving blades that can dominate views or command visual attention.<br><br>Depending on viewer sensitivity, potential for long-term shadow flicker impacts for viewers close enough to fall within the shadows cast by the turbines. | |
| **Recreation Resources** | | | | | |
| | General construction impacts.<br><br>Potential long-term impacts in the vicinity of onshore and offshore facilities from access restrictions and potential visual impacts from the facilities. | General construction impacts.<br><br>Potential long-term impacts such as land cover required for the arrays and associated facilities required for the project resulting in access restrictions to area as well as visual impacts created by the presence of the facilities and maintenance activities.<br><br>Potential impacts to nearby recreation areas from panels and other components that reflect and result in glinting, glare, and other visual effects. | General construction impacts.<br><br>Potential long-term impacts from access restrictions to the site and visual impacts associated with the new facilities.<br><br>Potential impacts to recreation resources from light pollution, particularly those areas where a dark night sky is valued (i.e., campgrounds). | General construction impacts.<br><br>Potential long-term impacts such as access restrictions due to the presence of wind turbines, movement of the rotor blades, shadow flicker, blade glinting, aviation warning lights, roads, vehicles, and workers conducting maintenance activities.<br><br>Potential impacts to nearby recreation areas from strong vertical lines of the turbines dominating views and large sweep of moving blades commanding visual attention. | General construction impacts.<br><br>Potential long-term impacts including access restrictions due to the presence of the wind turbines, the sweeping movement of the rotor blades, lighting for marine and aviation navigation, and the land/sea transition site. |

## Table S-9b. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)

| Resource Area | Ocean Thermal Energy Conversion | Photovoltaic Systems | Solar Thermal Systems | Wind (Land-Based) | Wind (Offshore) |
|---|---|---|---|---|---|
| | | | | Potential intrusion to the natural scenery and viewshed depending on the viewer sensitivity.<br>Potential impacts to the night sky for nearby recreation areas (i.e., campgrounds) from aviating warning lights. | |
| **Land and Marine Transportation** | | | | | |
| Land Transportation | None. | Short-term transportation impacts associated with construction traffic. | Short-term transportation impacts associated with construction traffic. | Potential short-term impacts on roadway traffic during project development (i.e., transportation of wind turbine components such as the blades and turbines to the construction site). | Potential short-term impacts on roadway traffic during project development (i.e., transportation of wind turbine components such as the blades and turbines to the harbor for transport to the construction site). |
| Marine Transportation | Potential obstruction impacts to marine navigation including to tourist cruises, passenger ferries, fishing vessels (recreational and commercial), and large commercial cargo ships.<br><br>Potential impacts to military marine operations, surface and subsurface navigation from both floating and submerged structures. | None; installation and operation of a utility-scale PV system would not impact marine transportation. | None; installation and operation of a solar thermal system would not have any marine transportation impacts as it would be totally land-based. | Minor impacts on marine transportation from shipment via marine cargo ship. | Potential navigation hazards to domestic and military marine transportation including to military submarine operations from undersea structures (mooring cables and power lines extending down to the ocean floor). |
| **Airspace Management** | | | | | |
| | Potential impacts to military transportation operations (marine surface and aviation operations). | Potential hazards to aircraft and pilots from sunlight reflection; dependent on the magnitude of reflection (glint and glare) from solar power systems. | Potential hazards to both military and civilian aircraft from reflections of the concentrated solar power facility. | Potential hazards to airspace navigation, both military (training and operations) and civilian (including tourist industry helicopters/fix-winged aircraft). | Potential hazards to airspace navigation, both military (training and operations) and civilian (including tourist industry helicopters/fix-winged aircraft). |

**Table S-9b. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Ocean Thermal Energy Conversion | Photovoltaic Systems | Solar Thermal Systems | Wind (Land-Based) | Wind (Offshore) |
|---|---|---|---|---|---|
| | Potential impacts on approach paths to airports. | | Potential air turbulence hazards to both military and civilian aircraft (likely limited to low altitude aircraft i.e., helicopters or during take-offs and landings) from Conservation Stewardship Program plants employing a dry cooling system. | Potential impacts to aviation navigation and communication systems such as radar.<br><br>Potential hazards to aircrafts downwind of rotor induced turbulence. | Potential impacts to aviation navigation and communication systems such as radar.<br><br>Potential hazards to aircrafts downwind of rotor-induced turbulence. |
| **Noise and Vibration** | | | | | |
| | Short-term noise and vibration impacts to sensitive noise receptors, including potential impacts to marine mammals and sea turtles.<br><br>Long-term noise and vibration impacts from operation of an ocean thermal energy conversion facility 3.5 miles off-shore would be minimal with implementation of best management practices. | General construction impacts. | General construction impacts. | General construction impacts.<br><br>Operational noise and vibration impacts from land-based wind turbines would occur when wind conditions are favorable, day or night. | Short-term noise and vibration impacts to sensitive noise receptors, including potential impacts to marine mammals and sea turtles.<br><br>Long-term noise and vibration impacts from operation of wind turbines located 5 miles offshore would be minimal with implementation of best management practices. |
| **Utilities and Infrastructure** | | | | | |
| | General construction impacts.<br><br>Potentially moderate effects to electric utilities (site-specific). | General construction impacts.<br><br>Potential minimal impacts to electric utilities (site-specific). | General construction impacts.<br><br>Potential minimal impacts to electric utilities (site-specific). | General construction impacts.<br><br>Potential minor impacts to electric utilities (site-specific). | General construction impacts.<br><br>Potential impacts to electric utilities (site-specific). |
| **Hazardous Materials and Waste Management** | | | | | |
| Hazardous Materials | General construction impacts. | General construction and operation impacts. | General construction impacts. | General construction impacts. | General construction impacts. |

**Table S-9b. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Ocean Thermal Energy Conversion | Photovoltaic Systems | Solar Thermal Systems | Wind (Land-Based) | Wind (Offshore) |
|---|---|---|---|---|---|
| | Potential exposure to hazardous materials during operations from large quantities of ammonia and/or chlorine gas/liquid, including through accidental releases or leaks.<br><br>Potential for fires or explosions from chorine and gaseous ammonia combinations. | Potential exposure to trace amounts of hazardous materials (i.e., cadmium, selenium, arsenic) if panels were broken. | | | Potential hazardous materials impacts associated with construction from munition response sites and the potential use of batteries for energy storage. |
| Waste Management | General construction impacts. | General construction and operation impacts.<br><br>Potential hazardous waste impacts resulting from trace amounts of cadmium, selenium, or arsenic if solar panels are broken and/or during solar panel decommissioning/disposal. | General construction impacts. | General construction impacts. | General construction impacts.<br><br>Minimal construction and demolition waste.<br><br>Potential impacts during the decommissioning and dismantling of the wind turbine as result of turbine removal. |
| Wastewater | Potential impacts to wastewater effluent from added chlorine. | General construction impacts.<br><br>Potential impacts from wastewater discharge resulting from disposal of PV modules at their end-life, particularly from potential leaching or contamination from cadmium containing materials. | General construction impacts. | General construction impacts. | Minor and limited wastewater impacts from construction and during operations/maintenance activities from personnel and machinery operations. |
| **Socioeconomics** | | | | | |
| | Very small population and economic benefits (i.e., few | Very small population and economic benefits (i.e., few | Very small population and economic benefits (i.e., few | Very small population and economic benefits (i.e., few | Very small population and economic benefits (i.e., few |

**Table S-9b. Summary of Impacts for Utility-Scale Renewable Technologies and Activities (continued)**

| Resource Area | Ocean Thermal Energy Conversion | Photovoltaic Systems | Solar Thermal Systems | Wind (Land-Based) | Wind (Offshore) |
|---|---|---|---|---|---|
| | net new jobs) during construction and operation. | net new jobs) during construction and operation. | net new jobs) during construction and operation. | net new jobs) during construction and operation. | net new jobs) during construction and operation. |
| **Environmental Justice** | | | | | |
| | Small potential impacts to the general population.<br><br>Site-specific evaluation of impacted populations required. | Small environmental justice impacts. No disproportionately high and adverse impacts to minority populations or to low-income populations from solar photovoltaic panels operations. | Minimal potential for environmental justice impacts due to small environmental impacts to general population. | Potential environmental justice impacts depending on siting location. | Small potential for environmental justice impacts. |
| **Health and Safety** | | | | | |
| | General construction and operation impacts.<br><br>Potential worker exposure to chlorine and ammonia gases. | General construction and operation impacts. | General construction and operation impacts. | General construction and operation impacts. | General construction and operation impacts.<br><br>Potential for public health and safety impacts including to boats, both civilian and military marine vessels, and to the public onshore in the unlikely event the device were destroyed, damaged or if the loss of mooring/ spatial stabilization were to occur. |

# S.9 Alternatives Considered by DOE

DOE NEPA implementing regulations require that a PEIS analysis include a no-action alternative, which provides a baseline for comparison against the impacts of the proposed action. Under the no-action alternative, DOE would continue to support, through funding and other actions, the State of Hawai‘i in meeting its HCEI goals on a case-by-case basis, but without guidance to integrate and prioritize funding decisions and other actions.

Implementation of the HCEI in Hawai‘i will occur whether or not DOE develops guidance to assist in making decisions or other actions related to clean energy in Hawai‘i. Therefore, the potential environmental impacts associated with each of the renewable energy technologies likely would also occur under the no-action alternative; however, there may not be formal guidance in place that would assist DOE in taking actions that maximize the benefits of certain technologies while minimizing the potential adverse environmental impacts in important resource areas. If the goals of the HCEI are not met, the State of Hawai‘i would remain heavily dependent on fossil fuels and statutory greenhouse gas targets probably would not be met.

## Preferred Alternative

CEQ regulations [40 CFR 1502.14(e)] require DOE to identify its preferred alternative in this Final PEIS. DOE plans to incorporate the information presented in this PEIS into guidance that could build upon the permitting requirements, best management practices, and potential mitigation measures identified to minimize potential environmental impacts for future development of renewable energy projects and energy efficiency activities. Therefore, DOE’s proposed action is also the preferred alternative.