3.1 Introduction

The Hidden Hills Solar Electric Generating System (HHSEGS) will be located on privately owned land in Inyo County, California, adjacent to the Nevada border. It will comprise two solar fields and associated facilities: the northern solar plant (Solar Plant 1) and the southern solar plant (Solar Plant 2). Each solar plant will generate 270 megawatts (MW) gross (250 MW net), for a total net output of 500 MW. Solar Plant 1 will occupy approximately 1,483 acres (or 2.3 square miles), and Solar Plant 2 will occupy approximately 1,510 acres (or 2.4 square miles). A 103-acre common area will be established on the southeastern corner of the site to accommodate an administration, warehouse, and maintenance complex, and an onsite switchyard. A temporary construction laydown and parking area on the west side of the site will occupy approximately 180 acres.

Each solar plant will use heliostats—elevated mirrors guided by a tracking system mounted on a pylon—to focus the sun’s rays on a solar receiver steam generator (SRSG) atop a tower near the center of each solar field. The solar power tower technology for the HHSEGS project design incorporates an important technology advancement, the 750-foot-tall solar power tower. One principle advantage of the HHSEGS solar power tower design is that it results in more efficient land use and greater power generation. The new, higher, 750-foot solar power tower allows the heliostat rows to be placed closer together, with the mirrors at a steeper angle. This substantially reduces mirror shading and allows more heliostats to be placed per acre. More megawatts can be generated per acre and the design is more efficient overall.

In each solar plant, one Rankine-cycle steam turbine will receive steam from the SRSG (or solar boiler) to generate electricity. The solar field and power generation equipment will start each morning after sunrise and, unless augmented, will shut down when insolation drops below the level required to keep the turbine online. Each solar plant will include a natural-gas-fired auxiliary boiler, used to augment the solar operation when solar energy diminishes or during transient cloudy conditions, as well as a startup boiler, used during the morning startup cycle, and a nighttime preservation boiler, used to maintain system temperatures overnight. On an annual basis heat input from natural gas will be limited by fuel use and other conditions to less than 10 percent of the heat input from the sun.

To save water in the site’s desert environment, each solar plant will use a dry-cooling condenser. Cooling will be provided by air-cooled condensers, supplemented by a partial dry-cooling system for auxiliary equipment cooling. Raw water will be drawn daily from onsite wells located in each power block and at the administration complex. Groundwater will be treated in an onsite treatment system for use as boiler make-up water and to wash the heliostats.
Two distinct transmission options are being considered because of a unique situation concerning Valley Electric Association (VEA): the Tecopa Road/SR 160 Option and the Eldorado Option. VEA has announced that it plans to become a participating transmission owner (PTO) and turn operational control of its facilities over to the California Independent System Operator (CAISO). The Tecopa Road/SR 160 Option is only viable if VEA is successful in this endeavor, and VEA determines that there is sufficient capacity on its existing 230-kilovolt (kV) system to accommodate HHSEGS.

The Tecopa Road/SR 160 Option would require an approximately 10-mile-long generation tie-line (gen-tie line) from HHSEGS to the proposed Tap Substation, where the project would interconnect to the electric grid. The transmission line would originate at HHSEGS’s onsite switchyard, cross the state line and follow it (on the Nevada side) southeast turning northeast along Tecopa Road to the Tap Substation. The Tecopa Road/SR 160 Option also includes a 230-kV transmission line from the Tap Substation into the town of Pahrump with approximately 28.1 miles of transmission line and a 2-acre switch on private land with a 1-mile-long connection to the Eldorado Substation. The Tecopa Road/SR 160 Option is viable only if the Tap Substation and the associated transmission lines ultimately become part of the CAISO Balancing Authority Area, pursuant to VEA’s current plans, and sufficient excess capacity exists on the 230-kV system to accommodate HHSEGS’s transmission needs.

If VEA does not become a PTO,\(^1\) HHSEGS will use the Eldorado Option—a 500 kV gen-tie line to directly interconnect to the Eldorado Substation in Boulder City, Nevada. Under this scenario, the gen-tie line would follow the same 10-mile-long route to the Tap Substation as the Tecopa Road/SR 160 Option, and would continue for approximately 53.7 miles to the Eldorado Substation in Boulder City, Nevada, for direct interconnection to the CAISO-controlled grid. The proposed gen-tie line would likely be a multi-generator transmission line that could be available to serve other projects in the region.

To advance these proposed transmission arrangements for the project, the Applicant has filed an interconnection request for the projects with both VEA and CAISO. Copies of the study agreements and proof of payment are attached as Appendixes 3A and 3B, respectively. VEA is working with CAISO on a process for integrating its queue with the CAISO queue in the event that it becomes a PTO, and BrightSource is actively engaged in that process.

This section primarily discusses the transmission-related facilities located onsite, within the state of California. Under either option, the approximately 10-mile-long gen-tie line leaves the state of California 900 feet after exiting the HHSEGS onsite switchyard when it crosses over the eastern border of the project site. The necessary transmission facilities are located in Nevada once they leave the site and are subject to the U.S. Bureau of Land Management’s (BLM) permitting process. In addition, because the transmission facilities in Nevada will be addressed in a National Environmental Policy Act (NEPA) Environmental Impact Statement, these facilities are statutorily exempt from California Environmental Quality Act

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\(^1\) It is also possible that even if VEA becomes a PTO, the existing VEA 230 kV transmission line may not have sufficient capacity to accommodate the entire output of the HHSEGS project. Under this scenario, it is likely that the 500 kV gen tie line would become a CAISO network upgrade in Nevada.
(CEQA) review. Courtesy copies of materials provided to BLM will also be provided to the California Energy Commission (CEC) upon filing with BLM.

3.2 Onsite Facilities

3.2.1 Solar Plants and Gen-tie Lines
Solar Plant 1 and Solar Plant 2 will be connected to the electric grid via a gen-tie line (one circuit per generator) between each solar plant’s power block and the 230-kV onsite switchyard in the common area. Each facility’s interconnections are electrically identical except for the routing of the gen-tie lines. Power will leave the solar plants through each facility’s respective 13.8-kV generator circuit breaker, a 13.8-kV to 230-kV generator step-up transformer, and a 230-kV gas-insulated circuit breaker at the plant switchyard. Each of the gen-tie lines will be constructed underground from the power block through the heliostat field and will transition to an overhead configuration at the edge of the heliostat field until reaching the onsite switchyard. Power will be transmitted approximately 3,800 feet (0.7 mile) underground and 10,275 feet (1.9 miles) overhead for Solar Plant 1, and 7,300 feet (1.4 miles) underground and 3,270 feet (0.6 mile) overhead for Solar Plant 2 (see Figure 3.2-1, all figures at the end of their respective sections).

The conductors for each solar plant will be selected based on the maximum operating output capability of each facility determined by final heat balances. Ratings indicate a worst-case nominal output of 800 amperes. A 795-kcmil “DRAKE” ACSR conductor capable of carrying 800 amperes continuous, or alternative conductor selected during final engineering design, is recommended for the nameplate rating output.

From the onsite switchyard, the transmission line will head east approximately 900 feet where it crosses the state line into Nevada.

3.2.2 Onsite 230-kV Switchyard
The onsite 230-kV switchyard will consist of six 230-kV sulfur hexafluoride (SF₆) gas-insulated power circuit breakers arranged in a breaker-and-a-half configuration (Figure 3.2-2). The switchyard and all associated equipment will be designed for the maximum short-circuit and load-flow design conditions for the installation projected at least 25 years into the future. The switchyard will accept two generation feeds and two 230-kV lines connecting to the electrical grid.

All termination positions will have disconnect switches, surge arrestors, and coupling capacitor voltage devices required for the operation, maintenance, and protection of the lines and facilities. The switchyard will have a switchyard control building designed to accommodate all protection and control equipment, alternating current (AC) and direct current (DC) station power equipment and building HVAC equipment.

3.3 Transmission System Safety and Nuisances
This section discusses safety and nuisance issues associated with the onsite switchyard and gen-tie lines. Impacts from the offsite transmission lines will be considered under BLM’s NEPA analysis.
3.3.1 Electrical Clearances

Typical high-voltage overhead transmission lines are composed of bare conductors connected to supporting structures by means of porcelain, glass, or plastic insulators. The air surrounding the energized conductor acts as the insulating medium. Maintaining sufficient clearances, or air space, around the conductors to protect the public and utility workers is paramount to safe operation of the line. The safety clearance required around the conductors is determined by normal operating voltages, conductor temperatures, short-term abnormal voltages, wind-blown swinging conductors, contamination of the insulators, clearances for workers, and clearances for public safety. Minimum clearances are specified in the National Electrical Safety Code (NESC). Electric utilities, state regulators, and local ordinances may specify additional (more restrictive) clearances. Typically, clearances are specified for:

- Distance between the energized conductors themselves
- Distance between the energized conductors and the supporting structure
- Distance between the energized conductors and other power or communication wires on the same supporting structure, or between other power or communication wires above or below the conductors
- Distance from the energized conductors to the ground and features such as roadways, railroads, driveways, parking lots, navigable waterways, airports, etc.
- Distance from the energized conductors to buildings and signs
- Distance from the energized conductors to other parallel power lines

The HHSEGS gen-tie lines will be designed to meet all national, state, and local code clearance requirements.

3.3.2 Electrical Effects

The electrical effects of high-voltage transmission lines fall into two broad categories: corona effects and field effects. Corona is the ionization of the air that occurs at the surface of the energized conductor and suspension hardware due to very high electric field strength at the surface of the metal during certain conditions. Corona may result in radio and television reception interference, audible noise, light, and production of ozone. Corona is a function of the voltage of the line, the diameter of the conductor (or bundle of conductors), and the condition of the conductor and hardware. Field effects are the voltages and currents that may be induced in nearby conducting objects. The transmission line’s 60-hertz (Hz) cycle for alternating current can cause these electric and magnetic field (EMF) effects.

3.3.2.1 Electric and Magnetic Fields

Operating power lines, like the energized components of electrical motors, home wiring, lighting, and all other electrical appliances, produce electric and magnetic fields, commonly referred to as EMF. The EMF produced by the alternating current electrical power system in the United States has a frequency of 60 Hz, meaning that the intensity and orientation of the field changes 60 times per second.
The 60-Hz power line fields are considered to be extremely low frequency. Other common frequencies are AM radio, which operates up to 1,600,000 Hz (1.6 MHz); television, 890,000,000 Hz (890 MHz); cellular telephones, 900,000,000 Hz (900 MHz); microwave ovens, 2,450,000,000 Hz (2.4 GHz); and X-rays, about 1 billion billion (10^{18}) Hz. Higher frequency fields have shorter wavelengths and greater energy in the field. Microwave wavelengths are a few inches long and have enough energy to cause heating in conducting objects. High frequencies, such as X-rays, have enough energy to cause ionization (breaking of atomic or molecular bonds). At the 60-Hz frequency associated with electric power transmission, the electric and magnetic fields have a wavelength of 3,100 miles and have very low energy that does not cause heating or ionization. The 60-Hz fields do not radiate, unlike radio-frequency fields.

Electric fields around transmission lines are produced by electrical charges on the energized conductor. Electric field strength is directly proportional to the line’s voltage; that is, increased voltage produces a stronger electric field. The electric field is inversely proportional to the distance from the conductors, so that the electric field strength declines as the distance from the conductor increases. The strength of the electric field is measured in units of kilovolts per meter (kV/m). The electric field around a transmission line remains practically steady and is not affected by the common daily and seasonal fluctuations in usage of electricity by customers.

Magnetic fields around transmission lines are produced by the level of current flow, measured in terms of amperes, through the conductors. The magnetic field strength is also directly proportional to the current; that is, increased amperes produce a stronger magnetic field. The magnetic field is inversely proportional to the distance from the conductors. Thus, like the electric field, the magnetic field strength declines as one moves away from the conductor. Magnetic fields are expressed in units of milligauss (mG). The amperes fluctuate daily and seasonally as the usage of electricity varies, resulting in corresponding changes to the magnetic field around a transmission line.

Considerable research has been conducted over the last 30 years on the possible biological effects and human health effects from EMF. This research has produced many studies that offer no uniform conclusions about whether long-term exposure to EMF is harmful or not. In the absence of conclusive or evocative evidence, some states, California in particular, have chosen not to specify maximum acceptable levels of EMF. Instead, these states mandate a program of prudent avoidance whereby EMF exposure to the public would be minimized by encouraging electric utilities to use low-cost techniques to reduce the levels of EMF.

**3.3.2.1.1 Transmission Line EMF Reduction**

In keeping with the goal of EMF reduction, the gen-tie lines will be designed and constructed using the principles outlined in the Southern California Edison Company (SCE) publication, “EMF Design Guidelines for Electrical Facilities” (SCE, 2004).

The primary techniques for reducing EMF anywhere along a transmission line are to:

1. Increase the pole height for overhead design
2. Use compact pole-head configuration
3. Minimize the current on the line
4. Optimize the configuration of the phases (A, B, C)
3.3.2.2 Corona Effects

Corona is a function of the voltage of the line, the diameter of the conductor, and the condition of the conductor and suspension hardware. The electric field gradient that causes corona is the rate at which the strength of the electric field changes with distance and is directly related to the line voltage. Corona typically becomes a design concern for transmission lines at 345 kV and higher, and is less noticeable on lines operated at lower voltages.

The electric field gradient is greatest at the surface of the conductor. Large-diameter conductors have lower electric field gradients at the conductor surface and, hence, lower corona than smaller conductors, everything else being equal. Irregularities (such as nicks and scrapes on the conductor surface) or sharp edges on suspension hardware concentrate the electric field at these locations and, thus, increase the electric field gradient and corona at these spots. Similarly, contamination on the conductor surface, such as dust or insects, can cause irregularities that are a source for corona. Corona also increases at higher elevations where the density of the atmosphere is less than at sea level.

Raindrops, snow, fog, frost, hoarfrost, and condensation accumulated on the conductor surface are sources of surface irregularities that can increase corona. During fair weather, the number of these sources is usually small and the corona effect is also small. However, during wet weather, the number of these sources increases (for instance due to rain drops standing on the conductor and energized hardware) and corona effects are greater. During these wet conditions or foul weather conditions, the conductor will produce the greatest amount of corona noise. However, during heavy rain the ambient noise generated by the falling rain drops is generally greater than that generated by corona. However, HHSEGS will likely not be operating during inclement weather, so corona would likely not occur during rains.

3.3.2.2.1 Audible Noise

Corona-generated audible noise from transmission lines is generally characterized as a crackling, hissing, or humming noise. The noise is most noticeable during wet conductor conditions such as rain or fog. Sometimes a 120-Hz hum is also present during foul weather. During fair weather, audible noise may be barely perceptible as a sporadic hissing, crackling or humming sound. Audible noise from transmission lines is often lost in the background noise at locations beyond the edge of the right-of-way, particularly where the line runs near a source of background noise such as a freeway. Because the gen-tie lines will be onsite, there will be no increase in public exposure to audible noise. In addition, the gen-tie line connecting to the Solar Plant 2 power block (the area closest to residences) will be underground once it passes the administration complex, and therefore, will not emit audible noise.

3.3.2.2.2 Radio Interference

Corona-generated radio interference is most likely to affect the amplitude modulation (AM) radio broadcast band (535 to 1,605 kilohertz); frequency modulation (FM) radio is rarely affected. Only AM receivers that are tuned to a weak station and are near transmission lines have the potential to be affected by radio interference. An example is the humming noise on an AM radio that happens when the radio is near a power line but diminishes as the radio moves away from the line. The gen-tie line closest to residences will be underground, further diminishing the possibility of radio interference to the public.
3.3.2.3 EMF and Corona Conclusions
Because the gen-tie lines will be located onsite, their presence will not increase public exposure to either EMF or audible noise.

3.3.2.4 Induced Current and Voltages
A conducting object such as a vehicle or person in an electric field will have induced voltages and currents. The strength of the induced current will depend on the electric field strength, the size and shape of the conducting object, and the object-to-ground resistance. Examples of measured induced currents in a 1-kV/m electric field are about 0.016 milliampere (mA) for a person, about 0.41 mA for a large school bus, and about 0.63 mA for a large trailer truck.

When a conducting object is isolated from the ground and a grounded person touches the object, a perceptible current or shock may occur as the current flows to ground. Shocks are classified as below perception, above perception, secondary, and primary. The mean perception level is 1.0 mA for a 180-pound man and 0.7 mA for a 120-pound woman. Secondary shocks cause no direct physiological harm, but may annoy a person and cause involuntary muscle contraction. The lower average secondary-shock level for an average-sized man is about 2 mA.

Primary shocks can be harmful. Their lower level is described as the current at which 99.5 percent of subjects can still voluntarily “let go” of the shocking electrode. For the 180-pound man this is 9 mA; for the 120-pound woman, 6 mA; and for children, 5 mA. The NESC specifies 5 mA as the maximum allowable short-circuit current to ground from vehicles, trucks, and equipment near transmission lines.

The mitigation for hazardous and nuisance shocks is to ensure that metallic objects on or near the right-of-way are grounded and that sufficient clearances are provided at roadways and parking lots to keep electric fields at these locations sufficiently low to prevent vehicle short-circuit currents from exceeding 5 mA.

Magnetic fields can also induce voltages and currents in conducting objects. Typically, this requires a long metallic object, such as a wire fence or aboveground pipeline that is grounded at only one location. A person who closes an electrical loop by grounding the object at a different location will experience a shock similar to that described above for an ungrounded object. Mitigation for this problem is to ensure multiple grounds on fences or pipelines, especially those that are oriented parallel to the transmission line.

3.3.3 Fire Hazards
The onsite gen-tie lines will be designed, constructed, and maintained in accordance with the stringent requirement of the NESC. The NESC establishes clearances from other man-made and natural structures as well as tree-trimming requirements to mitigate fire hazards. The proposed onsite transmission corridors are not located in the vicinity of facilities that would contribute to a fire hazard.
3.4 Applicable Laws, Ordinances, Regulations, and Standards

This section provides a list of applicable laws, ordinances, regulations, and standards (LORS) that apply to the onsite facilities, including the switchyard during the construction and operations phases of the project.

3.4.1 Design and Construction LORS

Table 3.4-1 lists the applicable LORS for the design and construction of the onsite facilities, including the switchyard.

<table>
<thead>
<tr>
<th>LORS</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 1119 “IEEE Guide for Fence Safety Clearances in Electric-Supply Stations”</td>
<td>Provides recommended clearance practices to protect persons outside the facility from electric shock.</td>
</tr>
<tr>
<td>IEEE 998 “Direct Lightning Stroke Shielding of Substations”</td>
<td>Provides recommendations to protect electrical system from direct lightning strokes.</td>
</tr>
<tr>
<td>IEEE 980 “Containment of Oil Spills for Substations”</td>
<td>Provides recommendations to prevent release of fluids into the environment.</td>
</tr>
<tr>
<td>Suggestive Practices for Raptor Protection on Power lines, April 1996</td>
<td>Provides guidelines to avoid or reduce raptor collision and electrocution.</td>
</tr>
<tr>
<td>Overhead Conductor Manual</td>
<td>Provides general design guidelines.</td>
</tr>
<tr>
<td>Electrical and Biological Effects of Transmission Lines, A Review</td>
<td>Provides guidelines to avoid or reduce raptor collision and electrocution.</td>
</tr>
</tbody>
</table>

3.4.2 Hazardous Shock LORS

Table 3.4-2 lists the LORS regarding hazardous shock protection for the onsite facilities, including the switchyard.

<table>
<thead>
<tr>
<th>LORS</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>NESC, ANSI C2, Section 9, Article 92, Paragraph E; Article 93, Paragraph C.</td>
<td>Covers grounding methods for electrical supply and communications facilities.</td>
</tr>
</tbody>
</table>
3.4.3 Communication Interference LORS
The applicable LORS pertaining to communication interference are listed in Table 3.4-3.

TABLE 3.4-3
Communications Interference LORS

<table>
<thead>
<tr>
<th>LORS</th>
<th>Appliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title 47 CFR Section 15.25, “Operating Requirements, Incidental Radiation”</td>
<td>Prohibits operations of any device emitting incidental radiation that causes interference to communications. The regulation also requires mitigation for any device that causes interference.</td>
</tr>
</tbody>
</table>

3.4.4 Fire Hazard LORS
Table 3.4-4 lists the LORS governing fire hazard protection for the onsite facilities, including the switchyard.

TABLE 3.4-4
Fire Hazard LORS

<table>
<thead>
<tr>
<th>LORS</th>
<th>Appliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 CFR 1250-1258</td>
<td>Fire Prevention Standards for Electric Utilities</td>
</tr>
</tbody>
</table>

3.4.5 Jurisdictional Agencies
Table 3.4-5 identifies agencies with jurisdiction related to the above-referenced LORS.

TABLE 3.4-5
Jurisdictional Agencies for Onsite Facilities, Including the Switchyard LORS

<table>
<thead>
<tr>
<th>Agency or Jurisdiction</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>California Public Utility Commission</td>
<td>Regulates construction and operation of power and communications lines for the prevention of inductive interference. (General Order No. 52)</td>
</tr>
<tr>
<td>Federal Aviation Administration</td>
<td>Establishes regulations for marking and lighting of obstructions in navigable airspace. (AC No. 70/7460-1G)</td>
</tr>
</tbody>
</table>

3.5 References

California Public Service Commission, General Order 52-Construction and Operation of Power and Communication Lines

California Public Service Commission, General Order 95-Rules for Overhead Electric Line Construction.


United States of America, 47CFR15.25-Operating Requirements, Incidental Radiation.
Figure 3.2-1
Onsite Gen-tie Lines
Hidden Hills Solar Electric Generating System

LEGEND
- Solar Power Towers
- Transmission Line
- Underground Transmission Line
- Solar Field Heliostat Arrays
- Access Roads
- HHSEGS Boundary

Source: DWG. M-SK-001
FIGURE 3.2-2
230 kV Switchyard One-line Diagram
Hidden Hills Solar Electric Generating System

Source: Drawing E-SKE-001, Rev 0.