

POWER PLANT RELIABILITY

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SUMMARY OF CONCLUSIONS

The applicant predicts an equivalent availability factor of 92 to 98 percent, which U.S. Bureau of Land Management (BLM) and California Energy Commission staff (hereafter jointly referred to as staff) believe is achievable. (The availability factor of a power plant is the percentage of time it is available to generate power; both planned and unplanned outages subtract from this availability.) Based on a review of the proposal, staff concludes that the Ivanpah Solar Electric Generating System (ISEGS) would be built and would operate in a manner consistent with industry norms for reliable operation. This should provide an adequate level of reliability. Conditions of Certification referred to herein serve the purpose of both the Energy Commission's Conditions of Certification for purposes of the California Environmental Quality Act and BLM's Mitigation Measures for purposes of the National Environmental Policy Act (NEPA).

INTRODUCTION

In this analysis, staff addresses the reliability issues of the ISEGS project to determine if the power plant is likely to be built in accordance with typical industry norms for reliable power generation. Staff uses this norm as a benchmark because it ensures that the resulting project would not be likely to degrade the overall reliability of the electric system it serves (see the "Setting" subsection, below).

The scope of this power plant reliability analysis covers:

- equipment availability;
- plant maintainability;
- fuel and water availability; and
- power plant reliability in relation to natural hazards.

Staff examined the project design criteria to determine if the project is likely to be built in accordance with typical industry norms for reliable power generation. While the applicant has predicted an equivalent availability factor of 92 to 98 percent for the ISEGS (see below), staff uses typical industry norms as the benchmark, rather than the applicant's projection, to evaluate the project's reliability.

LAWS, ORDINANCES, REGULATIONS, AND STANDARDS

No federal, state, or local/county laws, ordinances, regulations, or standards (LORS) apply to the reliability of this project. Power plant reliability is not normally considered under NEPA.

SETTING

In the restructured competitive electric power industry, the responsibility for maintaining system reliability falls largely to the state's control area operators, such as the California Independent System Operator (California ISO), that purchase, dispatch, and sell electric power throughout the state. Determining how the California ISO and other control area operators would ensure system reliability has been an ongoing effort. Protocols have been developed and put in place that allow sufficient reliability to be maintained under the competitive market system. "Must-run" power purchase agreements and "participating generator" agreements are two mechanisms that have been employed to ensure an adequate supply of reliable power.

In September 2005, California AB 380 (Núñez, Chapter 367, Statutes of 2005) became law. This modification to the Public Utilities Code requires the California Public Utilities Commission to consult with the California ISO to establish resource adequacy requirements for all load-serving entities (basically, publicly and privately owned utility companies). These requirements include maintaining a minimum reserve margin (extra generating capacity to serve in times of equipment failure or unexpected demand) and maintaining sufficient local generating resources to satisfy the load-serving entity's peak demand and operating reserve requirements.

In order to fulfill this mandate, the California ISO has begun to establish specific criteria for each load-serving entity under its jurisdiction. These criteria guide each load-serving entity in deciding how much generating capacity and ancillary services to build or purchase, after which the load-serving entity issues power purchase agreements to satisfy these needs. According to the applicant, the ISEGS is currently in negotiation with Southern California Edison to secure a power purchase agreement.

The California ISO's mechanisms to ensure adequate power plant reliability apparently were devised under the assumption that the individual power plants that compete to sell power into the system will each exhibit a level of reliability similar to that of power plants of past decades. However, there has been valid cause to believe that, under free market competition, financial pressures on power plant owners to minimize capital outlays and maintenance expenditures may act to reduce the reliability of many power plants, both existing and newly constructed (McGraw-Hill 1994). It is possible that, if significant numbers of power plants were to exhibit individual reliability sufficiently lower than this historical level, the assumptions used by California ISO to ensure system reliability would prove invalid, with potentially disappointing results. Accordingly, staff has recommended that power plant owners continue to build and operate their projects to the level of reliability to which all in the industry are accustomed.

As part of its plan to provide needed reliability, the applicant proposes to operate the 400-megawatt (MW) (net power output) ISEGS, a solar thermal power plant facility, comprised of two 100-MW plants (Ivanpah 1 and Ivanpah 2) and one 200-MW plant (Ivanpah 3), employing advanced solar power technology. This project, using renewable solar energy, would provide dependable power to the grid, generally during the hours of peak power consumption by the interconnecting utility(s) (BSE 2007a, AFC §§1.1, 1.2, 2.1, 2.2). This project would help serve the need for renewable energy in California, as 95 percent of the generated electricity would be produced by solar energy, a reliable

source of energy that is available during the hot summer afternoons, when power is needed most. Small natural gas-fired boilers would be used to bring the system up to operating temperature in the morning and periodically to keep system temperatures up when clouds briefly block the sunlight. These boilers are expected to be in use to produce only 5 percent of the average annual energy.

The project is expected to achieve an equivalent availability factor in the range of 92 to 98 percent (BSE 2007a, AFC §2.3.2.1). The project is anticipated to normally operate at high average annual capacity factors during periods of sunlight (BSE 2007a, AFC §2.3.21).

ASSESSMENT OF IMPACTS

METHOD FOR DETERMINING RELIABILITY

The Energy Commission must make findings as to how a project is designed, sited, and operated in order to ensure its safe and reliable operation (Title 20, CCR §1752[c]). Staff takes the approach that a project is acceptable if it does not degrade the reliability of the utility system to which it is connected. This is likely the case if a project is at least as reliable as other power plants on that system.

The availability factor of a power plant is the percentage of time it is available to generate power; both planned and unplanned outages subtract from this availability. Measures of power plant reliability are based upon both the plant's actual ability to generate power when it is considered to be available and upon starting failures and unplanned (or forced) outages. For practical purposes, reliability can be considered a combination of these two industry measures, making a reliable power plant one that is available when called upon to operate. Throughout its intended 50-year life, the ISEGS is expected to operate reliably. Power plant systems must be able to operate for extended periods without shutting down for maintenance or repairs. Achieving this reliability requires adequate levels of equipment availability, plant maintainability with scheduled maintenance outages, fuel and water availability, and resistance to natural hazards. Staff examines these factors for a project and compares them to industry norms. If the factors compare favorably for this project, staff will then conclude that the ISEGS would be as reliable as other power plants on the electric system and would not degrade system reliability.

PROPOSED PROJECT

Equipment Availability

Equipment availability would be ensured by adoption of appropriate quality assurance/quality control (QA/QC) programs during the design, procurement, construction, and operation of the plant and by providing for the adequate maintenance and repair of the equipment and systems discussed below.

Quality Control Program

The applicant describes a QA/QC program (BSE 2007a, AFC §2.3.2.5) that is typical of the power industry. Equipment would be purchased from qualified suppliers based on

technical and commercial evaluations. Suppliers' personnel, production capability, past performance, QA programs, and quality history would be evaluated. The project owner would perform receipt inspections, test components, and administer independent testing contracts. Staff expects that implementation of this program would result in standard reliability of design and construction. To ensure this implementation, staff has proposed appropriate conditions of certification in the section of this document entitled **Facility Design**.

Plant Maintainability

Equipment Redundancy

The project, as proposed in the AFC, would be able to operate only when the sun is shining. Maintenance or repairs could be done when the plant is shut down at night. This would help to enhance the project's reliability. Also, the applicant proposes to provide redundant pieces of equipment for those that are most likely to require service or repair. This redundancy would allow service or repair to be done during sunny days when the plant is in operation, if required.

The applicant plans to provide an appropriate redundancy of function for the project (BSE 2007a, AFC §2.3.2.2, Table 2.3-1). Because the project consists of three independent steam turbine generators, it is inherently reliable. A single equipment failure could not disable more than one plant, which would allow the other two plants to continue to generate at their full output. All other major plant systems are also designed with adequate redundancy to ensure their continued operation if equipment fails. Staff believes that this project's proposed equipment redundancy would be sufficient for its reliable operation.

Maintenance Program

Equipment manufacturers provide maintenance recommendations for their products, and the applicant is expected to base the project's maintenance program on those recommendations. The program would encompass both preventive and predictive maintenance techniques. Maintenance outages would probably be planned for periods of low electricity demand. Staff expects that the project would be adequately maintained to ensure an acceptable level of reliability.

Fuel and Water Availability

The long-term availability of fuel and of water for cooling or process use is necessary to ensure the reliability of any power plant. The need for reliable sources of fuel and water is obvious; lacking long-term availability of either source, the service life of the plant could be curtailed, threatening both the power supply and the economic viability of the plant.

Fuel Availability

Natural gas would be delivered to the project site through a new 6-mile, 4- to 6-inch diameter gas pipeline connected to the existing Kern River Gas Transmission Pipeline owned by Kern River Gas Transmission Company (KRG T). The natural gas service would be provided to ISEGS by Southwest Gas Company. The ISEGS would connect to

the KRGT pipeline 0.5 miles north of Ivanpah 3 (BSE 2007a, AFC §§1.2, 4.1). The KRGT pipeline system is a vital artery bringing natural gas into Utah, Nevada, and California. This system extends from the oil and gas producing fields of southwestern Wyoming through Utah and Nevada to the San Joaquin Valley near Bakersfield, California. According to KRGT, the pipeline currently has a design capacity of more than 1.7 billion cubic feet per day (KRGT 2007). The ISEGS would be a solar thermal power plant and the use of natural gas would be limited to unit warm up and brief periods of cloud cover. The use of natural gas is not anticipated to exceed 4 hours per day maximum and an average of 1 hour per day on average, and would not contribute to more than 5 percent of the average annual energy. The very limited use of fuel would have minimal impact on gas supplies. Staff believes that there will be adequate natural gas supply and pipeline capacity to meet the project's needs.

Water Supply Reliability

The ISEGS would use well water for domestic and industrial water needs. Two 100-percent capacity wells would be located at the northwest corner of Ivanpah 1, just outside the perimeter fence but within the construction logistics area and would supply water to all three plants. The wells would be connected to the project via a 570-foot water line to Ivanpah 2, from which the line would be extended to each plant (BSE 2007a, AFC §§1.2, 2.1, 2.2.7, 2.3.2.4). To minimize process water use associated with cooling, air-cooled condensers would be used. Package treatment plants would be used to provide potable water for drinking and sanitary uses. Staff believes these sources represent a reliable supply of water for the project. For further discussion of water supply, see the **Soil and Water Resources** section of this document.

Power Plant Reliability In Relation To Natural Hazards

Natural forces can threaten the reliable operation of a power plant. High winds, tsunamis (tidal waves), and seiches (waves in inland bodies of water) are not likely to present hazards for this project, but seismic shaking (earthquakes) and flooding could present credible threats to the project's reliable operation.

Seismic Shaking

The site lies within Seismic Zone 3 (BSE 2007a, AFC §2.3.1.1.1); see the "Faulting and Seismicity" portion of the **Geology, Paleontology & Minerals** section of this document. The project will be designed and constructed to the latest appropriate LORS (BSE 2007a, AFC Appendix 2). Compliance with current seismic design LORS represents an upgrading of performance during seismic shaking compared to older facilities since these LORS have been continually upgraded. Because it would be built to the latest seismic design LORS, this project would likely perform at least as well as, and perhaps better than, existing plants in the electric power system. Staff has proposed conditions of certification to ensure this; see the section of this document entitled **Facility Design**. In light of the general historical performance of California power plants and the electrical system in seismic events, staff has no special concerns with the power plant's functional reliability during seismic events.

Flooding

The project site elevation is approximately 2,765 feet above mean sea level (BSE 2007a, AFC §5.8.3.1). According to the Federal Emergency Management Agency, the site is not within either the 100- or 500-year flood plain (BSE 2007a, AFC §§2.3.1.1.1, 5.15.3.1.3). Staff believes there are no special concerns with power plant functional reliability due to flooding. For further discussion, see **Soil and Water Resources and Geology, Paleontology & Minerals**.

Comparison with Existing Facilities

The North American Electric Reliability Corporation (NERC) maintains industry statistics for availability factors (as well as other related reliability data). The NERC regularly polls North American utility companies on their project reliability through its Generating Availability Data System and periodically summarizes and publishes those statistics on the Internet <<http://www.nerc.com>>. Because solar technology is relatively new, no statistics are available for solar power plants. The project's power cycle is based on steam cycle. Because natural gas is the primary type of fossil fuel used in California, staff finds it reasonable to compare the project's availability factor to the average availability factor of natural gas-fired fossil fuel units. Also, because the project's total net power output would be 400 MW, staff uses the NERC statistics for 400–599 MW units. The NERC reported an availability factor of 85.07 percent as the generating unit average for the years 2002 through 2006 for natural gas units of 400–599 MW (NERC 2007).

The project would use triple-pressure, condensing steam turbine technology. Steam turbines incorporating this technology have been on the market for many years now and are expected to exhibit typically high availability. Also, because solar-generated steam is cleaner than burnt fossil fuel (i.e., natural gas), the ISEGS steam cycle units would likely require less frequent maintenance than units that burn fossil fuel. Therefore, the applicant's expectation of an annual availability factor of 92 to 98 percent (BSE 2007a, AFC §2.3.2.1) appears reasonable when compared with the NERC figures throughout North America (see above). In fact, these machines can well be expected to outperform the fleet of various turbines (mostly older and smaller) that make up NERC statistics. Additionally, because the plant would consist of three independent steam turbine generators, maintenance could be scheduled during times of the year when the full power output is not required to meet market demand, which is typical of industry standard maintenance procedures. The applicant's estimate of plant availability, therefore, appears to be realistic. Stated procedures for assuring the design, procurement, and construction of a reliable power plant appear to be consistent with industry norms, and staff believes they are likely to ultimately produce an adequately reliable plant.

CLOSURE AND DECOMMISSIONING AND MITIGATION

The closure or decommissioning of the ISEGS project would not maintain utilization of a solar renewable energy resource and could cause an increase in the reliance on fossil fuel. While this would not be the case if another solar power generation project were to follow in the place of ISEGS, this potential outcome is not assured at this time.

Therefore, the closure and decommissioning of ISEGS could result in a potentially negative impact in discontinuing to utilize renewable solar resources for power production compared to when ISEGS would be operating. However, this impact would not be the responsibility of the project owner to mitigate.

NO PROJECT / NO ACTION ALTERNATIVE

In the No Project / No Action Alternative, the proposed action would not be undertaken. The BLM land on which the project is proposed would continue to be managed within BLM's framework of a program of multiple use and sustained yield, and the maintenance of environmental quality [43 U.S.C. 1781 (b)] in conformance with applicable statutes, regulations, policy and land use plan.

The results of the No Project / No Action Alternative would be the following:

- The impacts of the proposed project would not occur. However, the land on which the project is proposed would become available to other uses that are consistent with BLM's land use plan, including another solar project.
- The benefits of the proposed project in reducing greenhouse gas emissions from gas-fired generation would not occur. Both State and Federal law support the increased use of renewable power generation.

If this project is not approved, renewable projects would likely be developed on other sites in the Mojave Desert or in adjacent states as developers strive to provide renewable power that complies with utility requirements and State/Federal mandates. For example, there are three large solar projects proposed on BLM land in Nevada within a few miles of the Ivanpah site. In addition, there are currently 66 applications for solar projects covering 611,692 acres pending with BLM in the California Desert District.

NOTEWORTHY PROJECT BENEFITS

This project would help serve the need for renewable energy in California, as 95 percent of the generated electricity would be produced by a reliable source of solar energy that is available during the hot summer afternoons, when power is needed most. Small natural gas-fired boilers would be used to bring the system up to operating temperature in the morning and periodically to keep system temperatures up when clouds briefly block the sunlight. These boilers are expected to contribute to no more than 5 percent of ISEGS' average annual energy.

CONCLUSION

The applicant predicts an equivalent availability factor of 92 to 98 percent, which staff believes is achievable. Based on a review of the proposal, staff concludes that the plant would be built and operated in a manner consistent with industry norms for reliable operation. This should provide an adequate level of reliability. No conditions of certification are proposed.

RESPONSES TO AGENCY AND PUBLIC COMMENTS

Staff has not received any agency or public comments regarding power plant reliability.

MITIGATION MEASURES/PROPOSED CONDITIONS OF CERTIFICATION

No conditions of certification are proposed.

REFERENCES

BSE 2007a—Bright Source Energy/ Solar Partners I, LLC/ J. Woolard (tn: 42174). Application for Certification, Volumes I and II, for the Ivanpah Solar Electric Generating System. Submitted to CEC/Docket Unit on 8/31/2007.

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