POWER PLANT RELIABILITY

Testimony of Shahab Khoshmashrab

SUMMARY OF CONCLUSIONS

The applicant predicts an equivalent availability factor of 92- 98%[1]. Staff believes this is achievable. Based on a review of the Application for Certification (AFC), staff concludes that the Hidden Hills Solar Electric Generating System (HHSEGS) 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.

INTRODUCTION

In this analysis, California Energy Commission (Energy Commission) staff addresses the reliability issues of the project to determine if the power plant is likely to be built in accordance with typical industry norms for reliability of power generation. Staff uses this level of reliability as a benchmark because it ensures that the resulting project would likely not degrade the overall reliability of the electric system it serves (see "Setting" 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 reliability of power generation. While the applicant has predicted an equivalent availability factor of 92-98% for HHSEGS (see below), staff uses typical industry norms as a 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, and standards (LORS) apply to the reliability of this project.

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

[1] The plant would be available 92-98% of the time when the source of energy (the sunlight) is available, which is when the plant is expected to be available to come online. This availability factor mainly reflects maintenance and unplanned outages, and is a reflection of the maturity and capability of the technology.

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 that allow sufficient reliability to be maintained under the competitive market system have been developed and put in place. “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 HHSEGS has signed a power purchase agreement with Pacific Gas & Electric Company.

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 500-megawatt (MW) (net power output) HHSEGS, a solar thermal power plant facility employing an advanced solar power technology. This project, using mostly renewable solar energy[2], would provide dependable power to support the grid. This project would help serve the need for renewable energy in California, as most of its generated electricity would be produced by a reliable source of energy that is available during the hot summer afternoons, when power is needed most.

[2] Auxiliary boilers will supplement power generation when solar insolation drops below the level required to keep the turbines online.

ASSESSMENT OF IMPACTS

METHOD FOR DETERMINING RELIABILITY

The Energy Commission must make findings as to the manner in which the project is to be designed, sited, and operated to ensure 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 the project exhibits reliability at least equal to that of other power plants on that system.

The availability factor for a power plant is the percentage of the time that it is available to generate power; both planned and unplanned outages subtract from its availability. Measures of power plant reliability are based on the plant's actual ability to generate power when it is considered available and are based on 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.

Power plant systems must be able to operate for extended periods without shutting down for maintenance or repairs. Achieving this reliability is accomplished by ensuring 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 the project and compares them to industry norms. If they compare favorably, staff can conclude that HHSEGS would be as reliable as other power plants on the electric system and will therefore not degrade system reliability (see below for analysis).

EQUIPMENT AVAILABILITY

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

Quality Control Program

The applicant describes a QA/QC program (HHSG 2011a, AFC § 2.3.2.5) typical of the power industry. Equipment would be purchased from qualified suppliers based on technical and commercial evaluations. The project owner would perform receipt inspections, test components, and administer independent testing contracts. Staff expects implementation of this program to yield typical reliability of design and construction. To ensure such implementation, staff has proposed appropriate conditions of certification under the portion of this document entitled **Facility Design**.

PLANT MAINTAINABILITY

Equipment Redundancy

A generating facility called on to operate in base-load service for long periods of time must be capable of being maintained while operating. A typical approach for achieving this is to provide redundant examples of those pieces of equipment most likely to require service or repair.

The applicant plans to provide appropriate redundancy of function for the project (HHSG 2011a, AFC § 2.3.2.2). The project, as proposed in the AFC, would be able to operate 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. The nature of solar thermal generating technology also provides inherent redundancy; the series arrangement of solar collector assemblies would allow for reduced output generation if one (or possible several) rows of solar collectors were 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.

Furthermore, all plant ancillary systems are designed with adequate redundancy to ensure continued operation in the face of equipment failure. Balance of plant equipment would be provided with redundancy; examples include spare circulating pumps, feed water pumps and condensate pumps (HHSG 2011a, AFC § 2.3.2.2).
Staff believes that equipment redundancy would be sufficient for a project such as this.

Maintenance Program

The applicant proposes to establish a preventive plant maintenance program typical of the industry (HHSG 2011a, AFC § 2.3.2.5). Equipment manufacturers provide maintenance recommendations with their products; the applicant would base its maintenance program on these recommendations. The program will encompass preventive and predictive maintenance techniques. Maintenance outages would be planned for periods of low electricity demand. In light of these plans, staff expects that the project would be adequately maintained to ensure acceptable reliability.

FUEL AND WATER AVAILABILITY

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

Fuel Availability

Natural gas would be used in natural gas boilers for startup, overnight freeze protection, and supplementary power production[3]. A 12-inch diameter natural gas supply pipeline for HHSEGS would connect to a Kern River Gas Transmission (KRGT) pipeline approximately 32.4 miles southeast of the project site. A tap station on the main KRGT transmission pipeline would be installed at that interconnection point just north of Goodsprings in Clark County, Nevada. A gas metering station would be required at the interconnection point to measure and record gas volumes from the KRGT metering station (HHSG 2011a, AFC §§ 2.1, 2.2.3, CH2 2012ee, p.1). KRGT's natural gas supply

[3] On an annual basis, heat input from natural gas would be limited by fuel use and other conditions to less than 10% of the heat input from the sun.

system draws from extensive supplies originating in the Rocky Mountains. It draws from the oil and gas producing fields of southwestern Wyoming through Utah and Nevada to the San Joaquin Valley near Bakersfield, California, and is capable of delivering the required amount of gas for this project. Staff agrees with the applicant's prediction that there would be adequate natural gas supply and pipeline capacity to meet the project's needs.

Water Supply Reliability

The project would use groundwater for plant service needs, steam boiler makeup, heliostat washing, and fire protection. Groundwater would be drawn daily from six onsite groundwater supply wells; two new wells per power block (primary and backup) and two wells at the administration complex. The entire 500-MW net project would require up to 84.5 gallons per minute (gpm) (average) raw water make-up, with 30 to 50 gpm required by each plant, and 3.5 gpm (average) required for potable water use. Turbine cooling would be provided by air-cooled condensers, supplemented by a partial dry-cooling system for auxiliary equipment cooling (HHSG 2011a, AFC §§ 2.3.2.4, 5.15, 2.2.5). The applicant intends to drill a temporary well to be used during construction only, primarily for the onsite concrete batch plant used to serve project construction needs. Staff believes these sources yield sufficient likelihood of a reliable supply of water. (For further discussion of water supply, see the **Water Supply** 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), seiches (waves in inland bodies of water), and flooding would not likely represent a hazard for this project, but seismic shaking (earthquake) may present a credible threat to reliable operation.

Seismic Shaking

The project site lies within Inyo County in the eastern part of California. These areas are considered to exhibit low seismic activity (HHSG 2011a, AFC § 5.4.3.3); see the "Faulting and Seismicity" portion of the **Geology and Paleontology** section of this document. The project would be designed and constructed to the latest applicable LORS (HHSG 2011a, AFC Appendices 2A and 2B). 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 earthquakes.

FLOODING

The site's elevation ranges from approximately 2,590 feet above mean sea level (amsl) to approximately 2,680 feet amsl (HHSG 2011a, AFC § 5.4.3). The project site is located in an area affected by two Federal Emergency Management Agency established Special Flood Hazard Zones. Both zones are classified as Zone A, which is defined as an area subject to a 1% annual chance of flooding with no base flood elevation determined (HHSG 2011a, AFC § 5.15.3.1.4). With proper plant design (ensured by adherence to the proposed **Facility Design** conditions of certification), and appropriate mitigation measures to reduce potential flooding impacts caused by large storm events proposed in **Soils and Surface Water** conditions of certification, including **SOILS-5**), staff believes there are no concerns with power plant functional reliability due to flooding. For further discussion, see **Soils and Surface Water**, **Water Supply** and the **Geology and Paleontology** sections of this **FSA**.

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 500 MW, staff uses the NERC statistics for 400–599 MW units. The NERC reported an availability factor of 85.15% as the generating unit average for the years 2005 through 2009 for natural gas units of 400–599 MW (NERC 2010).

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 HHSEGS 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% (HHSG 2011a, AFC § 2-2.1) 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 two independent steam turbine generators and many rows of heliostats, maintenance could be scheduled during the times of the year when the full power output is not required to meet market demand, which is typical of industry standard maintenance procedures. Also, because the plant would operate when the sun is shining, maintenance can also be performed during the nighttime hours. 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.

NOTEWORTHY PROJECT BENEFITS

This project would help serve the need for renewable energy in California, as most of the electricity generated would be produced by a reliable source of energy that is available during the hot summer afternoons, when power is needed most.

CONCLUSION

The applicant predicts an equivalent availability factor of 92-98%, which staff believes is achievable. Based on a review of the AFC, 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.

PROPOSED CONDITIONS OF CERTIFICATION

No conditions of certification are proposed.

REFERENCES

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