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SECTION 6.0

Alternatives

This section discusses alternatives to the Alamitos Energy Center (AEC) as proposed in this Application for Certification (AFC). The alternatives analyzed include the "no project" alternative, technology alternatives, water supply alternatives, and wastewater disposal alternatives. These alternatives are discussed in relation to the environmental, public policy, and business considerations involved in developing the project.

This section evaluates reasonable alternatives to the AEC that could feasibly attain most of the project objectives and reduce or eliminate any significant effects of the project. As demonstrated by the analyses contained in this AFC, the project will not result in any significant environmental impacts. Therefore, as detailed in the following sections, there are no alternatives that would be preferred over the proposed project.

6.1 Project Objectives

The primary project objective is to replace the existing Alamitos Generating Station power plant with a modern, state-of-the-art, efficient, fast-starting, combined-cycle natural gas power plant, the AEC. Related project objectives are to:

- Reuse the existing brownfield, power plant site and existing infrastructure, including the existing Alamitos Generating Station switchyard and related facilities, the Southern California Edison (SCE) switchyard and transmission facilities, the Southern California Gas Company (SoCalGas) natural gas pipeline system, the Long Beach Water Department (LBWD) potable water connections, process water supply lines, existing fire suppression and emergency service facilities, and the administration, maintenance and certain warehouse buildings.
- Replace ocean water once-through cooling (OTC) with dry cooling to comply with the California State Water Resources Control Board's (SWRCB) *Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling* (OTC Policy) and consistent with the California Independent System Operator (CAISO) 2011-2012 Transmission Plan (SWRCB, 2010; CAISO, 2012a).
- Provide fast starting and stopping, flexible, controllable generation with the ability to ramp up and down through a wide range of electrical output to allow the integration of the renewable energy into the electrical grid in satisfaction of California's Renewable Portfolio Standard, displacing older and less-efficient generation.

The AEC will provide up to 1,936 megawatts (MW) of environmentally responsible, cost-effective, operationally flexible, and efficient generating capacity to the Los Angeles Basin Local Reliability Area in general, and specifically to the western Los Angeles Basin sub-area.[1] The achievement of the project objectives is contingent on using qualifying technology under the South Coast Air Quality Management District's (SCAQMD) Rule 1304(a)(2) that allows for the replacement of older, less-efficient electric utility steam boilers with specific new generation technologies on a megawatt to megawatt basis (that is, the replacement megawatts are equal or less than the megawatts from the electric utility steam boilers). Rule 1304(a)(2) requires the electric utility steam boiler be replaced with one of several specific technologies, including the combined-cycle configuration used in the AEC design. Without accessing Rule 1304(a)(2) provisions, the Applicant would be required to acquire emission offset credits for particulate matter and volatile organic emissions and these credits are for all practical purposes unavailable.

[1] As defined by the CAISO's "Local Capacity Technical Study Overview and Results" report dated April 17, 2012.

6.2 Project Overview

6.2.1 General Project Description

AES Southland Development, LLC (AES-SLD) proposes to construct, own, and operate the AEC—a natural-gas-fired, air-cooled, combined-cycle, electrical generating facility in Long Beach, Los Angeles County, California. The proposed AEC will have a net generating capacity of 1,936 MW and gross generating capacity of 1,995 MW.[2] The AEC will replace and be constructed on the site of the existing Alamitos Generating Station.

The AEC will consist of four 3-on-1 combined-cycle gas turbine power blocks with twelve natural-gas-fired combustion turbine generators (CTG), twelve heat recovery steam generators (HRSG), four steam turbine generators (STG), four air-cooled condensers, and related ancillary equipment. The AEC will use air-cooled condensers for cooling, completely eliminating the existing ocean water OTC system. The AEC will use potable water provided by the LBWD for construction, operational process, and sanitary uses but at substantially lower volumes than the existing Alamitos Generating Station has historically used. This water will be supplied through existing onsite potable water lines.

The AEC will interconnect to the existing SCE 230-kilovolt switchyard adjacent to the north side of the property. Natural gas will be supplied to the AEC via the existing offsite 30-inch-diameter pipeline owned and operated by SoCalGas that currently serves the Alamitos Generating Station. Natural gas compressors, water treatment facilities, emergency services, and administration and maintenance buildings will be constructed within the existing Alamitos Generating Station site footprint. Stormwater will be discharged to two retention basins and then ultimately to the San Gabriel River via existing stormwater outfalls.

The AEC will include a new 1,000-foot process/sanitary wastewater pipeline to the first point of interconnection with the existing LBWD sewer system and will eliminate the current practice of treatment and discharge of process/sanitary wastewater to the San Gabriel River. The project may also require upgrading approximately 4,000 feet of the existing offsite LBWD sewer line downstream of the first point of interconnection, therefore, this possible offsite improvement to the LBWD system is also analyzed in this AFC. The total length of the new pipeline (1,000 feet) and the upgraded pipeline (4,000 feet) is approximately 5,000 feet.

To provide fast-starting and stopping, flexible generating resources, the AEC will be configured and deployed as a multi-stage generating (MSG) facility. The MSG configuration will allow the AEC to generate power across a wide and flexible operating range. The AEC can serve both peak and intermediate loads with the added capabilities of rapid startup, significant turndown capability (ability to turn down to a low load), and fast ramp rates (30 percent per minute when operating above minimum gas turbine turndown capacity). As California's intermittent renewable energy portfolio continues to grow, operating in either load following or partial shutdown mode will become necessary to maintain electrical grid reliability, thus placing an increased importance upon the rapid startup, high turndown, steep ramp rate, and superior heat rate of the MSG configuration employed at the AEC.

By using proven combined-cycle technology, the AEC can also run as a baseload facility, if needed, providing greater reliability to meet resource adequacy needs for the southern California electrical system. As an in-basin generating asset, the AEC will provide local generating capacity, voltage support, and reactive power that are essential for transmission system reliability. The AEC will be able to provide system stability by providing reactive power, voltage support, frequency stability, and rotating mass in the heart of the critical Western Los Angeles local reliability area. By being in the load center, the AEC also helps to avoid potential transmission line overloads and can provide reliable local energy supplies when electricity from more distant generating resources is unavailable.

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[2] Referenced to site ambient average temperature conditions of 65.3 degrees Fahrenheit (°F) dry bulb and 62.7°F wet bulb temperature without evaporative cooler operation.

The AEC's combustion turbines and associated equipment will include the use of best available control technology to limit emissions of criteria pollutants and hazardous air pollutants. By being able to deliver flexible operating characteristics across a wide range of generating capacity, at a relatively consistent and superior heat rate, the AEC will help lower the overall greenhouse gas emissions resulting from electrical generation in southern California and allow for smoother integration of intermittent renewable resources.

Existing Alamitos Generating Station Units 1–6 are currently in operation. All six operating units and retired Unit 7 will be demolished as part of the proposed project. Construction and demolition activities at the project site are anticipated to last 139 months, from first quarter 2016 until third quarter 2027. The project will commence with the demolition of retired Unit 7 and other ancillary structures to make room for the construction of AEC Blocks 1 and 2. The demolition of Unit 7 will commence in the first quarter of 2016. The construction of Block 1 is scheduled to commence in the third quarter of 2016 and construction of Block 2 is scheduled to commence in the fourth quarter of 2016. The demolition of existing Units 5 and 6 will make space for the construction of AEC Block 3. AEC Block 3 construction is scheduled to commence in the first quarter of 2020 and will be completed in the second quarter of 2022. The demolition of existing Units 3 and 4 will make space for the construction of AEC Block 4. AEC Block 4 construction is scheduled to commence in the second quarter of 2023 and will be completed in the fourth quarter of 2025. The demolition of remaining existing units is scheduled to commence in the third quarter of 2025.

Construction of the AEC will require the use of onsite laydown areas (approximately 8 acres dispersed throughout the existing site) and an approximately 10-acre laydown area located adjacent to the existing site. The adjacent 10-acre laydown area will be shared with another project being developed by the Applicant (Huntington Beach Energy Project [HBEP] 12-AFC-02). Due to the timing for commencement of construction for these two projects, the adjacent laydown area will already be in use for equipment storage before AEC construction begins.

6.2.2 Need for New Generation

The CAISO has identified a need for new power generation facilities in the western sub-area of the Los Angeles Basin Local Reliability Area to replace the ocean water OTC plants that are expected to retire as a result of SWRCB's OTC Policy. The results from CAISO's year 2021 long-term Local Capacity Requirements study (CAISO, 2012a) estimates that between 2,370 and 3,741 MW[3] of replacement OTC generation is required in the Los Angeles Basin to meet the future needs of the area. The requirement for replacement generation in light of OTC retirements in the Los Angeles Basin, along with other long-term transmission planning assumptions, is also confirmed in CAISO's *Once-Through Cooling and AB-1318 Study Results* presented on December 8, 2011 (CAISO, 2011). CAISO also notes that many of the OTC facilities are in locations critical to local electrical reliability and repowered or replacement generating capacity with characteristics that support renewable integration in these same locations would provide both local capacity for reliability and essential grid support for a future with ever-increasing amounts of variable renewable energy. The effect of the repower/replacement OTC facilities reduces the number of total megawatts required compared to new generation developed elsewhere (CAISO, 2012b).

The California Public Utilities Commission (CPUC) confirmed the need for new generation in the Los Angeles Basin in a decision authorizing procurement of between 1,400 and 1,800 MW of new electrical capacity in the western Los Angeles sub-area to meet long-term local capacity requirements by 2021 and that at least 1,000 MW but no more than 1,200 MW must be from conventional gas-fired resources (including combined heat and power resources). Further, the CPUC found the following: a significant need for local generating resources to replace retiring OTC plants in the Los Angeles basin local area under every scenario analyzed by CAISO; that a significant amount of the 1,400 to 1,800 MW procurement be met through conventional gas-fired resources in order to ensure local capacity reliability needs are met; and that gas-fired resources at

[3] This range of OTC replacement capacity corresponds to the CAISO "Trajectory" planning scenario, which has been defined as the most likely planning scenario.

current OTC sites meet CAISO's criteria for meeting local generating needs but other resources can also meet or reduce the local generating needs but may not be as effective (CPUC, 2013). The CPUC decision authorizing procurement of between 1,400 and 1,800 MW of new electrical capacity in the western Los Angeles sub-area did not consider any replacement generation for the loss of the San Onofre Nuclear Generating Station (SONGS). It is expected that further procurement authorization from the CPUC will result from its assessment of the electrical capacity needs in the absence of SONGS. As a modern, gas-fired generation plant located at an existing OTC site, the AEC will satisfy these resource and reliability needs.

6.3 Alternatives Analysis Regulatory Requirements

The Energy Facilities Siting Regulations (Title 20, California Code of Regulations [CCR], Appendix B) guidelines titled *Information Requirements for an Application* require:

> A discussion of the range of reasonable alternatives to the project, including the no project alternative…which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project, and an evaluation of the comparative merits of the alternatives.

The regulations also require:

> A discussion of the applicant's site selection criteria, any alternative sites considered for the project and the reasons why the applicant chose the proposed site.

The California Environmental Quality Act's Guidelines for Implementation, 14 CCR Section 15126.6(a), requires an evaluation of project alternatives based on the comparative merits of "a range of reasonable alternatives to the project, or to the location of the project, which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project." The analysis must also address the "no project" alternative (14 CCR Section 15126.6 (e)). The Guidelines further state that the range of alternatives is governed by the "rule of reason," which requires consideration only of those alternatives necessary to permit a reasoned choice and to foster informed decision making and public participation (14 CCR Section 15126.6 (f) (3)). Further, as discussed below, the Legislature has determined that an off-site alternatives analysis is not required for a project like AEC that "has a strong relationship to the existing industrial site." (Public Resources Code Section 25540.6(b).)

6.4 The No Project Alternative

The no project alternative is the scenario where the project is not approved. The no project alternative is the existing conditions at the time the application is accepted by the CEC as well as what would be reasonably expected to occur in the foreseeable future if the project were not approved, based on current plans and consistent with available infrastructure and community services (14 CCR 15126.6(e)).

If the AEC is not approved, the existing conditions and infrastructure would remain in place and continue to operate. Under the no project alternative, the existing Alamitos Generating Station would still need to comply with the SWRCB's OTC policy, by either (1) replacing the present ocean water OTC system with a closed-loop cooling system, (2) employing other engineered solutions to reduce impingement and entrainment of marine life through the OTC system, or (3) operating only during electric system emergencies or during any extension of the target date for replacement of OTC systems.

The existing plant could be retrofitted with a closed-loop cooling system, which would not use ocean water. Such a system could consist of a cooling tower using wet-cooling technology, or a dry-cooling system. Wet-cooling technology would employ cooling towers that would take up significant space at the current site. A wet cooling system would have a visible plume and require substantial fresh water to operate. Because the availability of Title 22 reclaimed water is limited, cooling tower water requirements would have to be met with potable fresh water.

A dry-cooling system would employ an air-cooled condenser, which would have to be large enough to meet the cooling demand of the existing steam generator units. An air-cooled condenser large enough for the existing plant is not feasible on the limited land available at the existing Alamitos Generating Station. A replacement closed-loop cooling system, using either wet- or dry-cooling technology was rejected as a feasible option because these options would either place a significant demand on local water supplies, cause local visibility issues, or would not be possible on the limited land available at the site.

Other engineered solutions for the ocean water intake include technology and systems that have not yet been demonstrated beyond the conceptual or pilot-scale. There has been some progress made with certain efforts to limit the impacts from impingement and entrainment into intake systems on rivers; however, none of these systems has been demonstrated at the scale of the 2,000-MW Alamitos Generating Station or to the level of impingement and entrainment mortality reduction as required by the OTC Policy.

Based on CAISO's 2021 projection, and the CPUC findings of the need for OTC replacement generation, decommissioning existing OTC facilities such as the Alamitos Generating Station units without adequate replacement generation could create reliability concerns. Therefore, if the AEC is not approved and if the Alamitos Generating Station were unable to find an engineering solution to replace the OTC system, the Alamitos Generating Station could either operate only during electric system emergencies or during any extension of the target date for replacement of OTC systems.

The no project alternative is not environmentally preferable to the AEC project because the AEC is environmentally superior to the operation of the existing generating facility in terms of efficiency, air quality, water quality, and visual impacts among other environmental issues discussed in this AFC. The no project alternative would not reuse the existing brownfield, power plant site and existing infrastructure and would not provide fast starting and stopping, flexible, controllable generation with the ability to ramp up and down through a wide range of electrical output .

The no project alternative would not allow for the integration of the renewable energy into the electrical grid in satisfaction of California's Renewable Portfolio Standard, displacing older and less-efficient generation. The no project alterative would not provide up to 1,936 MW of operationally flexible, and efficient generating capacity to the Los Angeles Basin Local Reliability Area in general, and specifically to the western Los Angeles Basin sub-area. The no project alternative will not provide local capacity for reliability needs, serve peak southern California energy demand, and will not provide flexible generation to allow the integration of the ever-increasing contribution of variable renewable energy into the electrical grid.

Further, the no project alternative foregoes the AEC's capital cost for power plant equipment, estimated to be approximately between $1.1 billion and $1.3 billion. The no project alternative would not result in approximately $89.79 million in local purchases of materials and supplies during construction and demolition and approximately $8,312,000 per year of local operational expenditures. In addition, the AEC is expected to bring increased property tax revenue to the City of Long Beach.

In summary, the no project alternative would not meet the basic project objectives, would eliminate the proposed project's benefits, and would not avoid potential significant impacts; the proposed AEC project does not result in any significant impacts.

6.5 Power Plant Site Alternatives

Because the AEC will be located within the boundaries of an existing power plant property (the Alamitos Generating Station) with operating power plant units, a discussion of site alternatives is not included in this AFC. Public Resources Code Section 25540.6(b) reads, in part:

> (b). . . The commission may also accept an application for a noncogeneration project at an existing industrial site without requiring a discussion of site alternatives if the commission finds that the project has a strong relationship to the existing industrial site and that it is therefore reasonable not to analyze alternative sites for the project.

The AEC has a strong relationship to the existing industrial site; a power plant has been located on this site for nearly 60 years. The proposed AEC project will use the existing infrastructure and ancillary facilities of an existing power plant, on a site zoned for a power plant, at a location that has been used for a power plant for nearly 6 decades. The primary objective of the AEC project is to replace the existing Alamitos Generating Station conventional steam boiler technology power plant with the AEC—a modern, state-of-the-art, efficient, fast-starting, combined-cycle natural gas power plant that uses the existing brownfield, power plant site and existing infrastructure. Therefore, in enacting Public Resources Code Section 25540.6, the Legislature determined that it is reasonable not to analyze offsite alternatives for projects with such a strong relationship to an existing industrial site.

6.6 Alternative Project Design Features

This section addresses alternatives to some of the AEC design features, such as the locations of the natural gas supply pipeline, electrical transmission interconnection, and water supply pipeline.

6.6.1 Alternative Natural Gas Supply Pipeline Routes

The AEC will connect to the existing natural gas pipeline; therefore, there will be no significant impacts associated with the AEC. Thus, no further discussion of alternatives is required.

6.6.2 Electrical Transmission System Alternatives

The AEC will connect to the existing onsite electric switchyard, which connects the existing facilities to the SCE electrical system; therefore, there will be no significant impacts associated with the AEC. Thus, no further discussion of alternatives is required.

6.6.3 Water Supply Alternatives

The AEC will use air-cooled condensers (dry cooling) rather than the ocean water OTC system used for the existing Alamitos Generating Station. An air-cooled plant typically uses less than 7 percent of the total water use of a comparable wet-cooled plant. Fresh water demand at the AEC will be limited to onsite potable water use, makeup water for the new generating units' steam cycle, and for cooling of the air intake into the CTG. AEC is expected to use 176 acre-feet per year (AFY)[4] of potable water on average for power plant cooling and process water, fire protection, and potable uses. The water will be provided by the LBWD, which supplies all of the city's potable water needs using a mix of groundwater pumped from the Central Groundwater Basin and purchased surface water that is imported by the Metropolitan Water District of Southern California from the Colorado River or the State Water Project. Water use would vary from approximately 166 gallons per minute (gpm) [or 0.24 million gallons per day (mgd)] to 905 gpm (or 1.3 mgd), depending on ambient temperature and humidity. Total potable water demand would never exceed more than 176 AFY. Furthermore, the AEC's annual water use of 176 AFY is approximately 57 percent lower than historical use by the existing Alamitos Generating Station units of 412 AFY (2010 to 2012).[5]

Potential water supply sources for the AEC include:

- Potable water provided by the LBWD
- Ocean water from the Pacific Ocean
- Secondary treated wastewater from the Sanitation Districts of Los Angeles County's Joint Water Pollution Control Plant (JWPCP) in the city of Carson, more than 13 miles northwest of the AEC site

[4] The annual water requirements for the AEC operating at a 42 percent annual capacity factor (3,682 hours per year) will be approximately 176 AFY, substantially less than the actual historical water consumption of the existing Alamitos Generating Station.

[5] See Section 5.15, Water Resources, of this AFC.

- Tertiary treated wastewater from the Los Coyotes Water Reclamation Plant (LCWRP) approximately 8.2 miles to the north of the AEC site; or
- Tertiary treated (CCR, Title 22) wastewater from the City of Los Angeles Terminal Island Water Reclamation Plant (TIWRP) more than 12 miles to the west of the AEC site at the Port of Long Beach

Potable water, as well as secondary treatment or recycled water, would need to be further treated at the power plant site to meet water quality requirements for use within the plant. The California Energy Commission's (CEC) 2003 Integrated Energy Policy Report (IEPR) states, "Consistent with the Board [SWRCB] policy and the Warren-Alquist Act, the Energy Commission will approve the use of fresh water for cooling purposes by power plants which it licenses only where alternative water supply sources and alternative cooling technologies are shown to be 'environmentally undesirable' or 'economically unsound.'" (CEC, 2003). The AEC will efficiently use water in its dry-cooling system, thereby eliminating OTC. Use of potable water for power plant cooling was not considered further.

Ocean water could be used as makeup water for a saltwater cooling system, or could be desalinated to be used as fresh water. Use of ocean water in the cooling tower system is discussed in Section 6.7.2, Power Plant Cooling Alternatives.

Regional sources of secondary treated wastewater includes the JWPCP. Using secondary treated reclaimed water from the JWPCP would require construction of an approximately 13-mile-long pipeline from the AEC site to the JWPCP site located in the city of Carson. The JWPCP does not currently produce secondary treated wastewater for reuse, but rather discharges its effluent through a series of outfalls into the Pacific Ocean. This is because the JWPCP is designed to accept the effluent from 10 other treatment plants operating at higher elevations that is considered too salty for use as reclaimed water. Use of treated wastewater from the JWPCP would require additional treatment to meet tertiary treatment influent standards, in addition to construction of a pipeline of at least 13 miles in length through a heavily urban area. Use of secondary treated wastewater from the JWPCP would require construction of a treatment facility either at the JWPCP or at the AEC site to further treat the wastewater to the standards required for power plant use, as well as storage facilities to ensure sufficient treated water is on hand at all times, and an approximately 13-mile-long pipeline connecting the two facilities. Construction and operation of the tertiary treatment facility and the connecting pipeline would create their own environmental impacts, including those associated with disposal of the waste products created during the treatment process. Therefore, considering the potential environmental impacts, secondary treated wastewater from the JWPCP is not a viable source of makeup water for AEC.

Regional sources of tertiary treated wastewater (treated to Title 22 standards) include the LCWRP and the TIWRP. Using tertiary treated reclaimed water from the LCWRP would require construction of an approximately 8.2-mile-long pipeline, and use of tertiary treated water from the TIWRP would require construction of a pipeline longer than 12 miles. Construction of these pipelines would be through heavily urban areas and would result in their own environmental impacts. As of 2012, the LCWRP had the capacity for approximately 11.6 mgd of tertiary treated water to be made available for sale, more than enough for the 1.3 mgd than the AEC would require (Hall, pers. comm., 2012).

In addition to having sufficient quantities, recycled water must also be "available" for use. The criteria for determining the availability of recycled water include: 1) the source of recycled water is of adequate quality and is available for these uses; 2) the recycled water may be furnished for these uses at a reasonable cost to the user (considering all relevant factors including the present and projected costs and if the cost of supplying the treated recycled water is comparable to, or less than, the cost of supplying potable domestic water); 3) the use is not detrimental to public health; 4) the use will not adversely affect downstream water rights, degrade water quality, or cause injury to plant life, fish and wildlife (California Water Code Section 13550).

Although sufficient quantity of tertiary treated wastewater would be available, the costs of such water call into question whether it is indeed "available" as defined in the California Water Code and the construction of an 8.2-mile pipeline would have greater impacts than use of dry-cooling as proposed by the project.

6.7 Technology Alternatives

The AEC configuration was selected from a wide array of technology alternatives. These include generation technology alternatives, fuel technology alternatives, combustion turbine alternatives, storage alternatives, and nitrogen oxide (NO_x) control alternatives.

6.7.1 Generation Technology Alternatives

Selection of the power generation technology focused on those technologies that can use the natural gas readily available from the existing gas pipeline system, and meet the requirements of SCAQMD's Rule 1304(a)(2), which limits the generation technology options for the replacement of existing utility steam boilers to either combined-cycle technology or other use of advanced turbine technology, or a renewable energy resource while continuing to meet the project's objectives. Following is a discussion of the suitability of such technologies for application to the AEC that were rejected for failing to meet the AEC's project objectives.

6.7.1.1 Conventional Boiler and Steam Turbine

This technology burns fuel in the furnace of a conventional boiler to create steam. The steam is used to drive an STG, and the steam is then condensed and returned to the boiler. This technology can achieve thermal efficiencies up to approximately 36 percent when using natural gas, although efficiencies are somewhat higher when using oil or coal. Several conventional boiler/steam turbine technologies were reviewed but rejected because of regulatory prohibitions or public acceptance. Specifically, the technologies rejected were oil, coal, and municipal solid waste generation.

Because of this technology's low efficiency and large space requirement, and because it would not meet the requirements of SCAQMD Rule 1304(a)(2), conventional boiler and steam turbine technology was eliminated from consideration.

6.7.1.2 Nuclear

California law prohibits new nuclear plants until the scientific and engineering feasibility of disposal of high-level radioactive waste has been demonstrated. To date, the CEC is unable to make the findings of disposal feasibility required by law for this alternative to be viable in California. The technology, therefore, is not implementable.

6.7.1.3 Simple-cycle Combustion Turbine

Aero-derivative turbine-generator units are able to achieve thermal efficiencies up to approximately 38 percent. A simple-cycle combustion turbine has a quick startup capability and comparable capital cost to that of a combined-cycle, and is appropriate for peaking applications. However, simple-cycle combustion turbines have lower thermal efficiency and emit more air pollutants per kilowatt-hour (kWh). Because of this relatively low efficiency, and because only one manufacturer and one model of aero-derivative gas turbine generator currently meet the requirements of SCAQMD Rule 1304(a)(2), simple-cycle combustion turbine technology was eliminated from consideration.

6.7.1.4 Kalina Combined-cycle

This technology is similar to the conventional combined-cycle, except a mixture of ammonia and water is used in place of pure water in the steam cycle. The Kalina cycle could potentially increase combined-cycle thermal efficiencies by several percentage points. This technology is still in the development phase and has not been commercially demonstrated; therefore, it was eliminated from consideration.

6.7.1.5 Internal Combustion Engines

Internal combustion engine designs are also available for small peaking power plant configurations. These are based on the design for large marine diesel engines, fitted to burn natural gas. Advantages of internal combustion engines are that they use very little water for cooling because they use a closed-loop coolant system with radiators and fans; provide quick-start capability (online at full power in 10 minutes); and are responsive to load-following needs because they are deployed in small units (for example, 10 to 14 engines in one power plant) that can be started up and shut down at will. Disadvantages of this design include higher emissions than comparable combustion turbine technology. Additionally, an internal combustion engine installation is generally deployed at less than 150 MW and do not qualify as replacement generation technology under SCAQMD Rule 1304(a)(2). Because internal combustion engines would not meet the project objective to generate 1,936 MW of electricity and emission offsets are not available as required under New Source Review, this technology was eliminated from consideration.

6.7.2 Power Plant Cooling Alternatives

Wet-cooling technology was evaluated for the AEC as an alternative to the use of an air-cooled condenser system, using either freshwater, reclaimed water, or ocean water as the water makeup source. With a wet-cooled plant, water is pumped through a condenser, where it is exposed to pipes carrying steam from the steam turbine. The steam condenses to water and is recycled through the HRSG. Heated water cycling through the condenser is then pumped to a cooling tower, where large fans draw air through the heated water droplets, cooling the water, which is cycled back to the condenser, with evaporative losses of approximately 5 percent.

As described in Section 6.6.3, Water Supply Alternatives, wet cooling using fresh or potable water is discouraged by SWRCB and CEC policy. Wet cooling using recycled water is acceptable under state policy, but the choice of this cooling method depends on the availability of a supply of tertiary treated recycled water consistent with state law. Such recycled water is not currently available at the AEC site. As discussed above (see Section 6.6.3), tertiary treated water is available near the AEC site, but would require a new pipeline at least 8 miles long. Secondary treated water is available at the JWPCP facilities and could be used as a possible source of cooling water makeup, though doing so would require construction of a 13-mile-long pipeline and additional facilities to treat the wastewater to the tertiary standards required for power plant use. Wet cooling using ocean water in the cooling towers is another possibility, though this method would require taking suction off of an ocean intake structure for makeup supplies, creating project-related environmental impacts. Maintenance and operating costs for a cooling tower system using ocean water are also significantly higher than for systems using fresh or reclaimed water. The use of ocean water as cooling tower makeup water typically imposes a 4 to 8 percent performance penalty and a 35 to 50 percent cost penalty in comparison to freshwater towers of comparable cooling capability (Maulbetsch and DiFilippo, 2010).

The major drawback of wet cooling is that it takes large amounts of water to cool a large, combined-cycle power plant: approximately 16 times as much as a dry-cooled design. Therefore, because of the uncertainty in obtaining reliable and cost-effective water supply in sufficient quantities to allow use of wet cooling, and additional environmental impacts the AEC has been designed as a dry-cooled plant using an air-cooled condenser. No other technologies are currently available that are capable of adequately cooling the AEC without these additional costs and impacts.

6.7.3 Fuel Technology Alternatives

Technologies based on fuels other than natural gas were eliminated from consideration because they do not meet the AEC's objective of using natural gas available from the existing gas piping system. Additional factors rendering alternative fuel technologies unsuitable for use at the AEC are as follows:

- No geothermal or hydroelectric resources exist in Los Angeles County.

- Biomass fuels such as wood waste are not locally available in sufficient quantities to make them a practical alternative fuel, and space is limited at the AEC site.
- The AEC site does not experience sufficient wind resources to make a wind project feasible at the site. Additionally, wind technologies are not flexible and dispatchable resources because of their variable nature. Also, space is limited at the AEC site and these technologies require large expanses of land, and a wind power installation would not be compatible with surrounding land uses. Because wind resources are insufficient, and only a single 2 MW wind turbine could be installed at the site, wind energy was rejected as a viable energy alternative.
- Utility-scale solar technologies need to be sited in an area with high solar radiation[6] and require very large amounts of land (up to 10 acres per megawatt). Los Angeles County is not a viable location for concentrating solar technologies or utility-scale photovoltaic power plants because it lacks the large and open expanses of land necessary and is not a strong solar energy resource area. These resources are also available only during the daytime and have reduced availability on cloudy days. Approximately 26 MW of photovoltaic panels could be installed at the Alamitos Generating Station site considering the specific site orientation and setback requirements. The solar resource available at the site is also limited, considering the marine layer and fog, which is common in the area. Only 56,800 megawatt-hours per year of electricity could be generated with photovoltaic panels, as compared to the over 7,134 gigawatt-hours that could be available from the AEC.

The availability of the natural gas resource provided by SoCalGas and the environmental and operational advantages of natural gas technologies make natural gas the logical choice for the AEC.

6.7.4 NO_x Control Alternatives

To minimize NO_x emissions from the AEC, the CTGs will be equipped with dry low-NO_x combustors and selective catalytic reduction (SCR) using 19 percent aqueous ammonia as the reducing agent. The following combustion turbine NO_x control alternatives were considered:

- Steam injection (capable of 25 parts per million [ppm] NO_x)
- Water injection (capable of 25 ppm NO_x)
- Dry low-NO_x combustors (capable of 9 to 25 ppm NO_x)

Dry low-NO_x combustors were selected because these allow for lower NO_x emission rate from the combustion turbine over either water or steam (wet) injection. Furthermore, dry low-NO_x combustors result in a slight improvement in thermal efficiency over wet injection NO_x control alternatives, and will reduce AEC's water consumption.

Two post-combustion NO_x control alternatives were considered:

- SCR
- $SCONO_x$

SCR is a proven technology and is commonly used in combustion turbine electrical generating applications. Ammonia is injected into the exhaust gas upstream of a catalyst. The ammonia reacts with NO_x in the presence of the catalyst to form nitrogen and water.

$SCONO_x$ consists of an oxidation catalyst, which oxidizes carbon monoxide to carbon dioxide and nitric oxide to nitrogen dioxide. The nitrogen dioxide is adsorbed onto the catalyst, and the catalyst is periodically regenerated.

[6] Measured in terms of kWh per square meter of land. See the National Renewable Energy Laboratory for additional information about solar energy and maps of solar resource distribution (http://www.nrel.gov/gis/solar.html). The project area solar radiation is rated at approximately 5 to 5.25 kWh per square meter. Utility-scale solar energy plants are not currently being proposed for areas with solar radiation at levels this low.

While SCONOx has been used on smaller turbines, it has not been "scaled-up" to operate on turbines of the size that will be used for the AEC project. Even assuming that SCONOx could be scaled-up, the level of emission control effectiveness between the $SCONO_x$ and SCR technologies is approximately equivalent. However, the $SCONO_x$ technology does not use ammonia to reduce air emissions. The CEC recently summarized in the U.S. Environmental Protection Agency's opinion (CEC, 2007) "that $SCONO_x$ is no more effective for reducing air quality impacts than selective catalytic reduction…, and it also found $SCONO_x$ to be significantly more expensive and arguably less reliable, particularly for larger facilities." Therefore, $SCONO_x$ was not considered for use at the AEC.

The following reducing agent alternatives were considered for use with the SCR system:

- Anhydrous ammonia
- Aqueous ammonia
- Urea conversion

Anhydrous ammonia is used in many combustion turbine facilities for NO_x control, but is more hazardous than diluted forms of ammonia. Aqueous ammonia (an ammonia-water solution) is proposed for the AEC because of its safety characteristics.

Urea conversion technology uses solid urea (prill) in a reactor with steam to convert the urea to aqueous ammonia, which is typically stored in a tank for use by the SCR system during upsets in the process and plant startup activities. Although the urea conversion technology has been employed for power plants for a number of years, it only eliminates the need to truck aqueous ammonia to the site, because onsite ammonia storage is always included in the system design. Furthermore, the urea conversion process has a higher energy demand over an aqueous ammonia system as a result of consuming steam as part of the process. Finally, the urea process has proven to have poor reliability and slow response times, and it produces an inconsistent concentration of ammonia. The AEC power blocks are designed to be fast-start and fast-ramp units that require precise control of ammonia concentrations for emissions control. Therefore, urea conversion was considered and rejected.

6.7.5 Energy Storage

Energy storage options currently available include electrochemical energy storage, thermal energy storage, hydrogen production, and mechanical energy storage. Electrochemical storage includes several types of batteries and capacitors that meet specific needs and requirements in certain applications. However, at this time, these devices have not been deployed at a scale that would effectively substitute the 1,936 MW of generating capacity of this project and, furthermore, current electric load-serving entities have been unwilling to contract long-term power purchase agreements apart from specific direction of the CPUC.

Thermal energy storage generally is limited to heat energy storage from solar thermal applications for later use, such as steam for power production during evening hours, or for water or building heating purposes, and, therefore, would not meet the AEC objectives. Hydrogen production involves "storing" energy by using inexpensive or surplus energy (that is, off-peak energy from all sources, or surges of wind power during the night) to create hydrogen through hydrolysis, and then use the hydrogen to create energy for other purposes, including on-peak generation, as well as transportation purposes. However, hydrogen production has not yet been demonstrated as a cost-effective alternative to generation services that the AEC would provide.

Compressed air technology also stores energy by using inexpensive or surplus electrical energy to operate compressors that store high-pressure air for later release through an air-powered turbine, while flywheel technology uses off-peak power to accelerate large rotors (flywheels) to very high speeds, and then use the energy stored as angular momentum to spin a generator during on-peak power periods. While promising, compressed air and flywheel technology have not yet been demonstrated to be cost-effective methods for storing energy on a large scale.

The only utility-scale energy storage technology currently in use in California is pumped-storage hydroelectricity, in which energy is stored by pumping water from a lower reservoir to a higher reservoir when inexpensive or surplus energy is available, and then released through a turbine-generator when additional generating capacity and energy is needed. These projects require two reservoirs at significantly different elevations, plus a pumping/generating station and connecting penstock, and therefore have very specific siting requirements not generally found in the population centers of the greater Los Angeles Basin (CEC, 2011). Because of the very limited ability to site cost-effective energy storage facilities that are able to provide reliable electric power services to the Western Los Angeles Basin, energy storage technologies were considered but rejected for the AEC.

6.7.6 Waste Discharge Alternatives

The AEC will discharge process wastewaters to the LBWD via a new, 1,000-foot-long pipeline. Similar to the existing Alamitos Generating Station, stormwater from the AEC will be captured in onsite stormwater retention basins, processed through an oil/water separator as necessary, then discharged through the existing Alamitos Generating Station's stormwater outfalls. AES-SLD staff met with the staff of the California Regional Water Quality Control Board (RWQCB) Santa Ana Region on May 23, 2012, to discuss the discharge of AEC stormwater through the existing Alamitos Generating Station's stormwater outfall (see Appendix 5.15B for the RWQCB Meeting Summary notes). At this meeting, the RWQCB staff representative concurred with the approach for the continuation of discharging stormwater from the AEC through the existing outfalls, providing the project obtains a new National Pollutant Discharge Elimination System permit and the discharge meets all applicable water quality standards. The AEC will be designed to meet the current requirements of Los Angeles County for stormwater drainage design and discharge (see Section 5.15, Water Resources).

The alternative discharge method for process wastewater would be to construct a zero liquid discharge (ZLD) system in which concentrators and crystallizers are used to evaporate process wastewater and to remove the residual salts and other contaminants such that little or no water is discharged, and residual salt is trucked as a "salt cake" byproduct to a landfill. The CEC, as stated in the 2003 IEPR, has encouraged power plant developers to incorporate ZLD facilities into their power plant designs as a way of reducing discharges and maintaining the quality of state waters. The 2003 IEPR states:

> Additionally, as a way to reduce the use of fresh water and to avoid discharges in keeping with the Board's policy, the Energy Commission will require zero-liquid discharge technologies unless such technologies are shown to be "environmentally undesirable" or "economically unsound."

The use of a ZLD design was considered for the AEC and was eliminated from consideration for the following reasons:

- It is not necessary to use a ZLD system to control wastewater discharge in a plant using dry cooling because discharge volumes using dry cooling are relatively small, approximately one-sixteenth those of a wet-cooled plant.
- ZLD systems are technologically complex and expensive to construct, operate, and maintain, adding to the project's capital cost and reducing its return on investment, with no or marginal benefit in this case.
- ZLD systems have been found to be relatively unreliable, often resulting in plant outages that affect operating ability, the availability of power, and grid reliability.

To summarize, using ZLD for a dry-cooled plant of this nature would not support the AEC objectives of providing easily dispatchable, reliable, and economically viable power to the California grid. The initial construction, operations, and maintenance costs of a ZLD system, and the associated lost production costs, would be out of proportion to the environmental benefits of eliminating the low volume of wastewater expected to be generated by the AEC. The use of a ZLD system would be economically unfeasible, offer little or no environmental benefit, and would not eliminate the need to construct the wastewater pipeline required for AEC process/sanitary wastewater disposal.

6.8 References

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