

## **IV. CASE STUDY: MAMMOTH PACIFIC POWER PLANT**

### **View of Mammoth Pacific II**

The following section offers a firsthand account of the development process for a geothermal power plant. It reveals what took place behind the scenes to bring a power plant online near a small, California community, as indicated by the people who were involved in that process, both within and outside the developing company. This case study documents one plant's transformation from one of the most hotly contested to one of the most locally and internationally appreciated power plants in the United States.

#### **A. Setting**

Travel guides advertise Mono County, California, as a land of fire and ice. with extraordinary features [that] attest to the region's active geologic past. The largest city within Mono County, the Town of Mammoth Lakes, is a recreation area, where regular activities include skiing, mountain climbing, hiking, fishing, and is a land that one local described as Los Angeles. playground. At the time the Mammoth Pacific power plants were developed near the Town of Mammoth Lakes, the type of geothermal technology used was relatively new and unexplored. The effects of such a plant, especially upon such a prime recreation area prized for its natural beauty, were uncertain.

#### **B. Plans for Development**

The first unit at the Mammoth Pacific Complex, the 10-MW MP-I power plant that came online in 1984, was relatively unknown by constituents of Mono County. But the 1990 expansion, which added two 15 MW units to the Mammoth Pacific Complex, bringing the total capacity at the complex to 40 MW, met substantial public scrutiny. These two new facilities, one on private land, known as MP-II, and one on federal land (Inyo National Forest), known as PLES I, were proposed by Mammoth Pacific, L.P. (MPLP) as expansion projects.

#### **C. Public Reaction and Company Response**

Once plans for the expansion began, a full five years before permits were issued in 1989, people began voicing concerns related primarily to tourism and environmental impact.

With guidance from Mono County Economic Development Director Dan Lyster, the county established the Long Valley Hydrologic Advisory Committee (LVHAC) in 1986 in response to those concerns. Members of LVHAC included regulatory agencies such as Mono County; the Bureau of Land Management (BLM) the U.S. Forest Service (USFS); California Dept. of Fish and Game; California Division of Oil, Gas, and Geothermal Resources; and Mammoth Community Water District; as well as the developer. The meetings were open to the public and were regularly attended by technical groups, representatives from USGS, and local organizations such as the Sierra Club.

At the same time that the LVHAC was formed, MPLP (through its managing partner, initially Pacific Energy and currently Ormat) responded to the concerns voiced by constituents. According to Claude Harvey, Pacific Energy's Senior Vice President in charge of geothermal at the time, without a timely and comprehensive response to people's concerns, the expansion would never have been permitted.

When a project is going to be controversial, you've got to get in there and talk to the people directly, notes Harvey. You've got to knock on doors, show up at town meetings, respond to letters in the local paper. Explain the benefits of a geothermal power plant and the benign nature of the plant. That's what we [Pacific Energy] did, and, if we hadn't done so, the plant simply would not have come online, because we wouldn't have had the

meetings, respond to letters in the local paper. Explain the benefits of a geothermal power plant and the benign nature of the plant. That's what we [Pacific Energy] did, and, if we hadn't done so, the plant simply would not have come online, because we wouldn't have had the necessary public support..

Dwight Carey, an environmental consultant who worked with MPLP during the expansion, notes that MPLP's efforts to integrate itself into the community have been ongoing, and continue to this day under the efforts of Bob Sullivan, plant manager: .MPLP has made it a point to be a true member of the community - making presentations, inviting tours, sponsoring community events - and generally making sure that people in the community at all levels (both in the economic and environmental community) know what is going on. As a result, the community trusts MPLP, and is not willing to immediately believe the worst if issues or concerns are brought up..

#### **D. Permitting**

Though the permitting process began in 1986, only after a five-year struggle to obtain permits was permission finally granted for construction. The MP-II expansion project, located on private land, was approved by Mono County with a conditional use permit, a 22-page document that contained over 100 conditions that had to be met in order for the project to move forward. The PLES I project, located on public land managed by the Inyo National Forest, was approved with a similar extensive list of conditions. Each project was required to pay for its own detailed study (an Environmental Impact Report [EIR] for the MP-II project and an EIS for the PLES I project) that assessed all potential environmental impacts of each project and the potential cumulative impacts of all of the projects.

According to Lyster, these two projects were the most highly conditioned power plant projects in California, with a laundry list of water monitoring activities developed by LVHAC and required by the respective permits. Water monitoring activities, including quality, flow, and temperature monitoring of geothermal resource wells, hot and cold water springs, groundwater wells, and surface waters, were initially conducted by USGS, but subsequently some of those have been transferred to the power company. Additional permit conditions required transplanting pine trees, extensive revegetation of disturbed areas, archeological surveys and monitoring, and painting structures with specific colors approved by the agencies.

#### **E. Construction**

The expansion construction followed a breathtaking pace, the shortest amount of time Harvey had ever seen, so that the plants could reap the benefit of an investment tax credit. The company that designed the power plant, started by Harvey and Ben Holt, provided much of the financial backing for the project. Efficient, state-of-the-art facilities were operating in December 1990, just a year after construction began. Today, 15 years later, the plants continue to produce power with few hydrologic impacts, and minimal emissions or aesthetic impacts.

Notes Harvey, you'd never find a hotel that blended so well into this pristine environment.. A hotel wouldn't contribute as much money to the economy, and it certainly wouldn't provide electricity to the grid, he adds.

MPLP took steps that showed their willingness to integrate into the community. For example, they paid special attention to preserving and adding to the bicycle paths, they utilized costly and efficient technology to minimize noise, and they ensured that roads were accessible in the wintertime.

Harvey, who, before his tenure with Pacific Energy had built many power plants, including coal, natural gas, and nuclear facilities, says that the Mammoth Plants involved the longest, biggest, and most arduous permitting process he's ever gone through. I never got into [a project] as hot and controversial as Mammoth during my 40 years of experience, and that's ironic because the Mammoth plant was the most

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Richard Campbell, one of the primary engineers for the units at Mammoth, helped design a power plant that is not only environmentally benign, but also unobtrusive. He and the company he worked for, Ben Holt Company, designed low-lying, camouflaged facilities that are difficult to spot even from a major highway overlooking the plant. The company also put silencers in place to limit noise.

Based on Campbell.s design, the MP-I plant became the first of its kind to utilize air-cooled technology, rather than the water-cooled technology used by geothermal power plants before it. While water-cooled units emit generally harmless but noticeable steam plumes, air-cooled units have no visible emissions and minimal operating losses of geothermal fluid or gases. Besides reducing the aesthetic impact, air-cooled binary cycle technology requires no cooling water.a particularly important consideration in the Mammoth area where water availability is limited.

#### **F. Results of Monitoring Activity**

After years of monitoring, with the Mammoth power plants continually pumping at 12,500 gallons of hot water per minute, there have been few adverse impacts attributed to plant development. Even so, all monitoring efforts continue on a regular basis, and are made available once a quarter to any interested parties. With continued efficient management practices, the plant will likely stay online many years into the future. Carey measures the success of the plant based on the minimal impact over the last 15 years of operations: .none of the dire predictions about the worst case impacts of the expansion projects came true. The projects aren't that visible; no adverse impacts to the hot springs in Hot Creek or the hatchery or the Owens tui chub have been documented; deer are grazing amongst the wells; no spills have adversely affected the creeks; and tourism is doing well.. People slowly but surely began to realize that not only did the Mammoth Plants produce no negative impacts, it actually produced community benefits.

#### **G. Economic Benefits**

One such benefit is employment. Construction of the plant required a few hundred workers; current operation requires 21 full-time employees, with additional seasonal employees. The plants provide some of the best jobs in the Town of Mammoth Lakes, with a population of around 7,000. Both the original managing partner, Pacific Energy, and the current managing partner, Ormat Nevada, Inc., have made a commitment to hiring locally, with most full-time employees entering the geothermal field from a variety of backgrounds. Jobs histories of current Mammoth employees include positions as ski patrolmen, ex-miners, bartenders, and volunteer firemen. Ormat provides the considerable training needed for these highly skilled positions, and workers are encouraged to stay with the company long term. Indeed, most of them do.

.A number of our employees have been with us for 20 years.,. says Sullivan. I myself have been with the company for over almost 15 years.. Another benefit of the Mammoth Pacific geothermal plant is its low environmental impact. This type of plant produces minimal air emissions. A study showed that the pine trees surrounding the geothermal plants emit more greenhouse gases than the fugitive emissions from the power plants themselves. The effect on the deer population, which was one of the concerns of the California Department of Fish and Game when it sued Mono County to prevent the approval of the MP-II project, was found to be one half of one deer over the entire lifetime of the plant. Hawks have flocked to the area near the plants, and can be seen using the thermal currents to assist in soaring. In 1991, the California State Assembly passed a resolution commending the MPLP on the start-up of two of its geothermal power facilities in Mono County, recognizing its use of clean energy without .environmentally damaging emissions.. In addition, for four consecutive years (2000-2004), MPLP received from the California Department of Conservation an award for its outstanding environmental record at its Mono County geothermal facilities.<sup>110</sup>

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Another significant benefit has been the financial contributions of the power plant. MPLP has been designated a "good neighbor," by many locals, including Lyster, for making donations to local groups in the area. MPLP built a new community center from the proceeds of the power plants. According to Sullivan, MPLP is one of the largest taxpayers in the county, supplying over half a million dollars last year alone.

### **H. MP: A Success Story**

The Mammoth Pacific Complex, which supplies power enough for approximately 40,000 homes, has provided many socioeconomic benefits. MPLP's involvement at all levels, including monitoring, individual responses to citizens' concerns, sponsorship of community events, funding of community centers, and construction of aesthetically pleasing facilities, demonstrates its commitment to Mono County. Despite initial challenges, MPLP has emerged as a true success story for the geothermal community.

<sup>110</sup> DOE EERE Geothermal Technologies Program (Update Jan 2005). *The Award-Winning Environmental Performance of Geothermal Power in California*. Retrieved October 14, 2005, from [http://www.eere.energy.gov/geothermal/geopower\\_calif\\_awards.html](http://www.eere.energy.gov/geothermal/geopower_calif_awards.html).

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### **Glossary<sup>111</sup>**

**Aquaculture:**<sup>112</sup> farming of organisms that live in water, such as fish, shellfish, and algae.

**Baseload Capacity:** The generating equipment normally operated to serve loads on an around-the-clock basis.

**Baseload Plant:** A plant, usually housing high-efficiency steam-electric units, which is normally operated to take all or part of the minimum load of a system, and which consequently produces electricity at an essentially constant rate and runs continuously. These units are operated to maximize system mechanical and thermal efficiency and minimize system operating costs.

**Baseload:** The minimum amount of electric power delivered or required over a given period of time at a steady rate.

**Binary-Cycle Plant:** A geothermal electricity generating plant employing a closed-loop heat exchange system in which the heat of the geothermal fluid (the "primary fluid") is transferred to a lower-boiling-point fluid (the "secondary" or "working" fluid), which is thereby vaporized and used to drive a turbine/generator set.

**Biomass:** Energy resources derived from organic matter. These include wood, agricultural waste and other living-cell material that can be burned to produce heat energy. They also include algae, sewage and other organic substances that may be used to make energy through chemical processes.

**Capability:** The maximum load that a generating unit, generating station, or other electrical apparatus can carry under specified conditions for a given period of time without exceeding approved limits of temperature and stress.

**Capacity Factor:** a measure of the amount of real time during which a facility is used

**Capacity:** The amount of electric power delivered or required for which a generator, turbine, transformer, transmission circuit, station, or system is rated by the manufacturer.

**Carbon Dioxide:** A colorless, odorless, non-poisonous gas that is a normal part of the air.

Carbon

dioxide, also called CO<sub>2</sub>, is exhaled by humans and animals and is absorbed by green growing things and by the sea.

**Coal:** A readily combustible black or brownish-black rock whose composition, including inherent

moisture, consists of more than 50 percent by weight and more than 70 percent by volume of

<sup>111</sup> All terms from Energy Information Administration [EIA] (2002) *Glossary of Electricity Terms*, Retrieved August 1, 2006, from <http://www.eia.doe.gov/cneaf/electricity/epav1/glossary.html>; California Energy Commission [CEC] (2004), *Glossary of Energy Terms*, Retrieved August 1, 2006, from <http://www.energy.ca.gov/glossary/>; U.S. DOE Energy Efficiency and Renewable Energy Geothermal Technologies Program. *Geothermal Glossary*. Retrieved August 1, 2006, from <http://www.eere.energy.gov/geothermal/glossary.html>; from Hance (2005) (see footnote #5); or from the *Investing Glossary* accessible at [www.investorwords.com](http://www.investorwords.com) unless otherwise noted.

<sup>112</sup> Source: USGS

carbonaceous material. It is formed from plant remains that have been compacted, hardened, chemically altered, and metamorphosed by heat and pressure over geologic time.

**Combined Cycle:** An electric generating technology in which electricity is produced from otherwise lost waste heat exiting from one or more gas (combustion) turbines. The exiting heat is routed to a conventional boiler or to a heat recovery steam generator for utilization by a steam turbine in the production of electricity. This process increases the efficiency of the electric generating unit.

**Condensate:** Water formed by condensation of steam.

**Consumption (Fuel):** The amount of fuel used for gross generation, providing standby service, start-up and/or flame stabilization.

**Cooling tower:** A cooling tower is the structure associated with water-cooled heat extraction systems. Hot water is sprayed from the top of the structure and cascades against an upwards airflow that cools the water (mainly through evaporation).

**Cost:** The amount paid to acquire resources, such as plant and equipment, fuel, or labor services.

**Crust:** Earth's outer layer of rock. Also called the lithosphere.

**Debt:** An amount owed to a person or organization for funds borrowed. Debt can be represented by a loan note, bond, mortgage or other form stating repayment terms and, if applicable, interest requirements. These different forms all imply intent to pay back an amount owed by a specific date, which is set forth in the repayment terms.

**Demand (Electric):** The rate at which electric energy is delivered to or by a system, part of a system, or piece of equipment, at a given instant or averaged over any designated period of time.

**Demand (Utility):** The level at which electricity or natural gas is delivered to users at a given point in time. Electric demand is expressed in kilowatts.

**Direct impacts:** All expenditures associated with construction and maintenance of geothermal power plants. During the construction phase, it corresponds to the total investment associated with the power plant construction. During the operation and maintenance phase, it relates to all expenditures in goods and services associated with power plant operation and maintenance.

**Direct Use:** Use of geothermal heat without first converting it to electricity, such as for space heating and cooling, food preparation, industrial processes, etc.

**Dispatch:** The operating control of an integrated electric system to: Assign generation to specific generating plants and other sources of supply to effect the most reliable and economical supply as

the total of the significant area loads rises or falls. Control operations and maintenance of highvoltage

lines, substations and equipment, including administration of safety procedures. Operate the interconnection. Schedule energy transactions with other interconnected electric utilities.

**Distribution:** The delivery of electricity to retail customers (including homes, businesses, etc.).

**Drilling:** Boring into the Earth to access geothermal resources, usually with oil and gas drilling equipment that has been modified to meet geothermal requirements.

**Dry Steam:** Very hot steam that doesn't occur with liquid.

**Economics:** The study of how the forces of supply and demand allocate scarce resources. Subdivided into microeconomics, which examines the behavior of firms, consumers and the role of government; and macroeconomics, which looks at inflation, unemployment, industrial production, and the role of government.

**Economy of scale:** Reduction in cost per unit resulting from increased production, realized through operational efficiencies. Economies of scale can be accomplished because as production increases, the cost of producing each additional unit falls.

**Electric Plant (Physical):** A facility containing prime movers, electric generators, and auxiliary equipment for converting mechanical, chemical, and/or fission energy into electric energy.

**Electric Utility:** A corporation, person, agency, authority, or other legal entity or instrumentality that owns and/or operates facilities within the United States, its territories, or Puerto Rico for the generation, transmission, distribution, or sale of electric energy primarily for use by the public and files forms listed in the Code of Federal Regulations, Title 18, Part 141. Facilities that qualify

as cogenerators or small power producers under the Public Utility Regulatory Policies Act (PURPA) are not considered electric utilities

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as cogenerators or small power producers under the Public Utility Regulatory Policies Act (PURPA) are not considered electric utilities.

**Emissions Standard:** The maximum amount of a pollutant legally permitted to be discharged from a single source.

**Energy Policy Act 2005 (EPAAct):** (Public Law 109-58) is a statute which was passed by the United States Congress on July 29, 2005 and signed into law on August 8, 2005 at Sandia National Laboratories in Albuquerque, New Mexico. The Act, described by proponents as an attempt to combat growing energy problems, provides tax incentives and loan guarantees for energy production of various types.

**Energy Source:** The primary source that provides the power that is converted to electricity through chemical, mechanical, or other means. Energy sources include coal, petroleum and petroleum products, gas, water, uranium, wind, sunlight, geothermal, and other sources.

**Energy:** The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to motion (kinetic energy). Energy has several forms, some of which are easily convertible and can be changed to another form useful for work. Most of the world's convertible energy comes from fossil fuels that are burned to produce heat that is then used as a transfer medium to mechanical or other means in order to accomplish tasks. Electrical energy is usually measured in kilowatthours, while heat energy is usually measured in British thermal units.

**Environmental Impact Study:** A document required by federal and state laws to accompany proposals for projects and programs that may have an impact on the surrounding area.

**equity:** Ownership interest in a corporation in the form of common stock or preferred stock. It is the risk-bearing part of the company's capital and contrasts with debt capital which is usually

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secured and has priority over shareholders if the company becomes insolvent and its assets are distributed.

**Facility:** An existing or planned location or site at which prime movers, electric generators, and/or equipment for converting mechanical, chemical, and/or nuclear energy into electric energy

are situated, or will be situated. A facility may contain more than one generator of either the same

or different prime mover type. For a cogenerator, the facility includes the industrial or commercial process.

**Flash Steam:** Steam produced when the pressure on a geothermal liquid is reduced. Also called flashing.

**Fossil Fuel:** Any naturally occurring organic fuel, such as petroleum, coal, and natural gas.

**Fossil-Fuel Plant:** A plant using coal, petroleum, or gas as its source of energy.

**Fuel:** Any substance that can be burned to produce heat; also, materials that can be fissioned in a chain reaction to produce heat.

**Generating Unit:** Any combination of physically connected generator(s), reactor(s), boiler(s), combustion turbine(s), or other prime mover(s) operated together to produce electric power.

**Generation (Electricity):** The process of producing electric energy by transforming other forms of energy; also, the amount of electric energy produced, expressed in watthours (Wh).

**Geology:** Study of the planet Earth, its composition, structure, natural processes, and history.

**Geophysical survey:** Geophysical methodologies used during the exploration and drilling phases to locate the resource and identify the best suited sites to drill production wells. These may include gravity surveys, ground magnetic surveys, magnetotelluric surveys, electrical resistivity surveys, and seismic surveys.

**Geothermal:** Of or relating to the Earth's interior heat.

**Geothermal Energy:** Natural heat from within the Earth, captured for production of electric power, space heating or industrial steam.

**Geothermal Heat Pumps:** Devices that take advantage of the relatively constant temperature of the Earth's interior, using it as a source and sink of heat for both heating and cooling. When cooling, heat is extracted from the space and dissipated into the Earth; when heating, heat is extracted from the Earth and pumped into the space.

**Geothermal Plant:** A plant in which the prime mover is a steam turbine. The turbine is driven either by steam produced from hot water or by natural steam that derives its energy from heat found in rocks or fluids at various depths beneath the surface of the Earth. The energy is

**Geothermal Plant:** A plant in which the prime mover is a steam turbine. The turbine is driven either by steam produced from hot water or by natural steam that derives its energy from heat found in rocks or fluids at various depths beneath the surface of the Earth. The energy is extracted

by drilling and/or pumping.

**Geothermal Steam:** Steam drawn from deep within the Earth.

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**Geyser:** A spring that shoots jets of hot water and steam into the air.

**Geysers, The** (note: .The. of .The Geysers. is always capitalized): A large geothermal steam field located north of San Francisco.

**Greenfield project:** A greenfield project (as opposed to a project expansion) is a project that is developed on a resource (area) that is not used by an existing power plant.

**Greenhouse Effect:** The increasing mean global surface temperature of the Earth caused by gases in the atmosphere (including carbon dioxide, methane, nitrous oxide, ozone, and chlorofluorocarbon). The greenhouse effect allows solar radiation to penetrate but absorbs the infrared radiation returning to space.

**Grid:** The layout of an electrical distribution system.

**Gross Generation:** The total amount of electric energy produced by the generating units at a generating station or stations, measured at the generator terminals.

**Heat Exchanger:** A device for transferring thermal energy from one fluid to another.

**Heat Pumps:** *See Geothermal Heat Pumps*

**Hot Dry Rock:** A geothermal resource created when impermeable, subsurface rock structures, typically granite rock 15,000 feet or more below the Earth's surface, are heated by geothermal energy. The resource is being investigated as a source of energy production.

**Hydroelectric Plant:** A plant in which the turbine generators are driven by falling water.

**Independent Power Producers:** Entities that are considered nonutility power producers in the United States. These facilities are wholesale electricity producers that operate within the franchised service territories of host utilities and are usually authorized to sell at market-based rates. Unlike traditional electric utilities, Independent Power Producers do not possess transmission

**Indirect impacts:** This correspond to the economic impact that affects all industries that provides

goods and services to the industries directly involved in power plant construction or operation and

maintenance. Indirect impacts thus quantify the impact of changes in power plant construction or O&M activities on the industries that supplies it.

**Induced impacts:** Industries that experience both direct and indirect impacts will often change their employment levels to meet the new level of demand. These employment changes induce changes in income that are spent in the region to purchase goods and services. This income effect is the source of induced impacts. Induced impacts leads to further rounds of indirect and induced impacts as the increased demand for goods and services purchased by workers leads to further increases in output in other industries.

**Injection well:** Injection wells inject the brine back into the reservoir after using it in the power production process.

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**Injection:** The process of returning spent geothermal fluids to the subsurface. Sometimes referred

to as reinjection.

**Kilowatt (kW):** One thousand watts.

**Kilowatthour (kWh):** One thousand watthours.

**Known Geothermal Resource Area (KGRA):** A region identified by the U.S. Geological Survey as containing geothermal resources.

**Lead-time:** The amount of time between the placing of an order and the receipt of the goods ordered.

**Lease:** A contract between a lessor and a lessee for the use of a vehicle or other property, subject to stated terms and limitations, for a specified period and at a specified payment.<sup>113</sup>

**Levelized cost:** The present value of the total cost of building and operating a generating plant over its economic life, converted to equal annual payments. Costs are levelized in real dollars (i.e., adjusted to remove the impact of inflation).

**Lithologies:** properties of a rock formation

over its economic life, converted to equal annual payments. Costs are levelized in real dollars (i.e., adjusted to remove the impact of inflation).

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**Load (Electric):** The amount of electric power delivered or required at any specific point or points on a system. The requirement originates at the energy-consuming equipment of the consumers.

**Magma:** The molten rock and elements that lie below the Earth's crust. The heat energy can approach 1,000 degrees Fahrenheit and is generated directly from a shallow molten magma resource and stored in adjacent rock structures. To extract energy from magma resources requires drilling near or directly into a magma chamber and circulating water down the well in a convection-type system. California has two areas that may be magma resource sites: the Mono-Long Valley Caldera and Coso Hot Springs Known Geothermal Resource Areas.

**Mantle:** The Earth's inner layer of molten rock, lying beneath the Earth's crust and above the Earth's core of liquid iron and nickel.

**Megawatt (MW):** One million watts.

**megawatt hour (MWh):** One million watt-hours.

**Mitigation:** Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards

**Municipal utility:** Water or electric company over which the State Department of Public Utility Control does not have jurisdiction to regulate.

<sup>113</sup>Federal Reserve. *Glossary of Terms*. Retrieved August 1, 2006, from [www.federalreserve.gov/pubs/leasing/glossary.htm](http://www.federalreserve.gov/pubs/leasing/glossary.htm).

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**Natural Gas Combined-Cycle:** plants that generate electricity using two methods, the steam cycle and the gas cycle. In the steam cycle, fuel is burned to boil water and create steam which turns a steam turbine driving a generator to create electricity. In the gas cycle, gas is burned in a gas turbine which directly turns a generator to create electricity. Combined cycle power plants operate by combining the gas cycle and the steam cycle for higher efficiency.

**Natural Gas:** A naturally occurring mixture of hydrocarbon and nonhydrocarbon gases found in porous geological formations beneath the earth's surface, often in association with petroleum.

The

principal constituent is methane.

**Net Capability:** The maximum load-carrying ability of the equipment, exclusive of station use, under specified conditions for a given time interval, independent of the characteristics of the load.

(Capability is determined by design characteristics, physical conditions, adequacy of prime mover, energy supply, and operating limitations such as cooling and circulating water supply and temperature, headwater and tailwater elevations, and electrical use.)

**Net Generation:** Gross generation less the electric energy consumed at the generating station for station use.

**Nitrogen oxides (NOx):** Oxides of nitrogen that are a chief component of air pollution that can be produced by the burning of fossil fuels. Also called nitrogen oxides.

**Non-specular conductors:** conductors treated to reduce the amount of light reflected, usually by dipping the conductor in an acid bath that takes the shine off thereby reducing visibility.

**Nuclear Energy:** Power obtained by splitting heavy atoms (fission) or joining light atoms (fusion). A nuclear energy plant uses a controlled atomic chain reaction to produce heat. The heat is used to make steam run conventional turbine generators.

**Nuclear Power Plant:** A facility in which heat produced in a reactor by the fissioning of nuclear fuel is used to drive a steam turbine.

**Open-Loop Biomass:** <sup>114</sup>any agricultural livestock waste nutrients; or, any solid, nonhazardous, cellulosic or lignin waste material or by product of wood

or paper mill operations, including lignin in pulping liquors, which is derived from

**Outage:** The period during which a generating unit, transmission line, or other facility is out of service.

**Particulate Matter (PM):** Unburned fuel particles that form smoke or soot and stick to lung tissue when inhaled. A chief component of exhaust emissions from heavy-duty diesel engines

**Peak Demand:** The maximum load during a specified period of time.

<sup>114</sup>American Forest & Paper Association (August 2005). *Senate Corrections Comments*. Retrieved August 1, 2006, from

<http://www.senate.gov/~finance/Technical%20Correction%2005/Comments%20on%20Tax%20Technical>

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**Peaking Capacity:** Capacity of generating equipment normally reserved for operation during the hours of highest daily, weekly, or seasonal loads. Some generating equipment may be operated at certain times as peaking capacity and at other times to serve loads on an around-the-clock basis.

**Permeability:** The relative ease with which a porous medium can transmit a liquid under a hydraulic gradient. In hydrology, the capacity of rock, soil, or sediment to allow the passage of water.

**Plant:** A facility at which are located prime movers, electric generators, and auxiliary equipment for converting mechanical, chemical, and/or nuclear energy into electric energy. A plant may contain more than one type of prime mover. Electric utility plants exclude facilities that satisfy the definition of a qualifying facility under the Public Utility Regulatory Policies Act of 1978.

**Pollution:** Unwanted particles, mist or gases put into the atmosphere as a result of motor vehicle exhaust, the operation of industrial facilities or other human activity.

**power purchase agreement:** The off-take contract from a large customer to buy the electricity generated by a power plant.

**Power:** The rate at which energy is transferred. Electrical energy is usually measured in watts. Also used for a measurement of capacity.

**Price:** The amount of money or consideration-in-kind for which a service is bought, sold, or offered for sale.

**Production well:** A production well is a well drilled through a geothermal resource that produces geothermal brine.

**Profit:** The income remaining after all business expenses are paid.

**Qualifying Facility (QF):** A cogeneration or small power production facility that meets certain ownership, operating, and efficiency criteria established by the Federal Energy Regulatory Commission (FERC) pursuant to the Public Utility Regulatory Policies Act (PURPA).

**Rate of return:** The annual rate of return on an investment, expressed as a percentage of the total

amount invested. also called return

**Reconnaissance:**<sup>115</sup> A method of gathering data, often associated with surface surveys, in which archaeological remains are systematically identified and plotted on a map.

**Regulation:** The governmental function of controlling or directing economic entities through the process of rulemaking and adjudication.

**Reliability:** Electric system reliability has two components--adequacy and security. Adequacy is the ability of the electric system to supply to aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and unscheduled outages of system facilities. Security is the ability of the electric system to withstand sudden disturbances, such as electric short circuits or unanticipated loss of system facilities. The degree

<sup>115</sup> Archeological Institute of America (2006). *Glossary*. Retrieved August 1, 2006, from

<http://www.archaeological.org/webinfo.php?page=10299>.

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of reliability may be measured by the frequency, duration, and magnitude of adverse effects on consumer services.

**Renewable energy:** Resources that constantly renew themselves or that are regarded as practically inexhaustible. These include solar, wind, geothermal, hydro and wood. Although particular geothermal formations can be depleted, the natural heat in the earth is a virtually inexhaustible reserve of potential energy. Renewable resources also include some experimental or

less-developed sources such as tidal power, sea currents and ocean thermal gradients.

**Renewable Resources:** Naturally, but flow-limited resources that can be replenished. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Some (such as geothermal and biomass) may be stock-limited in that stocks are depleted by use, but on a time scale of decades, or perhaps centuries, they can probably be replenished.

Renewable energy resources include: biomass, hydro, geothermal, solar and wind. In the future, they could also include the use of ocean thermal, wave, and tidal action technologies. Utility renewable resource applications include bulk electricity generation, on-site electricity generation, distributed electricity generation, non-grid-connected generation, and demand-reduction (energy

they could also include the use of ocean thermal, wave, and tidal action technologies. Utility renewable resource applications include bulk electricity generation, on-site electricity generation, distributed electricity generation, non-grid-connected generation, and demand-reduction (energy efficiency) technologies.

**Reservoir:** A natural underground container of liquids, such as water or steam (or, in the petroleum context, oil or gas).

**Revegetation:**<sup>116</sup> Regrowing native plants, mainly trees and shrubs, by active restoration, natural process restoration, or both.

**Revenue:** The total amount of money received by a firm from sales of its products and/or services, gains from the sales or exchange of assets, interest and dividends earned on investments,

and other increases in the owner's equity except those arising from capital adjustments.

**Royalty:** A payment made for the use of property, especially a patent, copyrighted work, franchise, or natural resource. The amount is usually a percentage of revenues obtained through its use.

**Sales:** The amount of kilowatthours sold in a given period of time; usually grouped by classes of service, such as residential, commercial, industrial, and other. Other sales include public street and highway lighting, other sales to public authorities and railways, and interdepartmental sales.

**Slim-hole:** Slim-holes are small diameter wells drilled during the exploration phase in order to verify the existence of a productive geothermal resource and provide information about the geologic structure of the site. Such holes are sometimes preferred to "full-diameter production wells" since they are significantly less expensive.

**Socioeconomics:**<sup>117</sup> Research into the effects of both social and economic factors on individuals and communities. Socioeconomics begins with the assumption that economics is not a self-contained

system, but is embedded in society, polity, and culture.

<sup>116</sup>The Nature Conservancy. Retrieved August 1, 2006, from [www.tnccalifornia.org/glossary/](http://www.tnccalifornia.org/glossary/).

<sup>117</sup>Harvard University ([http://www.researchmatters.harvard.edu/topic.php?topic\\_id=260](http://www.researchmatters.harvard.edu/topic.php?topic_id=260)) and Society for the Advancement of Socio-Economics (SASE)

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**Solar Energy:** Heat and light radiated from the sun.

**Stability:** The property of a system or element by virtue of which its output will ultimately attain a steady state. The amount of power that can be transferred from one machine to another following a disturbance. The stability of a power system is its ability to develop restoring forces equal to or greater than the disturbing forces so as to maintain a state of equilibrium.

**Standby Service:** Support service that is available, as needed, to supplement a consumer, a utility

system, or to another utility if a schedule or an agreement authorizes the transaction. The service is not regularly used.

**Subsidence:** A sinking of an area of the Earth's crust due to fluid withdrawal and pressure decline

**Sulfur oxides:** Compounds containing sulfur and oxygen, such as sulfur dioxide (SO<sub>2</sub>) and sulfur trioxide (SO<sub>3</sub>).

**Sustainability:**<sup>118</sup> Economic development that takes full account of the environmental consequences of economic activity and is based on the use of resources that can be replaced or renewed and therefore are not depleted.

**System (Electric):** Physically connected generation, transmission, and distribution facilities operated as an integrated unit under one central management, or operating supervision.

**Temperature gradient hole:** A temperature gradient hole is a relatively slim and shallow hole (50-600 feet deep) that aims to estimate the rate of increase of ground temperature with depth.

**Transmission System (Electric):** An interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers, or is delivered to other electric systems.

**Transmission:** The movement or transfer of electric energy over an interconnected group of lines

and associated equipment between points of supply and points at which it is transformed for delivery to consumers, or is delivered to other electric systems. Transmission is considered to end

and associated equipment between points of supply and points at which it is transformed for delivery to consumers, or is delivered to other electric systems. Transmission is considered to end

when the energy is transformed for distribution to the consumer.

**Turbine:** A machine for generating rotary mechanical power from the energy of a stream of fluid (such as water, steam, or hot gas). Turbines convert the kinetic energy of fluids to mechanical energy through the principles of impulse and reaction, or a mixture of the two.

**Utility:** A regulated entity which exhibits the characteristics of a natural monopoly. For the purposes of electric industry restructuring, "utility" refers to the regulated, vertically-integrated electric company. "Transmission utility" refers to the regulated owner/operator of the transmission system only. "Distribution utility" refers to the regulated owner/operator of the distribution system which serves retail customers.

([http://www.sase.org/index.php?option=com\\_content&task=blogsection&id=5&Itemid=43](http://www.sase.org/index.php?option=com_content&task=blogsection&id=5&Itemid=43)). Retrieved August 1, 2006, 2006.

<sup>118</sup> USGS. *Glossary*. Retrieved August 1, 2006, from <http://biology.usgs.gov/s+t/SNT/noframe/zy198.htm>.

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**Watt:** The electrical unit of power. The rate of energy transfer equivalent to 1 ampere flowing under a pressure of 1 volt at unity power factor.

**Watt-hour (Wh):** An electrical energy unit of measure equal to 1 watt of power supplied to, or taken from, an electric circuit steadily for 1 hour.