Currently there are two promising methods of producing electricity from the sun. They are the Solar Cell (photovoltaic method) and the Solar Thermal Conversion method. Solar Thermal Conversion offers immediate application, due to using conventional power plant technology and material. ***RIGHT OF WAY*** *takes a look at both methods with reports on plants currently producing or will be shortly producing solar generated energy.*

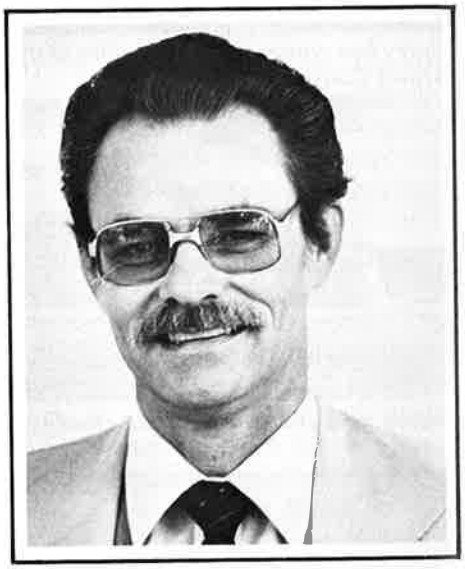
SOLAR REPOWERING A STEP FORWARD

by James E. Brown

The Power Plant and Industrial Fuel Use Act of 1978 restricts the use of oil or natural gas in new electric utility units or in new industrial boilers with a fuel heat input rate of 100 million BTU's per hour or greater, unless exemption is granted by the Department of Energy. The Act similarly encourages, and in some cases requires, that existing oil and natural gas facilities be converted to coal or to an alternate fuel such as solar energy. In complying with the intent of this Act, utilities are evaluating alternative repowering options for their existing gas and oil-fired units. One option being considered is the use of solar energy to displace a portion or all of the gas and/or oil that would normally be used for electric power generation; this option is called "solar repowering."

Solar repowering consists of locating solar hardware adjacent and connected to existing units to displace a portion or all of the fossil fuel normally used during daylight hours. The ability to operate on fossil fuel is retained, thus providing full backup capability and maximum operational flexibility during periods of inclement weather as well as for economic dispatch, if required, to meet load demand. The potential for conventional electric power generation at night is retained, thus eliminating the need for costly, multi-hour energy storage systems.

An assessme..t performed for the Department of Energy has established the technical feasibility, utility system impact, and economic attractiveness of de-



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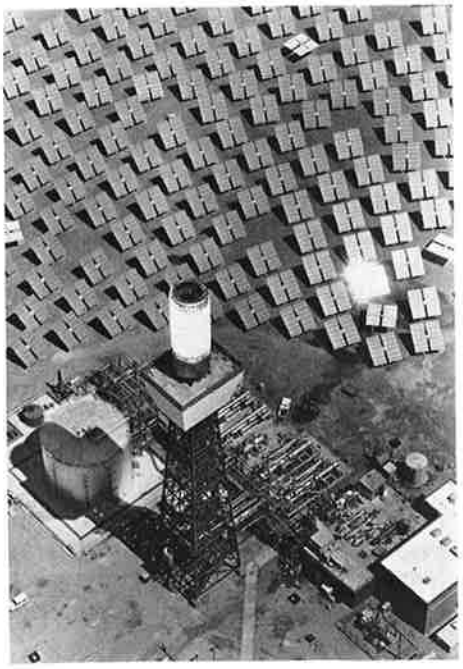
Mr. Brown is especially active in solar evaluations, representing his Company as Program Manager on three Department of Energy contracts for solar thermal power projects and as Assistant Project Manager and Construction Manager for a DOE solar photovoltaic project. He is Project Director for a cooperative DOE/El Paso Wind Evaluation Study.

He has authored and coauthored several papers presented at various forums including the American Society of Mechanical Engineers, Institute of Electrical and Electronic Engineers, and International Solar Energy Society dealing with investigative work in alternative methods of electricity generation.

Solar One: The first operating solar conversion unit.



monstrating the solar repowering concept. El Paso Electric (EPE) Company's Newman Unit 1 represents the first generation of utility repowering applications, characterized by an excellent solar resource, availability of unencumbered, flat land allowing location of the receivers adjacent to the turbine building, a substantial remaining unit lifetime, a reheat steam turbine and gas-fired boiler capable of withstanding solar transients without thermal storage, and the absence of major environmental or institutional constraints. These conditions allow for a simplicity of design that minimizes technical risk and maximizes the likelihood of a successful demonstration project that will develop utility industry confidence in this emerging technology.

This solar repowering concept utilizes the central receiver technology and consists of the addition of a solar collector field, a central receiver (boiler), and potentially a thermal energy buffer storage subsystem to existing generation facilities; the integration of the solar hardware with the existing systems; and the appropriate refurbishments/modifications to the existing generating unit which primarily involves the turbine-generator and the instrumentation and control system.

Steam generated in the central receiver will be mixed with any steam provided by the existing fossil steam generator prior to admission to the turbine. Attemperation of the solar-generated steam will ensure that the temperatures are maintained within turbine design limits. Solar-generated steam will be used for most of the flow, with fossil steam generation to replace any steam flow reduction due to intermittent cloud cover and for economic dispatch.

Background

The development of solar thermal power system technology for utility applications in the United States is primarily being undertaken by the Department of Energy (DOE) and the Electric Power Research Institute (EPRI). The primary objective of programs sponsored by DOE is to provide a sound technological and industrial base which will result in rapid commercialization of solar thermal technologies and thus contribute significantly to conserving our dwindling fossil fuel supplies. These programs are an important outgrowth of the national

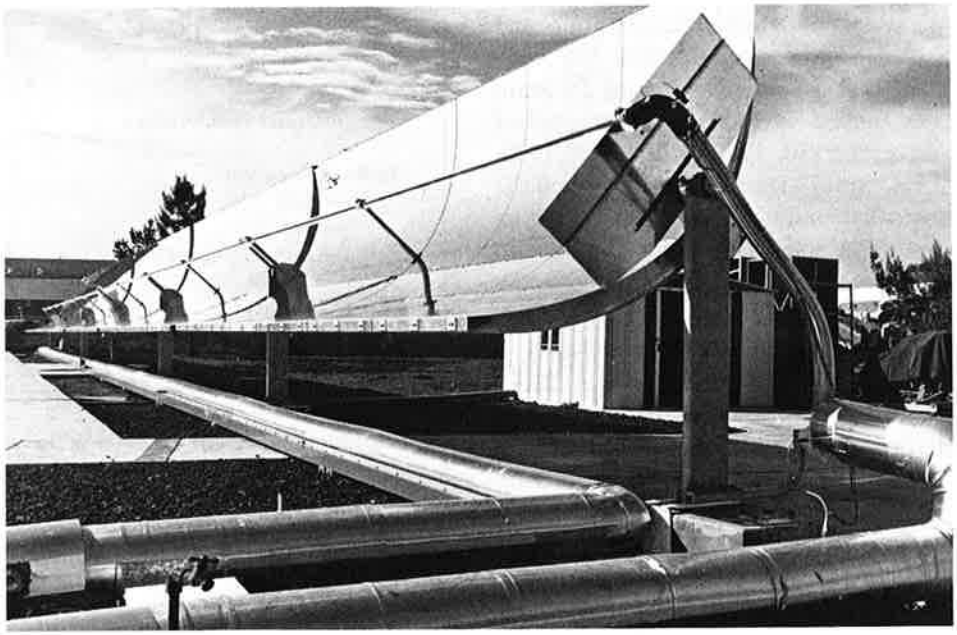
Solar Plant to Provide Energy Cheaper than Fossil Fuels

Construction has begun on the world's largest commercial, cost-competitive solar electric generating facility. A solar thermal system, designed and to be operated by Acurex Solar Corporation for the Southern California Edison Company, the Acurex facility will service the electrical needs of 6,000 typical homes during the daylight hours.

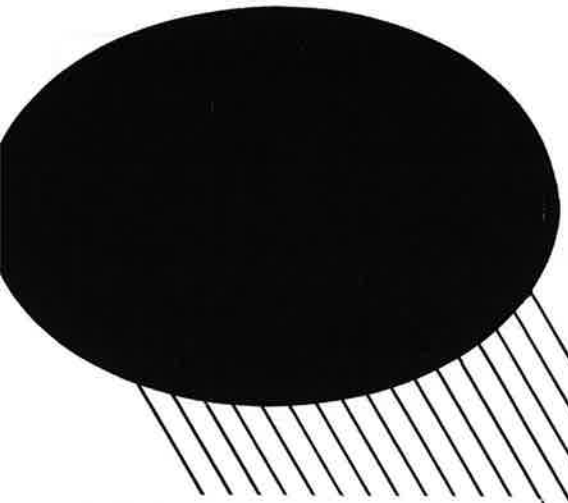
Located on 90 acres in San Bernardino County, California, the facility will use 5300 solar parabolic troughs. The price paid to Acurex for producing the electricity will be less than the price of electricity produced by burning fossil fuels. The plant will be rated at 12 megawatts.

A manufacturing plant will produce the solar energy trough collectors. It will have a capacity of over one million square feet to produce collectors for this and other projects. Acurex President Bob Mawhinney believes that the economies of scale of its Fremont, California plant will significantly reduce the cost of solar energy systems, making solar energy directly competitive with oil and gas for a wide variety of industrial applications.

The Acurex facility will use 750,000 square feet of parabolic trough collectors. The sun's energy is collected and concentrated by the trough collectors to generate steam to drive a turbogenerator, which will produce the electrical energy for Edison's power grid. The 5300 collectors will incorporate automated, single-axis solar tracking systems to keep them aligned with the sun throughout the day for maximum efficiency.



SOLAR TROUGH—The nation's first cost-competitive source of electric power from the sun will be built and operated by Acurex, Solar Corp., on Southern California Edison Company property in Daggett, near Barstow, Calif. The 90 acre site will accommodate more than 5,000 of the concentrating trough collectors shown above. Beginning late in 1983, the electricity produced by this 12 megawatt system will be sold to SCE at a cost lower than power produced by fossil fuels.



Paradoxically, the Reagan administration recently eliminated funding for solar repowering. Beginning fiscal year 1983, all financing will come from private sources.

desire to reduce usage of conventional oil and natural gas fuels in the generation of electrical energy. Solar repowering utilizing the central receiver technology has been identified as the most promising near-term application of this technology.

Studies initiated under contract to DOE of the solar repowering market for both utility and industrial process applications concluded that solar repowering can potentially save the equivalent of one-half million barrels of oil per day. The Solar Energy Research Institute performed an Analysis for DOE which concluded that solar repowering should be undertaken by DOE to develop a market for central receiver technology.

The studies gave sufficient promise for the solar repowering concept marketability that in 1979 DOE awarded multiple system design contracts for utility and industrial process applications. The Newman Unit 1 Solar Repowering Program was funded by DOE for the period of September 30, 1979, to July 15, 1980. EPE, through its study, demonstrated the technical feasibility and economic attractiveness of solar repowering reheat steam turbines using conventional water/steam technologies familiar to the utility industry in general and to plant operators of existing units specifically.

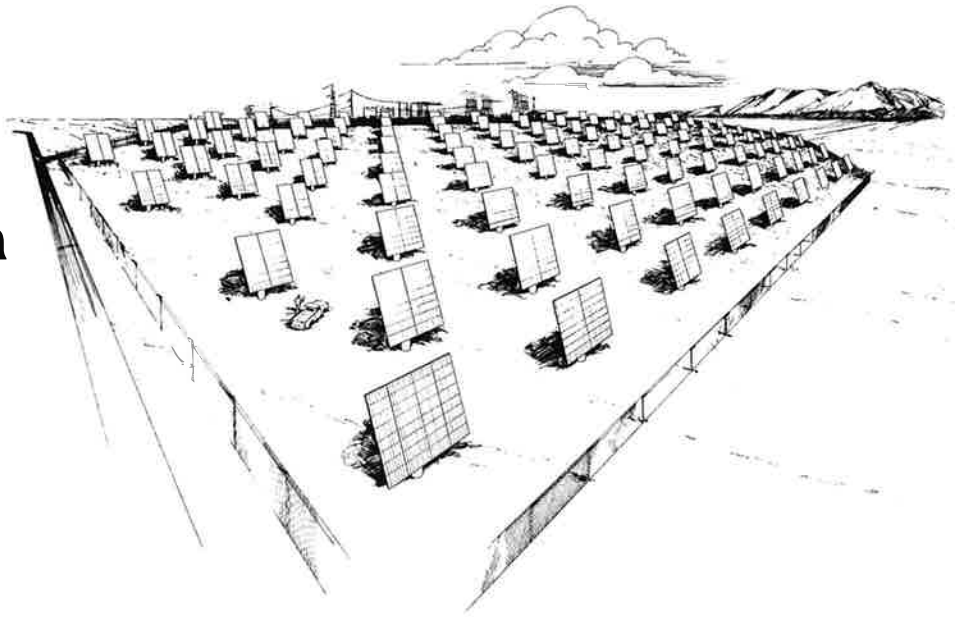
At the end of 1981, DOE issued a solicitation for an advanced conceptual design contract to further demonstrate solar repowering. Engineering decisions leading to construction will be made in late 1982. Demonstration units plan to be in operation by 1986 and form the foundation for the future commercialization of solar central receiver systems. Paradoxically, the Reagan administration recently eliminated funding for solar repowering. Beginning fiscal year 1983, all financing will come from private sources.

TABLE 1. SOLAR-REPOWERED NEWMAN UNIT 1

Unit Type	**Reheat Steam Turbine**
Unit Rating	**82.3 MWe**
Solar Repowering Percentage*	**50 Percent**
Plant Operating Scenario	**Maximize Solar Benefit** **Fossil Operation Full-Time and only on Cloudy Days** **Economic Dispatch Fossil Energy**
Collector Subsystem	
—*Field Configuration*	North Field (160° ARC)
—*Field Area*	370 Acres
—*Heliostat Area*	226,938m²
—*Number of Heliostats*	3981 (57m²/heliostat)
Primary Receiver	
—*Type*	External (Pumped, Recirculation Boiler/ Screened Tube Concept)
—*Size*	12.6m Dia × 15.7m Long (240° ARC)
—*Outlet Temperature*	1020°F
Reheat Receiver	
—*Type*	External
—*Size*	12.6m Dia × 15.7m Long (210° ARC)
—*Outlet Temperature*	1020°F
Tower Height	
—*Number of Towers*	1
—*Primary Receiver C/L*	155m
—*Reheat Receiver C/L*	139m
Electrical Power Generation Subsystem	
—*Cycle*	Steam Rankine (Reheat)
—*Net Unit Efficiency*	40 Percent
—*Turbine Inlet*	1450 psi/1000°F/1000°F
—*Heat Rejection*	Wet Cooling Tower
Fossil Boiler	
—*Type*	Gas/Oil
—*Rate Load Efficiency*	84.4 Percent
—*Hot Standby (%)*	28
—*Startup Energy*	100 MBTU
—*Warm Standby*	15 MBTU/Startup

* Based on a Insolation Level of 950 Watts/m²

Major Photovoltaic Facility To Be Completed Soon



ARCO Solar, Inc. Photovoltaic Facility at Southern California Edison Sub-Station

Solar photovoltaic is sunlight converted directly into electricity and as part of Southern California Edison's solar energy program, the largest solar photovoltaic facility will be built by ARCO Solar, Inc. The facility, located in San Bernardino County, California, will be built on twenty acres adjacent to the Edison Lugo station, using already established transmission lines to service the 300-400 homes that the plant will power. The plant is scheduled to begin service December, 1982.

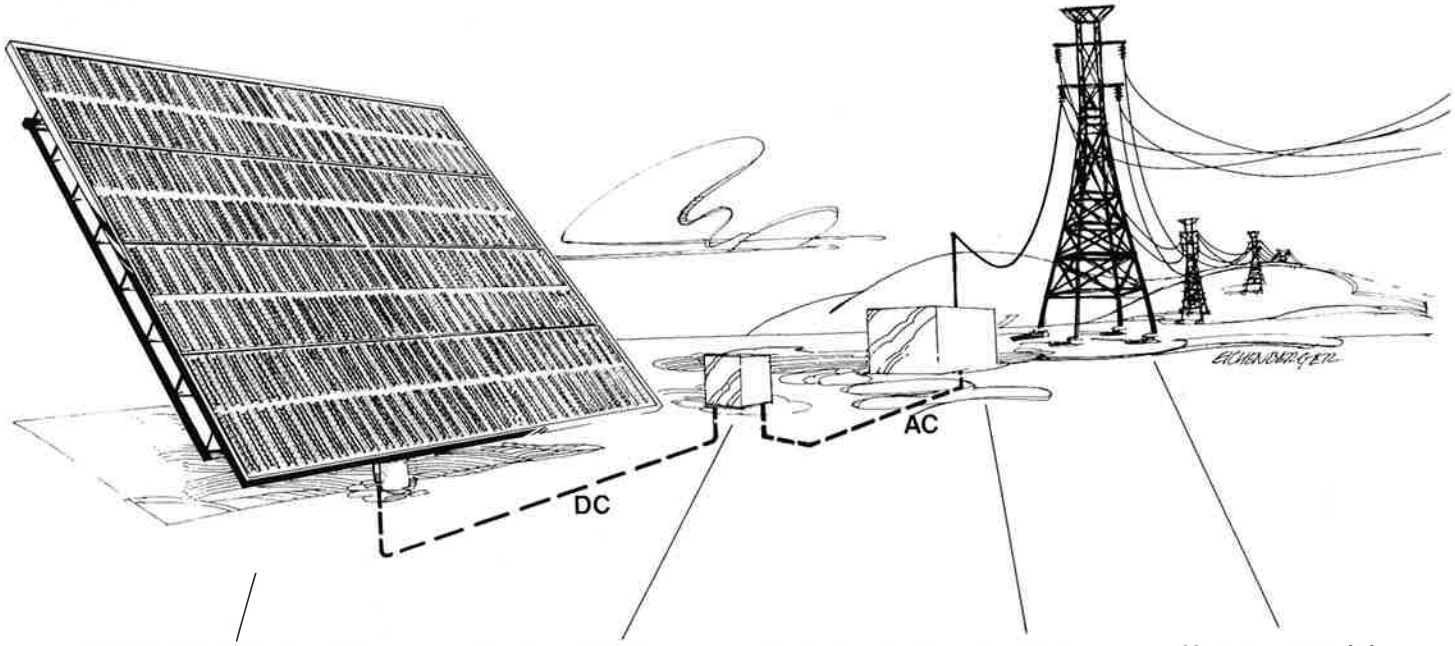
The ARCO Solar system has several unique features. The photovoltaic panels will be mounted on approximately 100 double-axis trackers which orient the panels consistently toward the sun throughout the day, taking into account seasonal changes of the sun's position. These computer-controlled trackers, developed by ARCO Power Systems, increase the average daily power output of the panels, thus lowering the average cost of electricity produced.

Although this is an operating rather than a research project, technology will be used that has not previously been demonstrated commercially on this scale. These technical advances include:

- the combination of double-axis trackers with mass-produced photovoltaic modules.
- the use of large-scale inverters to convert the DC electricity generated by the panels into AC current used in homes.

Both federal and state tax credits applicable to photovoltaic installations enable the project to be built at this time. ARCO Solar, Inc. believes that a combination of improved technology and further cost reductions over the next several years will make large systems economic in many foreign countries where electricity is more expensive than in the U.S.

The subsidiary also believes that photovoltaic technology eventually will develop to the point where it can be applied economically in large-scale systems in the United States without the assistance of solar tax credits.

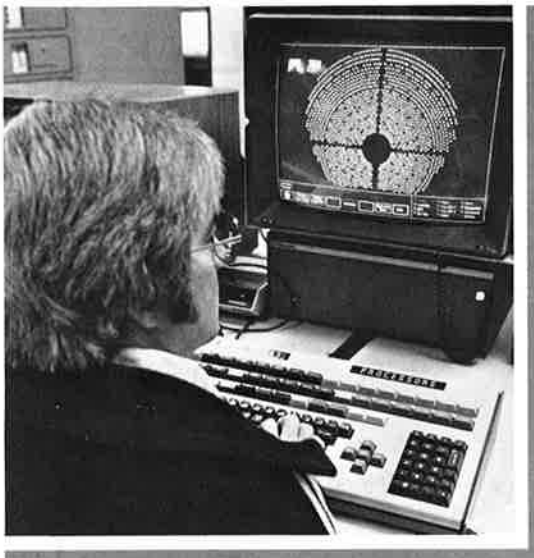


The First: SOLAR ONE

The following is a photoessay of Solar One, funded by the Department of Energy. Solar One was the first plant to successfully generate electricity for commercial use. The results of the April, 1982 generation were so encouraging that Southern California Edison is now accepting bids for Solar 100, designed to produce ten times the energy of ten-megawatt Solar One. The photos were provided by SCE.

A spectacular display of light is evident when dust or moisture in the air is lit by hundreds of heliostats (mirrors) at Solar One in Southern California's Mojave Desert. The world's largest solar-powered electrical generating station began "startup" tests early this spring and recently generated its first electric power. Each morning, heliostats reflecting the sun's rays are first focused on "stand-by" points, and then moved onto the receiver (boiler) atop a 300-foot tower as required to create steam to operate the turbine-generator below.

A field of giant mirrors (heliostats) reflects the sun's rays to Solar One's boiler (receiver) atop a 300-foot tower to produce super-heated steam and operate a turbine generator on the ground below. Several months of cautious "startup" activities are expected before achieving the full plant rating of 10-megawatts. This first-of-a-kind solar powered electric generating facility could provide enough power to meet the needs of approximately 6,000 homes. Ground facilities include the thermal storage tank, thermal storage system heat exchangers, turbine-generator deck and the control building.



Solar One's 1,818 heliostats, which continuously track the sun, are automatically controlled by a computer.