

STATUS OF THE SOUTHERN CALIFORNIA EDISON COMPANY 3 MW WIND

TURBINE GENERATOR (WTG) DEMONSTRATION PROJECT

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To demonstrate the concept of utility scale electricity production from a high wind energy resource, Southern California Edison Company (SCE) has initiated a program to construct and test a 3 megawatt (3,000 kW) Schachle Wind Turbine Generator (WTG) at a SCE-owned site near Palm Springs, California. The background and current status of this program are presented along with a summary of future planned program activities.

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With fossil fuels becoming increasingly expensive and in short supply, the wind is showing increasing promise of making an important, cost competitive contribution toward meeting the public's needs for electrical energy. Southern California Edison (SCE) has become especially interested in wind energy conversion for two primary reasons. First, over two-thirds of SCE's generating capacity consists of oil-fired units, and consequently SCE has a very high reliance on imported low sulfur fuel oil with the attendant problems of high fuels costs and embargo possibilities. Use of WTG's could help reduce this dependence on oil. Secondly, wind speed data obtained from a Department of Energy (DOE) meteorological tower show that there is an outstanding wind resource area near existing SCE substation and transmission facilities in the vicinity of Palm Springs, California (fig. 1).

These factors led SCE to undertake evaluations of WTG's (including designs of both DOE and private suppliers) for possible use on the SCE system (fig. 2). One of the private designs evaluated was that of Charles Schachle, Wind Power Products Company. The Schachle design had been under development since 1970, well before the beginning of the Federal Wind Program. Over three years were spent on blade design alone. These efforts culminated in construction of a prototype system with a 72 foot blade span which has been operational since May 1977 in Moses Lake, Washington (figs. 3 and 4). Results of SCE's evaluations of the Schachle WTG design indicated that it was an especially promising design for relatively near-term economical electricity production. Consequently, SCE decided to purchase and test a 3 mW Schachle WTG (fig. 5) at the SCE-owned test site near Palm Springs (fig. 6).

The purpose of the project is to demonstrate the technical and economic feasibility of the Schachle WTG as a necessary intermediate

step toward the more widespread installation of such WTG's to generate electrical energy for the SCE system on a commercial basis. It will also serve to give the public a first-hand opportunity to visualize how wind-generated electricity may contribute to their future energy needs.

Unique features of the Schachle WTG include a tubular conically shaped steel tower mounted on a concrete and steel base which will permit tower rotation to keep the blades facing into the wind. The blades will be constructed of laminated wood and fiberglass. The WTG also uses a hydraulic pump-motor link between the rotor (atop the tower) and the generator (at ground level) which allows a less complex gearbox design and permits the rotor blades to rotate more efficiently at speeds varying in proportion to the speed at which the wind blows. The unit will have a 165 foot blade span and a design rating of 3 megawatts in a 40 mph wind.

The unit was rated at 40 mph to maximize the energy (kW hr) output for the specific wind regional experienced at the SCE wind site near Palm Springs. Based on a significant quantity of wind data, it was determined that a unit rated for peak output at 40 mph would produce twice the energy of one rated at 25 mph at the site being considered. The value of the increased energy more than offsets the increased cost of the higher rated WTG. The unit will operate unattended and is expected to produce 6,000,000 kW hr/year in the winds present at the test site. This is enough electrical energy to supply the average annual needs of 800-1000 customers, and would save about 10,000 barrels of oil a year which would otherwise be used to generate this amount of electricity.

The total cost of the project is about \$2,000,000, of which \$1,000,000 is for the WTG unit and \$1,000,000 is for SCE's site work, substation and other interface equipment, test equipment, design review, and related expenses. The project is financed solely by Southern California Edison.

After obtaining the necessary siting permits, site preparation was begun in early December 1978, and was completed in early January 1979. Site fencing was complete by the first of February. The substation at the site was completed in late March.

The installation of the WTG foundation is projected to be complete by May. The tower and blade assemblies will then be installed at the site. The complete system including WTG, substation, control system, transmission line tie-in and test equipment is expected to be operational around mid-1979.

At that time a one- to two-year performance test program will be initiated. The purpose of the test program is to obtain operating data to evaluate various performance characteristics of the WTG and to determine its operating and maintenance characteristics. Data obtained will be recorded on magnetic tape for subsequent processing and analysis.

Data to be recorded include such items as wind speeds and corresponding mechanical and electrical output, blade and tower loadings, operation of the control system and other related parameters. Maintenance and overall reliability data will be taken. Data will be taken to determine whether there are any significant levels of noise, television interference, or impact on birds or other biota associated with operation of the WTG.

The WTG and data recording system will be capable of unattended operation, automatically coming on-line whenever adequate winds, above 10 to 12 mph, are present. Southern California Edison personnel at Devers Substation, a major substation 1/4 mile from the site and manned 24 hours a day, will monitor the operation of the WTG.

The data from the test operation of the WTG will be analyzed from technical, economic, and environmental standpoints. Results of the analysis of the WTG performance testing will be used in ongoing studies to evaluate the potential for installation of large arrays of such WTG's for commercial production of electrical energy in the high wind areas near Palm Springs. These studies will also incorporate the results of a current wind energy resource evaluation project jointly sponsored by Southern California Edison and the California Energy Commission in which wind data is being continuously monitored at 19 sites in the area.

As other promising WTG's, such as the DOE MOD-2 or other DOE or private designs, become available, SCE would be seriously interested in finding ways to use its wind test site for comparative testing of such designs in addition to the Schachle WTG.

The purpose of such testing is to develop as early as possible proven competitive designs which will serve to bring the price of wind turbine generators down to the lowest possible value. If the results of Edison's WTG tests and wind data collection efforts verify expectations, the first commercial implementation of large-scale WTG's could be a reality on the SCE system in the 1980's. The initial units would likely be installed in the high-wind areas in north central Riverside County near Palm Springs, but other areas will be explored which may also have the high winds necessary for efficient WTG operation, and later units could be installed in those areas.

There are a number of practical aspects that must be kept in mind when considering the implementation of WTG's for commercial energy production. First of all, even very large WTG's can produce only a few megawatts of electrical power each, and large numbers of them (800-1300) would be necessary to match the energy output of a single typical conventional fossil or nuclear fueled generating station. In this regard, it is exceedingly important to demonstrate that large arrays of WTG's can be installed in a way which is acceptable to the public. Secondly, the output of a WTG is very much dependent on the winds available at the site, and great care must be taken to select a site with an adequate

wind resource. Remote sites requiring long transmission lines to transport the energy to the customers may not be economically viable even if the resource is good. Thirdly, because the wind is not always available upon demand, conventional generation sources will continue to be required to provide back-up capacity so that customer electricity requirements are reliably met.

If progress in the general field of wind energy conversion continues, and if the performance of the SCE 3 WTG meets expectations, wind energy has the promise of providing a valuable and significant contribution to the energy needs of SCE's customers possibly as early as the 1980's. However, SCE does not consider wind to be the complete answer in itself. SCE must employ wind and other new alternate energy sources, along with conventional sources in appropriate combinations, to adequately meet its customers' needs for reliable and affordable energy for their homes and jobs.

Discussion

- Q. What kind of a bearing plan or track plan is designed for the base of the tower rotation? It looked quite weak.
- A. It is very similar to that used on Schschle's prototype, as shown in previous slides. The track will be upgraded to match the strength that is required for the 3 MW unit.
- Q. What is the overall efficiency of the hydraulic pumping and motor cycle? Is there a value for the prototype?
- A. We don't know the exact number, but we are looking at possibly a 25 percent loss in the hydraulic portion of the system. That matter will be evaluated in very strict detail during the operational testing program. The prototype utilized some off-the-shelf equipment not optimized for the WTG. I think the losses there are somewhat greater than the 25% value expected for the 3 MW unit.
- Q. The nacelle and rotor seem to be mounted forward pretty much into the wind. Is there a tendency to tip if the wind should have a 180 degree reversal? Is there a provision in the rear mount to provide negative load?
- A. Even with the wind from the rear, there should normally be no up forces on the rear leg. If in an extreme case up forces are encountered, they will be accommodated by the center pivot. The unit is designed to withstand rear winds comfortably in excess of 100 mph.

- Q. Did you consider a cost tradeoff for not putting the yaw on the tower?
- A. That's something we have been considering, but we have not addressed the concept in detail. In the Palm Springs area where our site is located, most of the strongest winds come from the west, and therefore, it might be cost-effective to design a simplified machine without yaw capability. That is a good point, and we will be investigating it in more detail in the future.
- Q. There seems to be a consensus that a two-blade machine is cheaper than a three-blade machine. Could you elaborate why you decided on a three-blade machine?
- A. That is a design decision made by Mr. Schachle. I believe the primary reason for three blades was to reduce dynamic loads, and Mr. Schachle chose three blades as the overall most cost effective approach for his specific wind turbine generator design.

AVERAGE MONTHLY WIND SPEED DEVERS SUBSTATION 1977 10 METERS

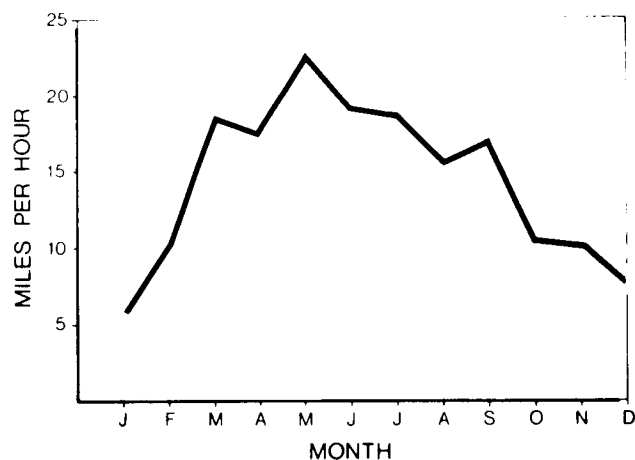


Figure 1

SCE PLANNING

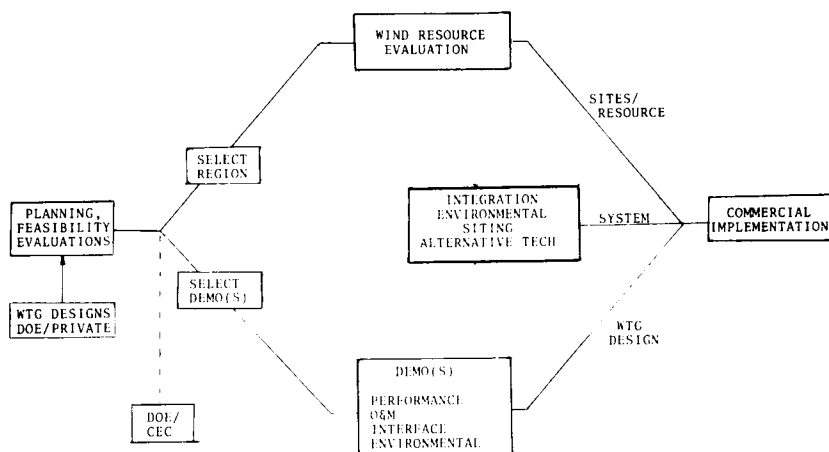


Figure 2

SCHACKLE WIND TURBINE GENERATOR (Moses Lake, Washington)

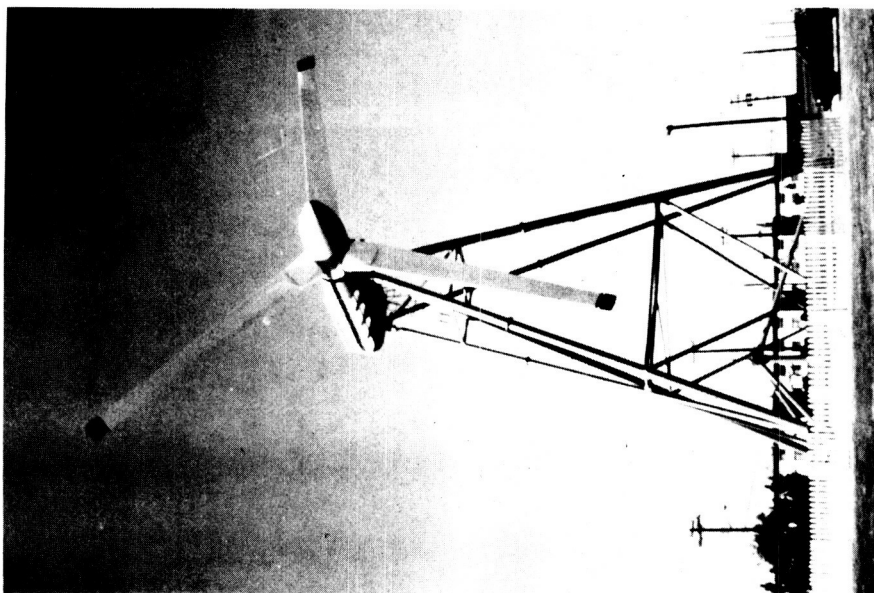


Figure 3

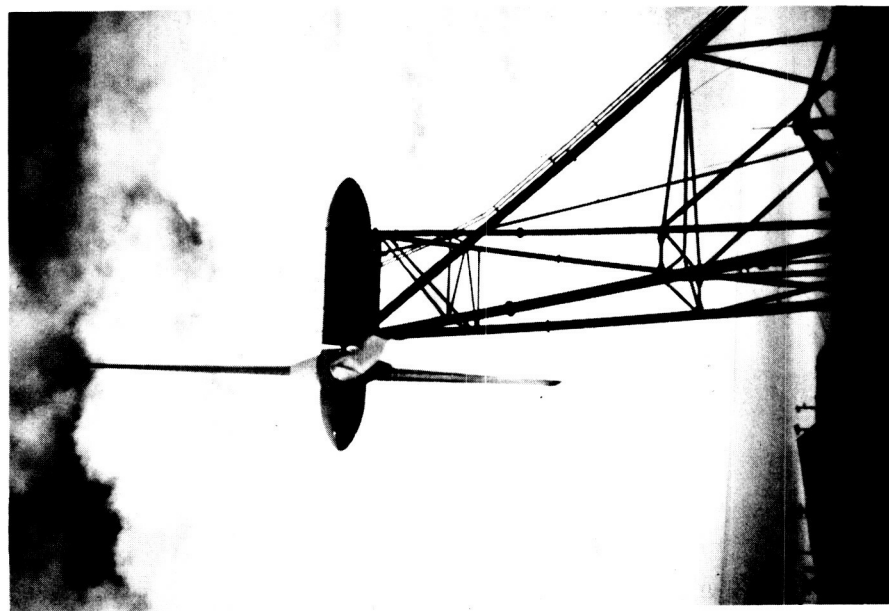


Figure 4



**FUTURE
SCE
WIND
ENERGY
TEST
UNIT**

Figure 5

SAN GORGONIO PASS (looking west)



Figure 6