Solar Hydrogen Project at Neunburg vorm Wald, Germany

SWB
A member of the Bayernwerk Group

Positive experience with generation of solar power

Monocrystalline solar cells in particular, have proved very reliable at Neunburg vorm Wald

For more than a decade now, the SWB facility at Neunburg vorm Wald, Germany, has been one of Europe's foremost test centers for photovoltaic systems. Experience with a total of nine different types of solar cell technology at the site is by all means positive.

Monocrystalline and amorphous solar modules have shown to be highly reliable. Problems were encountered above all with polycrystalline modules, but were overcome following discussions with the manufacturers.

Solar energy conserves limited resources

Economic growth and enhanced quality of life go hand in hand with an adequate supply of energy. World demand for energy is constantly on the rise, especially as a result of industrial development in the threshold countries. No end to the trend is in sight, which brings up the question how to ensure an adequate supply of energy well beyond present needs.

Modern engineering has led to the discovery and exploitation of ever newer reservoirs of fossil fuels, today's principal source or energy. No matter how optimistic forecasts may be, it remains a fact that these fossil fuels are consumed at a rate far exceeding that at which they can be regenerated. The world's natural resources are headed for inevitable depletion, making an early search for alternative sources imperative.

The spreading use of renewable forms of energy is one way to tackle the problem of finite resources and at the same time mitigate the environmental nuisance of carbon dioxide emissions. Hydro power has been used for decades to generate electricity, but these sources are strictly limited by geography. The locations where wind energy is practicable are few, mainly the northern coastal regions as far as Germany is concerned.

This has left solar energy, utilizable in the form of heat and electricity, as the renewable energy source of choice for the SWB project situated at Neunburg vorm Wald in eastern Bavaria. The objective of the project is to integrate the generation of electricity from sunlight into a solar hydrogen energy scheme. Hydrogen gas is employed to store energy, because the availability of sunlight is restricted to the daylight hours. During the time the sun shines, its energy is utilized for photovoltaic generation of electricity, with which water is dissociated into its elements hydrogen and oxygen by electrolysis. The gases are stored in suitable vessels and retrieved when needed to give up the energy they contain, for example in heaters, car engines or fuel cells plants.

Photovoltaic conversion of light to power

Conversion of sunlight to electricity takes place in solar cells. This is known as the photovoltaic effect, in which rays of light striking the surface of certain semiconductors force out electrons that move around in the material and can be collected as electrical energy. One such semiconductor is silicon, the material of which most of today's solar cells are made. Monocrystalline solar cells are constructed of silicon layers about three-tenths of a millimeter thick sawn out of a single crystal grown from the melted material. They are of very high quality and are relatively expensive due to their elaborate method of production. Polycrystalline solar cells are made up of silicon layers cut from a molded block of the material. Amorphous or thin-film cells are usually produced from semiconductor compounds, often not silicon, deposited on a thin glass, plastic or metal substrate in a film thickness of only a few thousandths of a millimeter. The separate cells are laminated on glass or plastic panels, fitted with electrical connections and installed at a suitable site in the form of modules.

All types of solar cell convert only a fraction of the incident light to electricity, which is expressed as their efficiency. The cell designs tested at the SWB project exhibited module efficiencies varying between five and 14 percent. Electrical output was predictably highest on the monocrystalline modules (14.4 percent) and lowest on the amorphous modules (4.6 percent) .

Nine different types of solar cell tested

At the beginning of 1990, in the first phase of the project, two solar cell fields totalling 266 kilowatts in power were commissioned. Performance of the modules and their output was monitored as part of an extensive test program. Whereas consistently good measurements were made on the monocrystalline solar cells, output of many of the polycrystalline modules decreased after some time. The cause was found to be failure of some of the aluminum conductors between the separate cells due to thermal stress. In the meantime the problem has been corrected by the manufacturer.

During the second phase of the project beginning in 1992, seven innovative photovoltaic systems rated at between 10 and 25 kilowatts power were added to the existing solar fields along with various new process developments and underwent testing. They included two amorphous solar cell technologies. The results are good although efficiency did not initially agree with the manufacturers' specifications in some instances. Problems were also encountered with conventional components for electric power conditioning, such as DC/DC and DC/AC converters, some necessitating considerable improvements.

Practical trials revealed that different methods of supporting the solar modules, as well as the modules themselves, have an effect on cost, energy yield and maintenance expense. This starts with the actual foundations. Depending on the shape of the terrain, it may be better to adopt a system of several small drilled foundations instead of fewer solid concrete slabs. Height of the tables is also a factor. Modules that have to be erected by crane and later can only be reached by ladder have practical drawbacks. Designs allowing easy access to the solar modules are more convenient for servicing.

Tests were also made at Neunburg vorm Wald to determine the best angle of orientation for energy yield and whether sun-tracking modules are distinctly superior to fixed-position types. Orientation at an angle of 30 degrees above horizontal proved to require less space and moreover gave a slightly better year-round energy harvest than a 40-degree angle with both direct and diffuse exposure to sunlight, the latter accounting for about a third of total exposure. The subfield equipped with manually adjustable tables was repositioned for maximum anticipated yield at monthly intervals in 1997 and in fact did deliver about 3.3 percent more energy than the fixed modules. On the other hand, the overall expense entailed with sun-tracking modules does not make them worthwhile at latitudes comparable to the Neunburg vorm Wald site and a fixed orientation at 30 degrees is fully sufficient since it ensures performance close to the optimum.