PYRON SOLAR GENERATOR

EARTH-FRIENDLY 21st-CENTURY ELECTRICITY

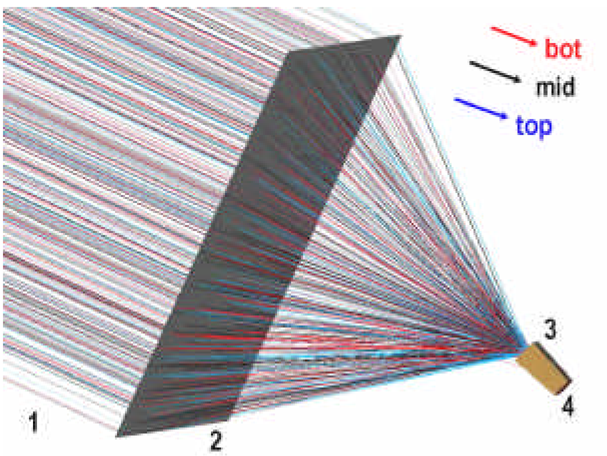
With Concentrating Photovoltaics Developed for Satellites

The future of large-scale solar electricity will be low-profile platforms floating in foot-deep water, turning to face the sun. Long elevation-tracking modules hold sun-focusing lenses and high-power cells, cooled by the water. Many adjacent circular ponds can cover the land, or one large pond, or anywhere water is still. Now solar power is ready to compete with coal.

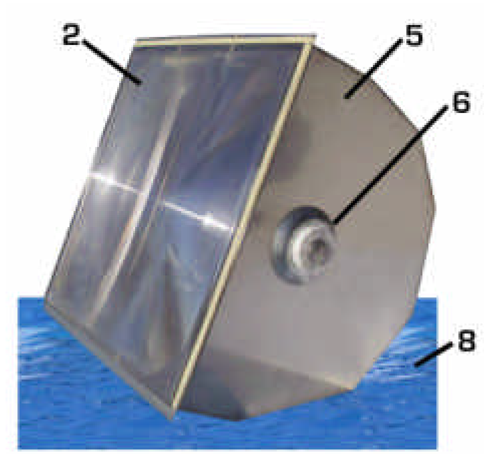
To date, the first thing large-scale solar electricity generation has meant is the conversion of the sun's energy into heat, and only then into electricity. California's LUZ power plants and the decommissioned Solar II are actually steam power plants with solar heat rather than combustion. Their heavy and expensive mirrors are high and far apart, so most of the sun's rays miss them.

Photovoltaic cells are already an electricity source on thousands of roofs, but on a large scale they have high per-Watt investment and large per-Watt usage of heavy metals. To produce a peak kilowatt requires seven square meters of these cells, and even more of thin-film cells.

From La Jolla in California, the famous seaside town with an impressive array of scientific institutes, comes the PYRON Solar Power System, with a solar cell that produces 800 (!) times more electricity than a conventional one-sun cell the same size. This concentration-advantage has been confirmed by NREL (National Renewable Energy Laboratory), an advanced facility of the U.S. Department of Energy. With these high-efficiency (30-34%) cells PYRON developed a truly 21st-century, Earth-friendly solar electricity generator, an innovative system with numerous positive implications for the sustainability of civilization-scale power and a hydrogen economy.



Sunlight [1] is focused by planar concentrator lens [2] into tilted optical adaptor [3], which smoothes it out over 3-layer (different color rays) high-efficiency solar cell [4].



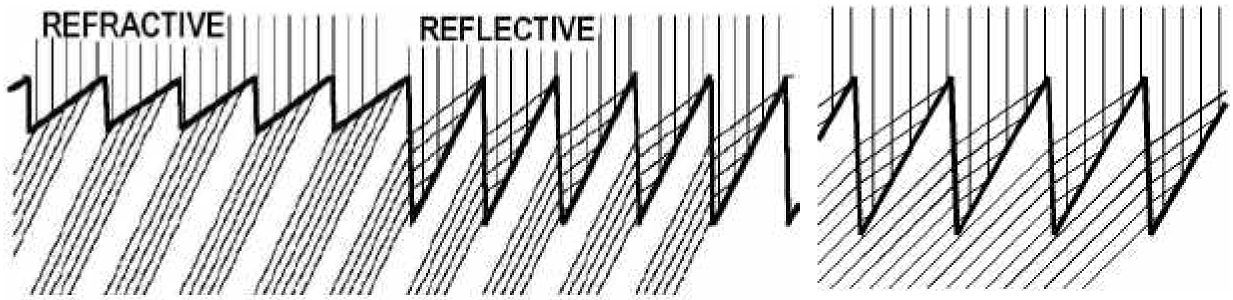
Floating concentrator module with lens [2], trough wall [5], tracking on shaft [6], in water [8], shown at lowest solar elevation.

The PYRON solar electricity generator consists of a large number of these mass-produced solar-electrical modules, which consist of the following elements:

- Plastic faceted concentrator lens [2], with inner refractive and outer reflective facets (see Figure below). Shortest wavelengths for upper cell-layer -- blue rays; median wavelengths-- black rays; longest, infrared wavelengths for bottom cell-layer -- red rays.
- Flux-smoothing optical adaptor [3] with entrance at the lens focus, tilted towards water.
- Satellite-developed 3-layer concentrator photovoltaic cell [4], capable of more than 10 Watts per square centimeter of electric output, (800 times a one-sun cell)
- Floating trough [5] swiveling on axis [6] for tracking in solar elevation .
- Optical conduit arranged around the optical adaptor conveys leftover solar heat to water [8].

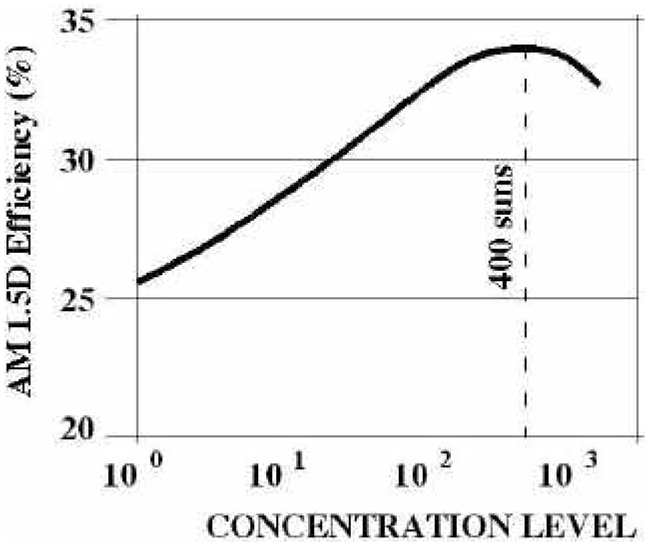
Only a 14” depth of water supports this low-profile floating system, one that uses 70% of all the sunlight shining on it, unlike all the sprawling land-hungry solar designs of the past. They catch only a few percent of sunlight at best, but use large, expensive tracking mirrors and literally tons of metal. The PYRON system, however, is only knee-high, using far less mass per watt produced. From a distance it resembles agricultural fields covered with plastic, not heavy industry. It can even be installed on existing lakes and artificial ponds, and is compatible with aquaculture.

Two close-ups are shown below of the facets of PYRON’s unique low-cost mini-faceted solar concentrator lens, mass-produced in thin plastic by high-precision molding. It uses conventional refractive facets in its central portion. At the maximum refractive deflection (left), reflective facets take over for the outer, short-focusing lens portion. At the right are shown the maximum, 45° deflection by the outermost, totally internally reflecting facets, in the far corner of the lens. Because

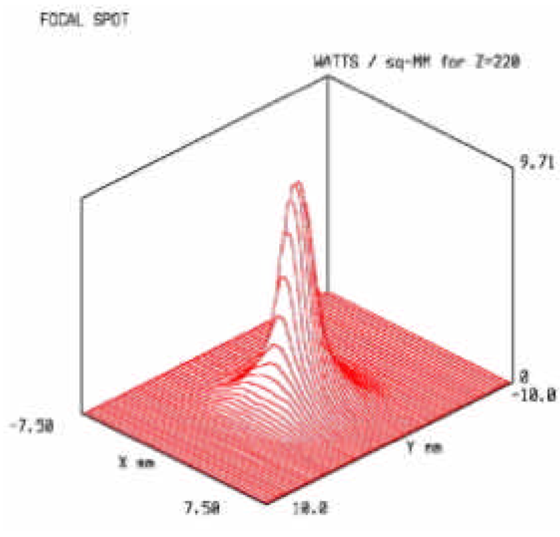


different wavelengths bend differently, the focal spot is highly non-uniform in spectrum.

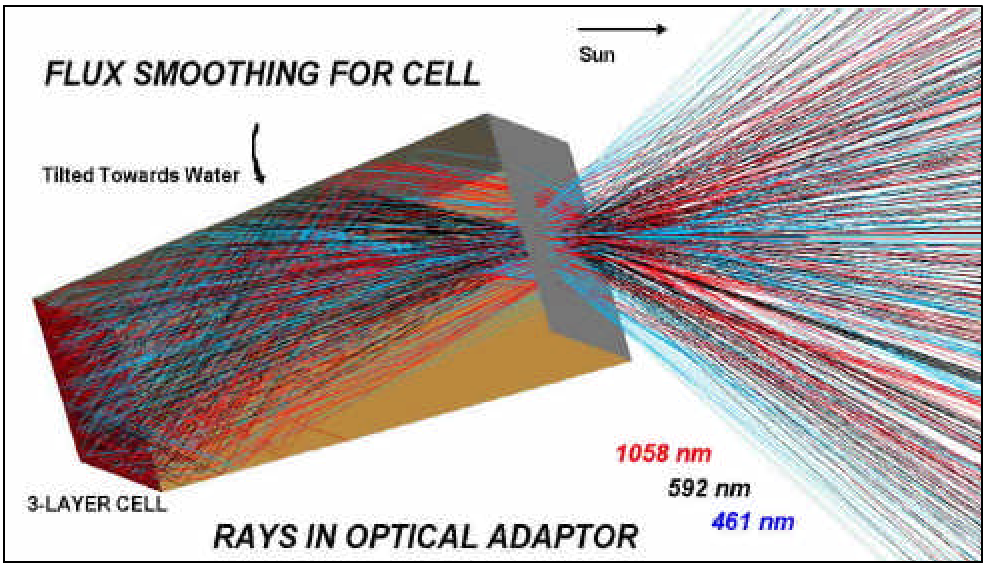
PYRON’s advanced photovoltaic cells were originally developed for satellites by Boeing-Spectrolab. They are really three cells in one, with overlaid thin layers, each specialized for short, medium, and long wavelengths, the key to their high efficiency (30-34%). Another advantage of these thin-film concentrator cells is their very low per-watt usage of heavy metals, unlike one-sun cells. Greater concentration gives greater efficiency, but only up to 400 suns, as shown in the Figure below, left. At higher concentration the efficiency drops because of higher resistance-losses in the cells. Extremely high concentrations can damage cells, so they are better off not being directly exposed to the concentrator-lens’s fierce focal spot, thousands of suns strong (below, right). Instead, the PYRON system uses an optical adaptor, made from high-purity glass, spreading out the concentrated flux of the round focal spot over the much larger square cell. The PYRON system provides uniform solar flux and room-temperature operation, for highest efficiency.



Cell efficiency varies with concentration. PYRON’s operates just below this peak.



High solar flux (9700 suns) at the focal spot 24 times higher than the cell-average.



Optical adaptor spreads out the spectrally blurred focal spot over the cell for uniformity of flux and spec-trum Its wider en-trance compen-sates for tracking errors. It also tilts downward toward the water.

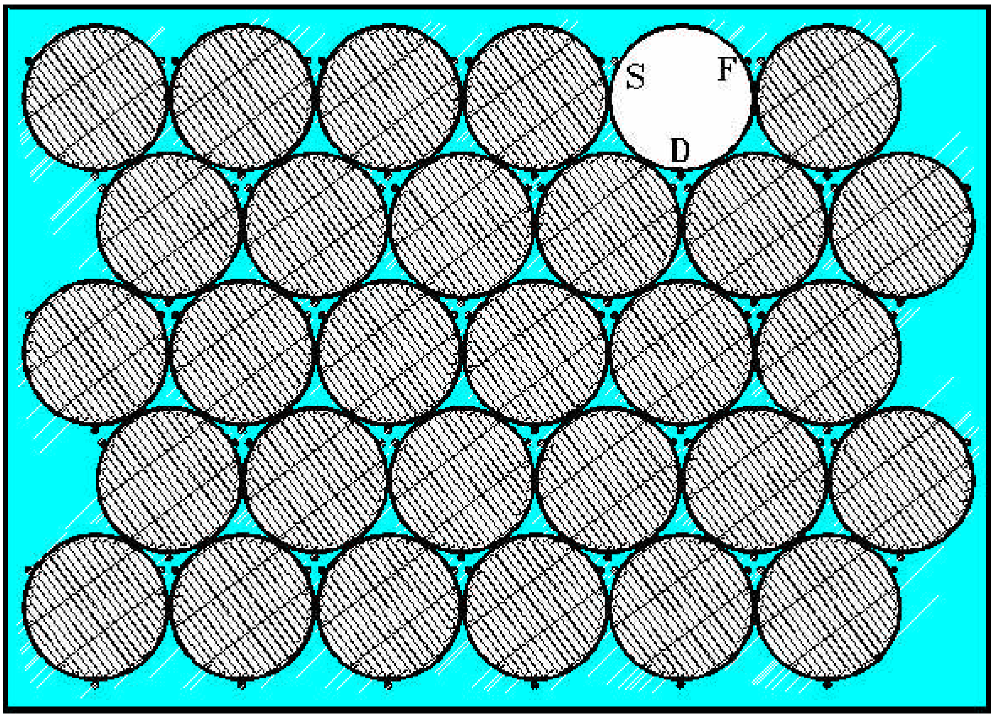
This optical adaptor provides two other performance advantages as well. First, it compensates for tracking errors up to a degree. Second, it can be tilted downward to bring the cell closer to the water. A thermally conductive heat-sink quickly spreads out the cell's excess heat and conducts it to the water. Even at optimum c25ell efficiency, two-thirds of the intense concentrated radiation is absorbed by the cell material, at such a high rate that only vigorous cooling can prevent destruction. One way full cell-lifetime (decades) can be assured is by keeping the cell's operating temperature near that of ambient. Such 'low delta-T' operation is made possible by PYRON's efficient geometry for heat conduction out of the cell and into the water.

This combination of lens, adaptor, and cell achieves a. solar-to-electric efficiency of 25% Up to nine of these lens modules lie in a single elevation-tracking trough floating in a shallow (14") layer of water. Each of the cells has its own optical conduit and heat-sink. The floating troughs tracks in sun elevation, while they also pivot from east to west (opposite in S. hemisphere) through the day in azimuth tracking.

Multiple rows of these troughs fill a circular platform, a floating skeleton that performs the azimuthal (east-to-west) tracking of the sun. Any number of these circular platforms can be combined into a solar power plant. The platforms cover 87% of the land, and 80% of each platform is covered with solar-concentrating lenses, so that 70% of all sunlight is intercepted.

A platform of 16.5 m diameter produces 50 kW_{peak} electricity.

Taking into account the distances between the platforms, necessary for set-up and maintenance, about 70% of the total land area of the solar power plant is used for electricity production, giving an efficiency (peak wattage for overhead sun) of over 20% for all land used. This decisive figure is only 1.2% for SOLAR II and 2.29% for LUZ. The Solar Chimney in Manzanares (Spain) has only 0.12%, 168 times less than PYRON. The PYRON System is much easier to install and maintain as well. Thus it requires far less land for large-scale solar power (billions of watts).



Each platform has its own tracking for azimuth and sun elevation, controlled by the platform's sun-sensors. An electric motor performs the azimuthal tracking by turning friction-wheel D. Roll F is mounted stationary, roll S is pushed in the direction of the rolls F and D by a spring. At night the platforms are oriented with the troughs parallel to the prevailing wind.

In high-sunshine lands, the PYRON photovoltaic electricity generator will compete strongly with conventional combustion-based electricity generation, on the bases of monetary payback, energy payback, and minimal environmental impact, making it the future's brightest solar prospect.

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