SOLAR STIRLING ENGINE

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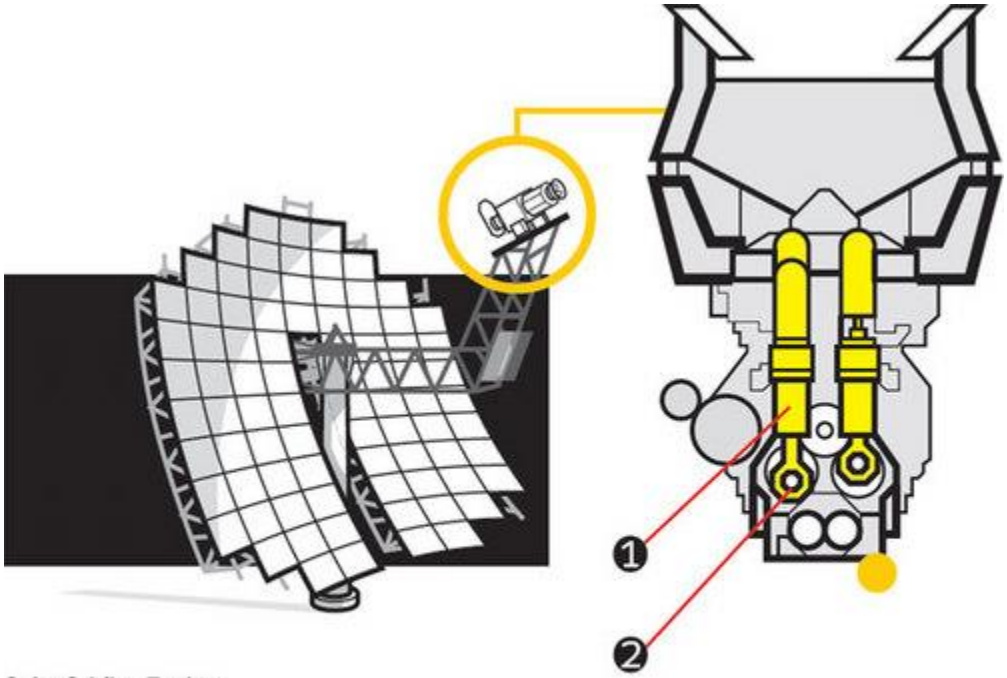

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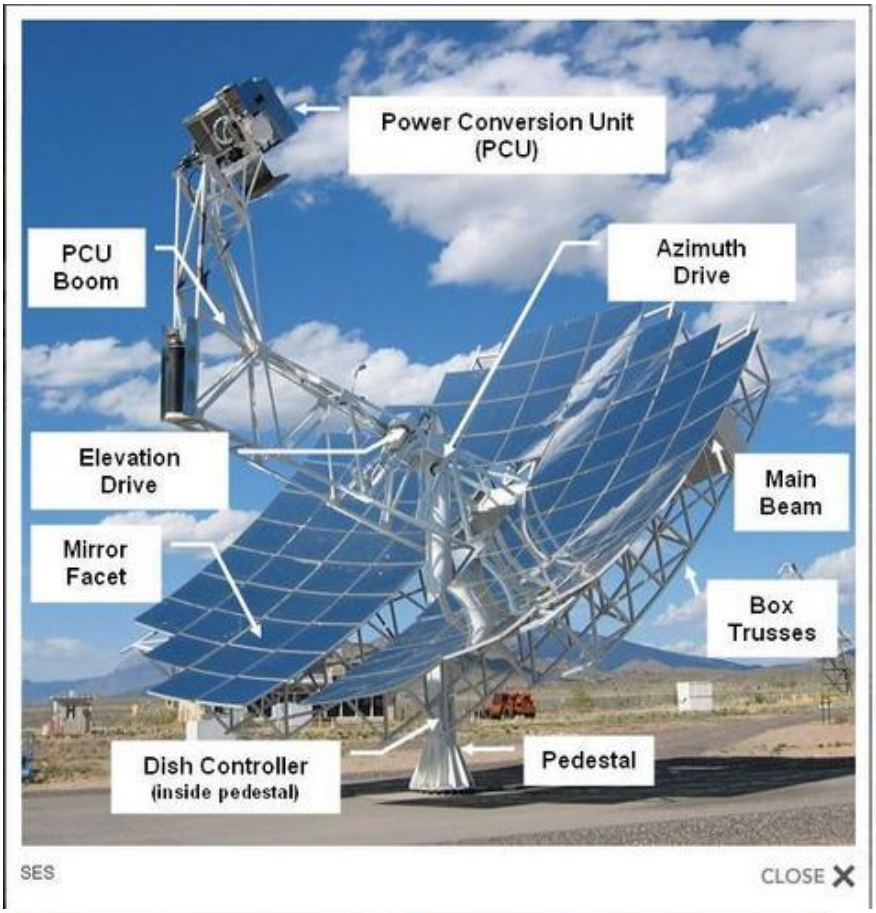
Most concentrating solar thermal designs use vast arrays of mirrors to power a large central turbine. In contrast, each one of Stirling Energy Systems' 38-ft.-wide dishes powers its own 25-kilowatt Stirling engine, which is suspended at the mirror's focal point. That means power can be generated by a single dish just as easily as by a 30,000-dish installation. The Stirling engine is a closed-cycle system, using the heat of the sun to expand hydrogen gas, pushing a piston (1), which rotates a crankshaft (2) to power an electrical generator. The hydrogen is cooled and condensed by a radiator, then sent back to the expansion cylinder.

With the help of a large dish of mirrors, the solar Stirling engine can use the concentrated heat from the sun as fuel to produce work. This system, named as the SunCatcher (below, right), was developed by Stirling Energy Systems Inc. The SunCatcher is comprised of a concentrator and a power conversion unit (PCU: below, left) – the Stirling engine. The concentrator consists of 82 curved glass mirrors, each three feet by four feet in area, supported by a 38-foot diameter dish structure. Unlike some other power generation systems which require the combustion of fossil fuels, these mirrors allow the Stirling engine to utilize solar energy by concentrating it onto the hot heat exchanger.

The Stirling Energy Systems configuration consists of a 4-95 Stirling engine – that is, four cylinders, each containing 95cc of hydrogen gas (shown left). As the engine completes each cycle, it turns a

small electric generator to produce power. Each system can generate up to 25 kW of electricity. Since the Stirling engine is the entire operation of the SunCatcher, increasing the efficiency of the engine will significantly benefit the overall system performance. The highest SunCatcher conversion efficiency ever recorded is 31.25 percent.



The SunCatcher is a clean system; the only fuel used is the sun and it does not produce any byproducts during electricity generation. Once operational, the only other resource it uses is a small amount of water to periodically clean the mirrors - 4.4 gallons per MWh of energy produced, which is

much less than traditional power generation usage (which can be 250 gallons power MWh). Since the Stirling engine does not use internal combustion, it is a very quiet system, emitting less than 66 dB at full load. The SunCatcher is a standalone system; the whole system will not be affected much if there is a problem with one dish. Contrast this with a parabolic trough plant which focuses all energy on a central turbine – when the turbine is down for maintenance, power production halts. Moreover, the SunCatcher produces close to maximum output even when the sun is obscured or low in the sky. While the highest efficiency recorded is 31.25 percent, the SunCatcher's full-year, sunrise-to-sunset efficiency is still a respectable 24 to 25 percent, roughly double the parabolic trough system's efficiency. Although the Sun Catcher system has many advantages, the challenge remaining is to turn the prototype into a low-cost, mass-producible design.

There are six SunCatcher systems planted in the New Mexico desert near Albuquerque, but this is only a testing site of the Solar Thermal Test Facility at Sandia National Laboratories (shown right). Stirling Energy Systems, Inc has just signed two large contracts to provide power for Southern California. The future power plant will be located in the San Diego area, and will include 12,000 dishes with a 300MW transmission capacity. The remaining 24,000 dishes will be built only if San Diego Gas & Electric is able to complete a proposed 150-mile transmission line between the plant and the city.

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