Sun Power: A Guide to Industrial Solar Options

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Long-term warranties, improved products and growing incentives mean the time has never been better to consider solar power for your plant or facility.

A 4.0 kw photovoltaic system atop a San Francisco duplex provides 85% of the building's power. Similar systems can be used to augment power in industry.

In the sun-baked California Gold Country foothills, a large regional water treatment plant cuts its annual electric bill by 50%. At the same time, similar plants all over the state watch their power bills jump by 6.5% each year.

In a San Francisco suburb, a busy auto-body repair shop with dedicated 3-phase lines for its heavy equipment has chopped its electric bill by 45% in three years.

And in rural Sonoma County, CA, a commercial diesel-fuel supplier for farmers, truckers and construction fleets has cut its electric bill by half.

How have they done it? A modern, grid-tied solar photovoltaic (PV) system supplies power to each of these mainstream businesses, supplementing or replacing utility power. Their systems are composed of PV panels mounted on a rooftop or open land, coupled to inverters that change the energy generated by the solar panels into usable AC power. They have enabled these businesses to reduce their dependence on the unreliable power supply of the California grid, and insulate them from electric utility rate hikes, which have gone up an average of 6.5% annually over the last 30 years. They have enabled each group to shift money in their annual budget from the Overhead column to the Operating Fund column, to reinvest in new equipment, new property, new personnel or to boost profits.

The reduced risk in investing in solar is attracting greater numbers of businesses, public agencies and non-profits to use power from the sun. In California alone, over 3,500 new solar systems went online in 2003, nearly doubling the state's solar energy portfolio. California grew from a total installed base of 33 megawatts of solar at the end of 2002 to 60 megawatts by the end of 2003, according to figures released by the California Energy Commission in February 2004. In addition, solar installers nationwide have greatly expanded the portfolio of commercial and government solar installations in the last five years.

Three factors are pushing down risk for solar: generous, stable incentives at the state and federal levels; a 25-year warranty from the top manufacturers of solar panels; and affordable financing programs that provide an acceptable return on investment (ROI).

The typical ROI for commercial solar systems is now about four to six years. After payback, businesses and public works agencies have guaranteed free energy and a new-found revenue stream for at least 30 to 35 years. And it's likely that today's solar system will produce electricity even longer before they begin to lose productivity. The silicon solar cell, which is used on commercial systems today, was developed 50 years ago at Bell Labs to provide power for remote Bell Telephone System signal relay towers. One of the first Bell Labs solar cells that started

generating electricity from sunlight in 1954 is still producing today.

Net metering pays for surplus energy

Net metering is a policy in effect in many states that requires public utilities to credit solar-energy producers for the energy they send out to the utility grid. In California, the policy is designed to reduce demand on the overloaded electric grid during hot summer days. Pacific Gas and Electric (PG&E), the utility covering most of Northern California, participates in net metering to incentivize businesses and public agencies to generate their own electricity and reduce demand.

The utility's energy-rate schedule, unique in the U.S., charges 3.8 times its the base rate between noon and 6 p.m. during summer months. Because California does not produce enough power to meet its own needs during peak air-conditioning periods, PG&E must purchase power from out of state to meet demand. The utility charges more for peak power in order to meet its higher costs, and also to reduce demand on the grid by encouraging conservation and the development of renewable energy sources like solar.

Under net metering, PG&E is required to credit solar energy producers at the retail rate for the time of day that the energy is sent back to the grid. The surplus energy nearly quadruples in value during peak demand periods.

By natural coincidence, noon to 6 p.m. is the "solar sweet spot." This is not only when PG&E charges the highest retail rate for energy, it's also when the sun is highest in the sky, solar is most productive, and solar systems can earn net-metered credits at the highest value. The sun creates the problem heat and solves it, with abundant sunlight to energize solar systems. The valuable Peak Rate utility credits multiply the value of a solar installation and help pay down its cost more quickly. After the system is paid for, they add to the solar producer's profits.

Solar on the job

In Oroville, CA, northeast of Sacramento, the 60-acre Sewerage Commission-Oroville Region (SC-OR) water-treatment plant now gets 50% of its power from solar energy. The SC-OR plant is the first wastewater treatment plant in the nation to use solar energy for its everyday operations. SC-OR serves 15,000 families in its region, and is designed to treat 6.5 million gallons of water a day.

Water treatment plants run 24/7 and have a mission-critical need for power. In 2001, SC-OR's energy costs jumped 41%, and during the 2000/2001 energy crisis in the state, they shot up $10,000 a month. When the plant superintendent investigated renewable energy, he learned about local and state incentives for solar and received approval to proceed with a solar system for the facility.

Sun Power & Geothermal Energy, of San Rafael, CA, designed and installed a 520 kw AC solar system for the plant. Unused land at the facility was ideal for siting a ground-mount solar system, which is composed of 5,184 PV panels mounted on three acres. It is designed to save an average of $240,000 each year over its first 25 years of use. The SC-OR system went online in November 2002, cost $4.8 million and received a utility rebate of $2.3 million, administered by the California Public Utilities Commission. The net-metered SC-OR solar system sends surplus energy back to the grid for credit with the utility on sunny days, after SC-OR takes the

power it needs. At night and on rainy days, SC-OR taps into the utility credit it earned on sunny days.
SC-OR's large solar system not only removes its own power demand from the grid. When surplus energy from the SC-OR system flows back to the grid, SC-OR's neighbors soak up the electrons the solar system sends back to local power lines before they ever reach a utility substation. By supplying extra power to its neighbors, SC-OR helps to reduce demand on the utility grid from the entire neighborhood, benefiting everyone on the grid.
At Blake's Auto Body in Rohnert Park, CA, the electric bill was out of control due to the demands of metal-working machines, lights, air conditioning and office appliances. After the California energy crisis, the company decided to install solar energy. The shop uses large hydraulic sheet-metal stampers and frame-straighteners on car bodies. These machines demand electricity in intermittent, high-amperage bursts. The utility supplies high-current power to each machine in dedicated 3-phase circuits. Other industrial equipment at the shop includes spray booths, electric welders and air compressors for power tools.
Sun Power designed and installed 500 solar panels that provide 50 kw AC &#151- a steady stream of electricity for lights, power and air conditioning. The solar system supplements the 3-phase power supplied by the utility to the large metal-shaping machines.
Like the SC-OR plant, Blake's solar system is net metered. On summer afternoons when heavy machinery is not in use and the solar system is generating power at its highest potential, the inverters send surplus electricity back up the line and the meter spins backwards, crediting Blake's at the peak-period retail rate. The net-metered credit helps pay down the bill for the utility's 3-phase power used by the shop.
At Royal Petroleum, an independent supplier of diesel fuel for truck fleets, farmers, and construction companies, a 31 kw AC solar system was recently designed and installed by Sun Power. Using 200 solar panels that supply 50% of its energy requirements, it is the largest solar-powered commercial fueling facility in the nation. Over the next 25 years, the system is expected to provide an 18% rate of return and cumulative savings of $268,000 at current electric utility rates. This will allow Royal to pay off its solar system in a little more than five years, and enjoy 20 years of free electricity from the system under the manufacturer warranty.

Incentives give solar an edge

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Like the coal, oil and nuclear industries, solar has benefited from government incentives to lower the price of installed kilowatts and attract new investment. The federal government offers all renewable energy producers a tax credit for commercial solar systems of 10% of the net cost after state rebates. Also, at least 38 states provide incentives for renewable energy. In addition to California, the leading states with the most active support of solar energy are New Jersey and New York. (Complete information on state and local incentives for renewable energy is provided by the Database for State Incentives for Renewable Energy (DSIRE) at www.dsireusa.org. Also see the chart in this feature.)
In California, California Energy Commission (CEC) and Public Utility Commission (PUC) rebates together with state and federal tax incentives currently subsidize the

cost of commercial solar systems by as much as 75%. For California solar systems under 30 kw, the CEC rebates $3.20 per watt. For larger commercial systems over 30 kw, the PUC rebate is equal to the lesser of $4.50 per watt or 50% of the project cost. The state tax credit is 7.5% of the net cost after state and federal incentives for businesses, and there is a five-year accelerated depreciation schedule. In addition, while a commercial solar system on a building adds to the appraised value of the building, the value of the solar system is exempt from property taxes.
Thirty-eight states and the District of Columbia also have some form of net metering. Most are limited to systems up to 25 kw. With the highest energy costs in the nation, California net meters PV systems up to 1 megawatt. In New Jersey, the limit is 100 kw and in New York, 10 kw. In Pennsylvania, solar systems from 10 kw up to 50 kw can be net metered depending on the local utility. In Ohio, which has more solar-powered gas stations than any other state, there is no limit to the size of the solar system that can be net metered.
About half the states have state loan programs for renewable energy. California and Oregon offer a mix of state, utility and local loan programs, while Colorado, Pennsylvania, Texas and Washington have utility or local programs only.

High-tech improvements

Inverters are the real technology success story of solar in the last five years and a key component in mainstream solar systems. Inverters change the DC (direct current) generated by a solar system into usable AC (alternating current). Inverters introduced four years ago operate at 96% efficiency, replacing the older generation that were no more than 60% to 65% efficient. This means that almost all the energy generated by the solar system is converted for use by electrical equipment.
To ensure maximum ROI generated by each solar system, businesses, government agencies or non-profits that are considering solar should look carefully at the factors that go into a proposed system and the track record of the designer/installer. Performance-based solar systems are designed to collect the most sunlight possible and convert it into power. Solar systems that produce what the designer and installer claim depend on engineers to integrate numerous complex factors when modeling each system, as well as professional installation.
When a solar system is designed to produce at peak efficiency, fewer PV panels and less space to mount them are required to meet energy production targets, thus saving space and the cost of adding and installing panels. For optimum performance, the following factors are critical:
&#149 For North America, the standard for optimal collection of sunlight is to orient PV panels to true south and tilt the panels so they face the sun at or near an average 90-degree angle throughout the year. The solar designer uses a special instrument called a Solar Pathfinder, which indicates specific areas of the installation site that will maximize a solar system's electric generation capability.
&#149 Solar modules should be mounted in a tilted position to allow cooling air flow across their front and back surfaces. Like computer chips, PV modules are primarily made of silicon. They use air flow to keep cool and stay productive, in the same way that a computer uses fans to cool the silicon chips.
&#149 Dust in the air gathers on PV modules just like it does on a car. The fine coating of dust that dulls a car's finish also reflects sunlight off the surface of a PV module, preventing light from penetrating the module to generate electricity. Tilted

modules are more productive because they stay cleaner by shedding dust when it rains.
&#149 Designers must consider shading that will degrade the amount of power produced. A shadow on one corner of a solar array will lower the production of an entire circuit. Panels that the designer/installer knows will be shaded should be connected on an isolated circuit, so the panels that always receive full sun are able to produce at their maximum potential.
&#149 Electricians look to minimize line loss in solar systems by inspecting and, if necessary, upgrading existing equipment. Transformers must work efficiently. The inverters have a shorter warranty period than solar modules and must be inspected regularly to make sure they continue to perform.
&#149 Solar panels selected for a system should be tested and rated by the installer and matched for output. Solar panels wired together in a circuit are individually able to produce only the energy that the lowest-performing panel is able to produce. The low-performers should be circuited together, and the panels that perform at or near the highest potential should also be on separate circuits.
&#149 If a solar system has mixed arrays, some at optimum orientation to the sun and others not, the best-producing arrays should be circuited together and the lower-performing arrays connected on an isolated circuit. Otherwise the optimum arrays receiving full sun throughout the year will never hit their potential and will perform no better than the arrays that are not installed for optimum sun exposure.

Live monitoring

The 520 kw solar system at the SC-OR water treatment plant uses 5,184 PV panels ground-mounted on three acres of land. It is designed to save an average of $240,000 each year over its first 25 years of use.

In 2003 the solar energy industry embraced live monitoring of AC output from solar systems, a major step in the maturation of the PV industry. Solar is now required by financing entities to report actual AC watts produced, just like hydro, gas and nuclear power plants. Monitored, efficient PV systems add a layer of accountability and verification of ROI. PV monitoring technology is available from a variety of vendors, and is usually provided by the installation contractor on the solar project. Without live monitoring of AC production, the size of a solar system in kilowatts is based only on panel ratings, no matter how productive the system actually is.
More than ever, solar can be a cost-effective and profitable part of the energy strategy for any business, non-profit or public agency. Solar technology is constantly improving while costs continue to decrease. Solar is the most elegant and efficient form of energy production, generating electricity with no emissions, air, ground or water, ever. With generous local, state and federal government incentives and low-cost financing, a typical 4- to 6-year ROI and a lifespan of 35+ years, a commercial solar system quickly pays for itself, then becomes a revenue builder by returning energy savings to the bottom line.
Gregory Kerwin is the marketing manager at Sun Power, a San Rafael, CA-based designer and installer of solar electric systems. The company was recently named to Entrepreneur magazine's Hot 100 Fastest Growing Companies in the U.S., and in the past year has constructed four of the top solar installations in the West, including the 520 kw solar-power wastewater treatment plant in Oroville, CA. For more information, visit www.sunpowergeothermal.com.