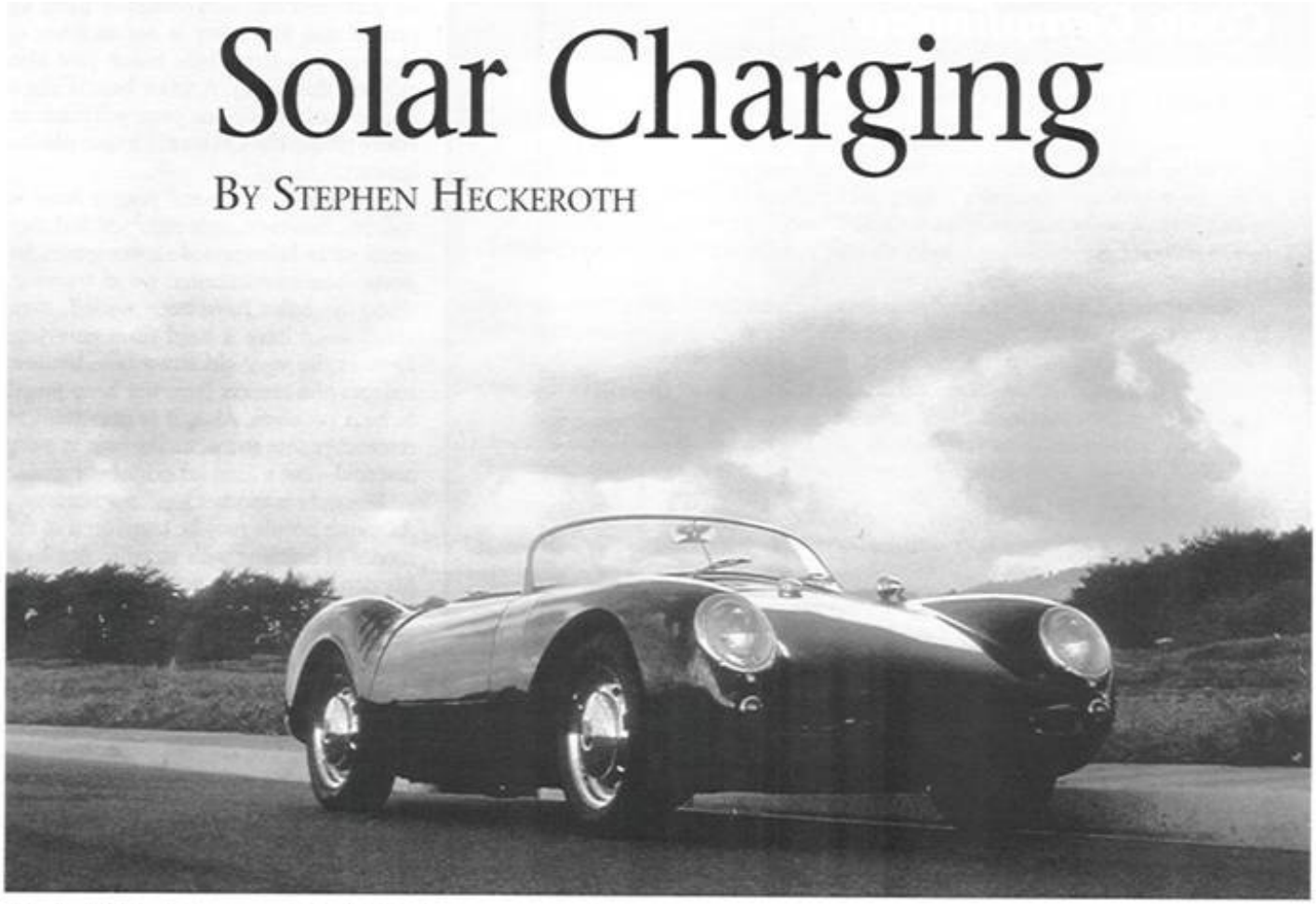
Solar Charging

By Stephen Heckeroth



This electric Porsche features a 100 mile (161 km) range, 115 mph (185 km) top speed and can go from 0 to 60 mph (0 to 96.5 km) in 9 seconds. The car costs $32,000.

A California architect demonstrates that the future is now when it comes to solar charging electric vehicles.

Since the late 1960s I have been concerned about the depletion of non-renewable energy resources and the pollution caused by their use. As an architect, I channeled my concern into refining residential passive solar design. I am now confident that—with good solar access—I can design a home that will have all its energy needs satisfied by the sun.

However, when it comes to resource depletion and air pollution, the automobile remains the real culprit. Transportation uses four times the energy that is used in housing and causes about 10 times

the air pollution because of its total reliance on petroleum. It was this realization that led me to develop MendoMotive, an electric vehicle (EV) company.

Electric Cars

In 1992, with off-the-shelf golf cart and forklift technology, I started converting every vehicle I could get my hands on. In a search for the lightest possible vehicle, I found fiberglass Porsche 550 Spyder replicas that weigh less than 1000 pounds. MendoMotive's first vehicles used 120 volt 400 amp controllers, 9-inch (23 cm) advanced DC motors and golf cart batteries.

The California zero-emission mandate has stimulated research and development around the world, and new products for EVs are surfacing almost weekly.

These vehicles had 50 horsepower (hp) drive trains with up to a 100-mile (161 km) range. There was no regenerative braking capability, and acceleration was about equal to an early VW Bug. Few chargers were available and it took 8 to 10 hours for a full recharge.

Since then, the California zero-emission mandate has stimulated research and development around the world, and new products are surfacing almost weekly. Currently there are a wide variety of affordable controllers on the market with regenerative braking and up to 320 volt and 1000 amp capacity, offering in excess of 300 hp. Some companies are also producing high voltage motors that offer much higher torque.

The author's Type III Karmann Ghia charging from a 3 kilowatt photovoltaic array. Batteries and a Trace 4 kW inverter are visible on the wall behind the car.

Bi-polar sealed lead-acid, nickel-metal-hydride and zinc-air batteries are all available on a prototype basis, offering up to four times the range for the same weight. Like any prototype, this new generation of batteries is expensive, but the cost will drop when volume allows mass production. Chargers now on the market are capable of full recharge in as little as 15 minutes.

I have upgraded my Type III Karmann Ghia with a new Italian ZAPI controller that has regenerative braking capable of producing over 115 hp. The regenerative braking not only increases range by 15 percent on hilly terrain, but it also reduces brake wear enough to make replacing the tires the only regular maintenance required on my Ghia.

We can now produce an electric Porsche that will outperform the original gas version in every category except range. Performance is no longer an issue, and with new generation batteries and quick recharging, range will be equivalent to current fossil-fuel-powered polluters. Nickel-metal-hydride and zinc-air batteries are non-toxic and offer much safer energy storage than a potentially explosive gas tank. When demand takes the production of EVs to the assembly line, their cost will drop to equal or less than the cost for an equivalent gas car.

This solar home uses integrated solar water heaters to heat water and a photovoltaic array to generate electricity.

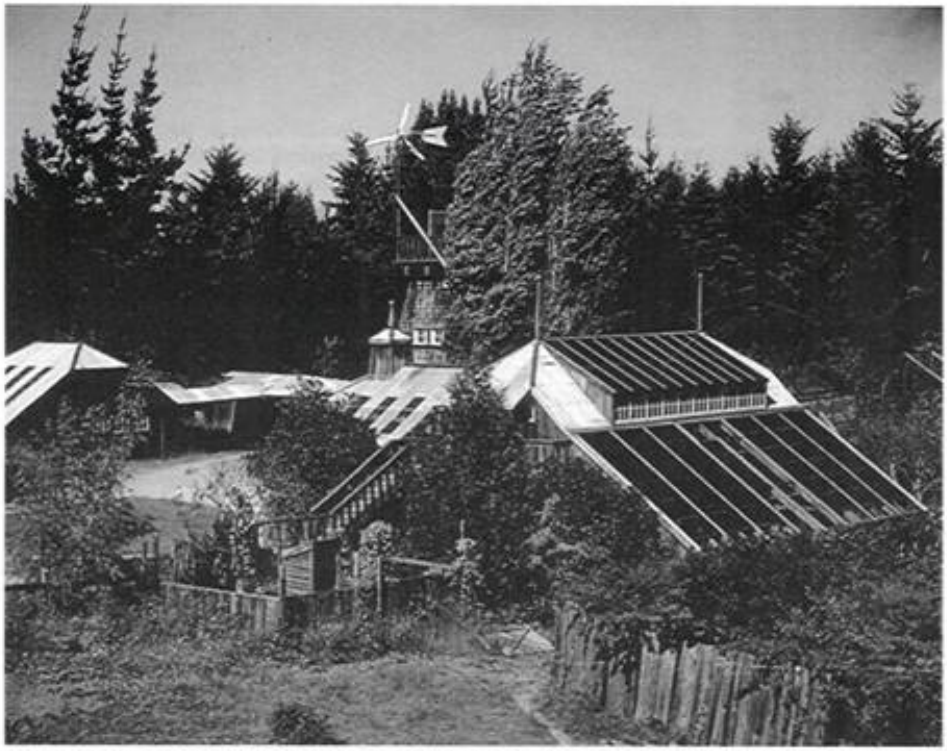
Solar Charging

Changing the image of electric vehicles from golf carts to high-performance cars can easily be accomplished, but the more fundamental issue is achieving mobility without pollution. This issue can best be addressed by planning our communities around pedestrians and ultra light vehicles. But for now this country has an infrastructure of roads designed for cars that have become less a means of transportation and more symbols of people's identity. Electric cars are the best transportation option to expedite the transition to clean and quiet pedestrian communities.

Opponents of electric cars argue that emissions are only transferred from the tailpipe to the smokestack or the nuclear power plant. This argument can be put to rest when photovoltaic charging stations are integrated into the roofs of the places we live, work and play.

Typically a roof's main function is to keep the rain out while maintaining a comfortable indoor temperature. When photovoltaic panels are used as roofing, the roof takes on a dual function by converting the sun's rays into electricity.

Crystalline, polycrystalline and amorphous silicon are the commonly available kinds of photovoltaics. Crystalline and polycrystalline are about 10 percent to 12 percent efficient in their conversion of sunlight into electricity, compared with 4 percent to 8 percent efficiency for amorphous panels. However, the overall efficiency of thin-film amorphous silicon panels, when compared to stationary crystalline panels, is increased by their ability to convert indirect or diffuse sunlight more efficiently. This also makes the amorphous panels very useful in areas with extended periods of overcast skies.



The author's solar homestead. Note the 3 kilowatt photovoltaic array of APS 24 volt amorphous silicon panels on the roof of the barn at right.

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Another advantage is their environmentally friendly manufacture. The thin film is applied without any waste, while the manufacture of crystalline panels results in significant material loss. The energy consumed in the manufacture of thin film amorphous panels is recuperated in as little as two months of use, as opposed to up to 5 years for crystalline panels. Because the thin film amorphous silicon adheres to materials that also make good roofing—metal, glass and ceramics, for example—thin film panels are versatile building materials.

United Solar Systems Corporation (Uni-Solar), is experimenting with a variety of amorphous silicon panels that, when fully commercialized, could turn all south-facing roofs into charging stations. The modules Uni-Solar is developing are metal-based units. The thin film is applied to steel, covered with a protective coating and used for roofing that produces 800 watts per 100 square feet (ft^2) (9.3 square meters (m^2).

Until recently, Advanced Photovoltaic Systems (APS) manufactured laminated glass panels capable of producing 400 watts per 100 ft^2 (9.3 m^2). We purchased these panels for $3/watt as APS was going bankrupt as a result of a lawsuit filed by Solarex. The panels were installed on the south-facing roof of our barn, replacing a leaky metal roof and avoiding the cost of new roofing material ($2/$ft^2$ [$21.60 m^2]). The labor involved in putting up the panels was about equal to replacing the old roof with new roofing material. As a result, the integrated PV installation cost $8/$ft^2$, including the avoided cost of new material.

The barn's 700 ft^2 (65 m^2) array produces a steady three kilowatts (kW) for seven or eight hours a day in the summer and 1.5 kW for four or five hours on a cloudy winter day. This yields a yearly average of 15 kilowatt-hours (kWh) a day. Using the new California net metering law (under which the utility must pay the same rate for home-produced power that is fed into the grid as they charge for electricity from the grid) and time-of-use rates, the array produces about $7.50 worth of electricity per day in the summer and a low of 75 cents per day in the winter, for an average of about $4 a day or $1500 a year. The system, including the Trace synchronous inverter and batteries, will pay for itself in less than seven years. Over its 30 year expected life, the PV roof will potentially generate $45,000 of income even in the unlikely event that utility rates remain constant.

The 3 kW array is capable of providing all the power for our house and an apartment in the barn loft. Our electric car and tractor can also be charged on sunny days.

Ideally, solar charging should be available where people spend their days—at work. Maybe businesses could be re-

A solar home featuring integrated photovoltaics and solar water heaters as well as a solar radiant floor.

Workers install a roof-integrated solar hot water panel.
Top Right: Sonoma State energy major graduates help install an integrated photovoltaics array.

A 192 volt electric porsche in front of the Mendo Motive shop.

quired to have solar charging stations in the same way they are now required to have parking places.

Electric Tractors

While battery weight is an obstacle to performance on the road, it is an asset in the field. Tractors need added weight for traction. This, coupled with the fact that tractors lack emission controls and cause significant air pollution, makes them ideal candidates for battery power.

Solar charging is a natural for lawn and garden tractors, because they are used more during the sunny season. The batteries in a well-designed electric tractor add stability and traction. With the addition of an onboard inverter, the batteries on even a small electric tractor can be used as a clean and silent mobile power source for garden and construction tools or even to power a whole home. Solar photovoltaics can charge the batteries over several days for use on a weekend or as an emergency power source. An electric tractor has fewer moving parts, requires less maintenance and, if mass produced, would cost the same as a comparable gas version.

MendoMotive's sister company Electrac has already converted several 20 hp tractors that are as powerful as their original diesel incarnations. We are currently seeking capital to build a prototype cordless lawn and garden tractor that will cut both pollution and the grass.

Because tractors lack emission controls and cause significant air pollution, they are ideal candidates for battery power. Tractors can also use the added weight of batteries for traction. The tractors pictured here cost $10,000 each.

When photovoltaic panels are used as roofing, the roof takes on a dual function by converting the sun's rays into electricity.

The solar age is here, but it is individual action that will lead to a reduction in the use of non-renewable polluting energy resources. Now is the time for action. ✪

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