Alternative Energy Systems

P A R T I

In a quest for energy independence, this couple found light at the end of the solar panel, and an added boost by harnessing the power of the wind.

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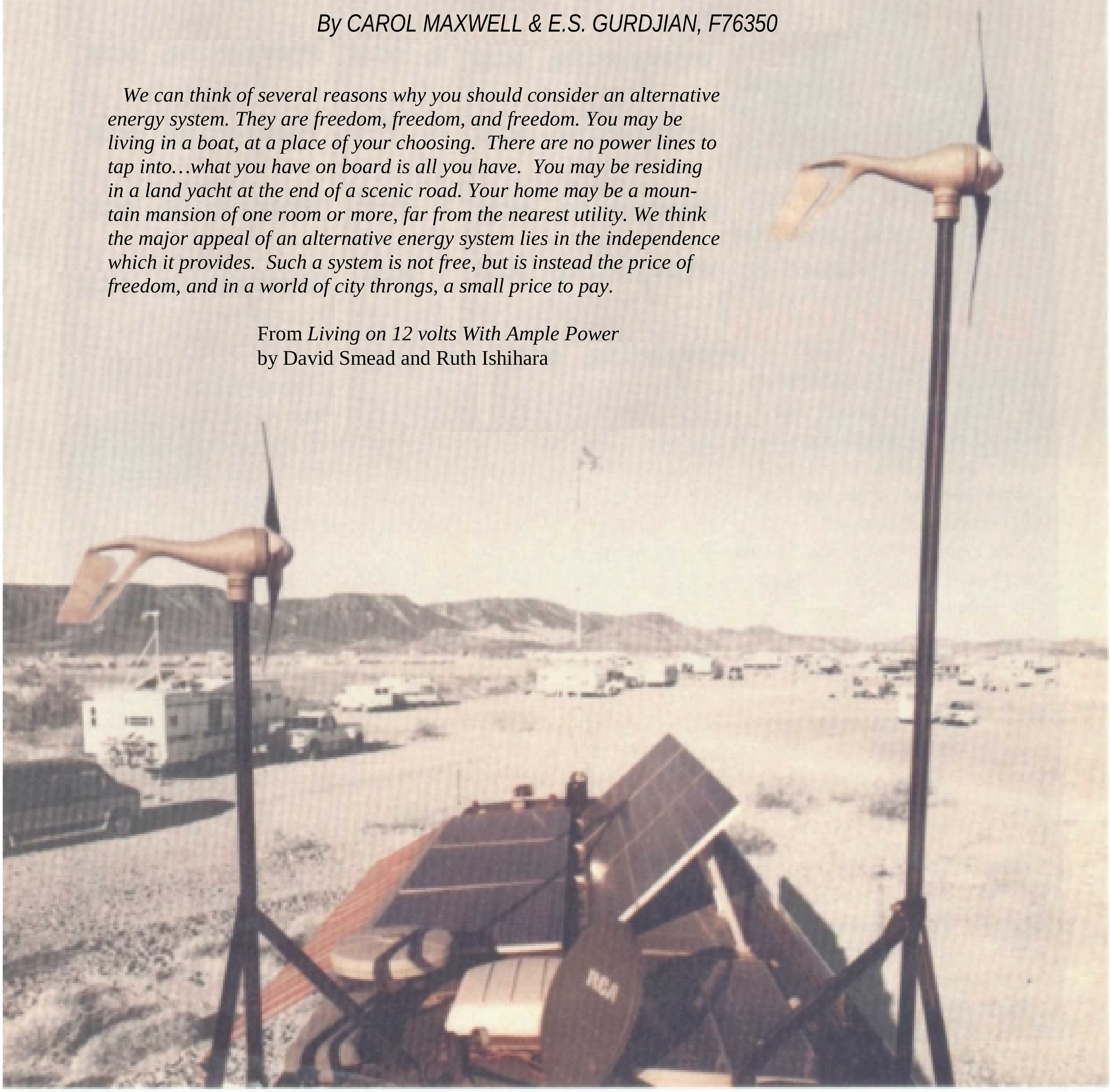
We can think of several reasons why you should consider an alternative energy system. They are freedom, freedom, and freedom. You may be living in a boat, at a place of your choosing. There are no power lines to tap into…what you have on board is all you have. You may be residing in a land yacht at the end of a scenic road. Your home may be a mountain mansion of one room or more, far from the nearest utility. We think the major appeal of an alternative energy system lies in the independence which it provides. Such a system is not free, but is instead the price of freedom, and in a world of city throngs, a small price to pay.

From *Living on 12 volts With Ample Power*
by David Smead and Ruth Ishihara



This article is Part I of a three-part series about alternative energy systems. Part II, which describes solar panel structure, will appear in next month's issue. Part III, which focuses on wind power, will appear in the January 1998 issue.

As we read the passage at left, the reasons for our lifestyle choices during the past 20 years suddenly became crystal clear. We had never arranged the words so effectively, but subconsciously we had been trying to achieve the same goal that Mr. Smead and Ms. Ishihara were promoting—energy independence.

This article series contains detailed information about a high-output alternative energy system. We realize that some RVers may never be interested in being energy independent, and others may not require as much power. The information presented here is intended primarily for people with fully optioned coaches, or for those working on a bus conversion who want to be energy independent and still be able to use all of their optional equipment for comfort and convenience while dry camping. We hope our experiences are helpful.

The discovery. In the late 1970s, Ed was practicing neurosurgery and Carol was teaching obstetrical anesthesia in Detroit, Michigan. We were constantly busy, but Ed still found time to tinker with Corvettes. Once a year, for three or four weeks, we would pack up our 1960 Corvette (as much as a Corvette can be packed) and head west. We would visit places with awesome vistas and feel the wind in our faces. We returned home refreshed and rejuvenated.

Unfortunately, it did not take much time for the awesome vistas to become faint memories. Each successive cross-country trip in the Corvette brought more hotel stays and more mystery meals in unknown restaurants. The glitter of the trips began to tarnish, and the Corvette became confining. We were moving in and out of rooms with our meager baggage, following countless other travelers before us. Somehow, this was not the tonic we were seeking.

During our last Corvette trip in 1983, we noticed something that had been there all the time — RVs. How could we have missed them? We had been blinded by our routine and had not even recognized that we had always been sharing the highways with these vehicles. September 1983 marked the beginning of our RV lifestyle change.

We started out in a 29-foot entry-level Class A motorhome. We still traveled only three or four weeks each year; weekend excursions were limited because of professional responsibilities. In an effort to "get away," we gravitated toward the back roads and more rustic public campgrounds.

In 1986 we moved up to a 34-foot Holiday Rambler Imperial. We still wanted to stay on the back roads, but the added options and increased electrical demands of the larger coach had us frequently wanting facilities with full hookups. Our road to freedom began with some major modifications to this coach. These included exchanging the coach's original 27-gallon gray water holding tank for a new 40-gallon tank. We also installed an additional 40-gallon gasoline tank behind the original 80-gallon tank. Another addition was a self-contained water treatment system that consistently provided safe and good-tasting drinking water from any potable water source. The modifications to our water treatment system added to the versatility of the coach when traveling or camping.

We also began to upgrade our electrical system. We started by installing an early version of the Intellitec AC Power Management System and adding an extra "house" battery to help power the inverter in the Holiday Rambler. After moving to our current coach, a Prevost conversion, we continued to modify the electrical system (see "Enhancing 12-Volt Charging System Performance," Family Motor Coaching, December 1994, page 166).

Enter the solar system. In July 1989, Carol was fulfilling a three-month contract in Fontana, California. We were staying at an RV park in San Bernardino that had metered electric. Because the park was paying commercial rates for electricity, park residents were charged commercial rates. Even with California diesel fuel prices, running the generator to power the air conditioners was less expensive than using metered electricity. This was when we seriously began to investigate solar electric power.

We purchased eight Siemens M55 (now called SM55) solar modules, rated at 3 amps and 53 watts each, and a 30-amp controller. The solar modules, or panels, generate DC electricity directly from sunlight. The more sunlight they receive, the more electricity they produce. *continued*

The authors installed wind turbines and solar collectors on their coach's roof to provide them with the power they need to live without hookups (opposite, above).

Table I
Solar, Wind Turbine, And AC Generator Output Statistics

		Daily Solar Amp-Hours		AC Gen Hours		Total Amp-hours	
Days	Date	Range	Average	Total	Avg/Day	Wind	Solar
13	12/19-12/31/96	90-320	242	54	4.2	215	3,140
11*	1/1-1/15/97	90-320	216	28.7	2.6	650	2,380
16	1/16-1/31/97	200-340	290	30.6	1.9	663	4,650
15	2/1-2/15/97	250-360	319	21.8	1.45	407	4,690
13	2/16-2/28/97	100-380	338	19.2	1.47	6.44	3,720

*Grid electricity was used for four days.

From December 19 through February 28, we experienced six days when wind speed were less than 10 mph and eight days when wind speed exceeded 40 mph. The data indicates that one wind generator produces amp-hours equivalent to 1 ½ Siemens M55 solar panels. The cost per amp-hour is approximately the same.

Table II
Daily DC Loads in Amps
(all at resting power, except icemaker

Ice maker	17.0
Inverter (electronics)	11.0
Inverter (kitchen & bath)	2.6
DC loads	8.4
Total	**39.0**

Inverter loads for electronics in amps:

VCR	1.1
AM/FM Stereo	0.1
Line amplifiers (3)	1.0 (3.6 W each)
Satellite positioners	0
DSS video amplifies	2.1
C-Band video amplifier	3.5
Amplified video selector	0.1 (6W)
Subtotal	**7.9**
TV	0.9
Drill charger	0.5
Computer	0.8
Inverter/misc.	0.9
Subtotal	**3.1**
Total	**11.0**

Inverter loads for kitchen & bath in amps:

Microwave/convection oven	.5
Razor charger	.1
Toothbrush charger	.1
Inverter	1.9
Total	**2.6**

Table III
Daily DC Phantom Loads in Amps

Digital thermometer		.280
Digital clock		.280
AM/FM radio		.125
AM/FM radio		.125
Driving computer #1		.125
Driving computer #2		.125
Tank monitor panel		.125
Weather station		.125
Propane detector		.162
Burglar alarm		.250
EMON II		.125
Battery monitor #1		.070
Battery monitor #2		.070
Battery monitor #3		.070
Battery monitor #4		.050-.150 (.028 sleep mode)
Refrigerator		.500
Electrolyte monitor		.125
*R/O pump		2.2
Other DC loads:		
	Freezer	3.0
	CO monitor	.3
	Tank moni-tor	.1
Total		**8.33-8.43**
**Primary water pump		8.3

*pump amps vary with pressure. R/O pump cycles repeatedly until reservoir tank is full
**Primary water pump on by demand only, so it is not Included in resting amp calculation.

The number of solar modules used depends on power needs and available sunlight. The controller, or charge regulator, is the link between the modules, the coach battery, and the equipment being powered. The controller protects the battery from overcharge or excessive discharge. We attached the modules to the coach's roof with 2-inch aluminum right-angle brackets purchased at a local building supply store.

Despite all of the information and advice we received from various solar power system dealers, we soon realized that the system we had installed lacked the capacity to meet our power requirements. Aside from powering the air conditioners, we still needed grid electricity during the evening hours to keep our batteries fully charged while maintaining the same lifestyle.

We continued to ask questions about solar power. Most solar salespersons could not believe our 24-amp capacity was not adequate. In June 1991 we added four more panels for a total capacity of 36 amps. This array performed reasonably well on long summer days in ideal weather. However, during shorter winter days, the system still could not supply the batteries with enough energy for our normal use.

Solutions. By accident, we learned about monitoring accurate amp-hour consumption and found a solution to our energy "crisis." Whenever we drove extensively, battery water consumption was excessive. We concluded that the alternator was overcharging the batteries. When we contacted David Smead of Ample Power, he suggested we use his NEXT Step Regulator to control our alternator, and that we also evaluate the EMON II (energy monitor). These devices, which enable temperature compensated three-stage charging by the alternator and the inverter/charger, eliminated most of our charging problems. The EMON II also completely monitors the electrical system. Hence, for the first time, we were able to determine our actual amp-hour consumption. It became quite apparent why our solar panel system was not performing as expected. We were using more amp-hours each day than we had calculated and more than our solar panels could supply. For our coach, buying 24 amps of solar capacity had been a waste of money, and 36 amps was only marginal.

In April 1994, we installed eight more panels for a total capacity of 60 amps. Since the controller was rated for only 30 amps, we installed the Solar Charger Interface for the EMON II, which could use a 70-amp relay. The solar panels were installed in a flat array that nearly covered the front half of the roof. The 2-inch airspace between the panels and the roof not only provided ventilation for the panels, but also furnished additional insulation for the coach interior. The solar panels performed very well that summer. We believed we had adequate capacity to maintain our batteries and that our installation was complete. We were almost correct.

We had heard about the Long Term Visitor Areas (LTVAs) on Bureau of Land Management land in Arizona and California, so we made plans to spend the winter of 1994-95 dry camping at these public sites. We started at Quartzsite, Arizona, and then moved to the Imperial Dam area near the Yuma Proving Grounds. There was plenty of sunshine, but to our surprise, we were never able to achieve our 60-amp rated output. We needed to run the diesel generator for two to six hours per day. Still, we were closer to our goal of freedom with comfort and convenience than ever before, and we were learning a great deal about dry camping.

The following winter, we returned to the imperial Dam. This time we modified the mounting brackets so that half of the solar array was tilted upward. We parked the coach facing west, so the panels faced south. The tilted half was almost perpendicular to the winter sun, and the curved slope of the roof enhanced the angle of the non-tilted half. It was not practical to tilt both sides, because one would shadow the other, which would decrease performance more than leaving one side flat.

We also recognized that our wire size was insufficient. We had used 6-gauge wire throughout the installation. We left the individual panels with the 6-gauge but increased the down feed wires to 2-gauge. With these modifications, our maximum output immediately increased from 45 to 55-plus amps, and later in the season to a full 60 amps. In addition, we added two 12-volt-DC wind turbines, each with a potential output of 30 amps. Table I shows solar, wind turbine, and AC generator output statistics. (Technical information and installation details regarding wind turbines will be discussed in a subsequent article about wind power.)

Allocating amps. To use our resources efficiently, we had to assess our power needs. Without any apparent activity, our base amperage draw was more than 35 amps. The first step was to determine where these 35 amps were being used. Our amp loads are shown in tables II and III.

One inverter powers AC kitchen appliances. The microwave convection oven LED display draws .5 amps, which accounts for 12 amp-hours per day. The U-Line icemaker draws 17 amps. Since it has a 50 percent cycle time, the icemaker accounts for another 204 amp-hours. This raises the daily total to 216 amp-hours for an apparently idle kitchen!

The second inverter supplies electronic equipment that requires 11 amps at rest for LED displays and memory features. DC loads account for another 7 amps. This 18-amp draw translates to 432 amp-hours over a 24-hour period. This means our total passive consumption each day is 648 amp-hours (432 + 216). These figures do not include any other active use. Turning on lights and using kitchen appliances, including the water pump or any other electrical device, increases the amp-hour consumption, which could nearly deplete our battery bank capacity of 880 amp-hours.

Clearly, the amp-hour consumption in a fully optioned Class A coach or bus conversion can be much higher than solar panel sales literature estimates. For example, an entertainment system with a VCR and a digital satellite system, including sound and video amplifiers, can consume 3 to 5 amps. Over 24 hours, this could add up to 72 to 120 amp-hours. This is just one example of a significant load that may be overlooked when estimating solar capacity requirements.

The amp load tables show some of the loads we've discovered in our coach. This data may help others to estimate how much power is required in a particular application. During extended periods of dry camping, a larger array of solar panels may be needed, or some options may need to be "de-powered."

We opted to deactivate the icemaker and use ice cube trays in the freezer compartment of the refrigerator. Next, we installed a switch to disconnect all of the TV electronics to save additional amps when we were not watching television. We maintained constant power to the chest freezer, to all electronics with memory features, and to demand devices. On average, we decreased the resting amperage consumption from 35 to 14.6 amps, which saves 490 amp-hours per day.

Although we use all of our optional equipment, we make an effort to avoid wasting electricity. We use lighting judiciously and turn off devices when they are not in use. For example, we do not let the computer run idly. When the coffee maker is finished dripping, we do not use the warmer. Instead, we transfer the coffee to an insulated carafe. When we run the diesel generator for a high-energy activity, we try to plan other activities at the same time. This may include laundry, convection cooking, running the dishwasher, ironing clothes, or charging the batteries on cloudy days. With planning and minimal compromise, we have been able to continue with normal activities and still reduce our average daily consumption to under 500 amp-hours. The solar panels produce approximately 300 amp-hours daily, so the diesel generator is used only one or two hours per day.

We could further decrease our consumption, but we tend to keep "writer's hours," often working late into the night, using power when the solar panels are not able to charge the batteries. This means that our batteries frequently have only a 50- to 60-percent charge remaining in the morning. Even with this heavy usage, our house batteries have lasted for more than five years and are still going strong. So far, the sun has risen each day and we start all over again.