1 Introduction and Background

In this book, I hope to show how the changes in technology that are bringing us cleaner, renewable energy can be advantageous to the ham radio operator both at home and in the field. Although we resist change and it might seem daunting at the large scale needed to ensure a bright, clean energy future, changing to cleaner energy is easy to do as individuals. It can actually cost less than continuing to rely on traditional energy sources, and it has great potential for emergency backup power.

In our daily lives, we routinely face milestones where we have to make significant energy decisions — for example, the hot water heater fails and needs to be replaced. With a little bit of homework, we can be prepared to make the right decision when one of our legacy energy systems becomes unreliable or wears out. Replacing it with electrical systems that can run on clean power will actually save money in the long run.

Overview

This first chapter will give a brief background of my experiences over half a century in ham radio and my use of energy in my hobby and my home. Chapter 2 will set the stage by discussing how so many of our electronic devices now run on universal power supplies that can use high-voltage dc input as well as ac, and how switching converters have virtually eliminated the heavy 60 Hz iron transformer.

Chapters 3 and 4 show how properly investing in solar panels and a grid-tie system can supply a typical home with energy at half the cost of commercial ac from the local utility company. Chapter 5 suggests ways to apply solar panels to a variety of do-it-yourself (DIY) projects. Along with this switch to high-voltage dc systems comes the potential for radio frequency interference (RFI), and as discussed in Chapter 6, that can be devastating to ham radio operation nearby.

Since our cars and trucks are the second biggest energy consumer in our lives, Chapters 7 and 8 consider how the electrification of vehicles by almost every major car manufacturer is revolutionizing transportation and also providing mobile and portable energy sources that can be tapped for ham radio use.

Backup and emergency power are covered in Chapters 9 and 10. The availability of very large batteries in electric vehicles (EVs) gives rise to low-cost battery storage systems in other applications, such as home energy storage. That topic is covered in Chapter 11.

Chapter 12 gets back to the original thesis that we are forced to make major energy decisions every few years anyway, and that we should be prepared to make a choice that is not only less destructive to our environment and air quality, but that will also save us money in the long run, and better position us for backup power. Chapter 13 explores my practical experience with my home and my church, which have gone solar. We are also switching to EVs for clean, renewable transportation at lower cost.

In Chapter 14, I note how my experience in amateur satellites and in the classroom has taught me how the critical details of the surface of a small satellite has a profound impact on the equilibrium temperature of that object in space. These same principles apply to something as small as an Amateur Radio cubesat satellite (typically about 4 inches in each dimension) and as large as the Earth. We should be concerned about how we are making changes to our surface (land use and atmosphere) that will have profound impacts on the average temperature of the Earth. And finally in Chapter 15, I discuss how these changes are important to stop the pollution of our atmosphere caused by burning fossil fuels when there are so many cleaner, renewable alternatives.

Ham Radio and Energy Background

Before delving into some of these topics, it might be interesting to go over some of my own personal random-walk voyage in Amateur Radio and energy.

From getting my Novice license in 1962 in middle school, my first project was inspired by an article in *QST* to rewind an old dc car generator for 60 Hz, 120 V ac output when driven from a lawnmower engine. It was clever and extremely simple. Just remove all the multi-pole windings and replace them with a single coil in the same slots, but in such a pattern to end up with a two-pole armature. One wire was connected to the metal armature and the other wrapped around all the segments of the commutator so that the brushes then acted as a slip ring to carry off the ac power with the other side being the frame. Then it was a simple matter to choose the right size pulley

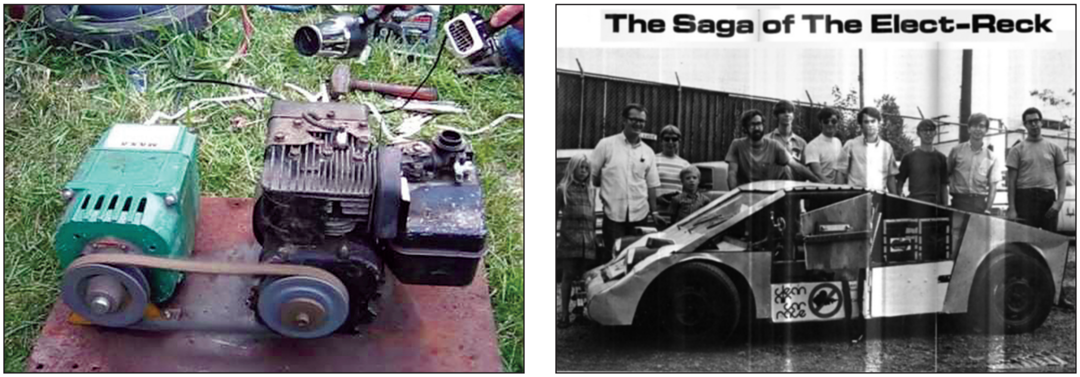

Figure 1.1 — A typical 1960s era homebrew generator (left) powered many portable operations. On the right, my first electric car project at Georgia Tech in 1970.

and adjust the field coil to get 60 Hz at around 110 V most of the time.

This portable power source provided a couple of hundred watts and went with us on all our local scout camping trips. It powered all our toys, which at the time were our first ham radios — military surplus ARC-5 transmitters with two tubes and capable of 75 W on CW, perfect for the Novice licensee.

My First Electric Vehicle (EV)

Amateur Radio was more or less on hold through college at Georgia Tech, where in 1970 my senior Electrical Engineering project was to build an electric car from an old WWII surplus aircraft starter motor on an old VW chassis (**Figure 1.1**). The goal was to make it to California in the first MIT/Cal-Tech Clean Air Car Race. Our car made it to the Mississippi River (St. Louis) before it would just not go another mile. For details, see "My first EV, The Elect-Reck at Ga-Tech - 1970" available online at **aprs.org/EV-at-tech.html.**

As a side note, in that final semester, an older fraternity brother took me for a ride in his Ford Mustang to give me my first sight of mobile ham radio. Where his ash tray used to be was a small metal plate with an on/off switch, a green and red lamp, and a connector for a big "car 54 where-are-you" carbon mic. This was wired to a huge suitcase-sized surplus commercial FM radio in his trunk, with crystals for operation on the original 146.94 MHz Atlanta FM repeater. I was hooked.

Early Ham Radio

I had attended Georgia Tech through the Navy ROTC program. After graduating in 1970, my first duty station was the Navy Post Graduate School in Monterey California, and the radio club was able to score a bunch of

Motorola Dispatcher FM radios in 1971. These had transistor receivers, but used instant warm-up pencil tubes in the transmitter. You had to pause one second from PTT for the dc/dc switching supply to squeal-up the high voltage and for the filaments to light before transmitting.

I put one under the seat of my MGB sports car and another on the side of my Honda 250 motorcycle. By 1972, I was stationed in Hawaii, and the dashboard of the MGB now had an old telephone dial and a new, bigger UHF suitcase-size Motorola transceiver that fully filled the trunk.

The telephone dial had not worked for a week since I finished it, but on a hunch, I turned the audio tone drive level down instead of up and up and up and bingo, without the overdrive distortion, it worked! I remember making my first successful telephone call through the Diamond Head autopatch late at night. The pulse tone dialing was just a tone oscillator and pulse dial inspired by a *QST* article on the Wichita autopatch. These surplus commercial mobile radios didn't even have transistors that could operate at UHF, and so the first stage of the receiver was simply a diode to downconvert to VHF, but it still had 1 microvolt sensitivity.

The Bluebox

A final communications adventure in 1972 was collecting 12 microswitches and cobbling together a crude keypad wired to eight twin-T transistor oscillators to generate touch-tones. The fun part was retuning these oscillators to the different tones used by the telephone long distance operators. This was called a *blue box* (**en.wikipedia.org/wiki/Blue_box**) and allowed the user to place a toll free 800-number phone call and then press a button for 2600 Hz, which would drop the trunk line connection and then allow you to dial your own new long-distance number.

Of course, this was of practically no use to me since I lived on a ship and did not have a phone! Ma Bell eventually moved to new signaling systems that did not use in-band tones. And they could also find and prosecute blue box users by listening for 2600 Hz tones on subscriber lines.

My Attempts at Wind Power

While stationed in Japan in 1973, my energy highlight was the construction of a 1 kW wind generator by laminating 21 layers of plywood into a 10-foot diameter, ideally shaped propeller mounted to an old car rear axle and 24 V truck generator. It was designed with a tip-speed ratio of 8-to-1 for maximum efficiency as a two-bladed propeller. These are far more efficient than 1-to-1 eggbeaters and other vertical axis types.

I waited weeks for there to be enough wind, and one day during lunch

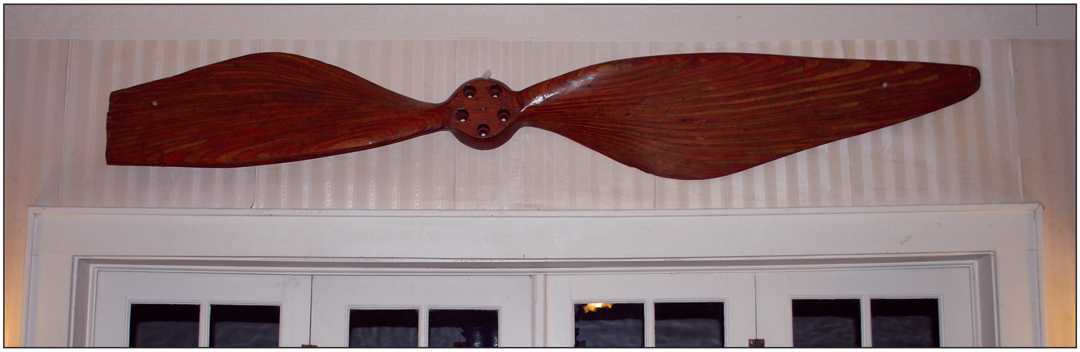

Figure 1.2 — My first attempt at 1.5 kW wind power and immediate failure.

Figure 1.3 — A 4 foot Airpax turbine installed on my roof just to prove how poor home wind is.

hour I decided to do an initial test in an approaching typhoon while our ship was in Sasebo, Japan. Since this was prior to building any kind of brake mechanism, the system lasted about 5 minutes after I mounted the blade before I jumped off the 10-foot tower about the same time the blade flew off and broke 2 feet off of one end.

It was a *wow* moment and sounded like the whop-whop of a helicopter. I decided that this kind of wind power was just too scary, but also just too rare to be of any practical value unless one lived on a beach somewhere. Generally most people do not have enough wind at home to be of any value whatsoever. Unless your hat blows off your head every day when you go outside, you don't have enough wind. But in the Navy, I did live near water, and so it was fun to try. The prop now hangs over the door in my living room (**Figure 1.2**).

After building another 21-layer prop, this time only 4 feet in diameter, I finally bought a commercial 4-foot wind turbine typical of those seen on sailboats. The plan was to cut off the top of my tallest tree and mount it up there, but I never got around to it. So I mounted it at roof height as shown in **Figure 1.3**. It probably turns a dozen times a year and actually generates power only during huge storms for an hour or so. Worthless.