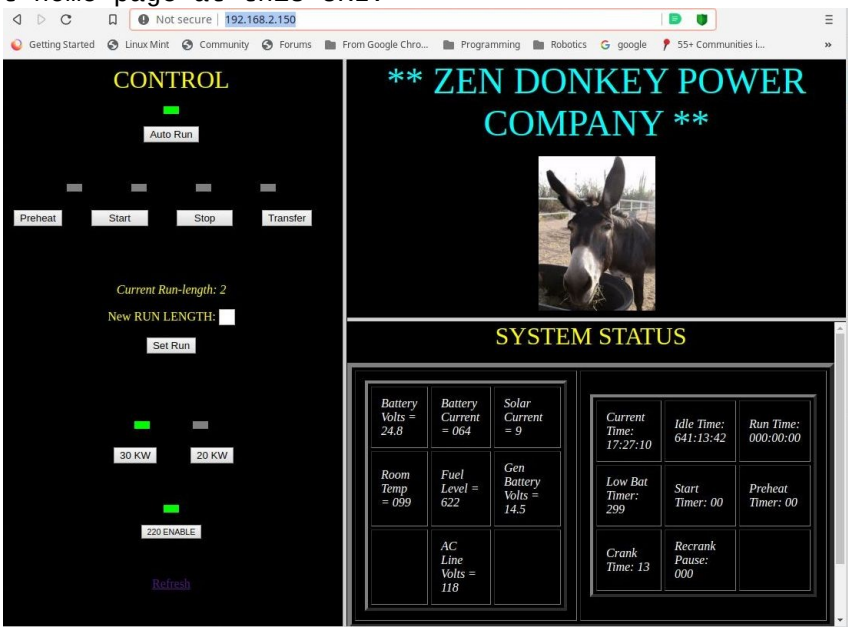
Remote Monitoring and Control of Power System

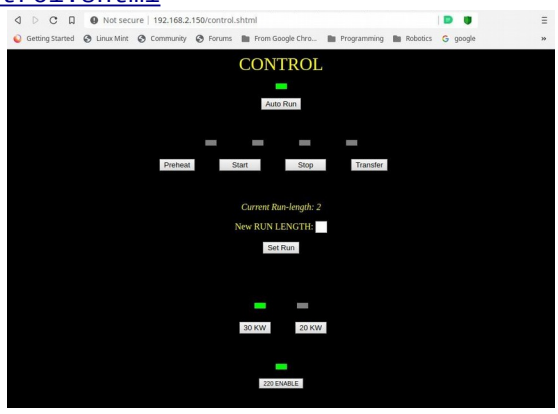
The web pages used to observe and control the operation of the power system are generated on the controller that enables the auto start of the generators. The laptop connected to it no longer has a functioning interface program and one would have to contact the manufacturer to modify this. The original control program web page is identified as “Zen Donkey Power Company” as the property was a donkey rescue facility at one time.

However, the web page can be accessed from a home network. One must configure their router to support a fixed IP address of http://192.168.2.150/. For example, the verizon router can configure the DHCP server to operate on 2.xxx and restrict assignment under 150 so there is no conflict. One’s ISP can advise on how to do this.

This is the root home page at this URL:

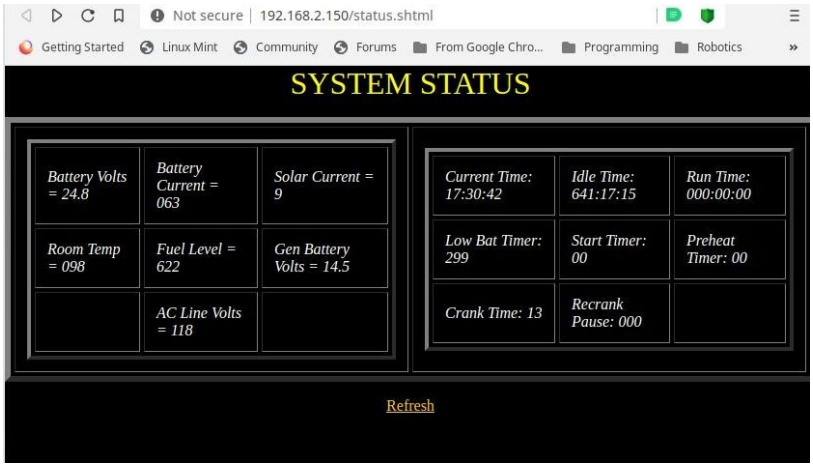


To make it easier to control, one can access system control only at http://192.168.2.150/control.shtml



When Auto Run is on the generator will start automatically at the low battery voltage, or start/stop can start or stop the generator when desired and transfer enables generator output to the house. Run Length selects 1,2, or 3 hrs of generator run time. The 30KW diesel or the 20KW propane generator can be selected.

The status page is the most frequently used page to monitor current activity: http://192.168.2.150/status.shtml. Opening it separately can avoid accidental changing of the control settings.



Note that the Solar Current (output from solar panels) and the Fuel Level sensor are not functioning. Battery Current is actually the current into the inverter which will go negative when the generator runs and the inverter acts as a battery charger. Idle time is hrs:min:sec time since the generator ran last. Run Time is a generator run countdown timer. The run time hr:min:sec is based on the control settings of 1,2, or 3 hours. 2 hrs is typical to use. Experience will be the guide when 1 or 3 hours is a better choice. Low Bat Timer is the 299 second countdown to start the generator when battery voltage is below 23.0 V. Start Timer, preheat timer, crank time and recrank pause are part of the generator startup and retry protocol.

If one wants to view the history of the power system, one must write their own software to do this. Anyone with a basic knowledge of programming can create a log of historical data and prepare graphs. The free graphing software gnuplot is illustrated after the sample code.

Here is a simple shell script to capture the voltage, current, temperature data from the web page every 60 seconds:

```
#!/bin/bash
while :
do
  curl  http://192.168.2.150/status.shtml >status.txt
  gawk -f curl.awk ./status.txt >>data.txt
  sleep 60
done
```

where curl.awk is the simple script:

```
{
    if ($0 ~ /<var>Battery Volts/) volts=$5;
    if ($0 ~ /Battery Current/) current=$5;
    if ($0 ~ /Room Temp/) temp=$5;
    if ($0 ~ /AC Line Volts/) line=$5;
    if ($0 ~ /Current Time/) time=$4;
    if ($0 ~ /Solar/) solar=$5;
}
END {
    if ((volts>1) && (time !~ /00:00:00/)) # in case signal is lost and returns invalid data
        printf("Current,%d,Volts,%.1f,line,%d,temp,%d,time,%s,solar,%d\n",
        current,volts,line,temp,time,solar);
```

```
}
```

This will create a cumulative data file that one can parse and create graphs, sound alarms, etc. as the user desires. I had settled on graphs with the last 5 days of inverter input current, battery voltage, power used, shed temperature, battery discharge power over night, and a table tracking current spikes, generator on/off times, and low line voltage. The live status is generally all that is needed to know what your current draw is (you learn to recognize if pool is running, well is running, etc.) and the voltage lets you know how soon the generator might start.

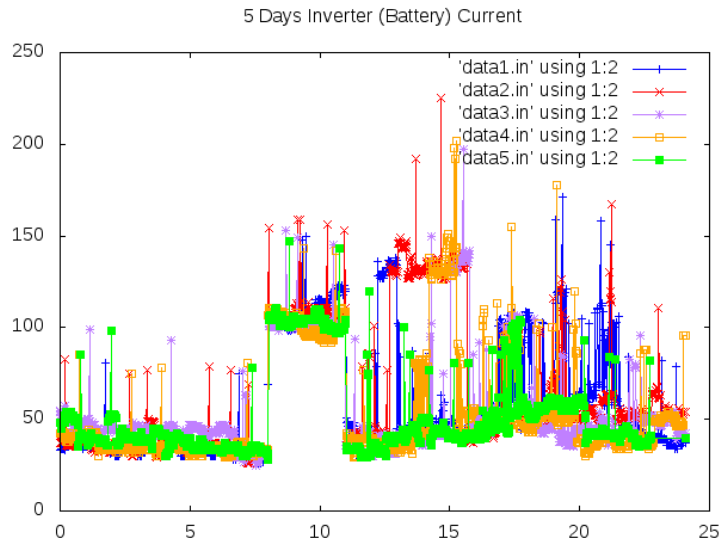
It is sometimes convenient to have an audible reminder when the generator starts or unusually large current is drawn. A simple script to have spoken words (text to speech spd-say program) when the generator starts or stops or an unusually high current occurs is as follows:

```
#!/bin/bash
while :
do
  curl  http://192.168.2.150/status.shtml >alarm.txt
  echo "Testing alarm"
  gawk -f alarm.awk ./alarm.txt >alarm.dat
  sleep 20
  cp alarm.dat alarmlast.dat
done
```

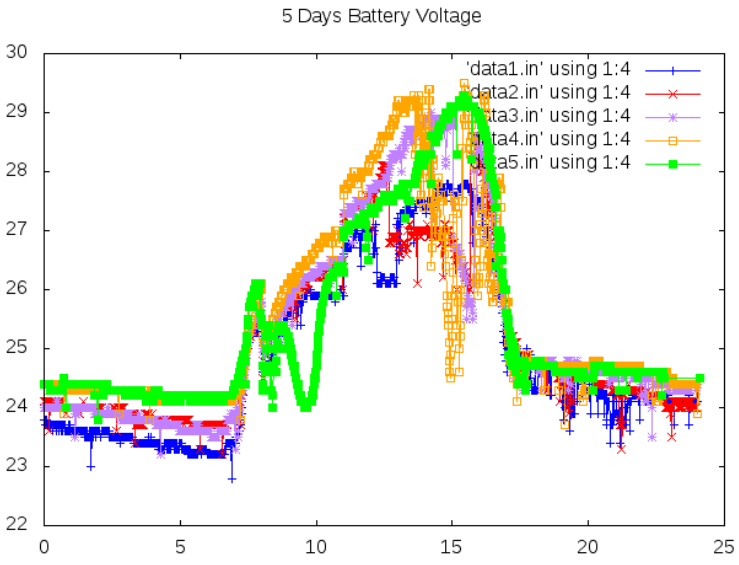
where alarm.awk is the following script:

```
{
    #if ($0 ~ /<var>Battery Volts/) volts=$5;
    if ($0 ~ /Battery Current/) current=$5;
    if ($0 ~ /Room Temp/) temp=$5;
}
END {
    ialarm=175 ; # sound alarm is over 175 battery amps
    mode=0; # current alarm
    if (mode==0) {
        getline last <"alarmlast.dat"
        if (current>=ialarm) {
            print last" "current" " >>"alarm.log"
            system("date >>alarm.log");
            system("/usr/bin/mplayer ./alarm1007.wav  >alarmjunk");
            system("sleep 1");
            system("/usr/bin/spd-say \"Current is at " current " amps\"")
        }
        getline genstart <"genstart.txt";

        if ((current<0)&&(genstart==0)) {
            genstart=1;
            printf "1\n">"genstart.txt"
            print last" "current" " >>"alarm.log"
            system("date >>alarm.log");
            system("sleep 1");
            system("/usr/bin/spd-say \"The generator has started\"")

        }
        if ((current>20)&&(genstart==1)) {
            genstart=0;
            printf "0\n">"genstart.txt"
            system("/usr/bin/spd-say \"The generator has turned off\"")
            system("sleep 5");
            system("/usr/bin/spd-say \"Current is at " current " amps\"")
        }
    }
    printf("%d\n",current);
```

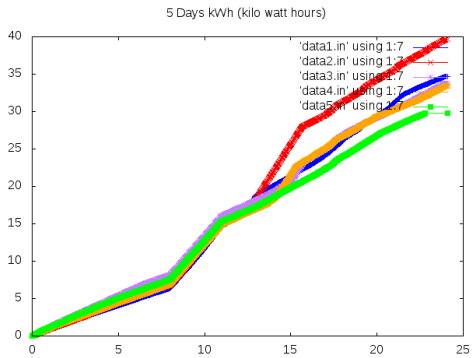
A couple of graphs are useful to see some typical behavior. Here is a 5 day record of inverter (battery) current where the pool pump (100A) on a timer is seen from 8-11am and the well is turned on manually in the afternoon (130A) and numerous short spikes are from the water pressure pump running:



The 5 day battery voltage graph from the same 5 days (the green dip at 10am was from the partial solar eclipse and the orange down spikes are from clouds passing by!):



Or even the kilowatt-hours consumed can be calculated and plotted:



Access to the status can be copied to a free web subdomain. Email and web access will made available to the new owner if desired. The power status plus graphs can be viewed at: http://zenpower.atwebpages.com/zen.html

There will be an annual renewal email sent to ***@gmail.com. (password: ***) The hosting service is https://cp1.awardspace.net/ *** New owner will take possession of the web page and email and can change passwords, etc.

The code to transfer local files to this website is as follows:

```
#!/bin/bash

HOST="***.atwebpages.com"
USER="xxx"
PASSWORD="***"
DESTINATION="zenpower.atwebpages.com"
ALL_FILES="status.shtml index.html zen.html volts.png temp.png today.png current.png noload.png
watthr.png discharge.png"

ftp -p -i -n -v $HOST <<EOF
user $USER $PASSWORD
cd $DESTINATION
pwd
mput $ALL_FILES
bye
EOF
```

The table of data at the bottom of the page includes a history of low line voltage, current spikes, generator on/off times. Only the spike heading is given. I will not support the code I wrote to generated the tables. I used gnuplot to create graphs which is free software available on Linux, Windows and Apple. I have provided sufficient details in this document for a programmer to write display code as desired. I used spd-say to vocalize warnings and curl to read web pages which are free on Linux machines and usually included when installing Linux.

I computed the no-load voltage based on a plot of voltage vs current and found the zero crossing. This is only an approximation and only valid when no battery charging current exists (night or generator running). I computed discharge whr by battery volts* times battery current (inverter current) from 1 hr before sunset to 1 hr after sunrise with sunrise/sunset times adjusted monthly. Spike currents were detected by inverter current changes of +70 amps (“Spike Threshhold”) to when the current dropped about 70%. Any spike lasting more than 50 seconds was removed as that was assumed to be an appliance being turned on then off. Low line voltage is triggered when line voltage drops about 10% (103 V). Voltage drops below 105V about 2x as often as below 103.