Plan Ahead or Bust the Electric Budget

Almost everyone has paid an electric bill on a house, apartment or some other form of living arrangements. That electric bill is based on the number of kilowatt hours of power which have been consumed over a given period of time usually that period is one month.

The kilowatt is a measure of electrical power and 1 kilowatt equals 1,000 watts. Watts are the basic unit of power. My most recent stick house electric bill was for 1540 KWH (kilowatt hours) of power consumed over a 30 day period. The electric company also breaks the bill down into how many KWH's of power were used each day of the billing period in this case 51.333 KWH per day. I broke that number down even further by dividing the 51.333 KWH per day by 24 (number of hour in one day). I now have the KW's or watts used per hour of one day. The result is 2.139 kilowatts or dividing by 1,000 (definition of kilo) gives me 2,139 watts used per hour during the past month in my stick house.

That means the AVERAGE power consumption over that 30 day period 24 hours each day was 2,139 watts per hour. As we all know none of us use the same amount of power each and every minute of every day, so we are going to see cases of 4,000 watts being consumed during the heat of the day but maybe only 1,200 watts consumed during the early morning hours, when we may be sleeping. This is just a way of keeping track of the power usage and for the electric company to charge each customer their fair share of the cost of producing the power sent to them.

My home is fairly new it was built using the 2006 electrical codes, rules and regulations. We have an electric panel rated at 200 Amps which is also capable of supplying 240 volts of electricity.

I am going to add two new words to this lesson, Volts and Amps (Amperes). Volts or Voltage is a unit of electrical PRESSURE. Where as Amps or Amperes is a unit of CURRENT or capacity. The three terms are used in a formula to define what or how electricity works. $P = I \times E$, where POWER is defined with the letter "P", CURRENT uses the letter "I" and VOLTAGE or VOLTS uses the letter "E".

POWER is defined by a unit as watts per unit of time, in this case one hour. We also express the unit in kilowatts per hour to take advantage of using smaller numbers, rather then using 2,100 WH (watts per hour) we use 2.1 KWH. CURRENT is defined by a unit as AMPERES or AMPS. To make the term AMPS easier to use in a formula we can use the term MILLIAMPS or how many (one thousandths) of an AMP of current are we using. When we are

talking about house current it is easier to use the term AMPS, but when we get into the RV electrical systems which uses a combination of AC (Alternating Current) and DC (Direct Current) we will be dealing with smaller numbers of AMPS at that point we will see the unit MILLIAMPS used more often.
VOLTAGE or VOLTS, the unit of measure for electro motive force (EMF) the electrical pressure or force used to push the AMPS through the wire.
In the United States we define electrical power as being made up of all three components of the above formula. We also use appliances which operate on either 120 volts or 240 volts. Most small appliances use 120 volts AC while the larger appliances use 240 volts AC. More on why the two different voltages are used at a later time.
Now, back to my stick house's electrical panel, the panel is rated at 200 amps and has both 240 and 120 volt wiring. The 240 volt wiring has two 120 volt components which are timed to be 180 degrees out of phase with each other. I do not want to go into the how or why 240 volts are what we have at this point, let us just agree that it is just the way it is.
The electrical panel has four wires with have the correct wire size to carry the rated capacity of the panel, in this case 200 AMPS. So each 120 volt wire can on its own carry 200 AMPS. We have two 120 volt wires, one neutral wire and a fourth which is a ground wire.
Back to the power formula, Power in watts is equal to 200 Amps multiplied by 120 volts. Which is 24,000 watts or in more simple units, 24 KW (Kilowatts). We have two 120 volt wires so we have the capacity of 48,000 watts or 48 KW per hour. So if I were to consume ALL of the available power supplied to my house, I would be using 48 KWH x 24 hours a day x 30 days in the average month, 34,560 KWH/month or 34.56 MWH/month (MWH) that is over <u>34 million watts per month</u>. I would not even like to think how much money that would cost me. The above is the <u>POTENTIAL</u> POWER USAGE of an average stick house in the United States.
But now back to reality, none of us would consume that much power at our stick house but we DO NOT have that capacity on our RV's. We have at best two 120 volt wires capable of carrying 50 Amps on each wire. We still have the four wires, two hot (120 volt) one neutral and a fourth with is the ground wire. So power wise, our RV is rated and built to allow the consumption of 120 volts multiplied by 50 amps equals 6,000 watts. We have two legs (wires) of 120 volts so in total we have the capacity to use 12,000 watts of power or 12 KW per hour in our Tiffin motor homes.
Unless we have the fortune to ONLY connect to newer or better built RV parks we will never have the campground SUPPLY our coach's FULL rated power capacity.

We also have our own portable power source, the Onan generator. In my case a 7.5 KW Onan diesel powered generator. Rated output is 31.75 amps on each 120 volt leg (wire) of our generator. This is a 120 volt **ONLY** generator but we have two 120 volt legs so, a total of 63.5 amps under full load. Again back to the power formula, 120 volts multiplied by 31.75 amps is equal to 3,810 watts, we have two 120 volt legs so a total of 7,620 watts from our on board generator.
Now if I am camping in an older or in some cases state or federal campground and they ONLY provide a 30 amp electrical service. The electrical pedestal is wired with three wires, one hot (120 volt) one neutral and the third is a ground wire. So back to the formula, power in watts is equal to 30 amps multiplied by 120 volts which equals, 3,600 watts or 3.6 KW per hour. We can further reduce the available power to 20 amps and using the same formula we now have 2,400 watts or 2.4 KW per hour. Or even 15 amps with 1,800 watts or 1.8 KW per hour.

Power available at the stick house:

200 Amp	48,000 watts per hour	48.0 KW per hour.

Power available when connected to shore power:

50 Amp	12,000 watts per hour	12.0 KW per hour.
30 Amp	3,600 watts per hour	3.6 KW per hour.
20 Amp	2,400 watts per hour	2.4 KW per hour.
15 Amp	1,800 watts per hour	1.8 KW per hour.

Power available while running the on board generator:

31.75 Amps	3,810 watts per hour	3.8 KW per hour
31.75 Amps	3,810 watts per hour	3.8 KW per hour
63.5 Amps	**7,620 watts per hour**	**7.6 KW per hour**

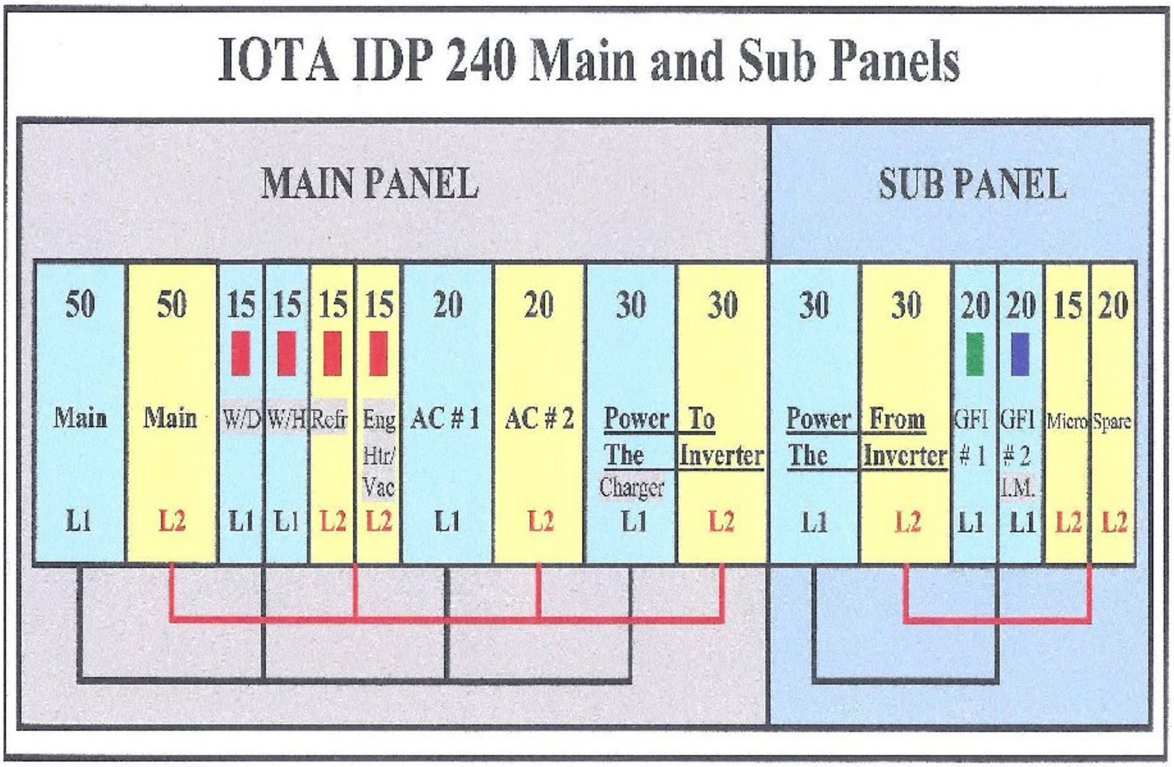
As you can see when using the on board generator we have more than twice the available capacity that we have when connected to 30 amp shore power but less then 64 percent (about 2/3) of what is available when connected to 50 amp shore power.

So what appliances do we use to consume the power connected to our RV's? The following is a short list of appliances which consume our coach's electrical power. Each unit has the rated wattage of the power consumed by using the appliance for one hour. In some cases the appliance will not be used for one hour, in those cases you will need to divide the wattage by 1/2 if only using for 30 minutes or 1/4 if only used for 15 minutes.

Curling Iron	30 watts
Home Theater System	90 watts
AC powered Lamp, (100 watt bulb)	100 watts
LCD TV	200 watts
Computer and accessories	200 watts
Norcold 1210IM Refrigerator	440 watts
Inverter/battery charger	1,000 watts or more
Microwave	1,700 watts, 15 min = 425 watts
1 AC/HP	1,560 - 2,000 watts
2 AC/HP's	3,120 - 4,000 watts
3 AC/HP's	4,650 - 6,000 watts
Clothes Dryer (120volt)	1,500 watts
Hair Dryer	1,500 watts, 30 min = 750 watts

The list is just a sample of the various electrical power consumers that are available in our modern RV's. So in most cases if we are connected to reliable 50 Amp shore power depending on how well the coach builder balanced the electrical loads, we can get by with operating most of our creature comforts which are built into our rolling homes. We begin having problems when we are required to use our generator or connect to 30 Amps of shore power or in some cases even less. That is when we need to understand how to and also be able to budget the available electrical power. In the event you do not understand how to budget your available electrical power or do not care to budget your available electrical power, then stand by to reset circuit breakers on your inverter, electrical panel, generator and/or outdoor electrical pedestal. Circuit breakers always trip when it is the least convenient to reset them, such as when it is cold, rainy, super hot or the middle of the night.

I took a picture of my coach's electrical panel and from that picture I made the following representation of how the Main Electrical Panel and its Sub Electrical Panel are electrically connected on my coach.



I marked each of the coach 120 volt outlets with a red, green or blue sticker the red marked outlets require shore power or generator power. The green and blue stickers tell me which GFCI circuit the outlet is fed from.
The two 50 Amp Main circuit breakers **FEED** the rest of the **Main Panel**. So the 4 - 15 Amp circuit breakers, the 2 - 20 Amp circuit breakers and the 2 -30 Amp circuit breakers are all receiving their power from the two 50 Amp Main Circuit Breakers. This panel is set up just like the panel in your house. The **black line** represents one leg (120 volts) of a two leg (240 volt) electrical panel the **red line** represents the second (120 volt) leg. So while we are connected to a 50 Amp shore power pedestal its no different then what we have at our stick house, however in place of our 200 Amp electrical service we ONLY have a 50 Amp electrical service AT BEST.
The Main panel is designed to take the voltage from the 2 -30 Amp circuit breakers and **FEEDs** the voltage to the inverter and its battery charger. The battery charger is fed from the 30 Amp L1 (black line) so some of the power is used for charging the various batteries connected to the inverter. The balance of L1 and all of L2 power is **FED** back to the 2 -30 Amps circuit breakers in

the Sub Panel. Those 2 - 30 Amp circuit breakers distribute the incoming power to the 3 - 20 circuit breakers and the 1 - 15 Amp circuit breaker located in the Sub Panel.

So far I have covered the two electrical panels on my coach and how they provide power while operating on Shore Power or Generator Power.

We also have a third possible case, where Shore Power and Generator Power are not desired or not available for what ever reason, such as time of night restrictions (11:00 PM to 07:00 AM). So we resort to our coach batteries to provide the 120 volt power for our needs and comforts.

We turn on our Inverter to create the AC power necessary for the operation of our TV's, Microwave, Coffee Maker and other comforts of home.

Looking back at the Main Electrical Panel we see all of the circuit breakers in the Main Electrical Panel **REQUIRE** either Shore Power or Generator Power to **FEED** the Main Panel. There for to use the 120 volts available from our inverter we are limited to those circuit breakers which are **FED** from the inverter. Those are the 3 - 20 circuit breakers and the 1 - 15 Amp circuit breaker located in the Sub Panel. On my coach those circuit breakers feed the 2 GFCI protected circuits and their outlets, the microwave outlet and one spare circuit, which is not used.

My coach came from Tiffin with an RV2012 series inverter which is capable of a constant capacity of 2,000 watts or 2.0 KW per hour. TMH also installed four Interstate U2200 batteries for the house batteries, those batteries are six volt deep cycle batteries capable of 232 Ahrs of power when wired in a series configuration. Wiring two six volt batteries in series will provide 12 volts of power. Wiring two sets of the series wired batteries in parallel will provide the coach with 464 Ahrs of power. It is best to never consume more than 50% of the battery SOC, so we can use 232 Ahrs of power before we should recharge the batteries. If we were to use 2,000 watts per hour then our battery bank would last almost 84 minutes at maximum consumption before the batteries should be recharged. 2,000 watts divided by 12 volts = 166.66 Amps. 232 Ahrs divided by 166.66 Amps = 84 minutes. Most of us will never run our inverter that hard but if you do then about 84 minutes is the life expectancy of one charge.

So to extend time between battery charging we either need to install a larger battery bank or use less power which will stretch our time between battery charging. In my case I added an additional 4 - U2200 batteries and upped my coach battery capacity to 928 Ahrs.

Look back at the above chart of appliances and their power consumption. By looking at the chart you can **PLAN** on how to budget (use) your available electrical power so you do not **BUST** your electrical budget.