How To Do An Electrical Energy Inventory For Your Camp

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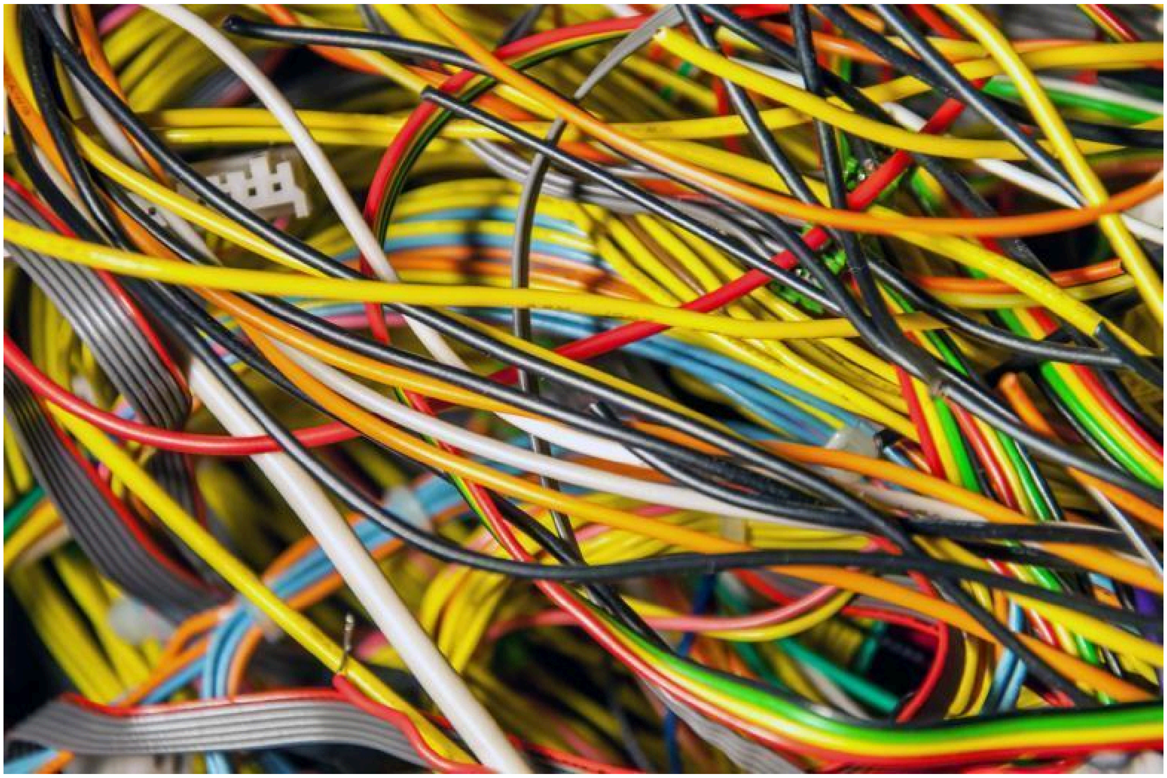

How much electrical power does your camp consume? What size generator or solar power system do you need? Can it power a refrigerator, freezer, lights, or sound system? What other devices will your campers need to power, such as 2-way radios, water pumps, or electric bikes? What else? How much will it cost to power everything? How can I reduce my carbon footprint?

By creating a simple power baseline inventory your camp can answer these questions and launch you towards a more efficient and sustainable burn.

Why do an inventory?

In any business an inventory of stock in trade is vital to the success of the business just as an inventory of the camp's electrical equipment is needed to be successful in the reduction of a camp's carbon footprint. It is through the use of an inventory that a camp can identify areas of waste. Just switching from incandescent or fluorescent lighting to LED lighting can make a huge difference in a camp's electrical load. If a camp uses refrigerators or freezers, it may be time to upgrade to more efficient models. Some camps even add better insulation to their food cooling systems. The same goes for air conditioning usage. Are the units properly sized for the space and efficiency, or were they some old units laying around and put to use?

What about power creep? We have all seen it. The camp starts out with a balanced system and then breakers start popping. Upon inspection, extension cords were found running everywhere and a number of unplanned items were plugged in. Sometimes the loads exceed the generation capacity, or sometimes the distribution system (circuit breaker panels, extension cords, power strips) needs to be rebalanced. If you are not tracking the camp's energy usage how can a camp get a handle on power creep? Also, the inventory can be used to make campmates aware of their power consumption which directly relates to the camp's carbon footprint. An inventory should be compared every year with the previous year to see what has changed in the electrical usage.

An inventory also helps identify hidden drains on the system that you never think about known as parasitic loads. That is when a piece of equipment draws power even when it is switched off. That AC unit might consume power even if the switch is in the off position. The wall phone charger has a transformer that draws power even when you are not using it. The paper shredder at home can be in a standby mode and be a parasitic load. What about the printer? See a LED light on? That’s a load wasting money and sending CO^2 into our atmosphere.

Generators and Solar/Wind Power Benefits from Doing an Inventory

Generators and renewable energy sources have a finite amount of power available on the playa. Generators are limited by their KVA rating. Solar and wind power are limited by the quantity of batteries and output of the wind turbine or solar panels. An inventory is important to make sure that the equipment is sized correctly.

Using the inventory to size a camp generator is vital to the camp's carbon footprint. Generators are not designed to operate at 100% for long periods of time. It is also important to have room for power surges and startup inrush current. A sweet spot will be to operate at 75-80% of rated load. Also, a generator overloaded will have a shortened life. We don’t run our cars at 100% nor should we run a generator that way. A lightly loaded generator is not being used efficiently and will burn excess fuel and oil. That said, based upon what the inventory tells you, it may be possible to use a smaller generator. A smaller generator, sized correctly, will burn less fuel and thus provide a smaller carbon footprint but remember that there are many different generators on the market. Try to find the most efficient unit you can afford based upon what you learn from your inventory.

As for solar and wind, an inventory is needed to properly size the system. Being batteries are the primary energy source it is possible, if the system is sized incorrectly, that the batteries will become depleted before the solar panels or turbine can recover the batteries. Ergo, you may be sitting in the dark. Also, sizing a system correctly prevents from overspending though more is better when sizing a system. It comes down to money and real estate for a renewable energy system.

Math is needed to do a proper inventory

It can be as easy as using a pad of paper and pen or building a spreadsheet that can do the math for you. Simple math is important to do a complete inventory of the camp's energy usage. The information needed for an inventory can be found on the nameplate of most pieces of electrical equipment. Look for following values such as Volts (V), Amps(A) or Watts (W). Simply put, Volts is the electrical potential to do work, Amps is the number of electrons flowing to get the work done and Watts is the power used in an electrical circuit. Power is defined as the work done per unit time in a circuit. Don't sweat the above. It gets easier.

Watts will be the most important unit needed when doing an inventory. The math to derive Watts is Volts X Amps = Watts. You can find either the Voltage or Amperage of a piece of equipment by using the following math; Watts/Volts=Amps or Watts/Amps=Volts. This is the basics of what is known as Ohms Law. An example of how this works is if you want to find out how many Watts a toaster uses, look at the nameplate on the toaster.

Example: The toaster nameplate might say, for example, the voltage is 120 V and uses 12.5 Amps.

The math to solve for Watts is 120 V x 12.5 A=1500 W

Example: What about a lightbulb? How many Amps is used by a 60 W light bulb at 120 Volts?

60 W/120 V=0.5 A

There is an issue using the nameplate information. It only tells you what the maximum running current would be, not the actual current or Watts used over a period of time. This does not provide for an accurate electrical inventory. It also does not take into account instantaneous peak starting power of, let's say, an air compressor or AC unit. The starting current can briefly be as high as 1 ½ - 6 times the running current. Anything with a motor can have high current inrush that might only last for a millisecond. Then there is what's known as a duty cycle. This is where a piece of equipment runs on and off over a period of time. A good example of this would be a refrigerator. The compressor turns on and off as it tries to maintain a set temperature. It might have a duty cycle of 50% where it is on half of the time. Of course, the duty cycle may vary as needed to keep the refrigerator at its set temperature. All this makes doing an accurate load inventory more difficult.

Tools

There is a simple way to find out how many Watts or Amps your toaster or a light bulb is using.by the use of a device called a Watt meter. It is sometimes generically known as a Kill-o-Watt (this is a brand name).

Just plug the meter into an outlet and plug the device you want to measure into the meter. Some of the values a typical Watt meter provides are Watts, Volts, Amps, kilowatt hours, Amp hours and power factor. This is a huge help when doing an energy inventory. If you let the device run for a given period of time you will get more accurate information for your inventory.

Other tools that will be beneficial to use when doing an inventory is a multimeter or amp clamp. These are used where a plugin meter won’t work.

More Math

There is one more step in the math to create a valuable unit of measurement: the Watt hour (Wh) or usually expressed as kilowatt hours (kWh). Simply put, it's the hours of operation X Watts =Wh

Example: a 60 W light bulb operated for 8 hour equals 480 Wh (60 W X 8 Hrs = 480 Wh or 480 Wh/1000 = .480 kWh).

Why is this important? Because it provides a unit of power usage for the inventory and, most importantly, in the default world, it is a unit of measurement that the power utility charges you by. Look at your power bill to see what your monthly kWh usage is. Multiply that number by what the utility charges per kWh.

Default World

Ok, that is all the math you need for now but let's use what's been learned and apply it in the default world where we have the largest carbon footprint. Looking at a porch light that is left on all night we find it has a 60 W incandescent bulb.

Example: The light is left on for 10 hours each night so the daily Watt hours is 60 W X 10 h = 600 Wh or 600/1000 = 0.6 kWh per day.

The annual kWh is 0.6 kWh X 365 days = 219 kWh per year.

The utility charges, for example in the Seattle area, $0.10341/kWh for a total annual cost of $22.65 per year ($0.10341/kWh X 219 kWh = $22.65).

Let's take it to the next step to see what the carbon footprint is for that one 60 W bulb. The national average of pounds of CO^2 /kWh is 0.92[1]pounds. The true number of pounds depends on what kind of power (solar, hydro, nuclear, coal, fossil fuel) is provided by your local utility.

So, for that one 60 W incandescent light bulb burning 10 hours per day: 0.92 lbs of CO^2 per kWh X 219 kWh = 201.48 lbs of CO^2 entering the atmosphere per year. That's not a pretty picture.

Let's change things around and use an 8.5 W LED bulb for 10 hrs per day

8.5 W X 10 h = 85 Wh per day

85 Wh/day X 365 days = 31,025 Wh per year or /1000 = 31.025 kWh per year

31.025 kWh per year X $0.10341 = $3.21 per year

31.025 kWh per year X 0.92 lbs CO^2 /kWh = 28.54 lbs CO^2 per year

So, by switching from a 60 W incandescent to 8.5 W LED lightbulb you can:

[1] U.S. Energy Information Administration (EIA) average lbs. of CO^2 per kWh provided by US utilities.

Save $19.43 per year

Save the planet 172.94 lbs of CO^2 per year

Armed with this information consider doing a practice run by doing an inventory of your home's electrical needs. Review your work and see where you can become more energy efficient. You might be surprised at not only how much CO^2 you can prevent from entering the atmosphere but how much money you can save too.

A fun project is creating a spreadsheet inventory that can do the math for you. It can be as simple or complex as you wish to create **or you can use the form already created at the end of this document**

Here is an example of a home inventory. 0.36 pounds of CO^2 per kWh was used on this spreadsheet for the state of Washington. The lower number is because the state uses more hydro, solar, wind and nuclear power than fossil fuels.

Space	Description	QTY	Voltage	A	W	pF	Phantom Load	Measured W	Hours of Operation /day	Total kWh/day	lbs of CO2/day	lbs of CO2/year
Kitchen												
	Stove, gas, electric start and LED	1	120	0.012	1.4			1.3	0.5	0.001	0.000	0.085
	Refridgerator	1	120	1.094	131.3	1		131.82	9.9	1.305	0.470	171.479
	Oven/microwave	1	220	11.5	2530.0				0.3	0.759	0.273	99.733
	Garbage disposal	1	120	8.1	972.0				0.1	0.049	0.017	6.386
	Dishwasher	1	120	9.6	1152.0				1.2	1.348	0.485	177.106
	Dishwasher, STBY, Unknown	1	120	0	0.0				0.0	0.000	0.000	0.000
	Coffee pot, STBY	1	120	0.079	1.3	0.133	X	1.22	24.0	0.029	0.011	3.847
	USB Charger outlet	1	120	1.5	180.0				4.0	0.720	0.259	94.608
	Lights, Sink, can LED, 13 w, 145 mA	3	120	0.145	39.2	0.75			1.0	0.039	0.014	5.144
	Lights, bar, can LED, 13 w, 145 mA	2	120	0.145	26.1	0.75			16.0	0.418	0.150	54.873
	Hood fan/lights LED, 5W	1	120	1.54	184.8				0.5	0.092	0.033	12.141
	Sonos, Play 5, STBY	1	120	0.121	7.1	0.487		6.79	24.0	0.163	0.059	21.413
	Alexa,	1	120	0.03	2.1	0.597		1.78	24.0	0.043	0.015	5.613
	light, over table, LED, 8.5w, 110mA	5	120	0.11	66.0				1.0	0.066	0.024	8.672
	Light, overhead, LED	3	120	0.042	15.1				0.0	0.000	0.000	0.000
								Room Total kWh/d		5.031	1.811	661.102

An example of a simple camp inventory

Qty	Discription	Volts	Amps	Watts	Hours of Operation/day	kWh/d
10	Camp incandescent bulb lighing	120		60	11	6.60
1	Refrigerator	120		130	12	1.56
1	Trike charging station	120	2	240	4	0.96
1	Phone Charging Station	120	2	240	8	1.92
1	Camp LED lighingt string	120	2.15	258	11	2.84
					Total KWh	13.88

What is your camp's CO^2 output from using a generator?

CO^2 is one of the greenhouse gases that has heat trapping ability and thus contributes to climate warming. While the gas does have a low heat trapping ability it is considered one of the most plentiful (82%) of the greenhouse gases in our atmosphere. One of Burning Man 2030 goals is to become carbon negative and one way to help reach that goal is to become aware of the volume of CO^2 our camps are pumping into the atmosphere. By tracking how many gallons of fuel a generator burns in a day a rough calculation can be made. The following conversions can be used to convert gallons burned by a generator into lbs of CO^2 released into the atmosphere[2].

Gas - 1 gallon of gas weighs 6.3 lbs. There is 19.6 lbs of CO^2 released for every gallon of gas burned.

Huh? (CO^2 = carbon + oxygen combined = more weight). A fun explanation https://climatekids.nasa.gov/review/carbon/gasoline.html

19.6 lbs of CO^2/gallon X gallons of gas burned in a day = pounds of CO^2 released into the atmosphere per day.

Example: Bobs camps generator burns 5 gallons of gas a day x 19.6lbs of CO^2/gallon = 98 lbs. CO^2 released into the atmosphere.

Diesel - 1 gallon of diesel weighs just under 7 lbs. There is 22.4lbs of CO^2 released for every gallon of diesel burned

22.4lbs of CO^2/gallon X gallons of diesel burned in a day = pounds of CO^2 released into the atmosphere per day.

What about DC powered devices?

The question may come up how to measure usage if you are working with DC powered devices when using a solar or wind generator. The good news is the math is basically the same. There are also DC rated meters, and amp clamps that can help you record the information needed to complete a power inventory.

Conclusion

A good step on the journey to reach Burning Man 2030 sustainability goals is to identify your camp's power needs. Having a written inventory will guide your camp towards more efficient usage and is also an important starting point if your camp decides to turn to renewable energy.

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[2] Federal Register (2010). Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, page 25,330 (PDF) (407 pp, 5.7MB, About PDF).

Once your camp's power usage has been identified the question becomes where can the electrical equipment be more energy efficient? Is there a way to reduce electrical power usage? An inventory is also useful for helping camp mates become aware of their energy usage.

Finally, if we are going to try to save the planet from carbon emissions it doesn't just happen on the playa. It is in the default world where we affect the planet the most…not just one week a year in the desert.

Quick Math Reference Guide

Volts X Amps = Watts,

Watts X hours of operation = Wh, divided by 1000 = kWh

Watts/Volts = Amps,

Watts/Amps = Volts

kWh X 0.92lbs[3] = lbs. of CO^2 released into the atmosphere (US average)

Math for the generator:

Gas -19.6 lbs. of CO2/gallon X gallons of gas burned in a day = pounds of CO2 released into the atmosphere per day

Diesel - 22.4lbs of CO2/gallon X gallons of diesel burned in a day = pounds of CO2 released into the atmosphere per day

[3] Look online for a more accurate conversion of pounds of CO^2 per kWh. It depends upon where you live as to what type of power your utility provides. Hydro, wind, solar and nuclear power is going to have a smaller carbon footprint compared to fossil fuels. The east coast burns more coal and has a higher release of carbon per kWh.

Camp Electrical Inventory

Camp Name | Date

Look for the information needed on the equipment's nameplate or use a Watt meter

Equipment Description	AC or DC	Operating Volts	X	Amps	=	(Watts	X	Quantity of Devices)	X	Hour of Operation	=	Watt/ hours	/1000 =	kilowatt hours
			X		=		X		X		=		/1000 =	
			X		=		X		X		=		/1000 =	
			X		=		X		X		=		/1000 =	
			X		=		X		X		=		/1000 =	
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			X		=		X		X		=		/1000 =	
			X		=		X		X		=		/1000 =	

When reviewing your camps electrical usage see where energy can be saved while being realistic of the hours of operation. Use this form to compare your camps usage in the years to come.

Total Kilowatt/Hours ______

Camp Name	Camp Carbon Footprint if Using a Generator	Date

Make of Generator	Model	Fuel Type Gas or Diesel	Voltage	KVA	Watts	Amps

Gallons used per day	Gas GPD	Diesel GPD
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		
Day 6		
Day 7		
Day 8		
Day 9		
Day 10		
Day 11		
Day 12		
Total Gallons Used		

Carbon Footprint Math

Gas - Total Gallons Used X 19.6lbs of CO2 per gallon = lbs of CO2

Gallons Used

__________ X 19.6/g = ________ Total lbs of CO2 released

Diesel - Total Gallons Used X 22.4 lbs of CO2 per gallon = lbs of CO2

Gallons Used

__________ X 22.4/g = ________ Total lbs of CO2 released

Carbon footprint per kWh

______ lbs of Total CO2 / ________ Total kWh = ________ Total CO2/ kWh

(taken from the Inventoy)