Batteries that Last for Decades

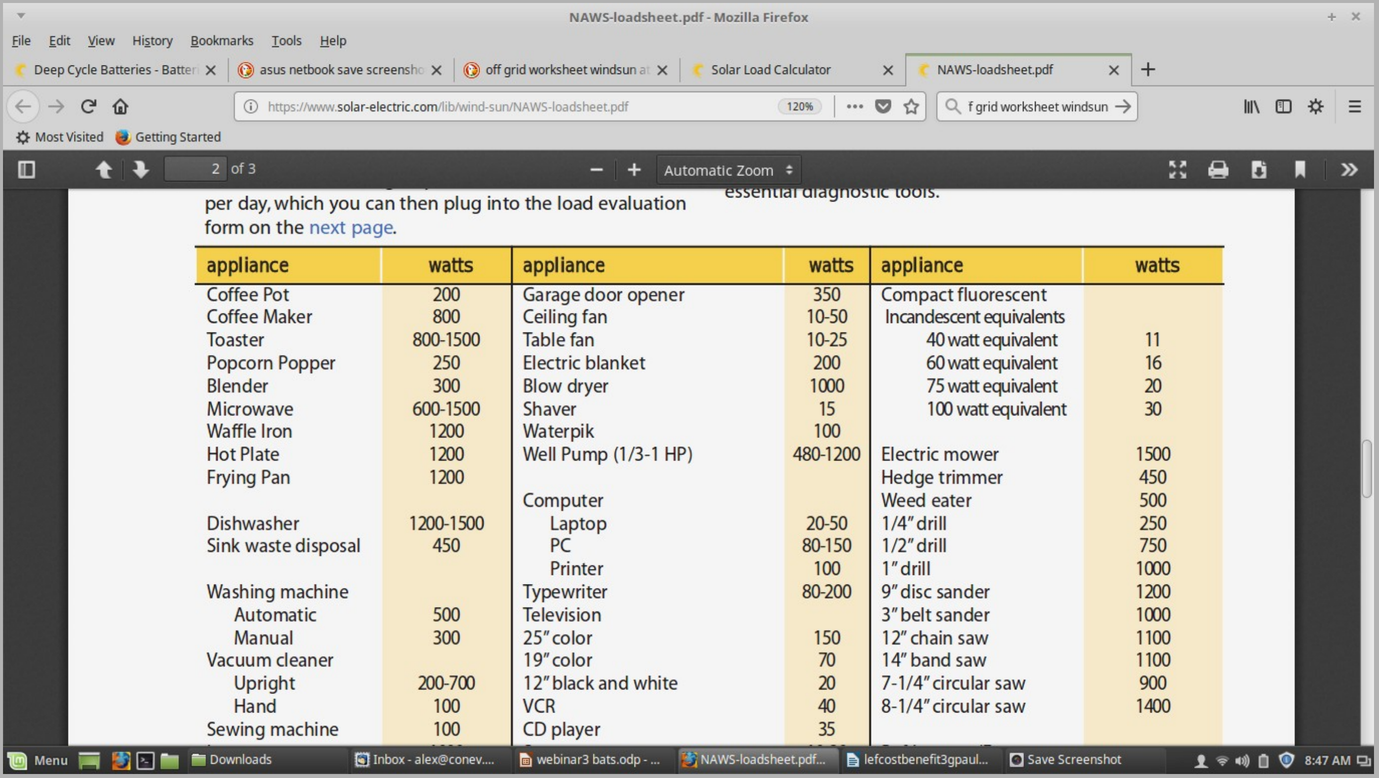
Wind and sun are renewable energy sources that operate without pollution once facilities are built to capture energy from these sources. The big problem is that both wind and sun are highly variable. A lot of work has been done to try to find better battery technologies so renewable energy can be stored. But what if an ideal battery technology was developed, but it was not profitable enough? What if battery companies make so much money selling bad batteries that they do not want to sell good ones?

We have a mystical view of technology, but technology evolves toward profit, not toward durability or function. More to the point, corporations want to sell goods and services to rich people, not poor people. Drug companies spend a lot of money developing blood thinners to help rich people who eat a poor diet instead of developing treatments for malaria even though malaria kills more people. The people who get malaria make less profitable customers.

This is the standard assessment chart used to size off-grid energy systems. This is where your enslavement to **someone else's** profit begins.

What does that have to do with renewable energy and batteries? Everything. AC grid power is created by generators that run around the clock, burning fossil fuel primarily. The environmental cost of maintaining AC power grids is massive. Starting a few decades ago, a movement started for people who wanted to live off-grid. The designers of Living Energy Farm built a number of off-grid homes and community facilities before we started on LEF. None of those off-grid facilities are still operational. Why? There are few reasons, and they all relate to batteries.

Lead-acid batteries cost less than 1/3rd as much as any other battery technology on the market. The standard design process for off-grid homes tries to imitate grid-powered energy systems. (See Longterm Integrated Village Energy – at http://www.livingenergyfarm.org/techdocs/howlefworks4.pdf for an explanation of the design process of a *conservationist* village economy at LEF.)



per day, which you can then plug into the load evaluation form on the next page.

essential diagnostic tools.

appliance	watts	appliance	watts	appliance	watts
Coffee Pot	200	Garage door opener	350	Compact fluorescent	
Coffee Maker	800	Ceiling fan	10-50	Incandescent equivalents	
Toaster	800-1500	Table fan	10-25	40 watt equivalent	11
Popcorn Popper	250	Electric blanket	200	60 watt equivalent	16
Blender	300	Blow dryer	1000	75 watt equivalent	20
Microwave	600-1500	Shaver	15	100 watt equivalent	30
Waffle Iron	1200	Waterpik	100		
Hot Plate	1200	Well Pump (1/3-1 HP)	480-1200	Electric mower	1500
Frying Pan	1200			Hedge trimmer	450
		Computer		Weed eater	500
Dishwasher	1200-1500	Laptop	20-50	1/4" drill	250
Sink waste disposal	450	PC	80-150	1/2" drill	750
		Printer	100	1" drill	1000
Washing machine		Typewriter	80-200	9" disc sander	1200
Automatic	500	Television		3" belt sander	1000
Manual	300	25" color	150	12" chain saw	1100
Vacuum cleaner		19" color	70	14" band saw	1100
Upright	200-700	12" black and white	20	7-1/4" circular saw	900
Hand	100	VCR	40	8-1/4" circular saw	1400
Sewing machine	100	CD player	35		

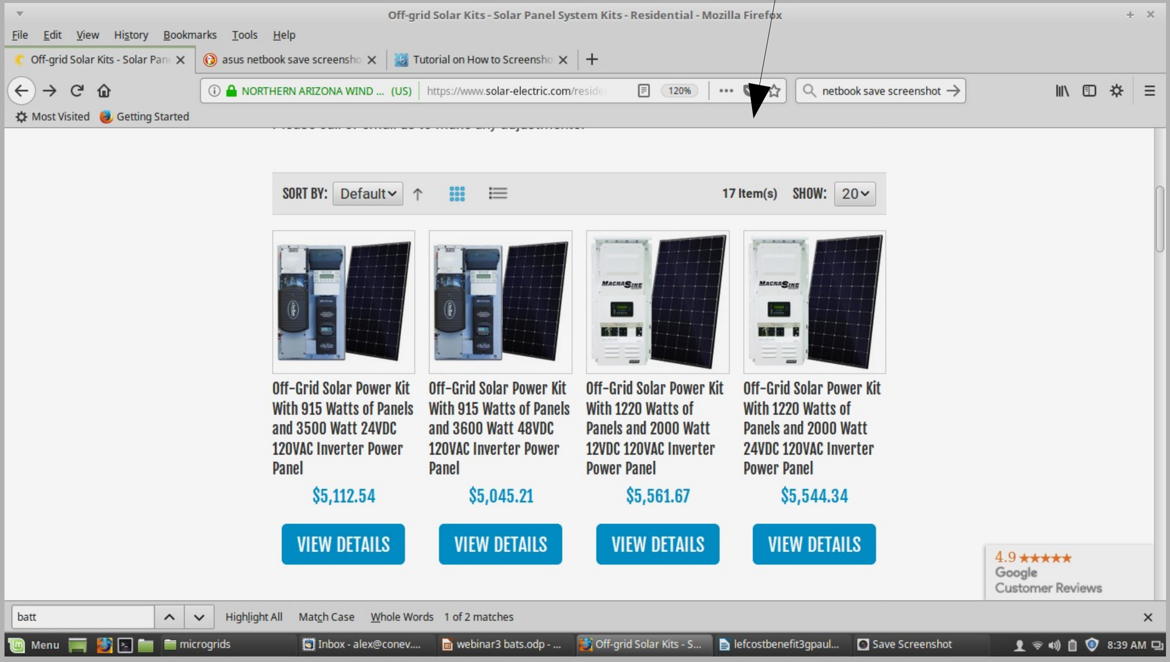
Off-griders use generators for backup power, but they are expensive and finicky, especially in cold weather. Off-griders find that their $5000 or $10,000 battery set needs replacing in 5 – 6 years, and isn't reliable even when it's fully operational. Back to the grid they go!

Every battery system is different, but here's the bottom line. All variants of lead-acid batteries (deep cycle, flooded, ABM, gel cells) weaken quickly and tolerate very shallow discharge. Whatever the "rating" of the battery says, you can't use much of the energy in the battery. If you discharge it deeply, you destroy it. They are also very toxic and explosive. They degrade with each charge cycle. What about other battery technologies? Lithium ion, lithium iron phosphate, and nickel iron batteries are all similar in cost, coming in at around three times as much per "amp hour" as lead acid. Lithium batteries are more expensive, somewhat more durable, but they still cannot be deeply discharged, and they degrade with each charge cycle. The promoters of lithium batteries are promoting them by saying they will last 10 years. (The deep cycle lead-acid salespeople say the same thing, but they never do.) How long do your phone or computer batteries last? Those are lithium. All the variants of lithium and lead-acid batteries degrade with each charge cycle, and are badly degraded if deeply discharged.

The conventional off-grid design process leads people to believe they need a LOT of battery power, and that commits most people to lead-acid batteries because any other alternative would be astronomically expensive. That's where bad design leads – to dead ends. Having installed lead-acid batteries based on unrealistic promises of their performance, off-griders soon learn that their lead acid batteries degrade at about 10% per year. With a conventional off-grid system using AC power, as the system is fatigued or simply overladed, the whole system shuts down, and leaves users in the dark. A normal off-grid house (like the ones we built prior to LEF) has 1000 to 2000 amp hours in battery storage. (An amp-hour is a combination of amps and hours, so a 1000 amp-hour set can support 200 amps output for 5 hours, or 500 amps output for 2 hours, or any combination that adds up to 1000.)

The basic idea behind Living Energy Farm is that we live what we talk about. We live in a fully off-grid community, and experience the benefits and limitations of our choices daily. We head some time ago that nickel iron (NiFe) batteries were better from a sustainability standpoint. We had never used NiFes before, and they are expensive. So we got an "experimental" 100 amp-hour NiFe set. We were warned by the salespeople that this set was small, and would not hold up well to the expected use in an off-grid house.

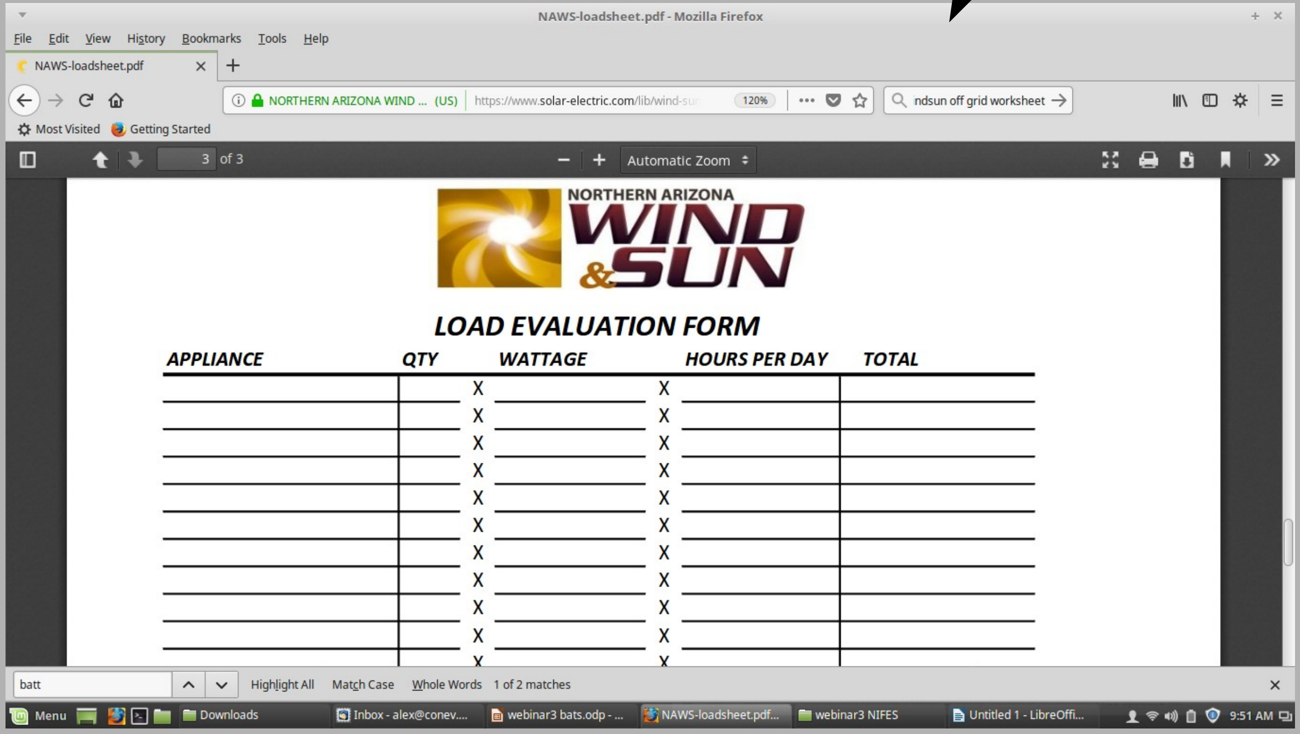
Prices for the very heavy off-grid equipment you are lead to believe you need by the standardized design worksheets. These prices do not include batteries or the rack to hold the solar panels.



We certainly didn't expect a battery set 1/10th the size of a "normal" off-grid setup to hold up to a small community of people. We had a small set of lead-acid batteries prior to the NiFes. It's performance was truly pitiful.

We hooked up our very small "experimental" NiFe set 7 years ago. If you try to power a conventional off-grid AC home with NiFes, we don't know what might happen. With LEF's LIVE systems design, the performance of the NiFes has been absolutely unbelievable. The rating system for batteries is an absolute lie! Combined with a good conservationist design, the NiFes have never failed us in 7 years, and show no signs of weakening. (We have a 100 year old Edison Nife that still works as well.) Every winter, we sit in wonder as day after day of heavily cloudy weather goes by. We use our LED lights as much as we want. We (and our interns) surf the net, watch movies, and play with electronic devices as much as we want. And still the power never gives out.

Take the energy loads from the previous worksheet and add them up here. "Ours not to reason why..." (That means you are not supposed to ask too many questions....) Northern Arizona Wind and Sun is a fine company, by the way. This is their worksheet, but they are not the bad guys in this situation.

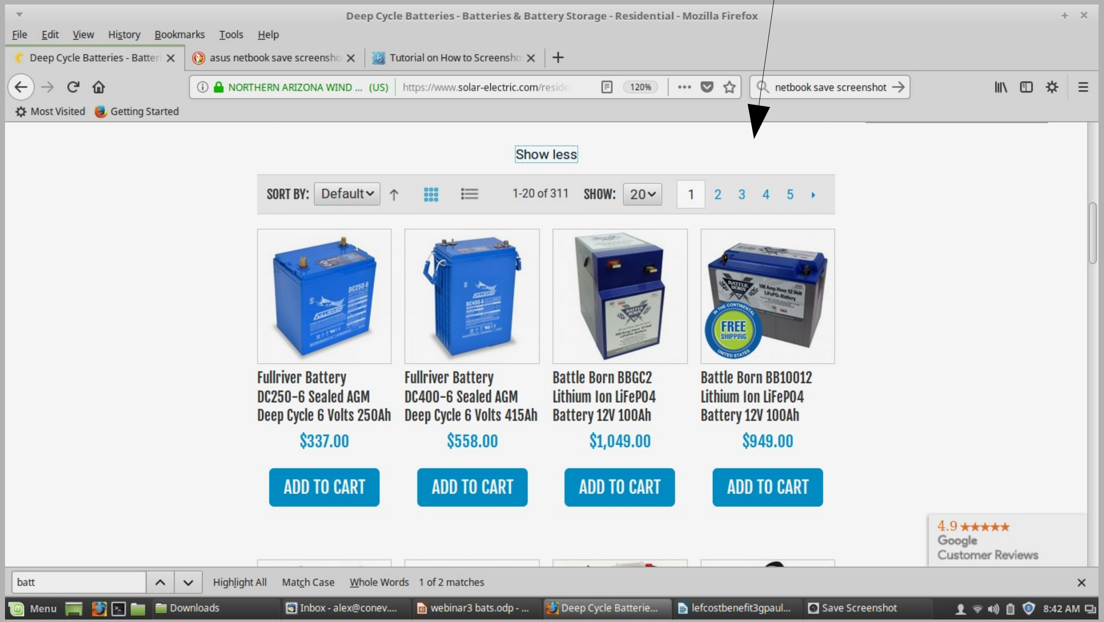


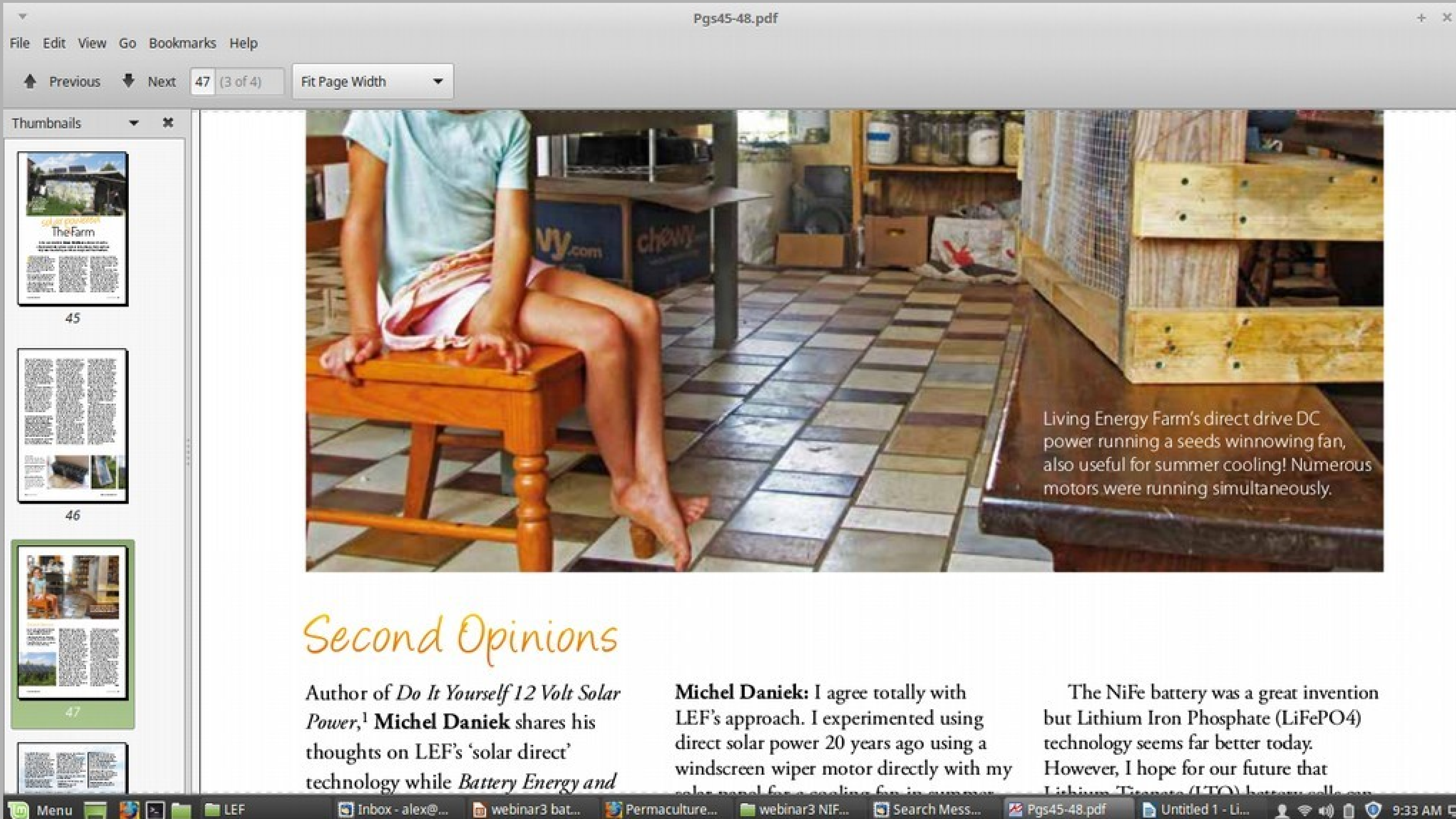
Having built off-grid systems and watched one after another fail, the performance of our LIVE design and NiFe battery system is pretty amazing. Our electricity just never fails us. And that's why we are trying to teach others how to do it. Centralized AC grids are causing massive destruction. The conventional off-grid design is utterly ineffective. But the market dominates. Even the non-profit organizations who tell their donors that they are trying to provide electrical services to the disadvantaged in the nonindustrial world will not deviate from the AC model. Why? We are not sure entirely, but the dominance of market forces weighs heavily. Conservationist design is like healthy food – addictive, unhealthy stuff sells better. And it would appear that many nonprofits would rather sell the illusion that everyone can live an American middle class lifestyle rather than giving people of limited income around the world what they actually need – reliable services.

The bottom line is you can't get smart answers by asking stupid questions, and the consumer economy is built on extremely destructive/ addictive patterns of consumption. Foolish energy design leads to the assumption that large amounts of energy are needed, and a trajectory of destructive choices follow from that (unquestioned) foolish design.

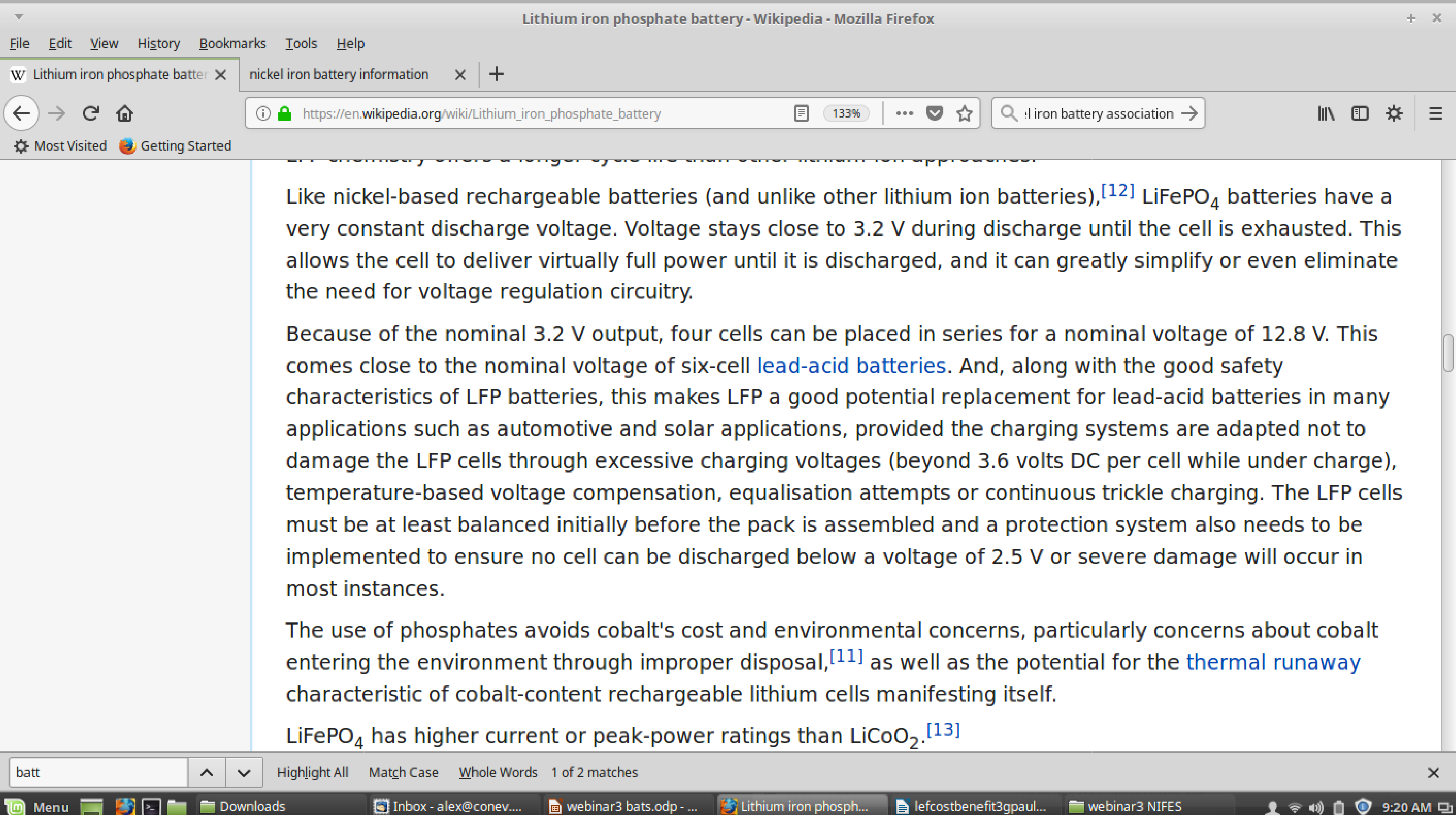
You need not remain enslaved to other people's maximum profitability.

Batteries from N. Arizona Wind and Sun.
1000 Amp-Hours would be considered a smallish system. First battery available:
6V X 2 = 12 V X 4 (to get 1000 AH) = 8 batteries = $2696 (but 12 volts is pretty wimpy)
24V system will work better = $5392
Prices do NOT include shipping. These batteries are lead, very expensive to ship.





Permaculture Magazine (https://www.permaculture.co.uk/) ran an article about LEF recently. The battery expert they consulted tells the audience that LiFePO4 (aka lithium iron phosphate) batteries are better than nickel-iron. The lithium iron phosphate batteries are some of the most expensive batteries on the market.



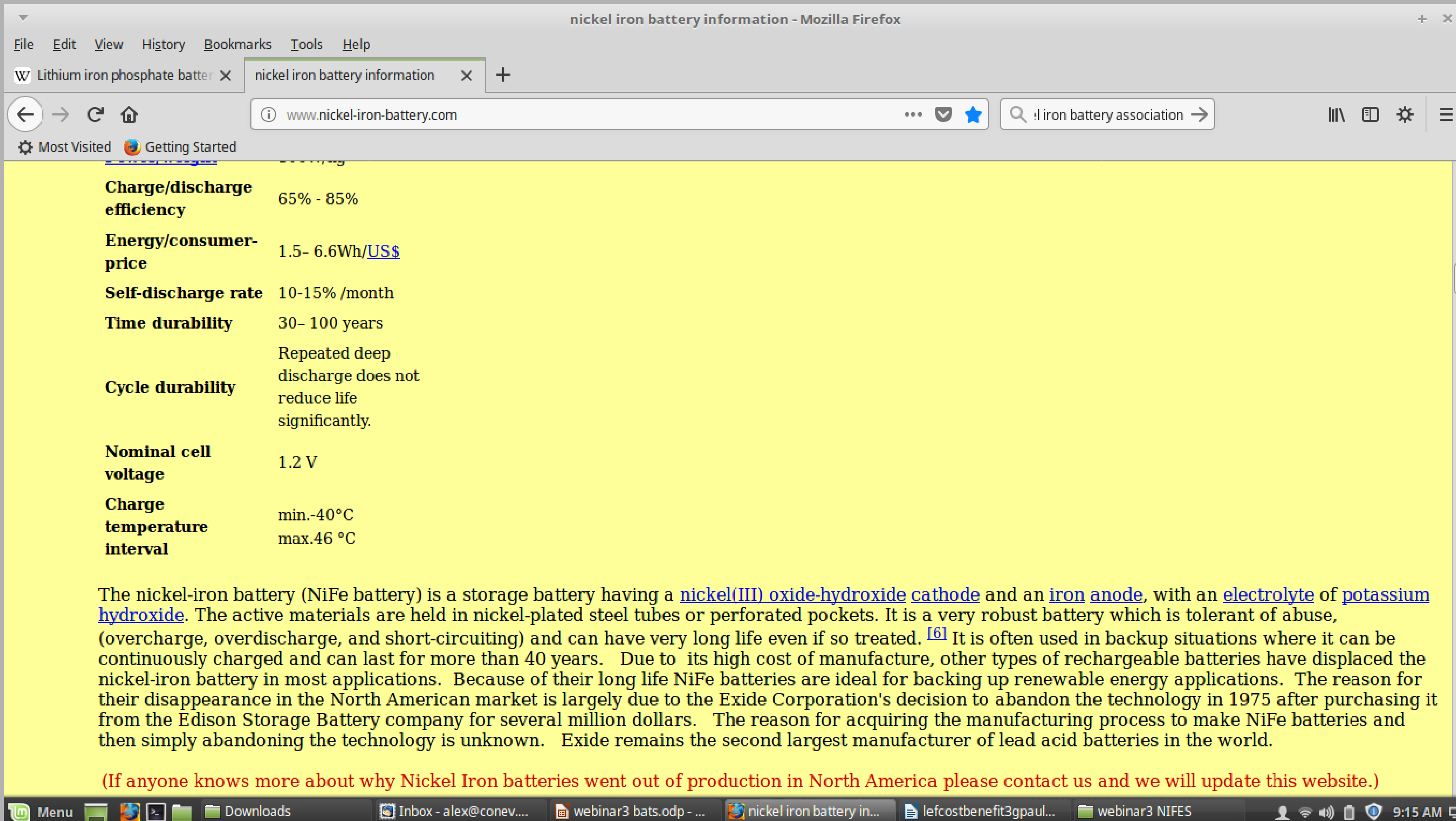
Like nickel-based rechargeable batteries (and unlike other lithium ion batteries),[12] $LiFePO_4$ batteries have a very constant discharge voltage. Voltage stays close to 3.2 V during discharge until the cell is exhausted. This allows the cell to deliver virtually full power until it is discharged, and it can greatly simplify or even eliminate the need for voltage regulation circuitry.

Because of the nominal 3.2 V output, four cells can be placed in series for a nominal voltage of 12.8 V. This comes close to the nominal voltage of six-cell lead-acid batteries. And, along with the good safety characteristics of LFP batteries, this makes LFP a good potential replacement for lead-acid batteries in many applications such as automotive and solar applications, provided the charging systems are adapted not to damage the LFP cells through excessive charging voltages (beyond 3.6 volts DC per cell while under charge), temperature-based voltage compensation, equalisation attempts or continuous trickle charging. The LFP cells must be at least balanced initially before the pack is assembled and a protection system also needs to be implemented to ensure no cell can be discharged below a voltage of 2.5 V or severe damage will occur in most instances.

The use of phosphates avoids cobalt's cost and environmental concerns, particularly concerns about cobalt entering the environment through improper disposal,[11] as well as the potential for the thermal runaway characteristic of cobalt-content rechargeable lithium cells manifesting itself.

$LiFePO_4$ has higher current or peak-power ratings than $LiCoO_2$.[13]

This is wikipedia with information on the lithium iron phosphate batteries. Apart from being very expensive, they self-destruct when deeply discharged, and need a computer to keep them “safe.”



Charge/discharge efficiency	65% - 85%
Energy/consumer-price	1.5– 6.6Wh/US$
Self-discharge rate	10-15% /month
Time durability	30– 100 years
Cycle durability	Repeated deep discharge does not reduce life significantly.
Nominal cell voltage	1.2 V
Charge temperature interval	min.-40°C max.46 °C

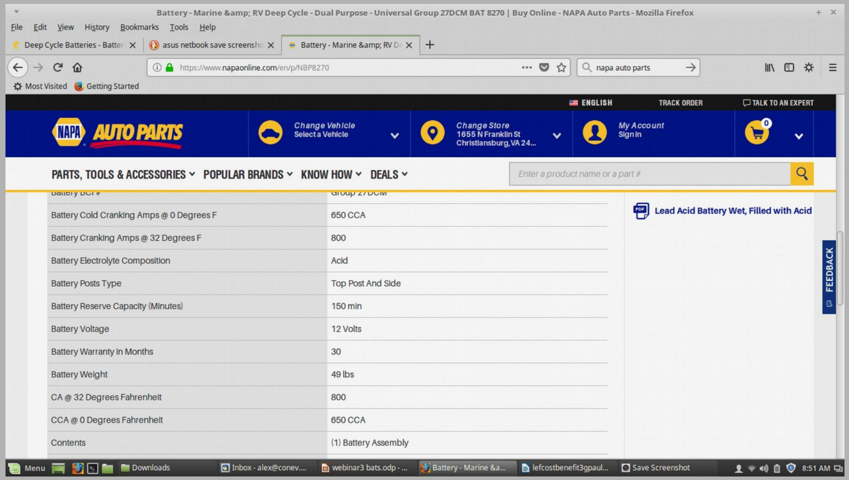
The nickel-iron battery (NiFe battery) is a storage battery having a nickel(III) oxide-hydroxide cathode and an iron anode, with an electrolyte of potassium hydroxide. The active materials are held in nickel-plated steel tubes or perforated pockets. It is a very robust battery which is tolerant of abuse, (overcharge, overdischarge, and short-circuiting) and can have very long life even if so treated. [6] It is often used in backup situations where it can be continuously charged and can last for more than 40 years. Due to its high cost of manufacture, other types of rechargeable batteries have displaced the nickel-iron battery in most applications. Because of their long life NiFe batteries are ideal for backing up renewable energy applications. The reason for their disappearance in the North American market is largely due to the Exide Corporation's decision to abandon the technology in 1975 after purchasing it from the Edison Storage Battery company for several million dollars. The reason for acquiring the manufacturing process to make NiFe batteries and then simply abandoning the technology is unknown. Exide remains the second largest manufacturer of lead acid batteries in the world.

(If anyone knows more about why Nickel Iron batteries went out of production in North America please contact us and we will update this website.)

Nickel Iron Battery Association, complete with an interesting conspiracy theory about the suppression (?) of nickel-iron batteries.
http://www.nickel-iron-battery.com/

This is an operational nickel iron battery, an Edison original from a miner’s lamp. It is perhaps 100 years old. Bottom line is there will never be an operational 100 year old lead acid, LifePO4, or lithium ion battery. Get that. ***These batteries far outperform and outlast anything else.***

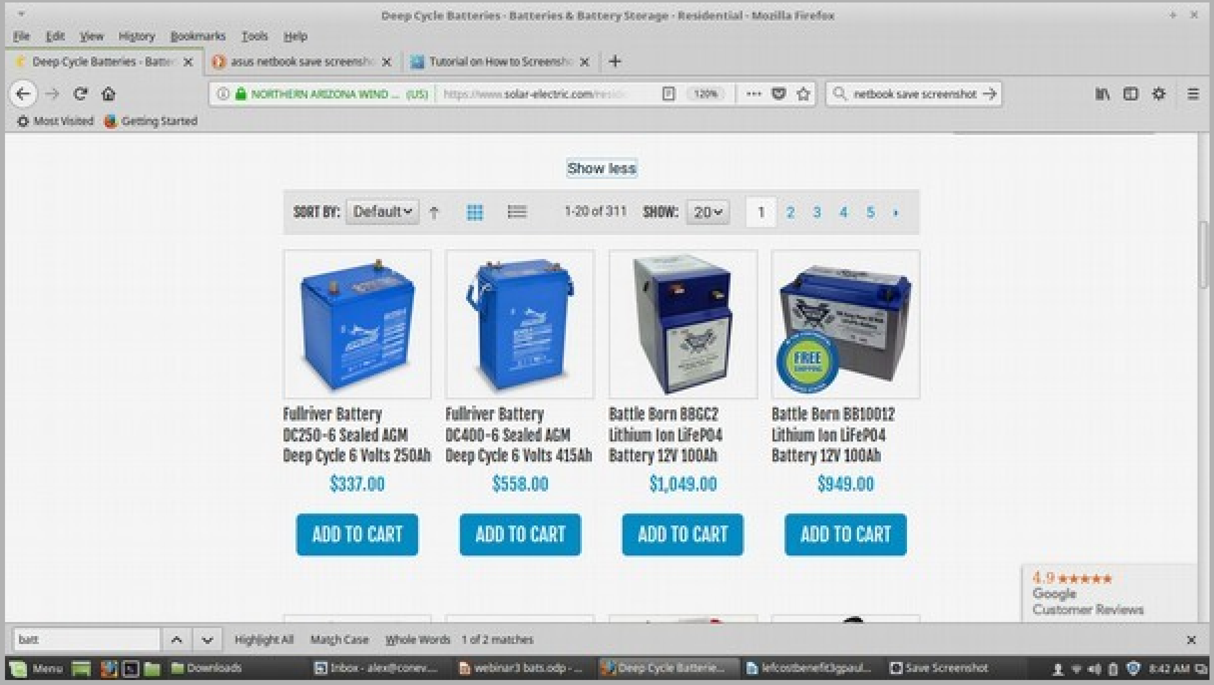
Battery Capacity -- A Mess of Misinformation



https://www.optimabatteries.com/en-us/experience/2014/02/battery-reserve-capacity

This shows cheap lead-acid battery options. So what is Reserve Capacity? It is a time measurement that explains how long a fully-charged battery can deliver 25 amps of current in an 80°F-environment, before the battery is discharged down to 10.5 volts.

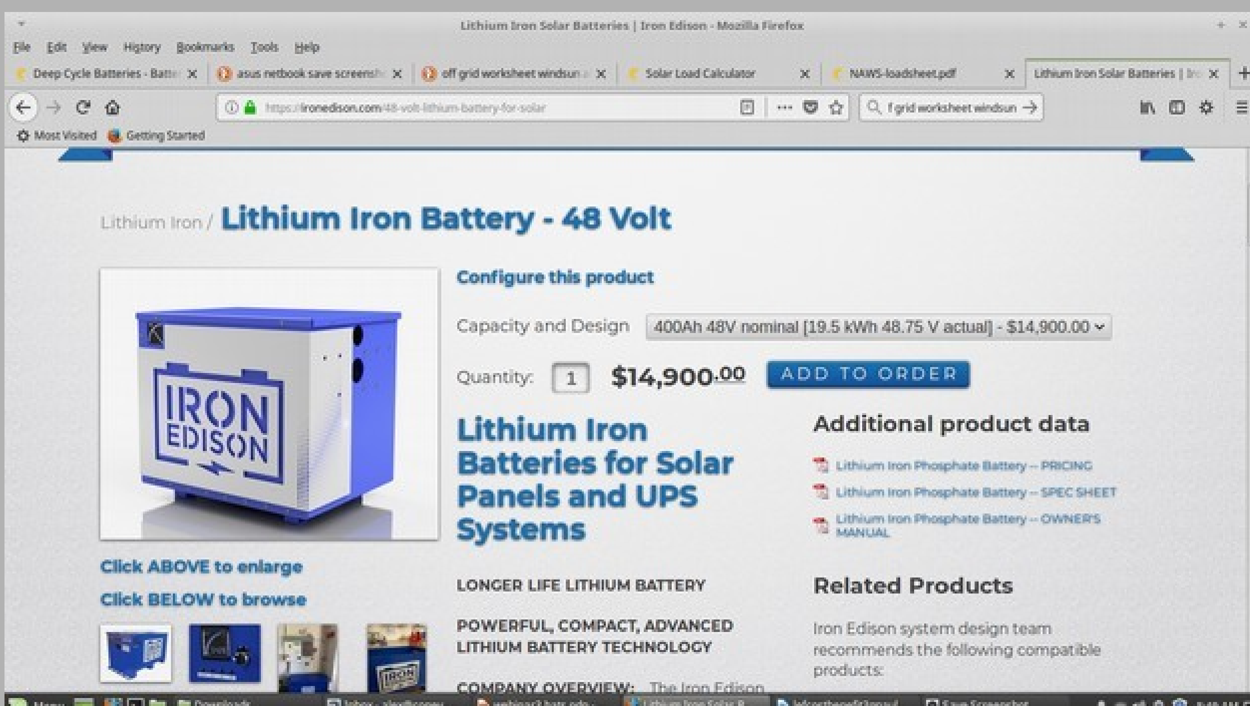
150 min / 60 min = 2.5hr   25A X 2.5 hr = 62.5 AH $93.59 / 62.5 AH = **$1.50/ AH for cheap lead-acids**



Lead Acid
2 X $337 = $674 @ 12V $674 / 250AH =
$2.70 / AH for higher quality lead acids

Lithium Ion
$1049 / 100 AH = **$10.5 / AH for lithium ion**

Nickel Iron
$1000 / 100 AH = **$10/ AH for nickel iron**



$14,900 / 4 = $3725 @ 12V
$3725 / 400 AH = **$9.31 / AH for a huge lithium iron** phosphate **set**

Looking at the prices, you can see why bad batteries dominate a consumerist market. They are much, much cheaper, and nobody expects anything to last, Except in the process we have cut ourselves off from the only viable alternative to AC grid power (smart design combined with durable batteries!)

Stacked Microgrid Functions in a Rural Mountain Ecovillage

By Diana Leafe Christian - Permaculture Magazine, UK, Winter 2015 issue

Cost Comparison of Living Energy Farm Off-Grid Electrical System

online at http://livingenergyfarm.org/techdocs/lefcostbenefit2.pdf

In the following, LEF refers to LEF's DC microgrid system. COGS refers to the community microgrid built near us, the “conventional off-grid system” above to which we are comparing our system.

Off Grid System Comparison

LEF – total power supply from photovoltaic (PV) power = 2000 watts
COGS – PV power = 4000 watts
LEF – total up-front per capita cost = $500
COGS – total up-front per capita cost = $2600
LEF – generator backup power = NONE
COGS – generator backup = YES
LEF – battery storage = 100 AH
COGS – battery storage = 2000 AH
LEF – annual battery degradation cost = $25
COGS – annual battery degradation cost = $1500 – $2000
LEF – annual equipment degradation cost = $100
COGS – annual equipment degradation cost = $1000
LEF – support for 24/7 use of appliances = NO
COGS – support for 24/7 use of appliances = YES
LEF – firewood for space heating dependency = 5% (active solar space heating supported by PV)
COGS – firewood for space heating dependency = 100%
LEF – refrigeration = yes but limited
COGS – refrigeration = yes, full size
LEF – air conditioning = YES (aqueous thermal absorption, not possible in all locations)
COGS – air conditioning = NO
LEF – system failure mode = no system wide failure, slowly weakening systems support conservation and allow correction before anything shuts down, multi-linear system cannot fail in total
COGS – system failure mode = immediate whole system collapse when batteries weaken, requires generator support which is difficult in inclement weather
LEF – support for smart phones, laptops, and internet = yes, but limited to battery powered devices
COGS – support for smart phones, laptops, and internet = yes
LEF – toxic impact of consumable materials = very low, no toxic heavy metals
COGS – toxic impact of consumable materials = high, extensive use of lead, re-processed abroad

LEF – life expectancy of core system components = 40 or more years
COGS – life expectancy of core system components = batteries, 5 – 7 years, generator, 10 years, other components, 40 years or more
LEF – non-electric energy storage = extensive
COGS – non-electric energy storage = none
LEF – behavioral impact of system design = slowly weakening systems teach users to adapt their lifestyle to energy availability. Some tasks have to wait for a sunny day.
COGS – behavioral impact of system design = With a conventional AC grid, enormous capital costs are invested in power production, and end users only pay for that energy in small increments. Consumptive behavior is encouraged. With a COGS system, the incentives are mixed. Like an AC system, capital is invested in power production, but a COGS system is limited in total power output, which users know. COGS operates with generator backup and users are habituated to AC grid power. In our experience of community-based COGS systems, users often plug in power using devices and forget them, just like they do with AC power. The LEF system does not allow that.

An old Russian NiFe

The insides of a NiFe. Notice, this is NOT precision construction. There have been a number of projects over the years to try to set up village production of these batteries. So far, profit has prevailed.

Sources for Nickel Iron Batteries

Qualmega
http://qualmega.com/
Cheapest source in the U.S., direct marketing portal for Changhong batteries. That is is most common source for NiFe batteries. They have a long turnaround time. Tell them Alexis from Living Energy Farm sent you.

Iron Edison
https://ironedison.com/
They keep NiFe batteries in stock, 100 AH and up, in the U.S., and can deliver more quickly.

Bimble Solar, UK
http://www.bimblesolar.com/

Iron Core Batteries, Australia
http://www.ironcorebatteries.com.au/
As far we we can tell, they are not carrying Changhong batteries. The U.S. distributors all carry Changhong.

Each distributor tends to claim their batteries are the best.....

And now for something completely different, we figured out a whole new way to use high voltage daylight drive, DC electricity. Common household power tools -- the old fashioned ones that have a plug, not a battery -- have “universal” motors that will run on AC or DC power. We took our 180 Volt, 8 Amp PV rack and cut it into two, making 90 Volts and 16 Amps. We put a bigger (30 Amp) switch on a power saw, and it runs like a champ! (DC power needs heavier switches. It tends to destroy small AC switches.) Really exciting for us to figure out a new way to have portable power! The photo is Alexis at Living Energy Farm using the aforementioned saw to cut heavy, one-quarter inch plate steel. Lots of moxy in that saw!

Warning: ALL battery systems have a capacity for high-amperage, heat generating discharge. ALL battery systems can start fires. ALL BATTERY SYSTEMS HAVE THE CAPACITY TO ACT LIKE AN ARC WELDER, MAKING SPARKS, HEAT, AND FIRE. Appropriate fusing or circuit breakers must be used. Consult a competent electrician.

DC Circuit breaker box, NOT the same as AC breakers.