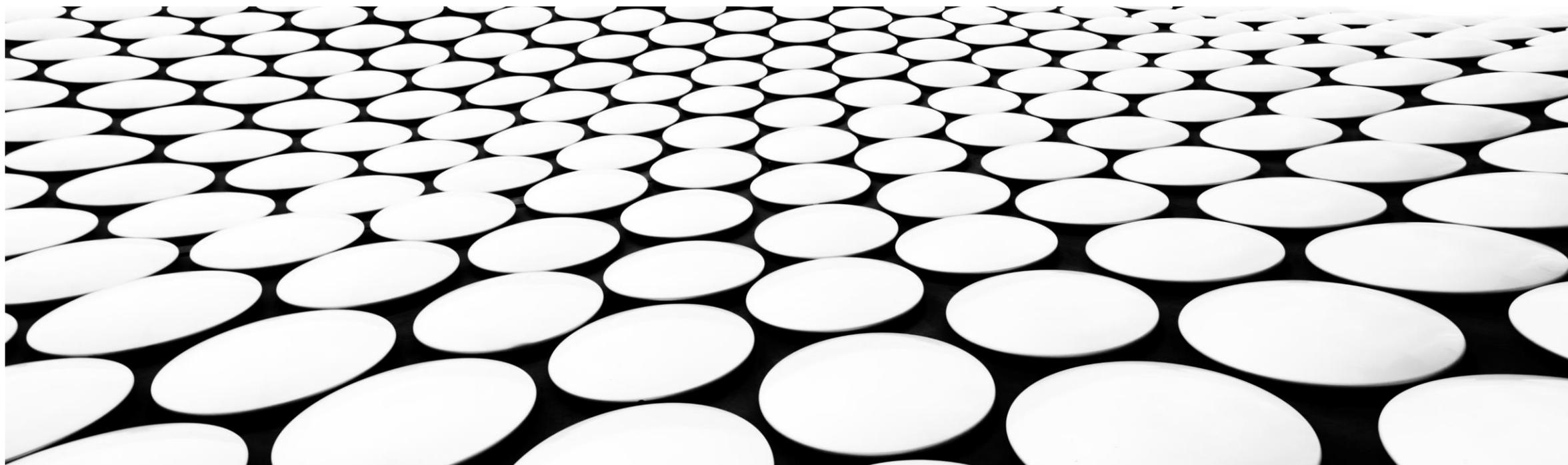

BATTERY TYPES AND SIZING FOR AMATEUR RADIO

(FEB 22 2020)

JP OUELLETTE - VE9ADV





JP OUELLETTE, CEM, CTECH

- Environmental Technology –NBCC -1990
- NB Power
 - Central Technical Services –F’ton (1990-1992)
 - Belledune Generating Station(1992-1999)
 - Shediac Customer Service (1999-2004)
 - Moncton Customer Service (2004-2010)
 - Product Management, Metering and Renewables (2010-Present)
 - Distributed Generation (Consumer level distributed generation including Net Metering and Embedded Generation)
 - Smart Grid
 - Solar System and Energy Storage modelling



INTENT

- Understand the basics of battery technology available today because much has changed
- Give ideas to the Amateur wanting to build a basic battery system to be used when the utility grid is not available or for portable operations.



BASICS

- Voltage - Difference of potential available from a battery
- Current – Rate of charge or discharge of a battery
- Energy – Typically expressed in Ah(Amphour) or mAh(milliAmphour), typically kWh for a home
- Polarity – Batteries have positive (+) and negative (-) terminals
- DOD – Depth of Discharge
- SOC – State of Charge

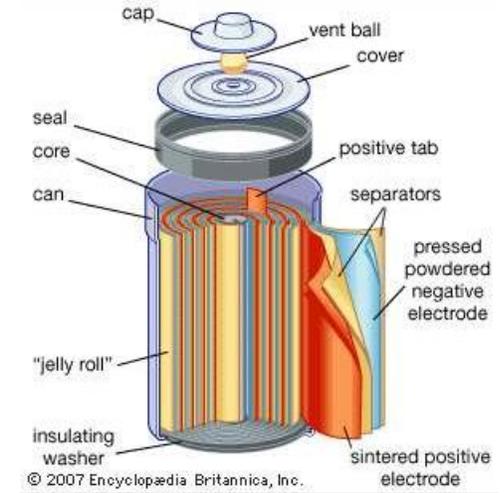


BATTERY TYPES TYPICALLY USED BY HAMS

- Nickel Cadmium (NiCd)
- Lead Acid or Sealed Lead Acid (SLA)
- AGM (Absorbed Glass Matt)
- NiMH (Nickel Metal Hydride)
- LiFePO_4 (Lithium Iron Phosphate)

NICKEL CADMIUM

- Nominal Cell Voltage of 1.2 Volts
- Pros:
 - Can be charged quickly
 - High Capacity for size
 - Temperature range -20C to 45C
 - Available in alkaline sizes from AAA to D, and multi-packs can be produced
- Cons:
 - Susceptible to battery damage if overcharged
 - Need to trickle charge if not used for extended periods (10% loss per month)
 - Suffers from memory effect if discharged and recharged to the same state of charge over a long period. This can be lessened by fully discharging the battery once a month.
 - Suffers from lazy battery effect where the battery is repeatedly overcharged. Voltage may seem ok when charged, but will discharge quickly over a brief period.
 - NiCd batteries are now at a disadvantage when compared to Lithium Ion and Nickel Metal Hydride which can be bought cheaper but still very useful in high discharge applications because it can handle those conditions without damage or loss of capacity.



Cadmium is a **VERY TOXIC** heavy metal.

Commercially used NiCd batteries will have automatic chargers that can be set to either prolong life (trickle charge when full), or increase performance (do periodic full discharge)

NiCd batteries can last up to 1,000 cycles before dropping to half capacity.

LEAD ACID AND AGM

- Nominal Cell voltage is 2.0 Volts (fully charged can be between 1.8 to 2.3 V)
- Pros:
 - Least expensive to purchase
 - High rate of charge and discharge
 - Easily rechargeable
- Cons:
 - Sulfuric Acid
 - Offgassing
 - Low Power Density
 - Low Depth of Discharge (20 % for Regular ~12 V, 50% for Deep Cycle ~10.7 V)
 - Sulfation of cells
- Specific to AGM
 - Can withstand more abuse because cells are somewhat more protected and energy density is a bit higher
- Lead-acid batteries do not have the "memory effect" mistakenly identified with first generation Ni-Cad batteries. Months of continuous undercharging will lower the capacity of the battery over time due to the accumulation of permanent lead-sulfate or "sulfation". **Deep discharges below twenty percent State-of-Charge (approximately 12.0 volts) can damage car batteries and will significantly shorten their service lives.**



NICKEL METAL HYDRIDE (NIMH)

- Nominal Cell Voltage is 1.2 Volts (Charging Voltage maintained between 1.4 to 1.6 volts)

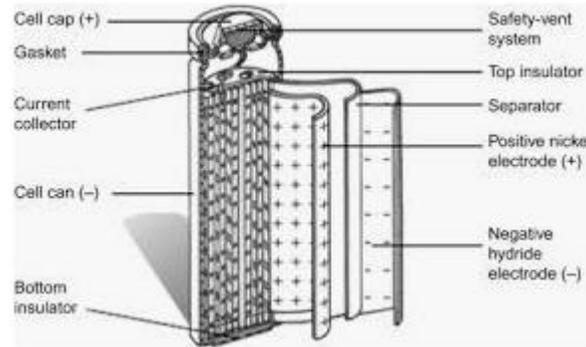
- Pros:

- High recharge cycle count if maintained properly
- Good low temperature performance
- Fairly cheap

- Cons:

- Low Energy density
- High self discharge, needs recharging after storage
- Memory Effect: needs periodic full discharge and can be rejuvenated
- Cobalt is toxic

- Very widely used in hybrid vehicles, good replacement for alkaline, battery technology has much improved recently



LITHIUM IRON PHOSPHATE (LIFEPO4)

- Nominal Cell Voltage is 3.2 V
- Pros:
 - Very stable compound and does not contain any heavy metals or toxic chemicals contrary to popular belief.
 - High energy density
 - Very resistant to self discharge
 - Can be discharged to 20 % of capacity safely (will not cause any damage to cells or premature failure)
 - Will last over a thousand charge cycles
- Cons:
 - Needs a special charger. Some batteries come with their own temperature/charge/discharge management system.
 - Perform poorly in cold conditions
 - Typically most expensive to purchase



WHAT DOES A HAM NEED FOR HIS/HER BATTERY SETUP?

- The question requires some information on how much energy will be needed for the period in question
 - Load
 - Assuming the radio is operated on 12 volts, you would need to apportion amps to voltage to estimate watts
 - Time
 - Estimate the time for the period without utility of battery recharge supply

- Or use an appliance meter!



USE CASE

- Radio brand X, model Y
 - 13.8 Volts
 - Rx with signal present 2.0 Amps, Tx 10.5 Amps
 - Would like to power for a 2 day weekend using 4 hours/day. Total 8 hours
 - Assuming Rx ~70% and Tx ~30%
- So.. 5.6 Hrs on Rx and 2.4 Hrs on Tx
- Total Rx energy... $13.8 \text{ V} \times 2.0 \text{ A} = 27.6 \text{ Watts} \times 5.6 \text{ hrs} = 154.6 \text{ Wh}$
- Total Tx energy... $13.8 \text{ V} \times 10.5 \text{ A} = 145 \text{ Watts} \times 2.4 \text{ hrs} = 348 \text{ Wh}$
- Total energy = $155 + 348 = 503 \text{ Wh} + \underline{20\%} = 604 \text{ Wh}$ or 600 Wh battery needed
- $600 \text{ Wh (VAh)} / 12 \text{ V} = 50 \text{ Ah}$ or 50,000 mAh @ 12 Volts

SELECTING A BATTERY

- <https://www.batteryspecialist.ca/12v-50ah-sealed-lead-acid-battery/>
- <https://www.batteryspace.com/nimhbatterypack12v52ah624wh40xfwithdischargi>
- <https://powerwerx.com/bioenno-blf-1250w-12v-50ah-lithium-iron-pvc>

NiMH Battery Pack: 12V 52Ah (624Wh 4x10S/S, F) Rechargeable Battery



Your Price: ~~\$590.00~~

In Stock

Product ID # 2617
Part Number: MHP-12V52Ah-4WR

Lead Time: 5 Business Day

Quantity:

[Add to a new shopping list](#)

[Email this page to a friend](#)



12 Volts 50Ah -Terminal L2 -
SLA/AGM Battery - UB12500

Universal Battery



~~\$219.95~~

\$149.95

Bioenno BLF-1250A 12V, 50Ah Lithium Iron
Phosphate (LiFePO4) Battery, PVC

State of the art 12V 50Ah Lithium Iron Phosphate (LiFePO4) battery. Built-in Anderson Powerpole connectors. The most versatile battery of the 12V lineup with a large capacity. Serious applications in surveillance and scientific instrumentation, this battery can do it all. [Read Full Description](#)

\$469.99

Add a Battery Charger?

None

6A Bioenno Charger **+\$38.99**

10A Bioenno Charger **+\$48.99**

Add a 20W Solar Panel with
Charge Controller **+\$79.99**

PORTABLE SETUPS



Renogy E.Flex 30W
Portable Folding 3-US...

COMPARE 

CAD \$109.99 [ADD TO CART](#)

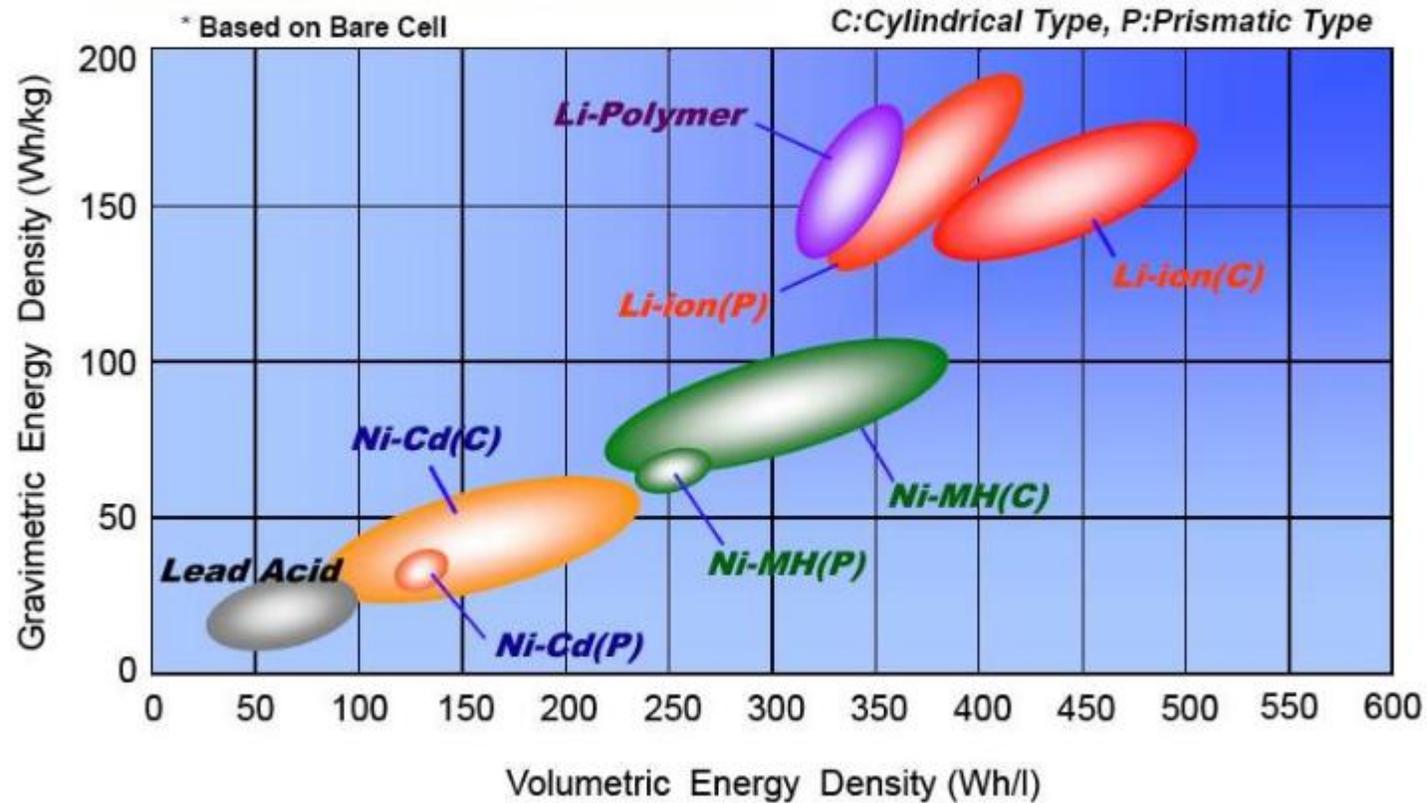


Only 7Ah capacity! SLA battery

SPECIFICATIONS BY BATTERY CHEMISTRY

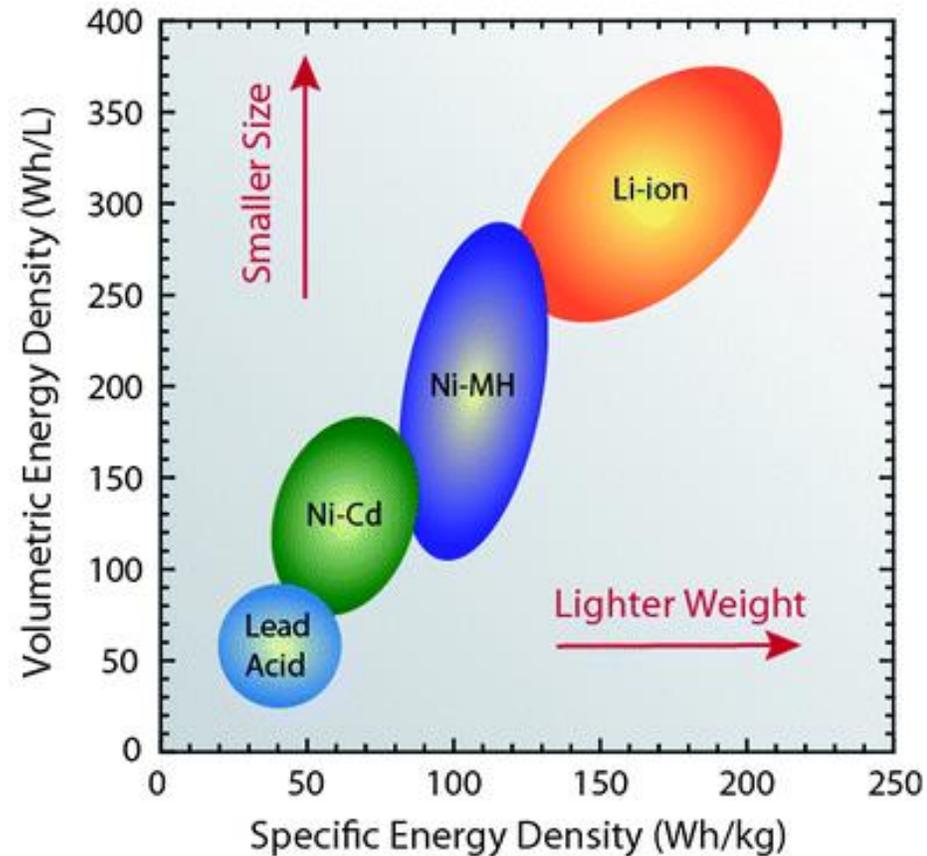
Comparison of Energy Density in Battery Cells

This battery comparison chart illustrates the volumetric and gravimetric energy densities based on bare battery cells.



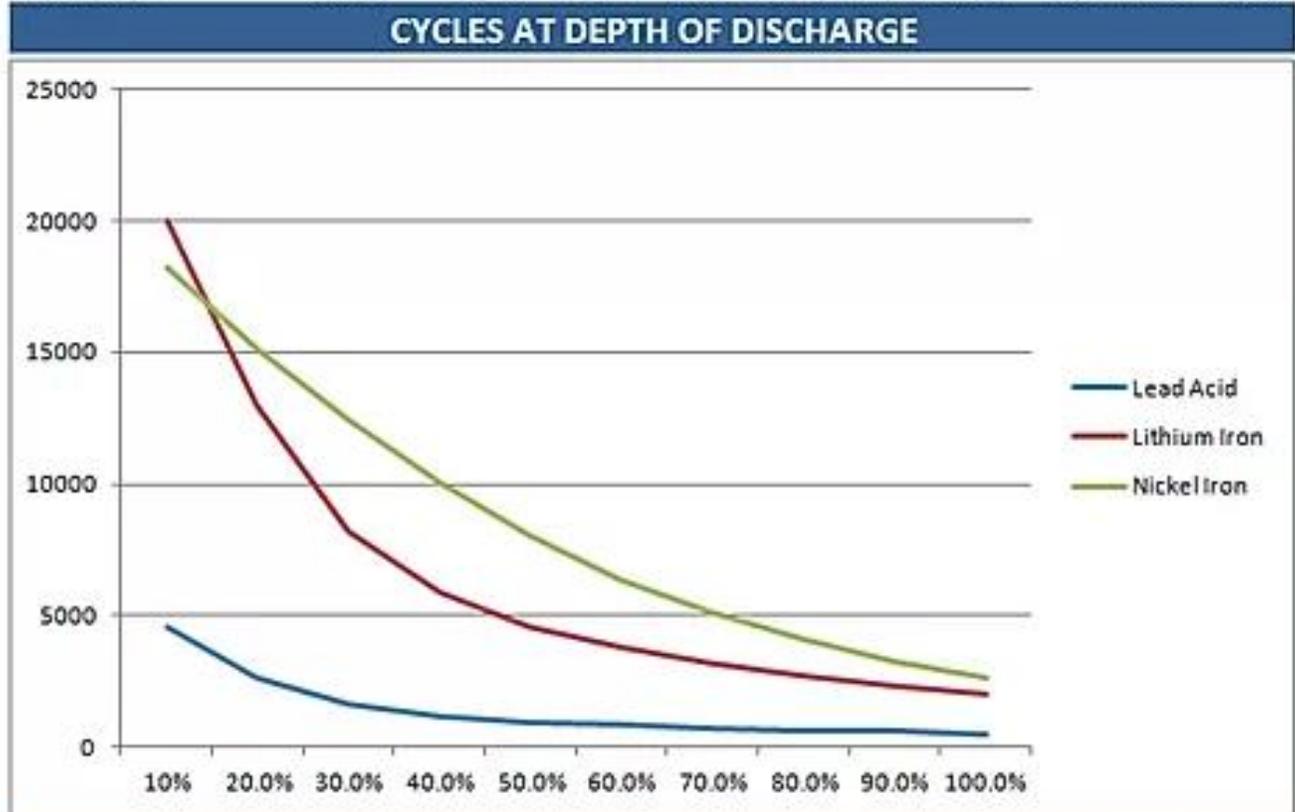
ENERGY DENSITY COMPARISON OF SIZE AND WEIGHT

The below battery comparison chart illustrates the volumetric and specific energy densities showing smaller sizes and lighter weight cells.



BATTERY CYCLE LIFE VS DEPTH OF DISCHARGE

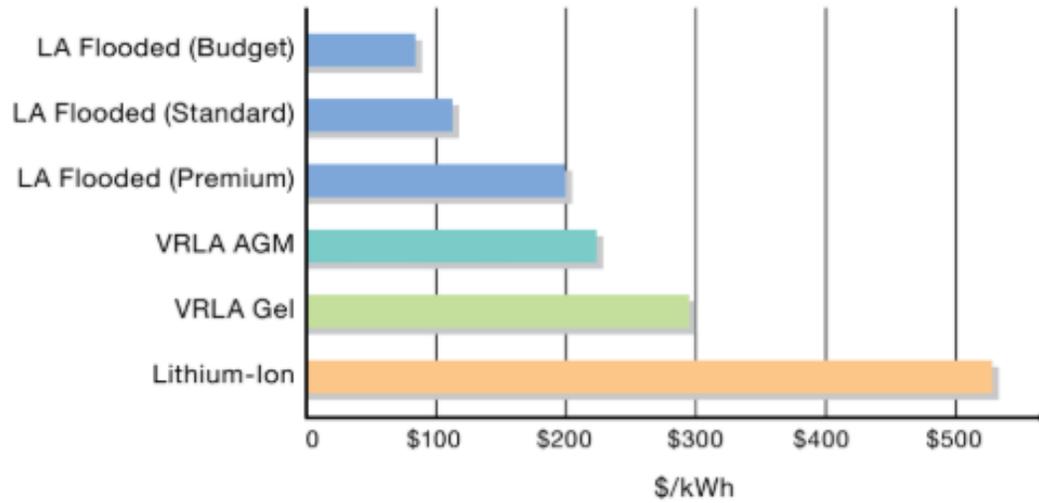
COMPARISON UNDER IDEAL CONDITIONS										
% Depth of Discharge	10%	20.0%	30.0%	40.0%	50.0%	60.0%	70.0%	80.0%	90.0%	100.0%
Lead Acid	4600	2600	1640	1180	966	836	724.5	648	590	500
Lithium Iron	20000	13000	8200	5900	4600	3800	3150	2700	2360	2000
Nickel Iron	18 250	15 148	12 421	10 061	8 049	6 359	5 037	4 069	3 256	2 604



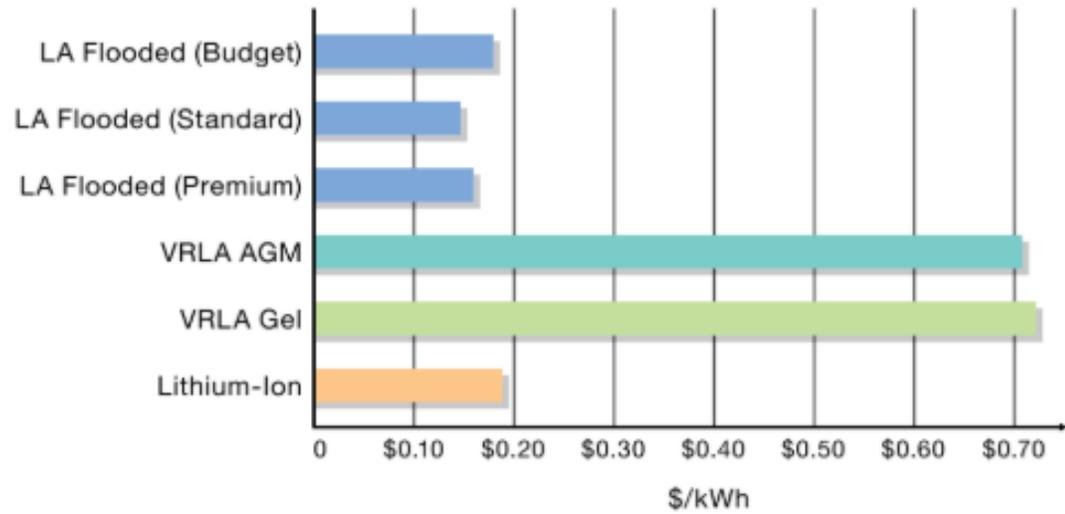
Temp 20° C/Charge Rate C0.2/Discharge Rate C0.2/Lead Acid battery gets 13.5 hour Charge

INITIAL VS LIFECYCLE COST

INITIAL COST PER BATTERY CAPACITY



TOTAL LIFECYCLE COST



REFERENCES

- <https://learn.adafruit.com/all-about-batteries>
- <https://www.epectec.com/batteries/cell-comparison.html>
- <http://batteryfaq.org/>
- <https://batteryuniversity.com/>
- <https://offgridham.com/>
- <https://ca.renogy.com/>
- <https://www.bioennopower.com/>
- <https://www.wikipedia.org/>
- <https://www.goalzero.com/>

QUESTIONS





CONTACT INFO

- jp.ouellette1@gmail.com