TRIATHLON®

INTELLIGENT BATTERIES

Scott Jensen – Regional Director

MORE flexible

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Ah vs kWh

Triathlon Lithium vs Competitors Lithium in US

BE THE EXPERT!

- **Change the conversation!**
  - **For different types of batteries, Amp Hour Comparisons are less useful**
    - **Measurement of energy storage capacity only**
    - **No consideration of voltage (force at which the energy flows)**
  - **Watt Hour / Kilowatt Hour Comparisons are more useful**
    - **Includes measurement of energy usage or work**
    - **Both amperage (flow) and voltage (force) are considered**

→ **Actual Usable Battery Capacity**

CAPACITY FOR WORK

Voltage (V) x Amp Hour (Ah) = Watt Hour (Wh)

Watt Hour (Wh) / 1000 = Kilowatt Hour (kWh)

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(V x Ah = Wh)/1,000 = kWh

- Find the kWh for Lead Acid batteries:
  - V -- #cells x 1.93V (avg discharge voltage of a lead acid cell)
  - Ah -- Ah of battery x 80% (Depth of Discharge)
  - Wh (Watt hour) -- V x Ah
  - kWh -- Wh / 1,000
- 18-125-13 kWh conversion:
  - V -- 18 x 1.93V = 34.74V
  - Ah -- 750 x .8 = 600Ah
  - Wh – 34.74V x 600Ah = 20,844 Wh
  - kWh – 20,844 / 1,000 = 20.84 kWh

(18 cells x 1.93V) x (750Ah x 80%) =
20,844 Wh / 1,000 = **20.84 kWh**

kWh is Key for Energy Comparisons

- kWh is the actual energy contained in the battery
- Triathlon's Lithium-Ion will closely meet the kWh requirement of the lead acid comparable
- Paired with true fast charge = a very powerful system!

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18-125-13 (36V 750Ah)

- V -- 18 x 1.93V = 34.74V
- Ah -- 750 x .8 = 600Ah
- Wh – 34.74V x 600Ah = 20,844 Wh
- kWh – 20,844 / 1,000 = 20.84 kWh

(18 cells x 1.93V) x (750Ah x 80%) =

20,844 Wh / 1,000 = **20.84 kWh**

24-125-13 (48V 750Ah)

- V -- 24x 1.93V = 46.32V
- Ah -- 750 x .8 = 600Ah
- Wh – 46.32V x 600Ah = 27,792 Wh
- kWh – 27,792 / 1,000 = 27.79 kWh

(24 cells x 1.93V) x (750Ah x 80%) =

27,792 Wh / 1,000 = **27.79 kWh**

- **Amp Hours don't tell the full story!**
  - **Voltage must have consideration**

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Amp Hour vs Kilowatt Hour – 36V vs 48V

- 18-90-19 (36V 810Ah)
  - V -- 18 x 1.93V = 34.74V
  - Ah -- 810 x .8 = 648Ah
  - Wh -- 34.74V x 648Ah = 22,512 Wh
  - kWh -- 22,512 / 1,000 = 22.51 kWh

(18 cells x 1.93V) x (810Ah x 80%) =

22,512 Wh / 1,000 = **22.51 kWh**

- 24-90-13 (48V 540Ah)
  - V -- 24 x 1.93V = 46.32V
  - Ah -- 540 x .8 = 432Ah
  - Wh -- 46.32V x 432Ah = 20,010 Wh
  - kWh -- 20,010 / 1,000 = 20.01 kWh

(24 cells x 1.93V) x (540Ah x 80%) =

20,010 Wh / 1,000 = **20.01 kWh**

- 48V, 6 TPzS 750 (48V 750Ah)
  - V -- 24 x 1.93V = 46.32V
  - Ah -- 750 x .8 = 600Ah
  - Wh -- 46.32V x 600Ah = 27,792 Wh
  - kWh -- 27,792 / 1,000 = 27.79 kWh

(24 cells x 1.93V) x (750Ah x 80%) =

27,792 Wh / 1,000 = **27.79 kWh**

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Amp Hour vs Kilowatt Hour – 36V vs 48V

18-90-19 (36V 810Ah)

- V -- 18 x 1.93V = 34.74V
- Ah -- 810 x .8 = 648Ah
- Wh -- 34.74V x 648Ah = 22,512 Wh
- kWh -- 22,512 / 1,000 = 22.51 kWh

(18 cells x 1.93V) x (810Ah x 80%) =

22,512 Wh / 1,000 = **22.51 kWh**

24-90-13 (48V 540Ah)

- V -- 24 x 1.93V = 46.32V
- Ah -- 540 x .8 = 432Ah
- Wh -- 46.32V x 432Ah = 20,010 Wh
- kWh -- 20,010 / 1,000 = 20.01 kWh

(24 cells x 1.93V) x (540Ah x 80%) =

20,010 Wh / 1,000 = **20.01 kWh**

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36V / 520Ah System kWh Calculation

- Find the kWh for Lithium batteries:
  - V -- #cells x 3.7V (avg discharge voltage of a lithium cell)
  - Ah -- Ah of battery (100% Depth of Discharge)
  - Wh (Watt hour) -- V x Ah
  - kWh -- Wh / 1,000

- TC 5210-10 kWh conversion:
  - V -- 10 x 3.70V = 37.00V
  - Ah – 520Ah
  - Wh – 37.00V x 520Ah = 19,240 Wh
  - kWh – 19,240 / 1,000 = 19.24 kWh

10 cells x 3.7V x 520Ah =

19,240 Wh / 1,000 = **19.24 kWh**

Triathlon's Common System Voltages

- 24V system = 25.9V
- 36V system = 37.0V
- 48V system = 51.8V
- 72V system = 74.0V
- 80V system = 81.4V

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18-125-13 (36V 750Ah)

- V -- 18 x 1.93V = 34.74V
- Ah -- 750 x .8 = 600Ah
- Wh – 34.74V x 600Ah = 20,844 Wh
- kWh – 20,844 / 1,000 = 20.84 kWh

(18 cells x 1.93V) x (750Ah x 80%) =

20,844 Wh / 1,000 = **20.84 kWh**

TC 5210-10 (36V 520Ah)

- V -- 10 x 3.70V = 37.00V
- Ah – 520Ah
- Wh – 37.00V x 520Ah = 19,240 Wh
- kWh – 19,240 / 1,000 = 19.24 kWh

10 cells x 3.7V x 520Ah =

19,240 Wh / 1,000 = **19.24 kWh**

➢ **THE POWER OF LITHIUM!**

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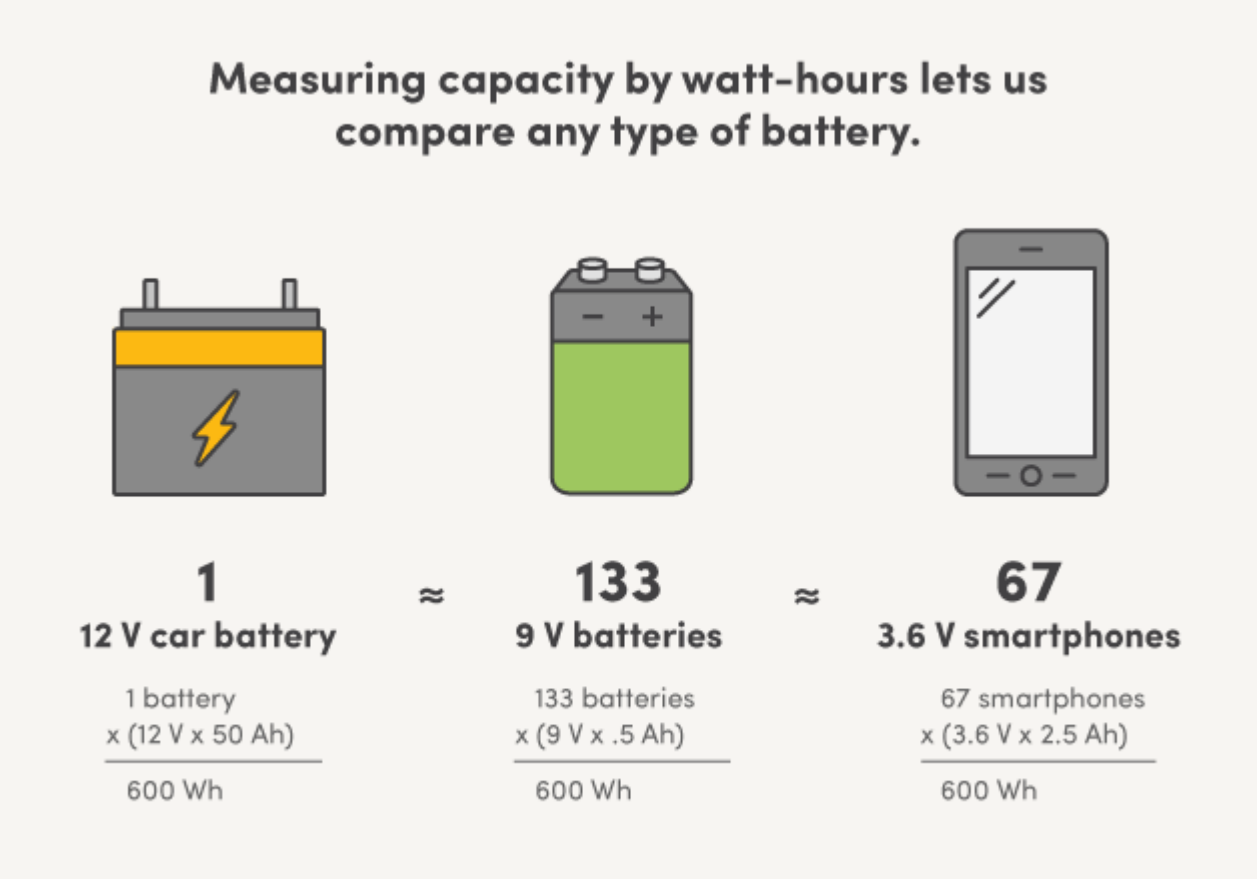
Triathlon Lithium vs Competitors Lithium in US



https://cdn.thewirecutter.com/wp-content/uploads/2017/10/Wattsinaname-Graphic-630.png

Watt Hours / Kilowatt Hours

- Allows us to compare all types of batteries accurately
- Provides consideration for both amperage (flow) and voltage (force)
- Allows us to know actual usable battery capacity
- Helps us understand how much “work” we will get from batteries

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Triathlon Lithium vs Competitors Lithium in US

	Lead-Acid	LiFePO4	NMC
Capacity @ C5	375Ah	240Ah	260Ah
Average Cell Voltage	1.93V	3.20V	3.70V
Number of Cells	12	8	7
DOD	80%	100%	100%
Energy Content in kWh	6.95kWh	6.14kWh	6.73kWh

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Triathlon Lithium vs Competitors Lithium in US

Discharge Rates	Lead-Acid	LiFePO4	NMC
Capacity @ C5	375	240	260
Capacity @ C4	345	240	260
Capacity @ C3	319	240	260
Capacity @ C2	266	240	260
Capacity @ C1	210	240	260

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Triathlon Lithium vs Competitors Lithium in US

Nominal Capacity at Temperature	Lead-Acid	LiFePO4	NMC
104° F / 40° C	103%	102%	104%
86° F / 30° C	100%	101%	101%
68° F / 20° C	96%	100%	100%
50° F / 10° C	90%	97%	98%
32° F / 0° C	82%	90%	92%
14° F / -10° C	70%	81%	86%
-4° F / -20° C	52%	69%	73%

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BE THE EXPERT!

Comparing Ah Doesn't Work!

Triathlon's Lithium-Ion System provides a much greater overall value!

- Higher Voltage per Cell
- Fewer Modules with equivalent Power
- Greater Energy (kWh) per Battery

- Potential Cost Savings

80V 4 TPzS 620 Comparison (38.29 kWh)

- Competitor Lithium-Ion battery: 80V /**526Ah** / **35 kWh**

- Triathlon's Lithium-Ion battery: 80V / **416Ah** / **34 kWh** (Triathlon's next Ah rating is 468Ah / 38kWh)

- Batteries differ by 110Ah
- Batteries differ by only 1 kWh!

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BE THE EXPERT!

- **It's all about Fast Charging!**
  - Triathlon's Lithium Ion battery can charge 4-5 times faster than that of a lead acid battery (0-100% SOC)
  - 1-2 hour recharge vs 8 hour recharge lead acid
- **It's all about Productivity!**
  - Lithium-Ion has a higher and flatter voltage curve
  - High voltage is maintained throughout the discharge cycle

➢1 Triathlon Lithium-Ion Battery = up to 3 Lead-Acid Batteries!!!

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