The Perfect Electric Power setup

Calculating an electric power system using a battery-first method

I take no credit for this process, just for organizing it into this format, and in developing an auto-calculating worksheet in Microsoft Excel, which I am happy to share with anyone wanting it. The process comes directly from the November 2011 ***All Things That Fly*** podcast; episode #207 (http://allthingsthatfly.com/Archive.php?year=2011&month=Nov) which features Lucian Miller describing "The Perfect Electric Setup".
Not familiar with Lucian Miller? Check his background at http://allthingsthatfly.com/About.php.

This process has proven to be effective and efficient; however some argue that the first component to be chosen should be the propeller; but I've found that to be a more complicated approach. When I find an easy way to make those calculations, I'll reconsider my methodology, but for now, I'll continue using and sharing this proven method to developing **"The Perfect Electric System"**.

Feel free to contact me if you have questions, or need assistance running through the process.

Now, get out a piece of paper (or contact me for the auto-calculating worksheet) and let's work through the process.

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Step 1: Determine your models weight.

For this process, convert weight to pounds.

-If you're working on a new model (kit, ARF, or RTF), you may only have the manufactures expected or estimated finished weight. In most instances this will be adequate for our use, but you'll need to consider any major changes to the construction or added features you plan to add.

-If you're converting an existing model (converting from glow, gas or other electric system) you can use your current flying weight, while also considering any major changes in design or equipment.

-In glow to electric conversions, it is common for the new electric power system to be slightly lighter than the glow or gas powered version was. Take this into account, as changes to the airframe, or use of a heavier battery, or slight shift in motor placement are all means of easily avoiding a tail-heavy situation.

Example: Let's say we have a 4-pound airplane.

Step 2: Determine the models flying style.

You can determine the power requirements of a model based on the "Input Watts Per Pound" guidelines found below.

• 60-70 watts per pound; Minimum level of power for decent performance, good for lightly loaded slow flyer and park flyer models
• 70-90 watts per pound; Trainer and slow flying scale models
• 90-110 watts per pound; Sport aerobatic and fast flying scale models
• 110-130 watts per pound; Advanced aerobatic and high-speed models
• 130-150 watts per pound; Lightly loaded 3D models and ducted fans
• 150-200+ watts per pound; Unlimited performance 3D models

Example: Let's use 100 watts per pound, so our example is now: 4 lbs. x 100 watts = 400 total watts

Step 3: Divide the total desired watts by battery voltage to determine necessary amps.

Watts / Voltage = Amps

In this step, we compare the efficiency of various sized battery packs (3S vs. 4S, etc.).

Example: 400 watts / 11.1 volts (3S) = 36 amps
400 watts / 14.8 volts (4S) = 27 amps
400 watts / 22.2 volts (6S) = 18 amps

Step 4: Determine the Voltage to /Currant ratio by dividing the given Amp by the Voltage.

Amps / Voltage = V/C Ratio

The lower the Voltage/Currant ratio the better, and should be below 5, with 1 being ideal

Examples:	400w / 11.1v = 36 amps	36 amps / 11.1 volts = 3.2 : 1 v/c ratio
	400w / 14.8v = 27 amps	27 amps / 14.8 volts = 1.8 : 1 v/c ratio

In the example, while a 4S battery would be more efficient, the 3S v/c ratio is well within acceptable limits. For the sake of weight, let's choose the 3S configuration, thus 36 amps.

NOTE: You will repeat steps 5-7 several times; as you recalculate the formula for various battery capacities until you reach your acceptable flight times.

Step 5: Determine the battery discharge rate (C-rating).

Divide the desired Amps by the battery pack capacity, expressed in Amps (A).

Required amps / Capacity (A) = C-discharge rate

Example: 36 amps / 2.2 (2,200mAh) = 16.36 C
36amps / 5 (5,000mAh) = 7.2 C

Step 6: Determine Max. full throttle flying time.

In this step, we determine the maximum length of time the power system will run, given the previously determined values. To do this, we divide 60 minutes by the previously determined discharge rate.

60min / C-discharge rate = Max. full power time

Example: 60 min / 16.3 C = 3.6 minutes
60min / 7.2 C = 8.3 minutes

In this we see that a 2.2 amp (2,200mAh) battery will be fully depleted in 3.6 minutes,
A 5 amp (5,000mAh) battery will be fully depleted in 8.3 minutes.

Step 7: Apply the 80% rule.

In step 6, we determined the maximum length of time the system can run; however this will fully deplete and destroy the battery, so we apply the 80% rule, so as to not use more than 80% of the battery's capacity and avoid damage.

Example: 3.6 minutes x 0.8 = 2.8 minutes
8.3 minutes x 0.8 = 6.6 minutes.

Now we know how long we can safely run at full throttle without damaging the battery. Any amount of flying using lower throttle settings simply increases this "safe" flying time.

Step 8: Review the data.

So what does this process give us? Let's review the listed example, step by step;

Step 1:	4-pound airplane
Step 2:	400 watts of power
Steps 3-4:	36 amps of current
Step 5:	3,000mAh battery
Steps 6-7:	6.6 minutes safe full-throttle flying time.

Step 9: Put the numbers into action

Motor:	Look for a motor rated for 400+ watts, 12 volts and 36+ amps. Also consider prop clearance, and use manufacturer's listings for applicable sized props.
ESC:	Look for a 40 amp or greater ESC.
Battery:	3S 5,000mAh will provide 6.6 minutes of safe, full throttle flying time.

This is currently the best and easiest means of developing an electric power system I've found, and it's been quite useful and successful in the new-builds and glow-to-electric conversion I've done or helped with.
But I'm always looking for a better way, so let me know if you find it.