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GAS VS BATTERY POWERED MAINTENANCE TOOLS ON THE UNIVERSITY OF ARKANSAS CAMPUS



UNIVERSITY OF
ARKANSAS
Office for Sustainability

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UNIVERSITY OF ARKANSAS || Office for Sustainability

Purpose

The University of Arkansas (UA) has made a commitment to becoming carbon neutral by 2040. To meet this goal, the UA is systematically identifying opportunities to cost effectively reduce scope 1, 2, and 3 emissions. This doesn't mean that changing the way things are done is the purpose, it's to determine if there's a better method available. After reviewing the current equipment that are grounds crew utilize, we've determined that they're not only more expensive and have higher emissions but they are bad for the health of students, faculty, and staff on campus. The Office for Sustainability has done a review of the current 2-stroke engines used by our grounds crew, against battery powered alternatives.

Comparison

The Office for Sustainability compared the current model of leaf blower (Stihl 450 BR), as well as the current trimmer (Stihl 111 FSA R). For the battery powered grounds equipment we chose a Stihl BGA 85, and HUSQVARNA 436LiB battery powered leaf blowers, as for the trimmers we used the Stihl FSA 85 and HUSQVARNA 536LiX (HUSQVARNA, STIHLUSA). The Stihl equipment is powered by an AP 300 Stihl Lithium-Ion Battery, which maintains a varying charge time depending on which equipment it is used with. The comparison is primarily to determine the capital, environmental, and societal benefits to our campus. To better find this we compared the two energy sources for each category using carbon emissions (equivalents), monetary value, and energy consumption. At the time of comparison, the 2-stroke Engine grounds equipment used an Ethanol blend (E10) that is mixed into the fuel, which is the source of its primary pollutants.

Trimmers	<i>Stihl FSA 111 R</i>	<i>Stihl FSA 90 w/ AP300 Battery</i>	<i>Husqvarna 536LiLx</i>
<i>Power source</i>	Gas	Battery	Battery
<i>Service Life</i>	5	5	5
<i>Annual Cost</i>	\$300	\$129	\$133
<i>Annual Carbon</i>	642 Lbs.	242 Lbs.	220 Lbs.

Leaf Blowers	<i>Stihl BR 450</i>	<i>Stihl BGA 100 w/ AP300 Battery</i>	<i>Husqvarna 436LiB w/ BLi150x</i>
<i>Power source</i>	Gas	Battery	Battery
<i>Service Life</i>	5	5	5
<i>Annual Cost</i>	\$329	\$139	\$120
<i>Annual Carbon</i>	641 Lbs.	176 Lbs.	176 Lbs.

Information pulled from Tables 2 & 3

Trimmers

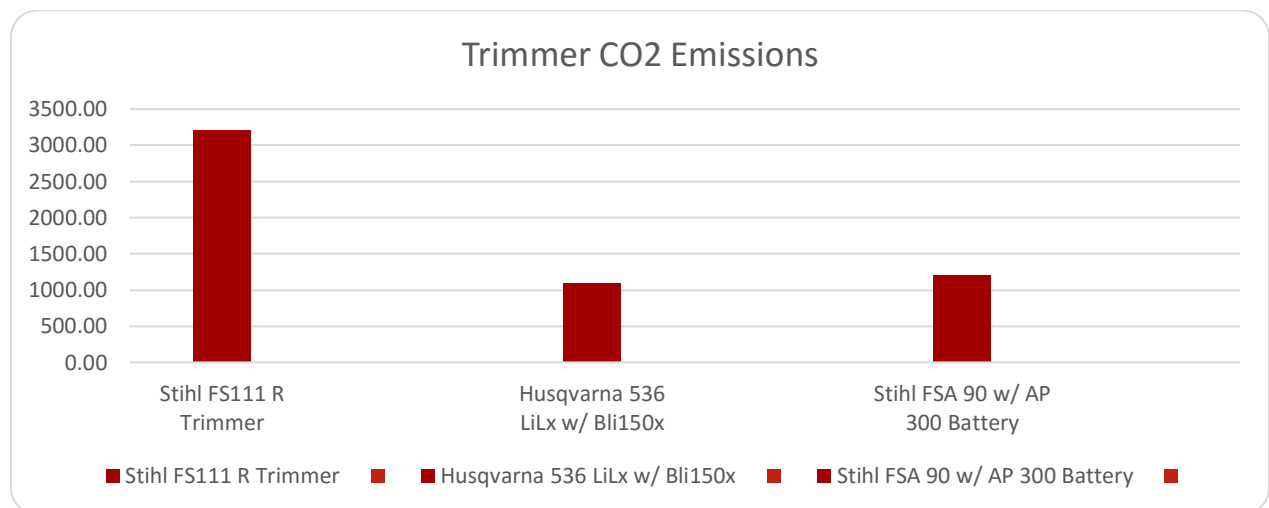
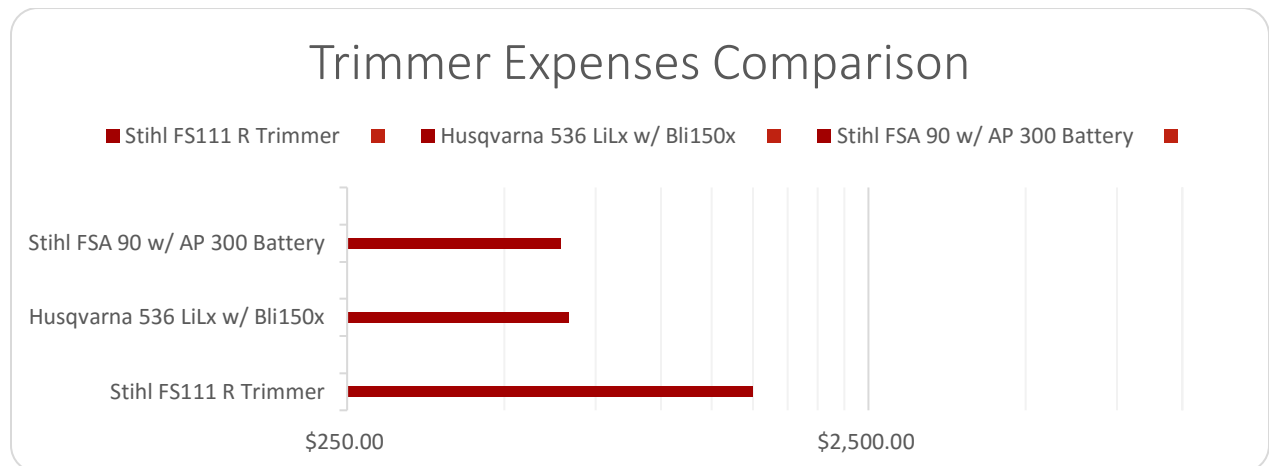
During analysis of the trimmers, there was an assumed 5-year service life along with using the current Arkansas averages for gas prices and energy. Using the June 2017 regional gas price we determined the amount of money it takes to power a 2-stroke Trimmer over its life against a cleaner battery powered version. In Table 1 you will see that the amount of money it takes to operate the fuel powered trimmer, as well as the CO₂ emission far exceed that of the Battery powered version. As of 6/20/2017 the current rates for fuel were at \$2.04, and the current rate for energy consumption is \$0.09 per kilo-watt hour (Administration, U. E. 2017). Which was used to help determine the reasoning behind why the 2-stroke engine emits more carbon then the battery powered version. Due to the E10 blend associated with operating the trimmer, and there being little to no regulations on their exhaust, the blend emits very dense emissions when compared with automobile exhaust. This E10 blend can be up to

200 times more polluting than the emissions of a car, and is therefore 200 times worse for the staff who breathe it. To ensure the accuracy of our calculations we used the hours, and locations of the grounds crew throughout campus to see if the usage of these machines were being used at times that would increase the maximum amount of people exposed. As for the battery powered versions of the trimmers, they don't directly emit any carbon however through the charging of its battery the power plant will emit carbon instead. To determine the proper amount of carbon emitted we used a study conducted by Environmental Protection Agency that covered the National Lawn and Garden Equipment emissions (Jamie L. Banks, P.M.). To be accurate we calculated the amount of emissions coming from the UA into the environment for each battery charge using the regions current emissions rate generated by power plants.

To further the investigation into the choice of battery over fuel powered trimmers, the need of knowing whether the battery powered trimmers can be sufficient enough to even pay themselves off. To figure this out a Return on Investment was calculated for each battery trimmer in relation to the Stihl trimmer currently being used. For the Stihl battery trimmer, it was found that the savings generated by switching to the battery powered version will completely cover the entire capital cost in 2.7 years after purchase. As for the HUSQVARNA battery trimmers ROI, it was found to be 2.4 years after the initial purchase. The capital benefits of switching to battery powered trimmers far outweighs the usage of the fuel powered versions, and will eventually save the university enough to replace the battery powered versions at their earliest expected end of use.

Table 2: Comparison of trimmer profiles and performance (5-year service life).

Model	Stihl FSA 111 R	Stihl FSA 90 w/ AP300 Battery	Husqvarna 536 LiLx
Power source	Gas	Battery	Battery
Estimated life	5	5	5
Capital cost	\$380	\$200	\$300
O + M cost(5yr)	\$1,122	\$343	\$366
Overall cost	\$1,502	\$573	\$666
Cost per year	\$300	\$129	\$133
R.O.I.	-	2.7	2.4
Weight	11 Lbs.	10.4 Lbs.	10.7 Lbs.
Carbon emissions	3210 Lbs.	1208 Lbs.	1097 Lbs.



Trimmer Profiles



Stihl FSA 90 w/ AP 300 Battery

- Runs for 35-45 minutes with battery at max
- Battery Charges in 25 minutes
- Less expensive than Husqvarna model, yet provides more power and versatility.
- Higher emission rate than Husqvarna 536



STIHL FS 111 R

- Fuel operated, longer and stronger run time
- Exhaust emissions are many times more harmful to health than a normal car
- Currently used model; highly rated
- With changing fuel costs the potential operating costs could skyrocket



HUSQVARNA 536 LiX w/ Bli150x

- Runs for 25 minutes per charge
- Significantly cheaper than current model
- Lower CO₂ than the STIHL FSA 90
- Shorter battery life, more inconvenient

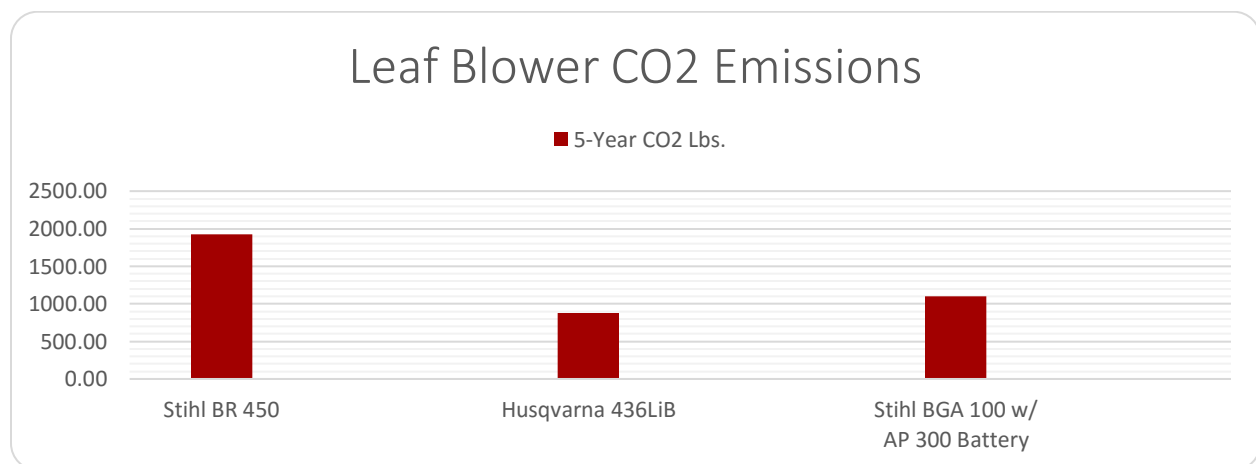
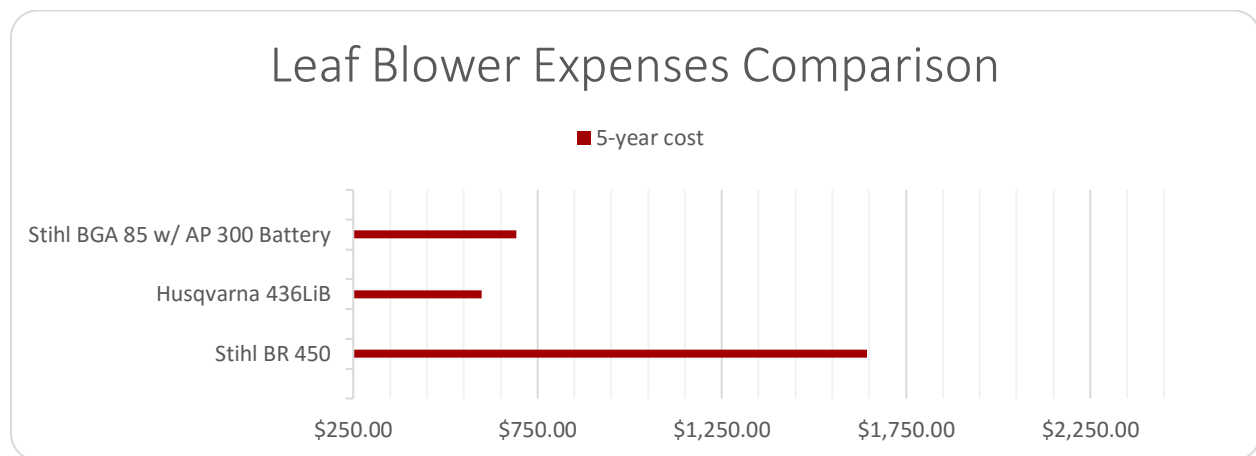
Leaf Blowers

As for the comparison of battery-powered leaf blowers to their fuel counterparts, we analyzed the current model against one from the same manufacturer. The results of the comparisons can be found in Table II seen below. If you look at the amount of gasoline it takes to fuel the leaf blower over a five-year period, letting you see how quickly the cost of refueling these can be. The amount of carbon that is emitted from the 2-stroke leaf blower is nearly double that of the carbon emitted from the charging of the battery. As for the decibels, you can see that the combustion engine makes more noise, however to make up for the loud noise it has an 80mph advantage on the battery powered models. In relation to the capital costs differences you can see where the most cost-effective model can be found. The calculations for my battery powered example include both the prices of a charger and one battery, even if you added 3 more batteries you'd still be saving money in the long run. Similar to the fuel trimmers emissions output, it has very deadly chemicals that are exhausted from the leaf blower engines. This is due to the leaf blower having both a denser and higher rate of emission. Due to the inefficiency of the 2-stroke engine you can easily see that electric Leaf blower may in fact be weaker than the 2-stroke, however it is quieter, cost-efficient, and helps combat noise pollution on campus.

To better determine if the switch to the battery powered leaf blowers was cost effective there was a Return on Investment calculated for the STIHL and HUSQVARNA models alike. The Stihl model was found to have generated enough in savings to pay off the initial capital cost in 4.7 years, which is before the earliest expected end of use. What the HUSQVARNA model lacked in power it made up for in cost effectiveness, with an ROI of 3.26 years it was significantly cheaper than the fuel powered versions. Its ROI is nearly enough to replace the leaf blower itself after it's shortest end of use.

Table 3: Comparison of leaf blower profiles and performance (5-year service life).

Model	Stihl BR 450	Stihl BGA 100 w/ AP300 Battery	Husqvarna 436LiB w/ BLi150x
Power source	Gas	Battery	Battery
Estimated life	5 yrs.	5 yrs.	5 yrs.
Capital cost	\$450	\$350	\$250
O + M(5yrs)	\$1,195	\$343	\$349
Overall cost	\$1,645	\$693	\$599
Cost per year	\$329	\$139	\$120
Decibels	77	66	81
Air Velocity	184 mph	104 mph	105 mph
Weight	23.4 Lbs.	10.8 Lbs.	8.3 Lbs.
Carbon emissions	1926 Lbs.	1098 Lbs.	878 Lbs.



Leaf Blower Profiles



STIHL BGA 100 w/ AP 300 Battery

- Less noise than alternatives
- Lower price but more emissions than alternative
- 35 minutes of run time at max output



STIHL BR 450

- Current model for the UA
- Uses a 2-stroke fuel engine
- Stronger and louder than the battery powered alternatives
- Very heavy model at 23.4 Lbs.



HUSQVARNA 436LiB w/BLi150x

- Lowest amount of CO₂ emissions
- Significantly less battery life than the BGA 100, at 24 minutes run time
- Lightest version of the leaf blower choices

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