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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 ARKNASAS || Office for Sustainability

Purpose

The University of Arkansas (U of A) has committed to become carbon neutral by 2040. To meet this goal, the U of A is identifying opportunities to cost effectively reduce scope 1, 2, and 3 emissions. To this end, the Office for Sustainability (OFS) has done a review of the current 2-stroke engines (gas) used by our grounds crew in comparison to battery powered alternatives (battery). The OFS has determined that the gas engines are more expensive and have higher emissions than their battery counterparts. Additionally, the gas engines have negative effects on the health of students, faculty, and staff on campus.

Comparison

The Office for Sustainability compared the current leaf blower (Stihl 450 BR) to the Stihl BGA 85 and HUSQVARNA 436LiB battery powered leaf blowers. The current gas-powered trimmer (Stihl 111 FSA R) was compared to the Stihl FSA 85 and HUSQVARNA 536Lilx battery powered trimmers. The comparison evaluated the monetary, environmental, and societal impacts of the tools by comparing carbon emissions equivalents (CO2e), capital investment, operational and maintenance (O+M) costs, energy consumption, and health impacts. At the time of comparison, the gas equipment used an Ethanol blend (E10) mixed with fuel.

Table 1: Summary of Comparison Results pulled from Tables 2 and 3.

Trimmers	*Stihl FSA 111 R*	*Stihl FSA 90 w/ Charger & Battery*	*Husqvarna 536LiLx w/ Charger & Battery*
Power source	Gas	Battery	Battery
Service Life (yrs.)	5	5	5
Annual cost	$328	$152	$153
Annual lb CO2e	642	242	220

Leaf Blowers	*Stihl BR 450*	*Stihl BGA 100 w/ Charger & Battery*	*Husqvarna 436LiB w/ Charger & Battery*
Power source	Gas	Battery	Battery
Service life (yrs.)	5	5	5
Annual cost	$370	$161	$153
Annual lb CO2e	641	220	176

Trimmers

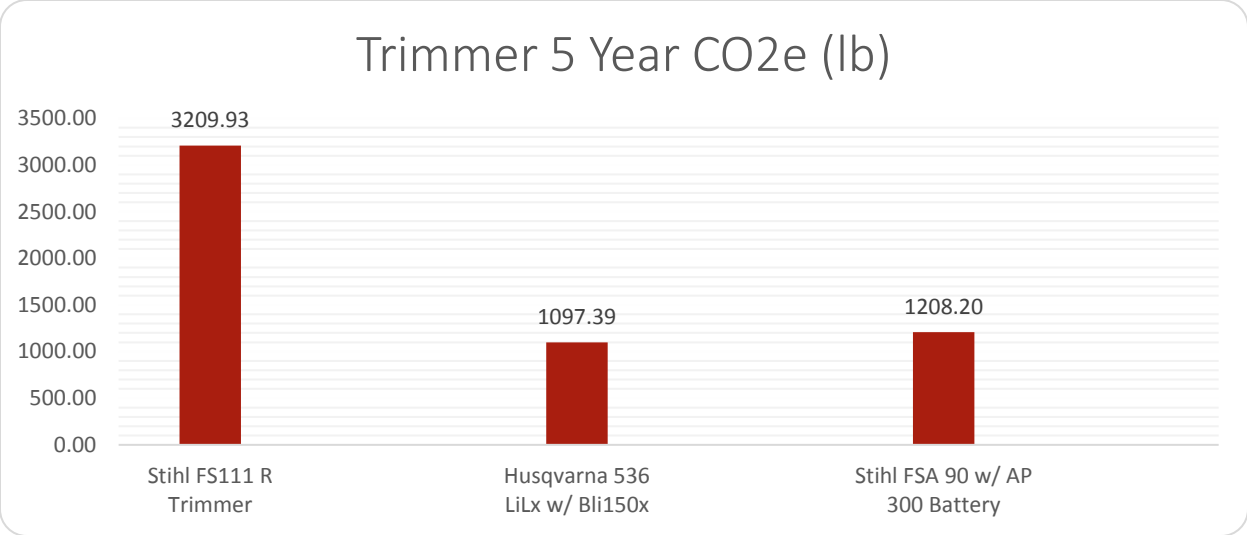
The comparison assumed a 5-year service life for the trimmers and used the June 2017 Arkansas averages for gas prices and energy. As of July 26th, 2017, gasoline was $2.04/gal (GasBuddy, 2017), and the electricity was $0.07/kWh (EIA, 2017). Table 1 shows that the annual cost and CO2e of operating the gas trimmer significantly exceed that of either battery version. The high CO2e of the gas trimmers is due to the E10 blend used as its fuel. The blend emits very dense emissions when compared with automobile exhaust, up to 200 times more polluting than the emissions of a car (Banks, 2011). This is especially concerning when one considers the health of the staff who breathe the exhaust while operating the trimmer. The times and locations of the use of the trimmers was also considered to analyze the maximum number of people exposed to the fumes. In comparison, the battery trimmers do not directly emit any CO2e when in use. Their CO2e occurs through the generation of the electricity at a

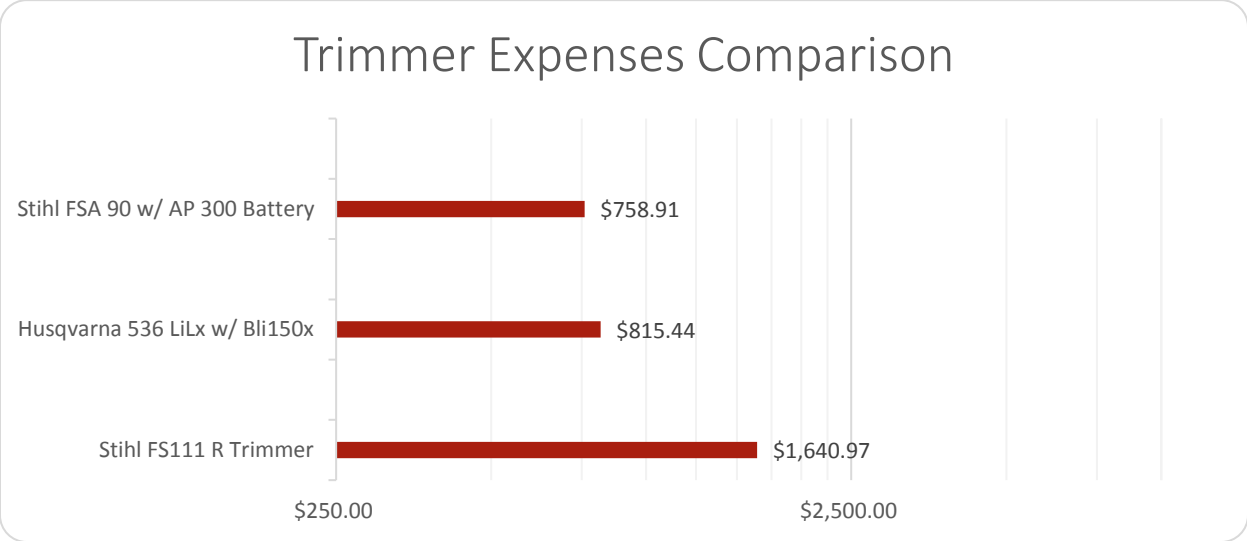
power plant which is then used to charge the battery. The CO2e was determined using a study of National Lawn and Garden Equipment emissions conducted by Environmental Protection Agency (Banks, 2011).

To analyze the economic viability of battery trimmers, a Return on Investment (ROI) was calculated for each battery trimmer in relation to the current Stihl trimmer. The ROI is essentially the amount of years it takes to recoup the capital cost of the equipment. Stihl battery trimmer was found to cover the capital cost in 2.7 years while the HUSQVARNA battery trimmer covered the capital cost 2.8 years. By the predicted 5-year end of life, the operational cost savings would be enough to cover the capital cost of replacing the battery powered tools.

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

Model	*Stihl FSA 111 R*	*Stihl FSA 90 w/ Charger & Battery*	*Husqvarna536 LiLx w/ Charger & Battery*
Power source	Gas	Battery	Battery
Estimated life (yrs.)	5	5	5
Capital cost	$380	$744	$720
O + M cost (5yrs.)	$1,261	$19	$45
Overall cost	$1,641	$763	$765
Annual cost	$328	$152	$153
ROI (yrs.)	-	2.5 – 3.0	2.6 - 2.9
Weight (lb)	11	10.4	10.7
5yr Emissions (lb CO2e)	3210	1208	1097


Trimmer 5 Year CO2e (lb)
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
3209.93
1097.39
1208.20
Stihl FS111 R Trimmer
Husqvarna 536 LiLx w/ Bli150x
Stihl FSA 90 w/ AP 300 Battery


Trimmer Expenses Comparison
Stihl FSA 90 w/ AP 300 Battery
$758.91
Husqvarna 536 LiLx w/ Bli150x
$815.44
Stihl FS111 R Trimmer
$1,640.97
$250.00
$2,500.00

Trimmer Profiles

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
- Changing fuel prices lead to unstable operating costs

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 CO2e rate than Husqvarna 536

HUSQVARNA 536 LiLx w/ Bli150x

- Runs for 25 minutes per charge
- Significantly cheaper than current model
- Lower CO2e than the STIHL FSA 90
- Shorter battery life, less convenient

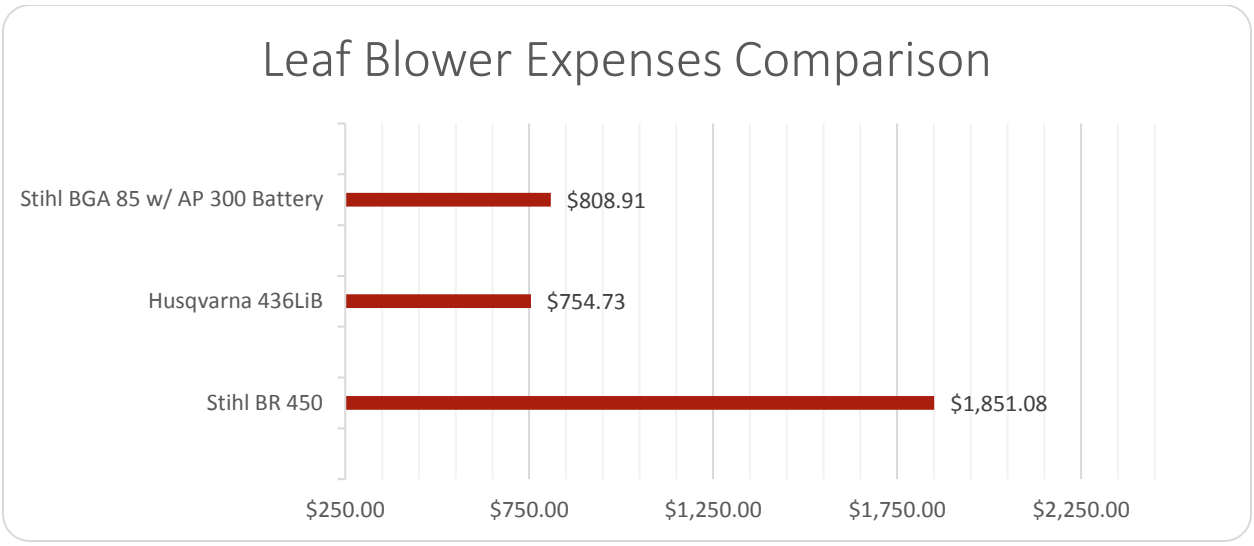
Leaf Blowers

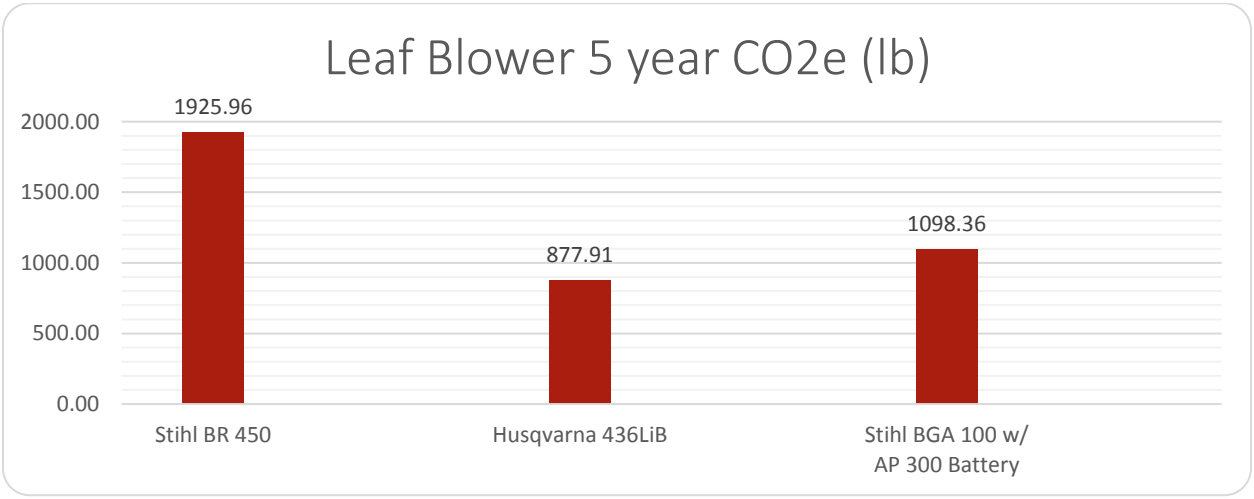
The comparison of the current gas blowers to their battery counterparts analyzed the capital and operating costs and CO2e of the different blowers, as well as the sound decibels emitted and the air velocity produced. The combustion engine of the gas blower makes more noise (77dB) than the STIHL model (56dB), but less than the HUSQVARNA (81dB). The gas blower also produces the highest air velocity, with an 80mph advantage over the battery blowers. However, this advantage in velocity comes at the cost of a high rate of CO2e emissions and a lower fuel efficiency. The CO2e emitted from the gas blower is nearly double that of the battery blowers, and has similar health concerns attached to its exhaust as the gas trimmer. Additionally, the operating cost of the gas blower is significantly higher than the battery alternatives due to the amount of fuel the gas engine requires.

To better determine the economic viability of the battery blowers, a Return on Investment was calculated for the STIHL and HUSQVARNA models. The operational cost savings of the Stihl battery trimmer was found to cover the capital cost in 2.7 years while the HUSQVARNA battery trimmer covered the capital cost 2.3 years, both before the earliest expected end-of-life.

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

Model	*Stihl BR 450*	*Stihl BGA 100 w/ Charger & Battery*	*Husqvarna 436LiB w/ Charger & Battery*
Power source	Gas	Battery	Battery
Estimated life	5 yrs.	5 yrs.	5 yrs.
Capital cost	$450	$790	$720
O + M (5yr.)	$1,401	$19	$45
Overall cost (5yr.)	$1,851	$855	$765
Annual cost	$370	$161	$153
ROI(yrs.)	-	2.7 – 3.1	2.3 – 2.9
Decibels	77	56	81
Air Velocity (mph)	184	104	105
Weight (lb)	23.4	10.8	8.3
5 yr. lb CO2e	1926	1098	878


Leaf Blower Expenses Comparison
Stihl BGA 85 w/ AP 300 Battery
$808.91
Husqvarna 436LiB
$754.73
Stihl BR 450
$1,851.08
$250.00
$750.00
$1,250.00
$1,750.00
$2,250.00


Leaf Blower 5 year CO2e (lb)
2000.00
1500.00
1000.00
500.00
0.00
1925.96
877.91
1098.36
Stihl BR 450
Husqvarna 436LiB
Stihl BGA 100 w/
AP 300 Battery

Leaf Blower Profiles

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 lb.

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

HUSQVARNA 436LiB w/BLi150x

- Lowest amount of CO_2 emissions
- Significantly less battery life than the BGA 100, at 24 minutes run time
- Lightest version of the leaf blower choices

Implementation & Evaluation

For the acquisition and purchase of the tools, the Facilities Management department will start by conducting the initial purchase of the units. After they've purchased the units, the Green Revolving Fund (GRF) will be used to provide their budget with the exact funding used for the purchase of the new units. During the projects lifecycle, and as time goes on, the saving generated between gas and electric powered units (operating costs) will be used to pay back the GRF. We've estimated, using current and regional prices, how much should be paid back into the GRF on an annual basis. The amount of gas that is being saved is 1628 Gallons per year (including E10 fuel blend), the monetary value of this return is $4,231 and will be the designated pay back amount.

To ensure that the project is done correctly, and to keep in alignment with the projects goals we will conduct a monthly survey beginning after the purchase. The monthly survey will be evaluated and the information will then be applied towards determining the efficiency of the project as a whole. Factors included in the survey are user satisfaction and observations, these will be used to determine if there are any changes that can be made to increase user satisfaction and project efficiency. The OFS plans on having a meeting with the entire grounds crew six months into the observation to help determine if the project is within bounds.

References

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Recommended Initial Fleet Upgrade

Trimmers	Unit	Trimmer with Battery	Units	9 Units w/ Battery
STIHL FSA 111	1	$743.65	9	$6,692.88

Leaf Blower	Unit	Blower with Battery	Units	7 Units w/ Battery
Stihl BGA 100	1	$789.84	7	$5,528.88
				Total
				$13,156.73

Table 1: These prices are recorded at retail price with all taxes included

Responses to concerns from the UASC Managed Systems Workgroup

What is the overall plan for this project?	This project is a pilot to see if this is a project that will work, and potentially expanded on. Data collection along with regular feedback from the Grounds Crew will allow us to better determine the impacts of our switch.
What are the plans for the old gas-powered equipment and or batteries?	The plans for the old batteries are in alignment with the Universities recycling policy, old batteries will be taken to the University Bookstore for disposal/reuse. The old gas-powered equipment will be recycled in shop for use on areas surrounding campus, or potentially auctioned off.
How many charges are there for each battery?	The hold up to “80% capacity after 500 charges”.
In relation to battery-life expectancy, will the grounds crew be satisfied with the switch?	The battery-life expectancy seems short at 35 minutes, however that is 35 minutes of continuous run time. Due to the engineering behind battery powered units it is important to note that there is no idling process, unlike the gas-powered models. Gas-Powered models have more difficulty associated with start-up making it a common practice to just walk from point to point while the motor still operates.