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# Battery-Powered Chain Saw Evaluations

Cover photo—A sawyer running a battery-powered chain saw at the test bucking station in a controlled, nonforested environment.

# Battery-Operated Chain Saw Evaluations

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## Introduction

Over the past several years, battery-powered chain saws have become more commonly available. Availability, combined with rapid improvements in battery technology, have U.S. Department of Agriculture, Forest Service employees curious about the efficiency of this technology for their day-to-day work.

The Forest Service Saw Program (National Crosscut and Chain Saw Program) asked the National Technology and Development Program (NTDP) to evaluate battery-powered chain saws in order to better understand these tools. Areas of interest include cutting performance, battery performance, noise, safety, cost, maintenance, user experience, and other considerations.

There are several key points to consider regarding battery-powered chain saws:

- Sawyers should treat them in the same manner as gas-powered chain saws when it comes to use, training, safety, and personal protective equipment (PPE).
- They are quieter and vibrate less, compared to gas-powered chain saws.
- They eliminate the repetitive actions required for pull-starting a gas-powered chain saw.
- They require less maintenance than gas-powered chain saws.
- They can weigh as much, or more, than similar-sized gas-powered saws.
- They can have different temperature-related recommendations for charging, operating, and storing. For all types of battery-powered chain saws, sawyers should be familiar with the saw's manual or manuals (the battery/charging station may have a separate manual).
- They may be cost-prohibitive for all-day jobs, based on the quantity of batteries and charging requirements needed to maintain near continuous runtime, because batteries are a significant portion of the cost of a kit (a kit, in this instance, includes the powerhead, bar, chain, battery, and battery charger).
- Their battery capacity doesn't always correspond with longer runtimes.
- They are effective at cutting and easy to operate, making them a good tool for small jobs.

## Cutting Performance on a Single Battery

An NTDP project team evaluated the battery performance of seven different types of battery-powered chain saw in a controlled outdoor setting. Two Forest Service certified sawyers with more than 35 years of combined experience operated the saws. The sawyer project team conducted bucking tests on lodgepole pine logs with all seven saws. The sawyers made bucking cuts on the logs until the battery died in each saw. They made 10 bucking cuts 1 to 2 inches apart before beginning to cut logs in longer lengths (between 5 and 8 feet) until the battery died. The project team recorded the diameter at each cut location, tallied the total number of cuts, and calculated the total diameter (sum) of logs cut per saw.

In the first test (indicated by the blue bars in figure 1), the sawyers made a series of cuts 1 to 2 inches apart in larger logs that averaged 11.6 inches in diameter. For the second test (indicated by the orange bars in figure 1), the project team selected smaller logs that averaged 8.7 inches in diameter.

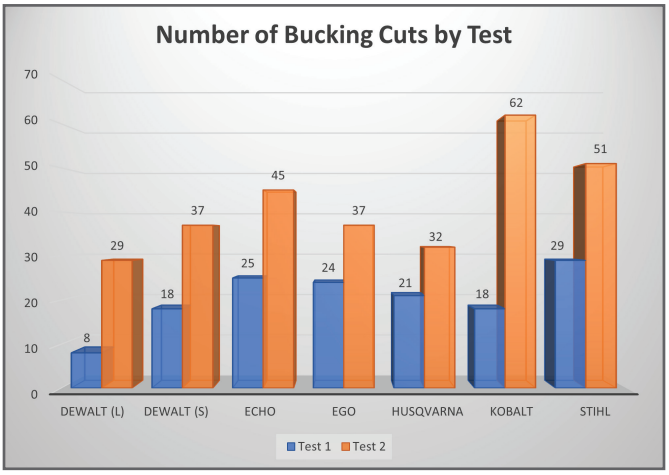


Figure 1—The diameter of the logs cut significantly impacted the total number of bucking cuts. The logs indicated in blue had an average diameter 2.9 inches wider than the logs indicated in orange.

The average log diameter between the first test (larger logs) and the second test (smaller logs) significantly impacted the total number of cuts and total diameter of logs cut per battery for all saw types tested (figures 1 and 2). The average difference in diameter between the logs in the two tests was 2.9 inches. When cutting smaller diameter logs, the average total number of cuts more than doubled, while the average total diameter of logs cut increased by 57.3 percent.

## Battery Performance—Saw Runtime While Bucking

The project team used a stopwatch to capture the total time of saw use when bucking (including non-cutting time during moves up and down the log). The team paused the stopwatch while placing new logs into cutting position and started it again when cutting continued.

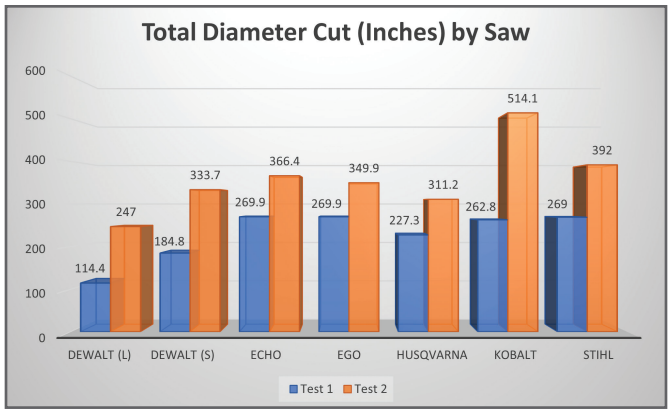


Figure 2—The total diameter of logs cut (in inches) per battery charge increased across all saws with smaller diameter logs (orange bars).

Results for saw runtime while bucking were inconsistent, but five of the seven saws ran longer during the second bucking test with smaller diameter logs (figure 3).

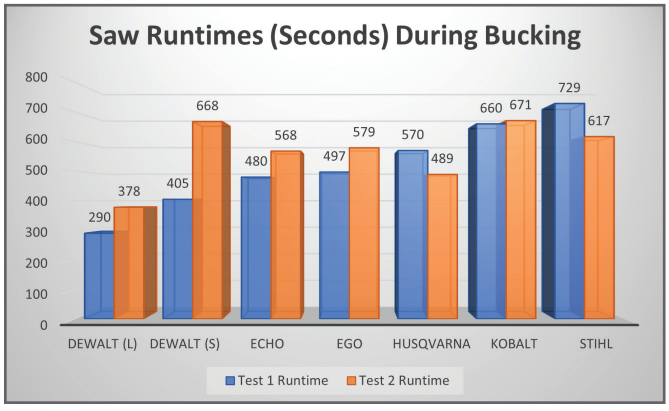


Figure 3—Saw runtimes were inconsistent, depending on the diameter of the log cut. Two out of seven saws had longer runtimes when cutting larger diameter logs (blue bars).

## Battery Performance Test—Non-Contact Runtime

To better understand how temperature affects chain saw battery performance, the project team conducted three non-contact runtime tests. They cleaned, tuned, topped off (with bar oil), and fully charged each saw before testing. They conducted the warm weather (70 °F) test indoors in a controlled environment. For cold weather testing, the project team chose to replicate a situation similar to one

where saws spend multiple days in a truck bed before use. To accomplish this, the team removed the batteries from the saws and placed them together outside under cover (figure 4) to expose them to natural temperature cycles before running them (48 hours for the 37 °F test and 66 hours for the 19 °F test). During the acclimation period, temperatures varied above and below the testing temperatures, but the team tested the saws at exactly 37 °F and 19 °F.

Figure 4—The seven test saws secured to a table in a covered outdoor setting.

Four of the seven saws had the best non-contact runtime performance at 37 °F (figure 5). The team based the Stihl runtime result at 70 °F and 37 °F on having to shut the saw down because it ran out of bar oil and was smoking before the battery went dead. For the 19 °F test, the team used a second Stihl (same model) and the bar oil lasted until the battery went dead, but this could be related to bar oil viscosity in cold temperatures. During the bucking test, the Stihl did not run out of bar oil before the battery died, so under normal use (rather than non-contact use) this isn't a concern.

At 19 °F, the EGO and Kobalt saws would not run. Including the two saws that would not run, five of seven saws had their worst non-contact runtimes at 19 °F. For those that did run, chain speed was initially slow until the battery warmed due to energy consumption and the saw warmed through friction. This chain speed lag lasted less than 1 minute for each of the saws.

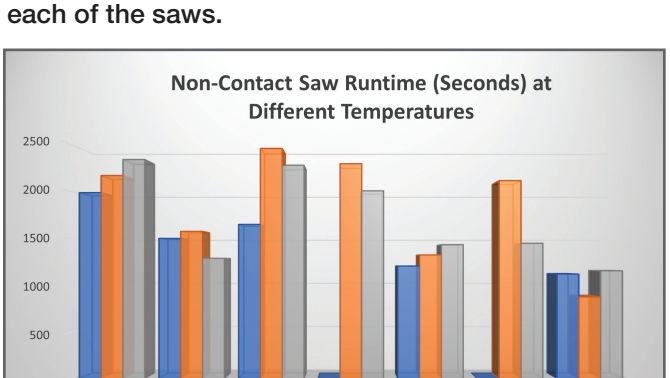


Figure 5—Graph displaying non-contact runtimes across test temperatures of 19 °F, 37 °F, and 70 °F. The coldest temperatures negatively impacted five of seven test saws, with two saws not running at all.

## Noise

The project team measured both no-contact (figure 6) and cutting-contact (figure 7) sound levels in a weighted decibel (dBA) that is an expression of the relative loudness of sounds as perceived by the human ear. The team measured sound levels for the seven test saws and compared them to those of a similarly sized gas-powered chain saw (a Homelite 240). All seven battery-powered saws were quieter than the gas-powered saw while running without contact. The battery-powered chain saws produced less noise under contact with the logs, except in the case of the larger DeWalt (L) chain saw, which made more noise under contact. The gas-powered chain saw had the same result as the majority of the battery-powered chain saws and produced less noise while cutting. The battery-powered chain saws were between 13.1 and 16.6 dBA quieter than a gas-powered chain saw that made no contact with the logs and between 5.8 and 10.8 dBA quieter than a gas-powered chain saw that made contact.

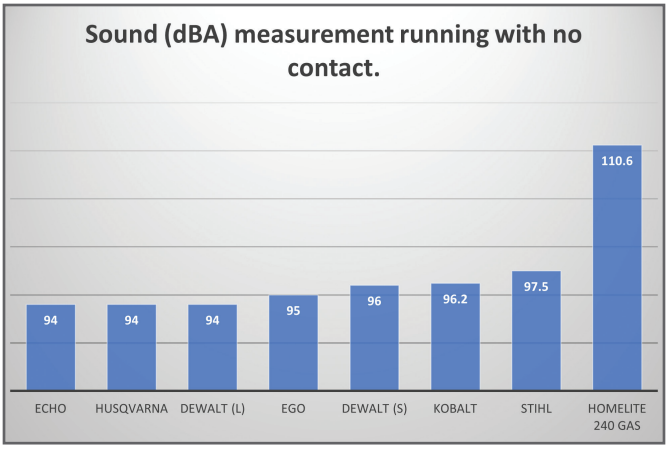


Figure 6—Battery-powered chain saws that had no contact with logs produced between 94 and 97.5 dBA of sound (dBA, a weighted decibel, is an expression of the relative loudness of sounds as perceived by the human ear). A similarly sized gas-powered chain saw was 13.1 dBA louder than the loudest battery-powered chain saw.

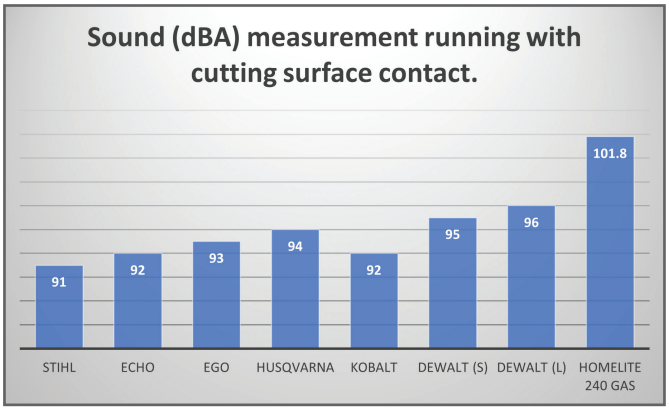


Figure 7—Sound levels generally decreased under contact with the logs. The gas-powered chain saws were 5.8 dBA louder than the loudest battery-powered chain saw.

Even though battery-powered chain saws are significantly quieter than gas-powered chain saws, they produce enough noise to cause hearing damage, so proper hearing PPE is necessary. According to the American Speech-Language-Hearing Association (ASHA), 94 dBA is considered "Extremely loud—dangerous to hearing." Using a battery-powered chain saw with no contact, the minimum noise level was 94 dBA (figure 8). Sawyers should wear hearing protection at all times when operating a battery-powered chain saw.

Figure 8—A team member capturing sound measurements while a sawyer makes a bucking cut.

## Safety

All saws tested had a chain brake, chain stop, and interlocking trigger safety mechanism. These specifications were the minimum required by the Forest Service National Saw Program manager. The project team researched battery-powered chain saw safety standards because safety features vary significantly from one saw to another.

The team reached out to several battery-powered chain saw vendors to inquire about the status of a specific American National Standards Institute (ANSI) standard for battery-powered chain saws and consistently received the answer that there is no ANSI standard for battery-powered chain saws. A representative from the Outdoor Power Equipment Institute stated Underwriters Laboratories (UL) "has published the 'national adoption' of the International Electrotechnical Commission (IEC) standard 62841-4-1 for electric chain saws." The saws we tested with a UL certification include both DeWalt saws (large and small sizes), the Husqvarna, and the Echo. The Stihl and EGO have a Canadian Standards Association (CSA) certification and the Kobalt has a Societe Generale de Surveillance S.A. (SGS) certification. UL, CSA, and SGS are all currently listed in the

Occupational Safety and Health Administration's (OSHA) approved Nationally Recognized Testing Laboratory Program (NTRL).

If the Forest Service National Saw Program chooses to accept the use of battery-powered chain saws, they need to determine which safety standard certifications are acceptable or required. The PPE standards required to operate a battery-powered chain saw would be the same as those for operating a gas-powered chain saw. PPE for sawyers includes approved head protection, eye protection, hearing protection, long-sleeved shirts, gloves, pants, leg protection, and boots.

## Cost

The project team sourced saw kits from a variety of vendors. A kit, in this instance, includes the powerhead, bar, chain, battery, and battery charger. Depending on the brand and vendor, the saw may not be sold as a full kit and certain components may need to be purchased separately.

Kits in this evaluation cost between $299 and $1088. An additional battery costs between $159 and $310, depending on the make and model of the chain saw.

## Maintenance

Maintaining or tuning a battery-powered chain saw is easier than maintaining or tuning a gas-powered chain saw. A battery-powered chain saw doesn't require mixed fuel to stabilize the fuel for storage and doesn't have a carburetor that must be tuned. Saw cleaning, chain sharpening, and bar oil needs are generally the same.

## Chain Sharpening

Battery-powered chain saws are not unique when it comes to sharpening the chain. Six out of the seven saws we tested had a ⅜-inch chain pitch and required a 5.2 millimeter (mm) round file. The Husqvarna saw we tested had a 0.325-inch pitch and required a 4.8 mm round file. Sharpening techniques are the same for all saws.

### *Bar Oil Flow Adjustment*

Gas-powered chain saws can commonly adjust the flow rate of bar oil. Only one of the battery-powered chain saws we tested (the Husqvarna) had the option to adjust bar oil flow rates. In instances where the battery-powered Stihl saw was running out of bar oil and smoking before the battery fully depleted, it would have been useful to adjust (decrease) the bar oil flow rate for that specific test, and possibly during the hottest working days.

### *Chain Tensioning*

Three of the seven saws tested had a chain quick-tension dial (figure 9). This feature eliminates the need to loosen the bar nuts with a bar tool (screwdriver/wrench combination).

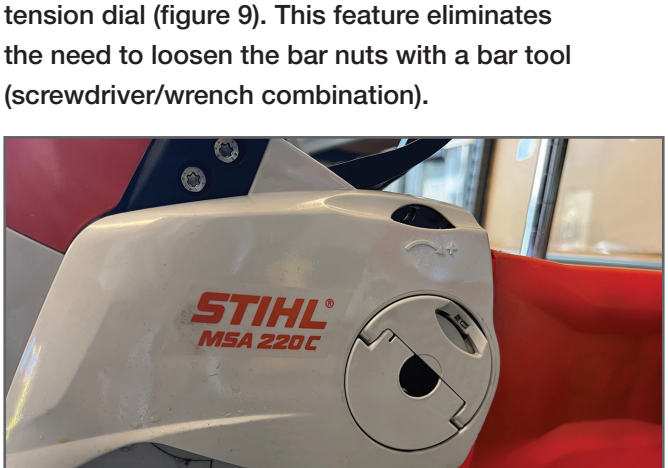


Figure 9—A chain quick-tension dial found on three of the seven saws tested.

## User Experience

After the battery died on each saw during the bucking tests, the project team interviewed the sawyer team for feedback about cutting ability, weight, balance, vibration, noise, and additional thoughts. The paragraphs below describe the results of the interviews.

In response to the statement "this battery-powered saw cuts just like the comparable gas-powered chain saw," both sawyers responded "mostly false" 100 percent of the time. These responses most likely resulted from the fact that chain speeds are slower (approximately 3,960 feet per minute) on battery-powered chain saws when compared with gas-powered chain saws (approximately 5,280 feet per minute). The sawyers interviewed typically use "professional" chain saws with large powerheads and more aggressive chains.

In response to the statement "this saw's weight is reasonable for its abilities," both sawyers responded "mostly true" 100 percent of the time. Regarding the statement "this saw is balanced and easy to handle," the sawyers gave 5 out of 7 test saws a "mostly true" or "true" rating, while they rated two saws "mostly false" because they were "tail heavy."

Both sawyers consistently rated battery-powered chain saw vibration as being "far less" when compared with a similarly sized gas-powered chain saw.

The sawyers were also consistent in their response to the statement "this saw was noticeably quieter when cutting compared to a gas-powered chain saw," selecting either "mostly true" or "true" for all seven test saws.

In the "Additional Comments" section of the testing feedback form, the sawyers stated that they liked the chain quick-tension option on the three saws that had it.

Trigger design feedback varied from "design and response is very good and feathering is possible" to "trigger design requires repositioning of the thumb and is difficult with gloves on."

Saw durability was "maybe" across the board because of the limited amount of use. Additionally, because the tests conducted required no transportation, we do not know how durable these saws are. We also don't know how many times each battery can cycle before performance decreases.

## Other Considerations

For continuous use of a battery-powered chain saw without line power or gasoline (generator) needs, we evaluated battery charge possibilities using a Jackery Explorer 500-ampere-hour (Ah) portable power station and a Jackery 100-watt (W) solar panel to charge the 80-volt (V) 5.9 Ah Kobalt saw battery. The power station cost $500 and the panel cost $200.

On a sunny day, we connected the solar panel and the Kobalt charger to a fully charged power station. We then placed a fully depleted Kobalt 80 V 5.9 Ah battery on the charger. The charge time took 46 minutes and the power station dropped from 100 percent to 62 percent.

Assuming some recharge of the Jackery solar power station during saw use, this example would provide for four full Kobalt battery cycles (about 45 minutes of saw use) based on our data. This equates to 72 11.6-inch cuts and 248 8.7-inch cuts. Without an additional battery or batteries, there would be lag time waiting for a single battery to recharge.

## Conclusion

Battery-powered chain saws are a useful tool for specific cases. They are not currently a good solution in work situations that require saws to run for prolonged periods of time. They require very little knowledge about maintenance or time to maintain. Temperature affects battery-powered saw performance, and sawyers should consider a battery maintenance plan, especially in colder climates.

Battery-powered chain saws generate less noise and vibration when compared with their gas-powered counterparts, but sawyers should handle them with the same safety precautions as a gas-powered chain saw and should wear the same approved PPE.

## About the Authors

**Damien Hoffman** joined the National Technology and Development Program (NTDP) in 2004 as a student at the University of Montana. He graduated in 2006 with a bachelor's degree in wildlife biology. He also has a bachelor's degree in sociology from the University of Minnesota-Morris. Hoffman has been a project manager for NTDP since 2011.

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## Library Card

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**Keywords:** batteries, battery, bucking, chain saw, chainsaw, charger, cutting, logging, safety at work, trees

## About NTDP

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