

WALKING THE GREEN WALK



THE SUSTAINABILITY FACT BOOK

CREATED BY THE CROWN BATTERY MANUFACTURING COMPANY FOR ENVIRONMENTALLY CONSCIOUS
STAKEHOLDERS AND ADVOCATES FOR A CLEANER WORLD.

sustainability

[suh-stey-nuh-bil-i-tee]

1. the quality of not being harmful to the environment or depleting natural resources, and thereby supporting long-term ecological balance.
2. a popular word, often times inappropriately used by manufacturers claiming to make “green” products, who in reality, do not.

As a company committed to improving our world with truly sustainable initiatives, ethical processes and innovative, clean products, Crown Battery developed this fact book as we recognized the need and obligation to separate truth from myth regarding the production of battery energy storage solutions.

To begin with, no battery is completely sustainable — not even our own. But some are substantially more sustainable than others due to closed-loop manufacturing, percentage of components and total products recycled and subsequently reused, energy type powering production and more.

The culmination of in-depth, objective research, the Crown Battery Sustainability Fact Book details criteria on how your business, home or lifestyle can become more sustainable, simply depending on the battery type you choose for power and energy storage. It also defines and provides guidance on identifying “greenwashing,” a practice commonly employed by some unethical manufacturers to make them seem more sustainable than they are.

ENERGY STORAGE AND BATTERIES: Sustainable or Greenwashed?

Whether relied upon for transportation, commercial or industrial needs, energy storage has long been vital to the well-being of our economy, national defense, and ourselves. And never more so than today and into the future, as global energy storage demand has nearly tripled since 2020, with private, corporate, and municipal renewable energy storage in particular seemingly increasing unabated. But how do you know whether the batteries you choose for energy storage are green — or just “greenwashed?”



The Truth Behind Sustainability:

A battery that’s 100% sustainable doesn’t exist. But you can select a far more sustainable battery from an ethical manufacturer — one that addresses climate change head-on, actively reduces carbon emissions and other pollution, and harnesses thoughtful engineering, recycled materials, and renewable energy to build a high-performance, longer-lasting product.

The Myth Behind Greenwashing:

The perfect, 100% sustainable battery exists. It charges fast under any conditions. It discharges 90+% yet somehow maintains surge capacity and powers equipment when it’s empty. It will be fully recyclable — any day now. It’s guaranteed to last for a decade — even though its manufacturer hasn’t been around for that long. It’s carbon-neutral with zero greenhouse gasses from production — as far as users know. And it only costs three times more!



What is “greenwashing?”

According to The American Heritage Dictionary of the English Language, 5th Edition, “greenwashing is the dissemination of misleading information that conceals abuse of the environment in order to present a positive public image.”

Unethical manufacturers, including some household-name battery companies, habitually rely on greenwashed customer engagement and marketing claims that not only mislead customers, but potentially put them at risk through unsafe and unsustainable practices.

Some common claims include:

- Selling “green” batteries that are only recycled at end-of-life 5% of the time
- Touting “50% recycled material goals” while using virgin-mined materials in their current products
- Using fossil fuels to power manufacturing of renewable energy storage and electric vehicle (EV) batteries
- Declaring their batteries do not negatively impact the environment (every battery does to some degree, including ours)

SO WHAT MAKES A BATTERY HIGHLY SUSTAINABLE?

Using the facts and statistics below regarding our own products, processes and initiatives – featuring some industry-firsts – as examples, Crown Battery has established a number of sustainability benchmarks. We are proud of these achievements and would confidently compare them to those of others claiming to manufacture sustainable battery energy storage solutions.

More Recycled than an Aluminum Can



99% recycled

(Source: US EPA)

100% Renewable Energy for Manufacturing



Crown Battery is the only large-format battery manufacturer recognized as a U.S. EPA Green Power Partner

Energy-Saving Programs



Saved 56,203,806 kWh in energy avoidance from May 2013–June 2021

(Source: Regression model from AEP Ohio & CLEAResult)

Safe for Employees and End-Users



Respirators required in manufacturing



No extended thermal runaway

Closed-loop Sustainability



~80% of parts from previously recycled material

(Made using previously recycled material + recyclable again and again)

Water Conservation



51% reduction in treated water discharged from 2016 to 2020

Clean Air & Water



99.97% air & water filtration

Air and water are even cleaner when they leave the plant than when they came in

Charity & Community



Crown Battery proudly supports quality education for all, along with the Ronald McDonald House, community food banks across North America, Rotary International, and United Way.

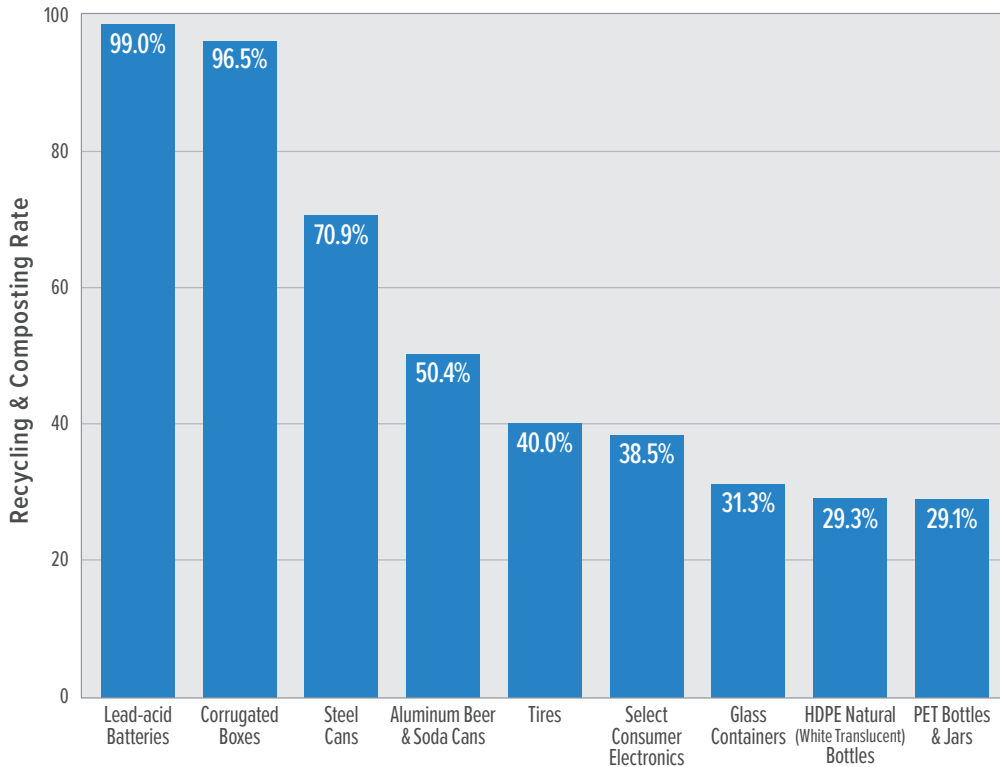
Recycling is one of the best ways to protect our environment, conserve resources and reduce our carbon footprint. Batteries vary widely in their recyclability: The most popular battery chemistry is recyclable lead-acid (flooded and maintenance-free AGM), followed by lithium-ion. Both battery chemistries have pros and cons depending on their application. But today, there's a chasm between their recycling potentials.

GREENWASHING ALERT:

All lithium-ion (Li-ion) batteries are fully recycled – and recyclable.

THE BATTERY RECYCLING GAP

Selected Products with High Recycling Rates / 2018



Does not include combustion with energy recovery.

According to the U.S. EPA¹, lead-acid batteries like Crown's are recycled 99% of the time at end of life.

And lead-acid battery content is also 99.3% recyclable, making them one of the most reclaimable products available. Spent lead-acid batteries are harvested to build new ones, with 80% of the material for new lead-acid batteries coming from previously recycled units.

BATTERY FACT:

Crown batteries are manufactured with 100% renewable energy **and** more recycled than an aluminum can² — a world-first.

¹U.S. EPA "Facts & Figures about Materials, Waste & Recycling"

²U.S. EPA "Advancing Sustainable Materials Management: 2018 Fact Sheet"

SUSTAINABILITY FACT:

Only 5% of lithium-ion batteries are currently collected for recycling, a major reason they are created from virgin raw materials.³ Presently, Li-ion batteries are approximately only 0% to 60% downcyclable (broken down to be reused for lower-value products), and at least 40% of the collected recycled material will be thrown away. Plus, valuable materials like cobalt are being phased out, further reducing recycling value.

There are three main reasons for lithium-ion's low downcycling rate:

1. Technological hurdles such as varied raw materials and complex assembly
2. Current recovery programs aren't profitable
3. There is not nationwide lithium-ion recycling infrastructure or legislation

³Chemical and Engineering News "It's time to get serious about recycling lithium-ion batteries"

Even Lithium-ion Manufacturers are Cognizant of the Sustainability Issue



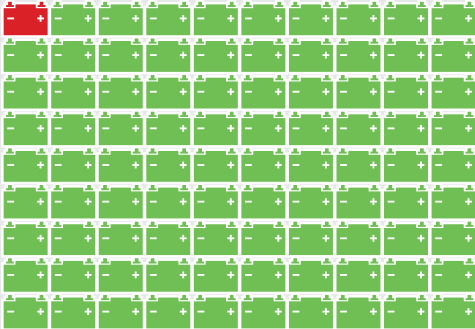
"All materials contained in a battery remain in their original form at end-of-life and the vast majority of these materials are then captured in the recycling process. Presently, only high-value elements are recycled and reintroduced into the supply chain. However, as recycling technology improves, we strive to reintroduce more and more materials back into their original commodity market. Over half of the materials in a battery cell are metals, which is great for sustainability given they are infinitely recyclable. The remaining materials are plastics, organics and other difficult-to-reuse materials. Research is underway by organizations all over the world to improve the recyclability of these remaining materials.

"Today, we work with third-party recyclers around the world to process all scrap and end-of-life batteries to recover valuable metals. Our recycling partners work with us to ensure that non-valuable or non-recoverable materials from the batteries are disposed of responsibly."

Excerpt from Tesla 2019 Impact Report, page 15

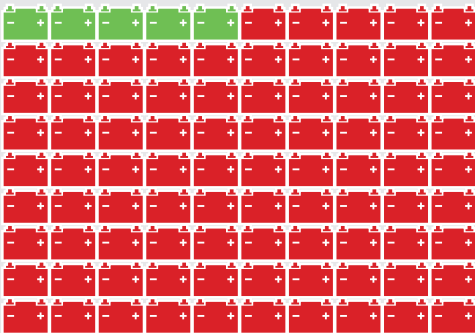
BATTERY RECYCLING COMPARISON

Lead-acid | 99% recyclable



99 out of 100 batteries already recycled

Lithium-ion | 0-60% recyclable



5 out of 100 batteries already recycled

Based on reports by the International Energy Agency and US Department of Energy.

VERIFY RECYCLING CLAIMS

If you're unsure of the accuracy of declarations made by manufacturers, Crown recommends comparing them to research conducted by the U.S. EPA, academic publications and peer-reviewed journals.

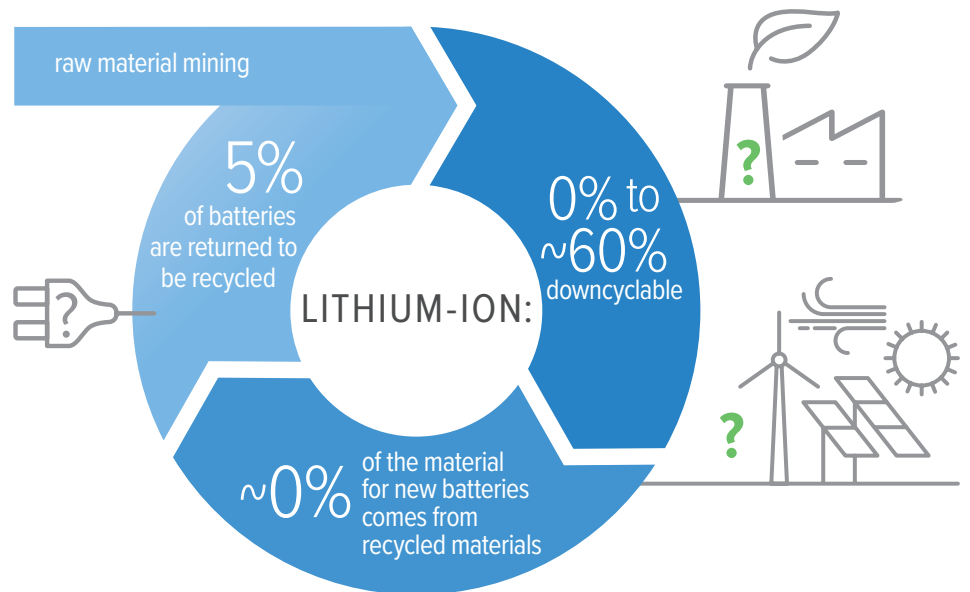
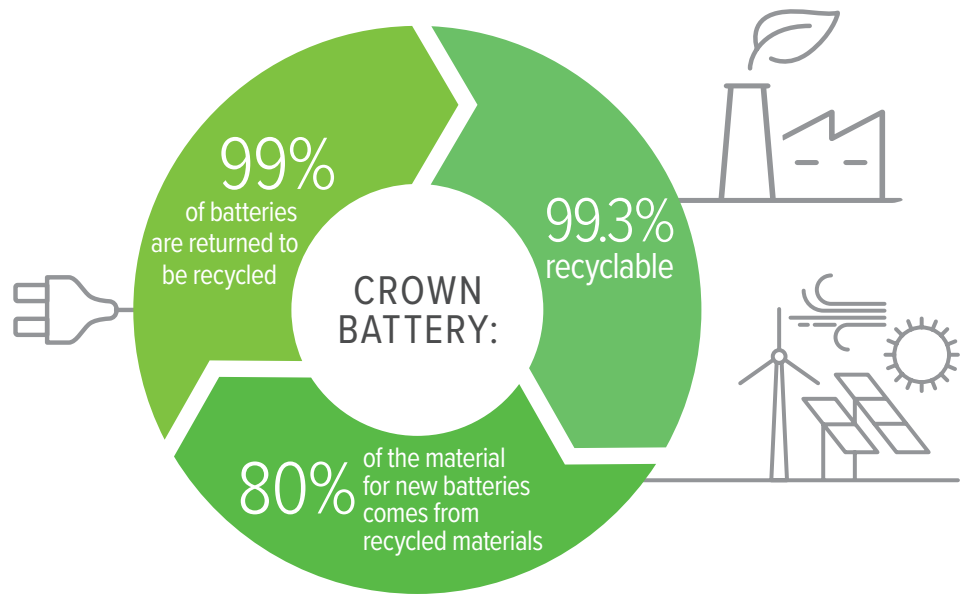
Confirmation can help keep your organization's sustainability reputation clean and objectives on track.

LIFECYCLE COMPARISON: Lead-acid vs Lithium-ion Batteries

Lead-acid batteries are considered a closed-loop manufactured product. That's because they're easy and profitable to recycle using automated processes. Raw materials are valuable. And there's a nationwide recycling infrastructure, along with government regulations and battery industry support.

"Currently, a vast recycling supply chain collects, stores, transports, recycles, and re-introduces more than 99% of lead back into the lead-acid battery supply chain."

– U.S. Department of Energy



By comparison, some emerging battery chemistries rely almost entirely on virgin mining. For instance, Li-ion lacks a national collection system; its recycling is complicated and requires skilled technicians; and virgin-mined, raw materials like lithium are up to six times cheaper than recycled materials.



SCRAP RECYCLABILITY RATIO:

Our chemistry holds an overwhelming advantage; but achieving balance for our planet is an objective that will benefit us all.

Presently, of those scrap li-ion batteries recycled, it takes approximately **28 tons to result in 1 ton of lithium ore**, with the remaining **27 tons of material landfilled**.

On the other hand, it takes **1.7 tons of end-of-life lead-acid batteries to produce 1 ton of recycled lead**, with **99% of the remaining 0.7 tons of byproduct reclaimed**, including plastic, polyethylene and sulfuric acid. **The resulting 0.007 tons, or 14 pounds, is disposed.**

GIVE OR TAKE?

Until recycling technologies, infrastructure and government regulations for lithium-ion catch up to lead-acid recycling levels, Li-ion battery users will likely need to pay for disposal, compared to the long-running user profitability of the lead-acid recycling model.

At present, government agencies and scientists are pushing hard to advance lithium-ion recycling – and eventually reach 90% recovery of “key materials” in the U.S., which is still 9.3% short of today’s lead-acid recovery rate. We strongly support all research to close the recycling gap between lead-acid and lithium-ion batteries, just like we supported lead-acid recycling from its infancy. It’s the right move for our environment, our communities, and our society.



U.S. DEPARTMENT OF ENERGY

LEARN ABOUT THIS PRIZE

Crown is a firm believer that all batteries should be recycled to the fullest measure, but some, such as lithium-ion batteries cannot, or are not. In fact, the U.S. Department of Energy even offers a prize to enterprising individuals and businesses in the hope of leveling the sustainability playing field. Competition guidelines clearly state: “This Battery Recycling Prize is NOT for lead-acid batteries as currently, a vast recycling supply chain collects, stores, transports, recycles, and re-introduces more than 99% of lead back into the lead-acid battery supply chain.”

POWERING PRODUCTIVITY:

Is a Battery Really Sustainable if the Energy Behind Its Construction Isn't?

Embodied energy is the total amount of energy needed to make a product. Despite what greenwashed messaging would have you believe, reporting from the World Economic Forum concludes that, “battery production uses a lot of energy, from the extraction of raw materials to the electricity consumed.”

BATTERY FACT:

“...battery production uses a lot of energy, from the extraction of raw materials to the electricity consumed.”

– World Economic Forum

As a major part of any battery's carbon footprint comes from its manufacture, it's important to consider the proportion of renewable to embodied energy when selecting a sustainable battery solution.

Introducing the First Battery Manufacturer that Uses 100% Renewable Electricity

Culminating a 20-year initiative that began at the turn of the millennium with the investment of on-site solar panels, wind turbines and geo-thermal cooling, in 2020, Crown Battery transitioned to 100% renewable electricity for our operations. Leveraging an integrated renewable energy program through American Electric Power (AEP) and interim renewable energy credit purchase enabled us to reach this milestone – the first battery manufacturer to do so. This significant step in minimizing our carbon footprint also gained our company recognition as a U.S. Environmental Protection Agency Green Power Partner.





Certificate of Partnership

presented to

Crown Battery Manufacturing Company

By the U.S. Environmental Protection Agency's Green Power Partnership in recognition of efforts to help reduce the negative health impacts of air emissions through the use of green power.

Matt Clouse, Branch Chief
Energy Supply and Industry Branch, Climate Protection Partnerships Division
Office of Air and Radiation, U.S. EPA

For its efficiency efforts, Crown Battery was one of just five companies to receive American Electric Power Ohio's 2020 Sustained Excellence Award. The award is earned based on significant energy efficiency involvement over consecutive years.

Crown was also awarded AEP Ohio's Continuous Energy Improvement Award in 2016, Sustained Excellence Awards for 2015 and 2014, and Large Manufacturing Energy Efficiency Champion Award for 2013.

Crown Battery is the first battery energy storage company to earn recognition as a U.S. EPA Green Power Partner.

CONSERVATION COUNTS:

Like any energy resource, just because a battery manufacturer primarily uses renewable energy doesn't mean they shouldn't save it. Thanks to operational energy reduction initiatives, third-party audits reveal Crown Battery has saved or **avoided using over 56.2 million kWh of electricity** over the past eight years – enough to power 5,109 homes.

In-house programs include installation of energy-efficient LED lighting throughout our facility, upgrading and replacing power-hungry equipment, implementing conservation awareness training, and encouraging and rewarding employees for sharing energy-saving suggestions.



"We reinvest all our energy rebates and incentives into new energy-saving equipment and programs. Because we're privately held, we can focus on long-term improvements instead of quarterly numbers."

— Bob Michael
Director of Plant Engineering
Crown Battery

SOURCING RESPONSIBLY:

Keeping Worker, Community Well-being at the Forefront.

In addition to resulting increases to sustainability and profitability, Crown Battery is proud that the investments we've made in renewable energy use and conservation helps protect and improve our workers and workplace, community, and global environment. Like every reputable manufacturer, worker safety is the top priority at Crown, and it's built into our culture, systems, facilities, and everything we do.



Without first ensuring the safety and well-being of our employees, we cannot protect the environment. And, since keeping our community safe, clean, and thriving ranks a close second, we realize every investment made in air and water quality and creating, reshoring and maintaining good paying jobs results in a strong, positive outlook for our corner of the world for years to come.

"With help from our team and AEP Energy, we've cut our carbon footprint and electric bill – all while creating jobs and building a better product. Now, we're excited to lower our carbon footprint even more. Sustainable energy management is a win-win for our environment, our company, our community, and our customers."

— Hal Hawk, CEO
Crown Battery



The following describes what safety and environmental protection look like in practice at Crown:

Extensive, career-long safety training for all employees:

- ▶ From onboarding and recurring reviews to job-specific certifications and our annual company-wide Safety Training Day.



Personal protective equipment and hygiene requirements for manufacturing employee:

- ▶ Wear P-100 negative-pressure respirators to guard against exposure to potential hazards.
- ▶ Wash hands before and after breaks, and shower before leaving the plant.
- ▶ Wear protective eyewear while working.
- ▶ Wear company-issued uniforms while working and change into street clothes before leaving.

Full-time, onsite registered nurse and wellness guidance:

- ▶ Teledoc on-demand remote access to other medical professionals.
- ▶ Facility hygiene protocols include round-the-clock cleaning and surface sanitizing.

Consistent evaluation and upgrade of equipment:

- ▶ Regular investments made to meet or exceed the latest safety standards, including passive and active safety measures.
- ▶ We comply fully with (and often surpass) all federal, state, and local government mandates for health and safety.



Cleaner Air. Cleaner Water. Cleaner Community.

Renewable energy use and recycling are only part of the sustainability story.

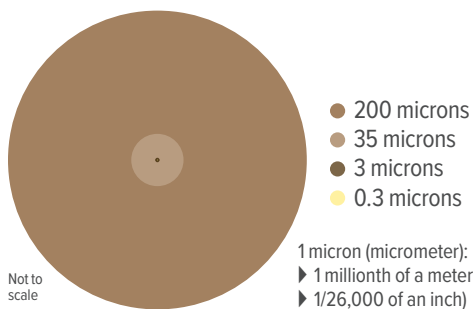
Regardless of mandates, ethical manufacturers do all they can to ensure healthful post-production air and water quality for the well-being of their employees and communities. Crown Battery is leading the way in our industry, having invested millions in air filtration and water processing and purification technology and processes.

"It's refreshing to work for a company that's looking beyond the next quarter to the next generation."

— Bob Michael, Director of Plant Engineering
Crown Battery

Air leaves our plant cleaner than the air in most hospital operating rooms to safeguard our workers, our families, and our community.

First, bag filters collect dust. Then, high efficiency particulate absorbing (HEPA) filters remove smaller particles. Our HEPA filters are 99.97% efficient at collecting dust particles at 0.3 microns or larger. By comparison, many hospitals only require minimum efficiency reporting values (MERV) 14 filtration, which filters 75% - 84% of particles 0.3 - 1.0 microns and 90%+ of particles sized 1.0 - 3.0 microns.⁴

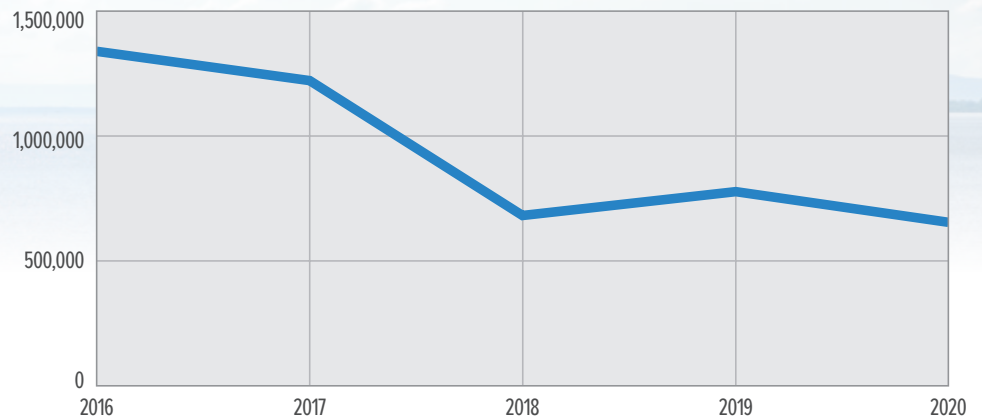


Human hair = 35-200 microns⁵
Hospital MERV-14 filter = 0.3 - 3.0 microns
Crown's HEPA filters = 0.3 microns

⁴The American Society for Healthcare Engineering, Air Infiltration

⁵American Industrial Hygiene Association

Gallons of Treated Water Discharged to City Sewers (per year)



LOWER IS BETTER! SIGNIFICANTLY, PRODUCTION INCREASED DURING THIS TIME.

Onsite water recycling and filtration: reuse and productivity up.

Before being released, all of our used water undergoes an extensive treatment and testing process that includes multiple samples and a minimum of 19 steps.

Two full-time technicians and a supervisor monitor the process to ensure

we exceed federal, state, and local standards for water treatment.

And because we've started recycling wastewater through a purifier (which includes multistage reverse osmosis with an ionizing bed finish), we're able to reuse hundreds of thousands of gallons in our acid mixing system.

WATER IMPACTS OF LEAD & LITHIUM RECYCLING

Water Usage per Metric Ton of Production

💧 = 2,000 gallons

Lithium: 500,000 gallons of water per 1 metric ton of production



Lead: 600 gallons of water per 1 metric ton of production

Source: Ecobat

Ask an expert on water quality and conservation:

"The importance of water quality and conservation is paramount to the City of Fremont. Crown Battery continues to exceed the City's and Ohio Environmental Protection Agency's (OEPA) regulations by implementing various technologically advanced treatment processes and programs designed to enable the facility to recycle plant process water that would normally be directly discharged to the City's Water Reclamation Center (WRC). By doing so, Crown Battery is preserving valuable capacity at the City's WRC and utilizing our water supply efficiently. The City is very appreciative of Crown Battery's commitment to be a valued partner and leader in the development and quality of our community and local area."

— Tucker Fredericksen, P.E, City Engineer, City of Fremont, Ohio, USA

WHAT'S NEXT?

In over 90 countries and 100 markets, businesses, governments and NGOs, and individuals trust Crown Battery products and support. Our batteries and chargers bring sustainable power to healthcare, sanitation, food and grocery, transportation, material handling, telecommunications, mining, off-grid schools and cities, government projects, homeowners, and solar and wind farms. Like you, decision makers in those markets increasingly choose to improve sustainability, safety – while reducing total operating costs.

Some of our goals for 2025 include:

- ▶ Continue collaborating with and co-funding joint R&D with the U.S. DOE Argonne National Laboratory and other members of the Consortium for Battery Innovation (CBI). This program is aimed at enhancing the performance of lead-acid batteries and the materials inside them. Work by research scientists here could ultimately lead to higher performing, lighter weight, fully recyclable batteries for stationary and mobile applications.
- ▶ Launch new efficiency programs and invest in even higher efficiency equipment to boost resource utilization and quality while reducing electrical use.
- ▶ Extend support for programs to end informal battery recycling by wildcat smelters in developing countries; unregulated recycling lacks proper safety standards and harms local communities. We're working with industry groups, NGOs, and others to stop bad practices.
- ▶ Encourage and incentivize raw material suppliers to use more renewable energy for production.
- ▶ Continue reducing our use of virgin-mined resources while building better/more batteries.
- ▶ Enhance our distributor technical training programs, including at our exclusive Commercial Services Center.

"We're proud of our entire team for incorporating energy efficiency into their daily work. Their efforts make it possible for us to protect the local environment and bring good, safe jobs to Northwest Ohio and North America."

— Hal Hawk, CEO, Crown Battery



WALK THE GREEN WALK

You can get closer to meeting your sustainability goals by working with a company that's making an impact. We welcome the opportunity to share more about our sustainability efforts and how we can help reduce the carbon footprints of your company and customers while providing the clean, reliable, and high-performance battery and energy storage solutions you need to power your operations.

If you're seeking a new and satisfying career path, find out how you become a part of the Crown Battery team and play a key role in our mission firsthand. In addition to being an ethical and forward-looking company that puts its people above all else, we provide competitive wages, generous benefits, a stable work environment and training to position you for success.

**CONTACT US FOR
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