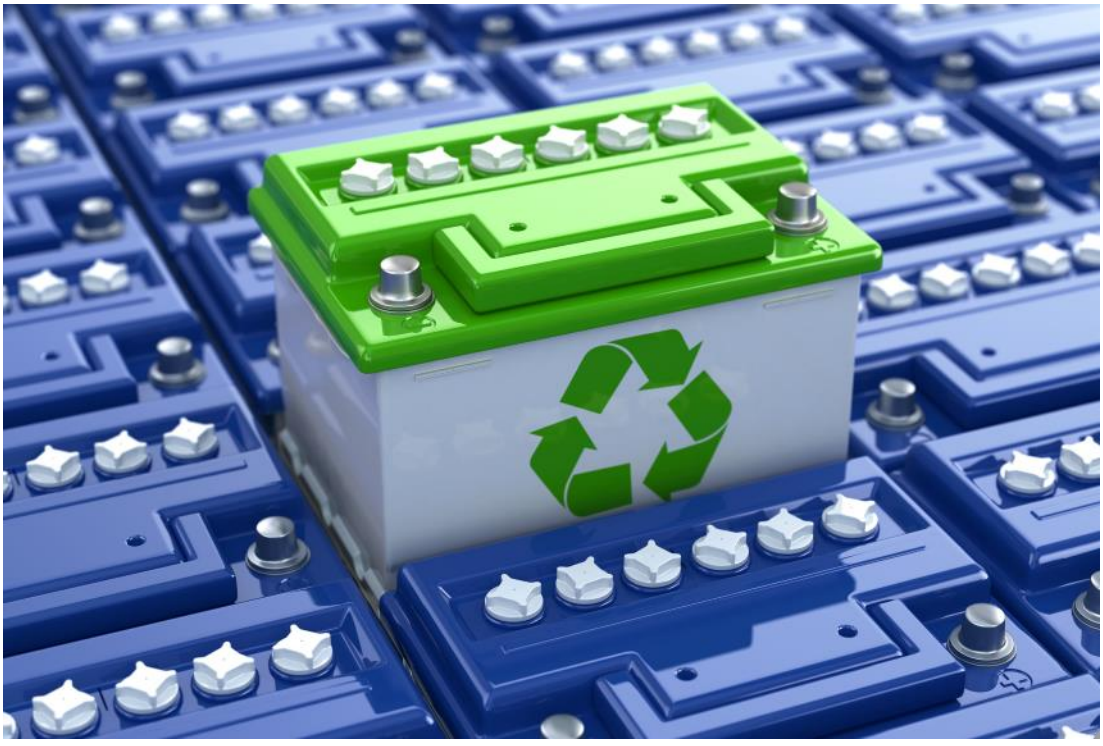
Economic Contribution of the U.S. Lead Battery Industry in 2021

BATTERY COUNCIL INTERNATIONAL

MARCH 2023



EBPO

Prepared for:
Battery Council International
330 N. Wabash Ave., Suite 2000
Chicago, IL 60611
www.batterycouncil.org

Prepared by:
EBP US
155 Federal Street, Suite 600
Boston, MA 02110
www.ebp-us.com

Contents

Executive Summary

The United States is home to a significant amount of lead battery manufacturing, recycling, and mining activity. This activity generates economic impacts which ripple through the national economy triggering growth in industry and supporting a wide range of jobs in the following ways:

1. When battery manufacturing, recycling, and mining companies employ workers and generate business income. These represent **direct impacts.**
2. When battery manufacturing, recycling, and mining companies purchase goods and services from other companies. These represent **supplier impacts.**
3. When workers at battery manufacturing, recycling, and mining companies, as well as workers at supplier companies, spend their after-tax income on consumer goods. These represent **worker spending impacts.**
4. Companies in the lead battery industry also employ workers in **transportation and distribution.** These activities further add to the industry's impact.
5. Companies in the lead battery industry innovate through ongoing **research and development.** These R&D activities contribute to the industry's future growth and productivity.

The U.S. lead battery industry is comprised of the following sectors: lead battery manufacturing, recycling, transportation and distribution, services such as installation and maintenance, and mining. The industry is also supported by numerous suppliers, retailers, and marketing companies. In 2021, the lead battery industry supported **37,490 direct jobs** in the manufacturing, recycling, mining, transportation and distribution, and services sectors plus an additional 742 R&D jobs. Direct jobs in the lead battery industry had a total payroll of $3 billion.

Production by the lead battery industry also generated indirect impacts through transactions with their suppliers, and induced impacts through workers at both Battery Council International member companies and suppliers spending their earnings on goods and services. When direct, supplier, and worker spending impacts are combined, the industry contributed the following total impacts to the national economy in 2021:

- **120,610 total jobs plus an additional 742 R&D jobs. Total jobs include:**
  - **37,490 direct jobs,**
  - **37,400 supplier jobs, and**
  - **45,720 jobs supported by worker spending;**
- **$8.5 billion in total labor income;**
- **$13.7 billion in total GDP; and**
- **$32.9 billion in total output.**

These impacts are spread across a variety of industries, with services, trade, manufacturing, and transportation benefiting the most. Finally, by paying local, state and federal taxes, the lead battery industry contributes $1.81 billion annually in federal tax revenue and $1.16 billion annually in state and local tax revenue.

Study Overview

This study measures the national economic contribution of the U.S. lead battery industry in calendar year 2021. The analysis was conducted using an economic impact model called IMPLAN. A survey was used to collect data including annual employment, sales, and payroll information from 18[1] Battery Council International (BCI) member companies that contribute to direct lead battery industry jobs in 38 states.[2] Survey results were added across companies to yield state-level activity that was put into a national IMPLAN model. Impact results are presented in terms of jobs, labor income, gross domestic product, output, and tax revenue to help estimate the contribution of the lead battery industry to the U.S. economy.

Lead Battery Industry Overview

Lead batteries are among the world's safest and most reliable sources of energy. Whether starting a car, storing power from a solar panel, or providing emergency backup power, lead batteries provide energy for the daily activities of billions of people around the globe.

Lead batteries are also among the most environmentally sustainable consumer products, with a recycling rate exceeding 99%. By comparison, the recycling rate for aluminum cans is 50%.[3] The typical new lead battery is comprised of more than 80% recycled material.[4] The lead battery industry uses a circular economy model, which means nearly all the materials used to produce batteries are either reused by the industry or recycled into other products (Figure 1).[5] Lead used in batteries can be infinitely recycled with no loss of performance—a quality that is unique among consumer products. This, coupled with high recycling rates, reduces the need to mine for virgin materials.

[1] Note that additional data were gathered outside of the survey process through interviews and report gathering on the part of two members.

[2] While BCI members have operations and facilities in 38 states, only 27 states are represented in this study, as not all BCI member companies contributed to this study.

[3] *Advancing Sustainable Materials Management: 2018 Fact Sheet*, Environmental Protection Agency, December 2020.

[4] "Environmental Impact and Life Cycle Assessment of Lead Battery and Architectural Sheet Production," The International Journal of Life Cycle Assessment, 2016.

[5] "The Circular Economy of Lead Batteries," April 18, 2019, Essential Energy Everyday, https://essentialenergyeveryday.com/wp-content/uploads/2019/04/Circular-Economy-Brief.pdf.

Figure 1. Circular Economy of Lead Batteries

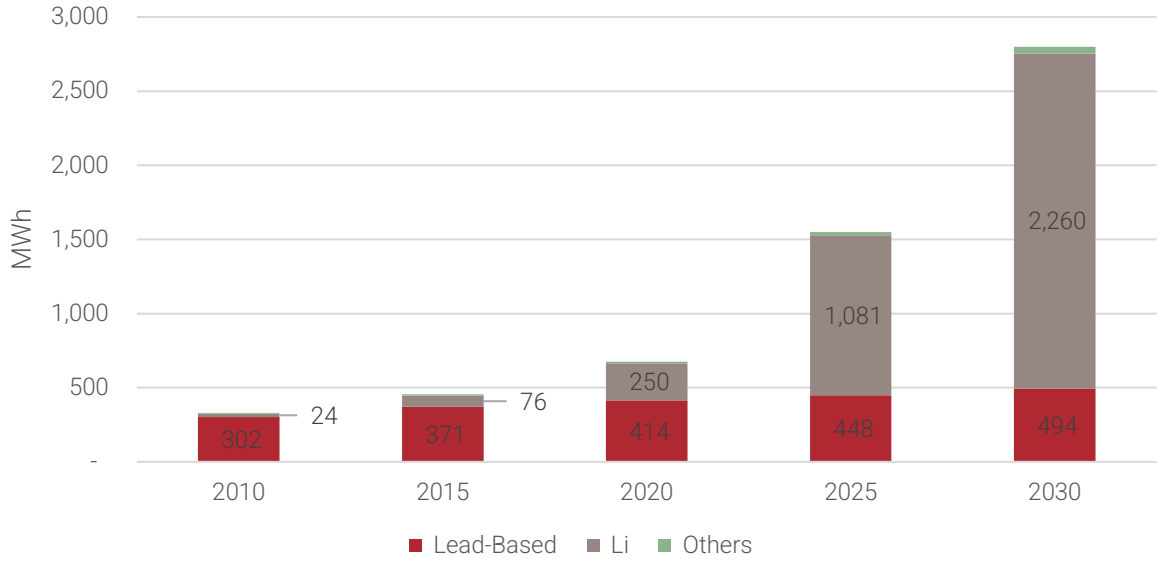
New Battery Demand and Recycling

Rechargeable batteries are needed now more than ever to meet the energy demands of the growing U.S. and world populations, and the growing need for batteries in new concepts of electric mobility and stationary energy storage (Figure 2). Unfortunately, many rechargeable batteries are not recycled profitably (and therefore hardly recycled at all) because the price of recycled materials is higher than the price of virgin materials. Lead batteries are the exception to this. Lead battery manufacturing is the most environmentally sustainable of all battery technologies, with lead batteries being the most recycled consumer product in the U.S. (Figure 3).

Rechargeable battery market projections show lead battery demand increasing over time, driven by shifts in population growth, a demand for more renewable alternatives to fossil fuels, and an increasing awareness of global warming and its effects[6]. From these trends, we are seeing a growth in alternative battery technologies, as well as a constant rate of sustained demand for lead batteries as the U.S. explores new concepts of mobility and energy (e.g., electric mobility, renewable energy storage).

[6] *The Rechargeable Battery Market and Main Trends 2020-2030*, Avicenne Energy, September 2022

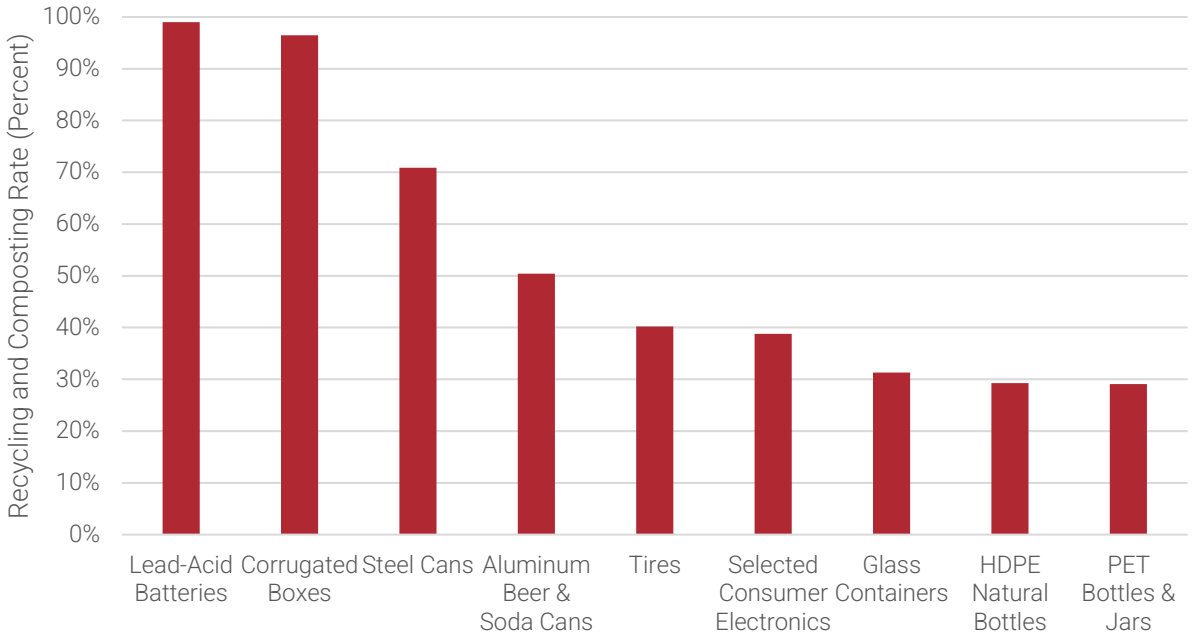
Figure 2. Rechargeable Battery Market Worldwide (2010 – 2030)



Source: Avicenne Energy Report: The rechargeable Battery Market & Main Trends, September 2022

While all this exploratory growth in new technologies is occurring, lead batteries are particularly noteworthy for their high rates of recycling. The EPA has been tracking a range of products with respect to their rates of recycling and composting to identify green products. As shown in Figure 3, lead batteries are at the forefront, with only corrugated boxes following closely behind (99% vs 97%).

Figure 3. Selected Products with High Recycling and Composting Rates

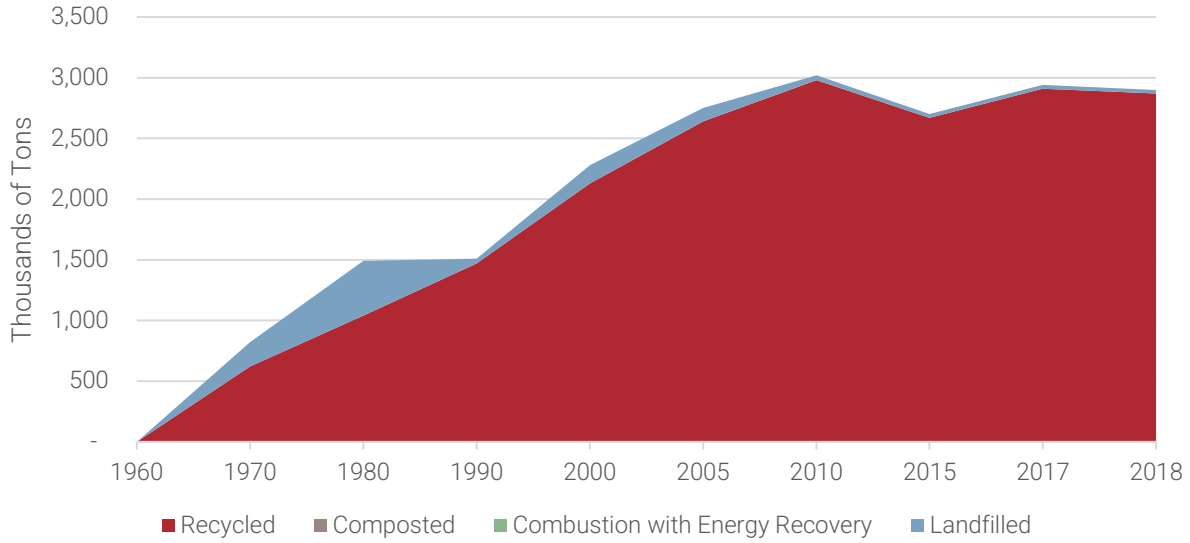


Source: *Advancing Sustainable Materials Management: 2018 Fact Sheet*, Environmental Protection Agency, December 2020.

This is not a new trend – the tracking of estimated recycling rates is maintained by the EPA and made part of a periodically updated report on materials, waste, and recycling. Figure 4 highlights the resulting estimated trend in recycling of batteries by the EPA.

It is critical to note that with the growth in demand for and consumption of lead batteries, the volume of recycled lead batteries has grown as well. The EPA data runs through 2018, thus does not capture any potential effects of more recent closures of recycling facilities in South Carolina. It will be interesting to see whether the rate of recycling will be able to keep up with the growth in battery consumption absent of any intervention, or whether more investments need to be made in additional recycling facilities and supporting technologies. If there is not sufficient recycling capacity to keep up with the growth in overall demand, then these high rates could be subject to change either by reducing the level of recycled content occurring, or as a growth in spent batteries and products for recycling outside of the U.S.

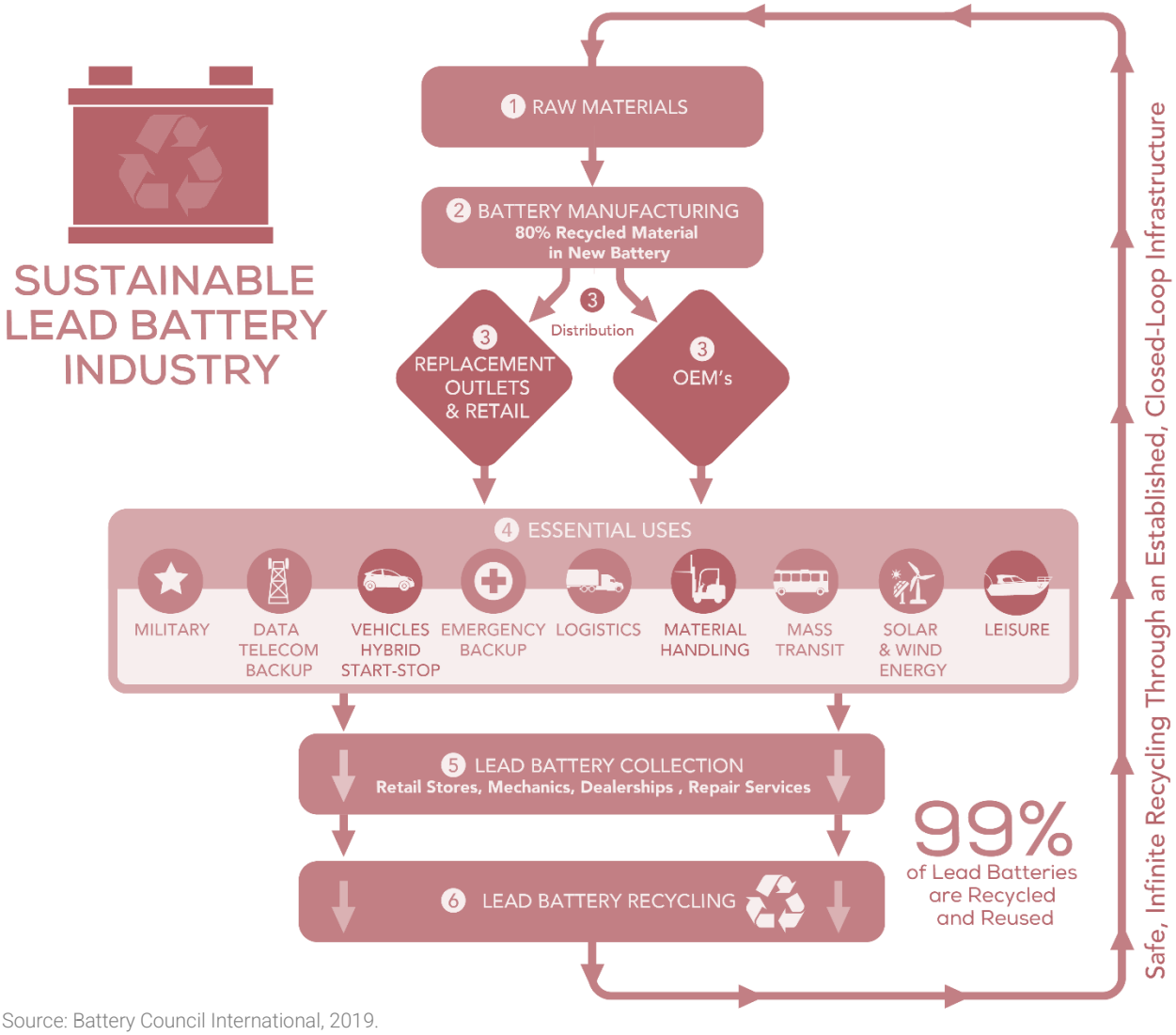
Figure 4. Lead-Acid Batteries Waste Management (1960 – 2018)



Source: EPA Facts and Figures about Materials, Waste and Recycling, 2018

The flowchart in Figure 5 illustrates how lead batteries are recycled and how their components are used to manufacture new batteries. This effective waste-reduction process is sometimes referred to as “cradle-to-cradle” production or a “closed-loop” industry. This model also supports domestic jobs and domestic supply of recycled materials to produce new lead batteries as demand increases.

Figure 5. Process of Recycling Lead Batteries



Source: Battery Council International, 2019.

Research & Development

Supporting new technologies and applications for lead batteries requires a commitment to constant innovation. In 2021 alone, the lead battery industry invested over $112.8 million in research and development to continue meeting the rapidly changing needs within transportation, renewable energy, communications, and many other sectors. Additional advancements are expected from notable collaborations between public and private entities. Major lead battery manufacturers and suppliers are currently partnering with the U.S. Department of Energy's Argonne National Laboratory, Pacific Northwest National Laboratory, The University of Toledo, the Missouri University of Science and Technology, and other institutions to research — and further advance — lead battery performance and energy storage applications.

Opportunities in Green Energy & Transportation

To date, innovation in lead battery production has significantly improved the lifespan of batteries and their ability to store energy. Lead batteries are a solution for renewable energy storage due to their long lifespan, ability to withstand extreme temperatures, and support of frequency regulation and load leveling. These features enable companies to store excess energy generated by wind turbines and solar panels when demand is low and store them for long periods of time. Lead batteries are more affordable than comparable energy storage solutions, both up front and during decommissioning.

Lead batteries are also enabling growth in electric vehicles (EVs) by providing critical safety and security functions. If an EV's primary battery fails, the auxiliary lead battery ensures vital functions like braking and steering which make them necessary. Undeniably, lithium battery technology has a role to play in fueling EVs of the future, but not to the exclusion of auxiliary lead batteries. This becomes materially important after announcements by the Biden administration of their intention to roll out funding and incentive programs to build out production facilities and grow a green market.[7] The nearshoring of such vehicle manufacturing jobs can serve as a source for locally produced lead batteries. This also comes with the announcement of discussions with Mexico's President on talks of generating a local chip and lithium supply chain to fuel EV production.[8]

Preparing to Fulfill Future Needs

A key opportunity for lead battery manufacturers is to store more energy in each battery, while still allowing users to extract power on-demand as efficiently as possible. Companies are exploring bipolar battery construction processes that can make lead batteries lighter, cheaper, faster-charging, and longer-lasting. Beyond developing improved batteries, manufacturers and recyclers are also working to make their processes more efficient. To further advance lead batteries in the marketplace, lead battery manufacturers and recyclers are members of the Consortium for Battery Innovation (CBI). CBI is the only global pre-competitive research organization that promotes innovation in lead batteries for energy storage, motive, and automotive applications. CBI has created a market-driven research "roadmap" based on a detailed analysis of market trends and future technical requirements of end users.

Finally, research and development support long-term job creation and other economic impacts. When companies advance their products and production processes by adopting new technologies, they become more efficient and generate more sales, in turn allowing them to hire additional workers.

[7] https://www.whitehouse.gov/briefing-room/statements-releases/2022/10/19/fact-sheet-biden-harris-administration-driving-u-s-battery-manufacturing-and-good-paying-jobs/

[8] https://www.theregister.com/2022/09/14/us_mexico_chips_batteries/

Supply Chains and COVID-19 Implications

The effects of COVID-19 are broader and farther reaching than the logistical nightmare endured by businesses over the last few years. Lead batteries have historically enjoyed a strong domestic supply chain, which has enabled them to weather international events from a supply chain perspective. However, lead batteries are not immune to sweeping events that alter demand, such as reductions in the availability of downstream applications like cars due to manufacturing shutdowns and supply shortages, or the forced pandemic isolation marked by stay-at-home orders. We can track the national trends in the import and export of lead batteries using U.S. trade data to examine the last few years of activity. Figure 6 highlights the value of U.S. lead-acid battery trade (exports and imports) over the preceding 5 years, highlighting a shift in trends between pre-pandemic levels (2017 – 2019) and the tail end of the pandemic (2020 – 2021).

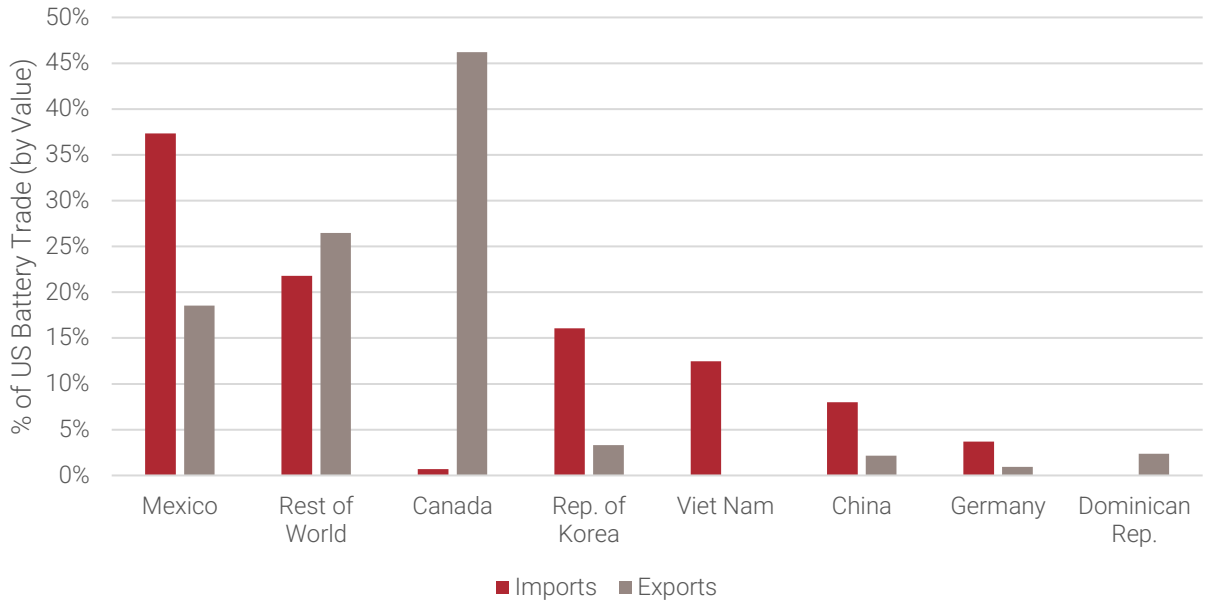
Figure 6. Broader U.S. Lead-Acid Battery Trade with the World

Source: EBP Analysis of USA Trade data

The U.S. import market was initially unaffected at the onset of the pandemic, though the increase in demand for non-automotive starting, lighting, ignition (SLI) applications led to a surge in imports to keep up with consumer needs. In contrast with the trend shown in imports, exports have fallen over the equivalent period, though likely for a similar reason.

Figure 7 highlights the critical import and export markets in 2021 by breaking down the top countries trading with the U.S. by value of U.S. imports and exports for lead batteries.[9] The figure highlights the relative importance of Mexico as a source of imported batteries, some of which are from recycled materials exported across the border, as well as the importance of Canada as a major export destination for finished goods.

Figure 7. Major U.S. Markets for Lead Batteries by Trade Value, 2021



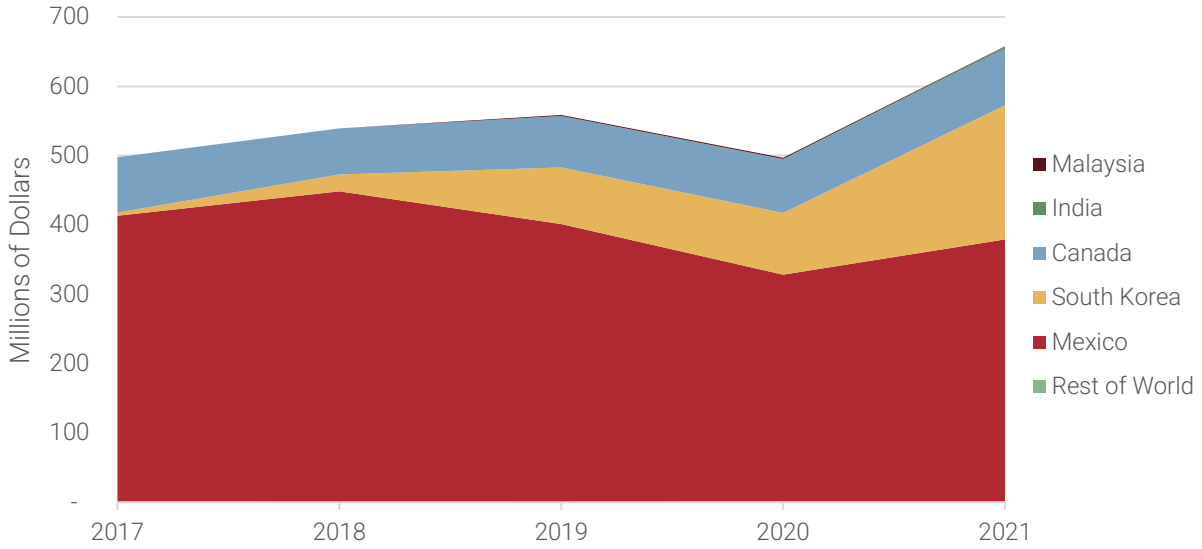
Source: EBP Analysis of USA Trade data

When batteries are used up, much of their contents are recycled domestically, however the U.S. does still export spent batteries out of the country to external facilities for recycling. Much of the volume of recycled batteries involve cross-border destinations. Figure 8 highlights both the volume of exports as well as the key export destinations of spent batteries.[10] Mexico represents a major supply chain partner, though in the past few years South Korea has seen a growing share of battery waste.

[9] Note the lead batteries are defined as the following HS codes which describe Secondary Batteries:
850710 – Electric accumulators; lead-acid of a kind for starting piston engines
850720 – Electric accumulators; lead-acid other than for starting piston engines
Not enough detail in the UN COMTRADE database to identify lead-acid primary batteries over other technologies.

[10] Note trade data not available for Lead, though the majority of activity taking place is believed to be related. Using HS Code 854810 (Waste and scrap of primary cells, primary batteries and electric accumulators)

Figure 8. Destinations of U.S. Exports of Spent Batteries for Recycling



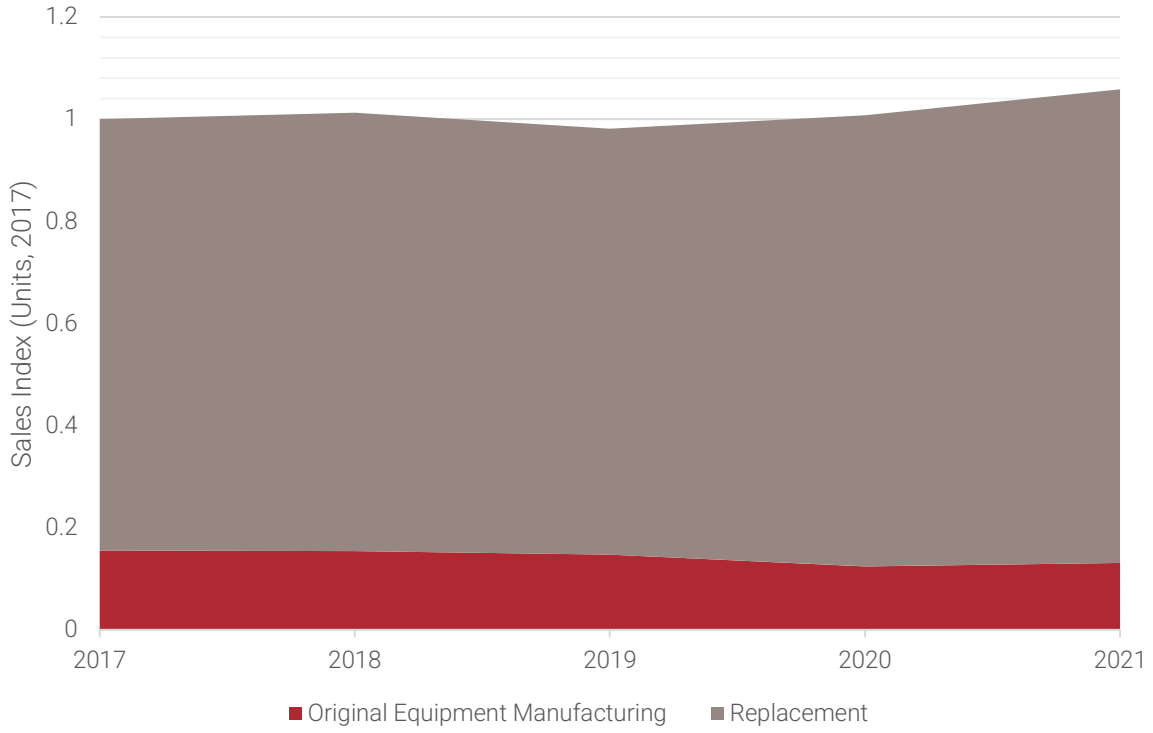
Source: EBP Analysis of USA Trade data

Effects of COVID-19 on Lead Battery Applications

COVID-19 has impacted more than just the supply chains of businesses – it has also had broader implications on the application of lead battery usage. Most lead battery applications have been focused on its automobile usage for starting, lighting, and ignition (SLI) applications. Historically, roughly 15% of those lead battery sales have been in the form of batteries in new cars. With the supply chain disruption in the Chinese auto making market, this could have spelled a downtick in sales for lead batteries. What prevented more serious decreases in lead battery manufacturing output are the shifts in overall usage. While automobile manufacturing was temporarily halted due to a range of factors (shortage of electronics, halting of Asian ports), lead battery producers were able to weather the storm by merit of the versatile applications of the batteries. Figure 9 uses proprietary data provided by BCI and depicts U.S. lead battery sales for SLI applications by use. The data reveals two important takeaways:

First, the lead battery market is resilient in its handling of the supply chain crisis and has grown its sales of SLI lead battery applications despite being heavily reliant on a constrained automobile industry. As shown in Figure 9, it is estimated that SLI applications have increased roughly 6% beyond pre-pandemic uses in 2021. The lead battery market has been adapting to global conditions.

Figure 9. U.S. Lead Battery SLI Sales: Index (2017 = 1.0)



Source: BCI Member Data

Second, the adaptation taking place was in the form of a surge in replacement batteries. As automobile owners similarly faced constraints, they held onto and maintained their existing vehicles as for many, new vehicles were simply too costly. Simultaneously, with a large segment of the workforce forced to quarantine and remain at home, a spike in the demand and use of recreational vehicles further bolstered sales of replacement batteries. We can see this in the decreasing size of the original equipment manufacturing application index above, relative to the overall indexed unit sales. However, that is not to say that the battery manufacturing sector did not experience challenges in keeping their supply chains going: just like any business, they have had to deal with changing logistics and labor issues.

Impacts of COVID-19 on BCI Members

Much can be learned from BCI member experiences during the COVID-19 pandemic: insight into how the crisis impacted their businesses and altered their outlook on market challenges demonstrates the strength of the battery manufacturing supply chain. As part of this study's survey, member companies were asked a series of questions, including:

1) How the supply chain crisis has impacted sales,
2) How it has impacted operations, and the businesses' approach to sourcing and shipping goods to market, and

3) How it altered their outlook on the next five years regarding the market and their ability to effectively operate within it.

The members who responded represented a diverse spectrum of businesses spread across the supply chain, each operating in different markets, and under varying degrees of exposure to the pandemic's effects. Despite the variation in background, there were some common themes regarding their experiences:

- Many companies noted that impacts were felt in the form of labor shortages and higher turnovers – part of the Great Resignation, a trend felt across much of the U.S., and transcending the battery sector as workers took the quarantine process as an opportunity to look to renegotiate and redefine their work life. This is also part of a broader awareness that the success of the battery industry is reliant on its ability to find a skilled and motivated workforce to maintain its competitive position.
- During this time, the movement of goods slowed – competition with skyrocketing e-commerce-based retail, and skyrocketing costs of fuel, container shortages, and myriad other factors led to longer lead times and more delays on both upstream and downstream applications, with lost sales being a lamented outcome.
- In response to these harsh realities, businesses responded with various approaches. Where it made sense, some businesses relied on higher inventory carrying costs as a way of mitigating delay of inputs, accepting the effects on their bottom line as a necessary evil.
- Some businesses ended up consolidating their sales along existing functioning logistics routes to continue service. Those with the ability to flexibly react to the situation began casting around for more adaptive responses: identifying opportunities for potential redundancy in their network in the form of alternate suppliers and seeking out new means of shipping their goods and forging relationships with shippers.

Lead Batteries & the Economy

Types of Economic Impacts

The lead battery industry creates jobs and generates business activity throughout the U.S. economy. The total economic impacts of lead battery industry include activity directly supported by companies within the lead battery industry as well as additional multiplier effects on suppliers throughout the country and on businesses where workers spend their income.

Each type of impact is quantified using the measures of jobs and value added (business revenue minus the cost of purchased goods and services). Value added impacts also reflect the lead battery industry's contribution to GDP.

Figure 10. Direct and Multiplier (Indirect and Induced) Impacts Generated by the Lead Battery Industry

Direct Economic Impact

BCI's members represent almost complete coverage of the U.S. lead battery manufacturing, recycling, transportation and distribution, services such as installation and maintenance, and mining industries. In 2021, the lead battery industry paid over $3 billion in wages to 37,490 employees, as shown in Table 1. Additionally, companies spent $112.8 million on research and development in 2021, which supported an additional 742 workers.

Table 1. Direct Jobs and Payroll at U.S. Lead Battery Companies in 2021

Activity	Employment	Payroll ($M)
Lead Battery Manufacturing	23,850	$1,805
Transportation and Distribution	8,010	$686
Lead Battery Recycling (incl. secondary smelting)	3,440	$261
Lead Mining	1,370	$135
Services (e.g., battery installation, maintenance)	820	$148
Total	37,490	$3,035

	Employment	Spending ($M)
Research & Development	742	$112.8

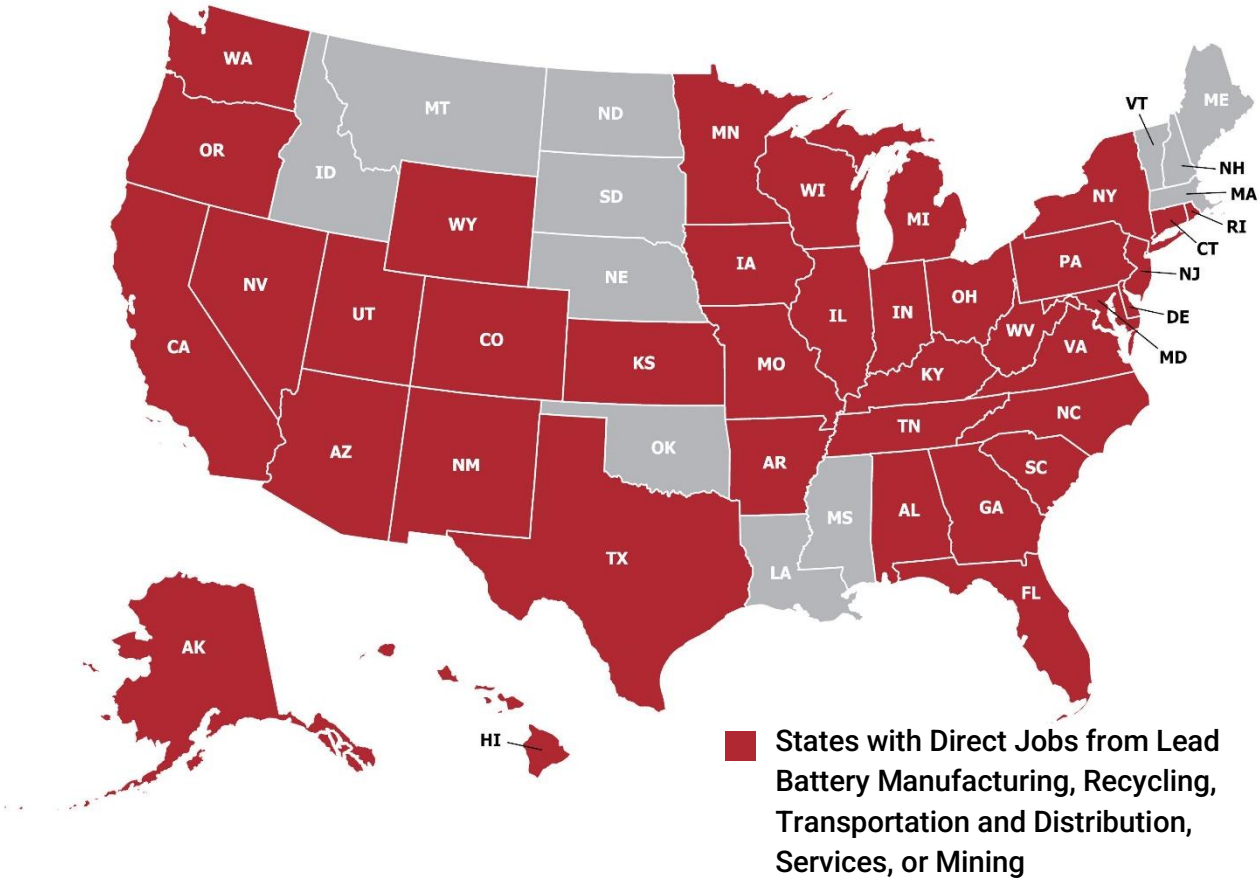
Source: BCI company survey and IMPLAN.

Geographic Distribution of Jobs

Companies with activity in the lead battery industry directly create jobs in 38 states[11] located in every region of the country, as shown in Figure 11. Of states represented by companies who participated in this study, 23 states have manufacturing activity, nine states have recycling activity, seven states have transportation and distribution activity, two states have battery services activity, and two states have mining activity. Fourteen states are home to more than one lead battery-related activity, while five states are home to more than two activities.

[11] While BCI members have operations and facilities in 38 states, only 27 states are represented in this study, as not all BCI member companies contributed to this study.

Figure 11. The Lead Battery Industry Provides Direct Jobs in 38 States



Note: While BCI members have operations and facilities in 38 states, only 27 states are represented by participants of this study, as not all BCI member companies participated to this study. States with direct lead battery operations that are not represented in this study include Colorado, Connecticut, Hawaii, Maryland, Nevada, New Jersey, New Mexico, Rhode Island, Utah, West Virginia, and Wyoming.
Source: BCI company survey.

Lead Battery Wages and Occupations

The lead battery industry pays high wages relative to other industry sectors. Average payroll-per-worker among U.S. battery companies is $81,000. This is higher than in professional services, retail and wholesale trade, construction and maintenance, and agriculture, as shown in Table 2.

Table 2. Payroll-per-Worker in the U.S. Lead Battery Industry and Other Sectors

Industry	Payroll-per-Worker ($2021)
Lead Mining & Recycling	**$82,600**
All Lead Battery Sectors	**$81,000**
Professional Services	$76,200
Lead Battery Manufacturing	**$75,700**
All private sector industries	$60,800
Retail & Wholesale Trade	$54,900
Construction & Maintenance	$49,900
Agriculture	$17,600

Source: BCI company survey for bolded industries and IMPLAN for non-bolded industries.
Note: All Lead Battery Sectors represents the average payroll-per-worker across all lead battery sectors represented in the BCI company survey.

Direct jobs in the lead battery industry are filled by workers in a variety of occupations, illustrated in Table 3. Production occupations account for more than half of all jobs in the lead battery industry, while high-skilled engineers, administrators, and managers account for another quarter.

Table 3. Occupations Included in the Lead Battery Industry

Occupation Category	Percent of Industry Workers
Production Occupations	53.9%
Architecture and Engineering Occupations	9.9%
Office and Administrative Support Occupations	8.5%
Management Occupations	7.4%
Business and Financial Operations Occupations	5.0%
Transportation and Material Moving Occupations	4.6%
Installation, Maintenance, and Repair Occupations	4.0%
Sales and Related Occupations	3.2%
Computer and Mathematical Occupations	1.8%
All other occupations	1.7%

Source: United States Bureau of Labor Statistics, 2021. Data is for NAICS 335900: Other electrical equipment and component manufacturing, which includes battery manufacturing.

Total Economic Contribution

The U.S. lead battery industry generated the following job impacts nationally in calendar year 2021:

- **Directly employed approximately 37,490 workers in manufacturing, recycling, transportation and distribution, services such as installation and maintenance, and mining industries, plus an additional 742 research & development jobs.**
- **Supported an additional 37,400 supplier jobs.** Supplier impacts (indirect impacts) result from companies in the lead battery industry spending money on goods and services.
- **Supported an additional 45,720 jobs from worker spending.** Worker spending impacts (induced impacts) result from workers at companies in the lead battery industry and their suppliers spending their wages throughout the economy.

Together these impacts total to 120,610 jobs nationally plus an additional 742 R&D jobs. In addition to its job impact, the lead battery industry supported approximately:

- $8.5 billion in labor income (includes wages and benefits),
- $13.7 billion in gross domestic product (GDP), and
- $32.9 billion in output or overall economic impact.

These impacts represent the lead battery industry's contribution to the economy in 2021, detailed in the table below.[12]

Table 4. Economic Impacts of the U.S. Lead Battery Industry in 2021

	Jobs	Labor Income ($B)	GDP ($B)	Output ($B)
Direct Impacts	37,490	$3.0	$4.2	$14.5
Indirect Impacts (Suppliers)	37,400	$2.8	$4.8	$10.1
Induced Impacts (Worker Spending)	45,720	$2.7	$4.7	$8.4
Total	120,610	$8.5	$13.7	$32.9

Note: Some totals may not equal the exact sum of individual rows due to rounding.
Source: Analysis by EBP based on industry survey and IMPLAN economic model for the U.S.

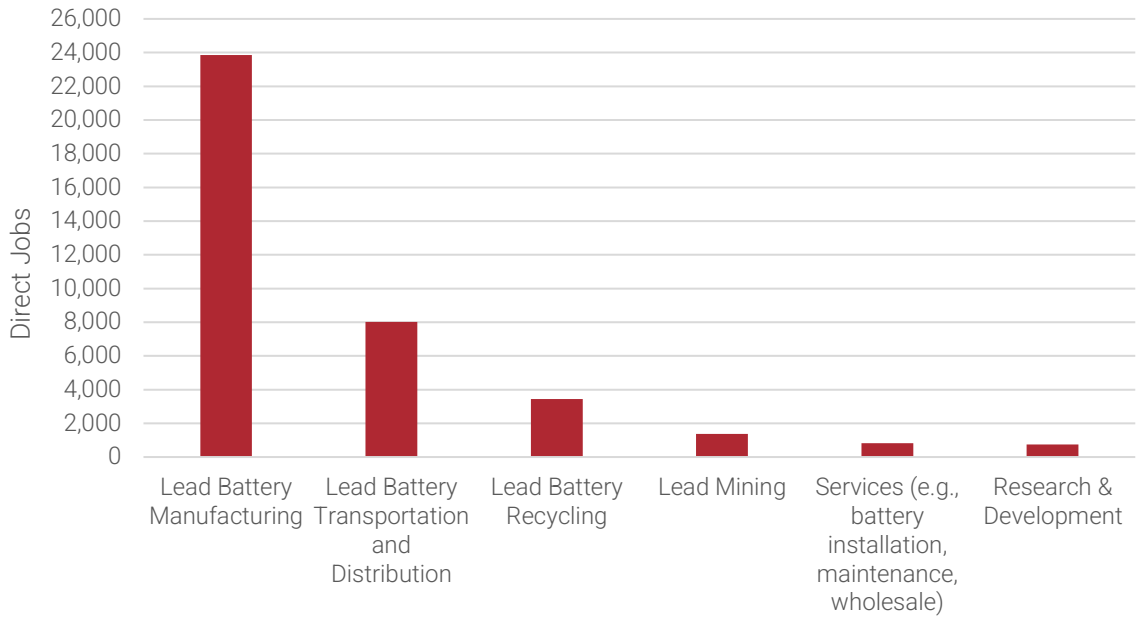
Note: Because lead battery manufacturers use both virgin and recycled lead, some lead mining and recycling companies support manufacturers within the same industry. Similarly, lead battery manufacturers depend on some transportation and distribution companies upstream in their value chain. The supplier impact from battery manufacturing reflects this fact by not counting jobs twice, and other impacts resulting from the purchase of virgin and recycled lead content.

[12] Gross Domestic Product (GDP) represents the total value of goods produced by the U.S. lead battery industry. Output represents total sales made by the industry. GDP is smaller than output because it excludes payroll, profits, and the cost of supplies. Labor income is a subset of GDP and GDP is a subset of output. Therefore, these figures should not be combined.

Job Impacts by Industry

Companies in the U.S. lead battery industry support direct jobs in six areas: battery manufacturing, lead recycling (including secondary smelting), transportation & distribution, lead mining, battery services (e.g., installation, maintenance, wholesale), and research and development. Direct jobs are those that exist at actual companies in the lead battery industry. These include 23,850 jobs in manufacturing, 3,440 in recycling, 8,010 in transportation and distribution, 1,370 in lead mining, 820 in battery services, and 742 in research and development. Figure 12 illustrates direct jobs by activity within the lead battery industry.

Figure 12. Direct Jobs Supported by the U.S. Lead Battery Industry in 2021

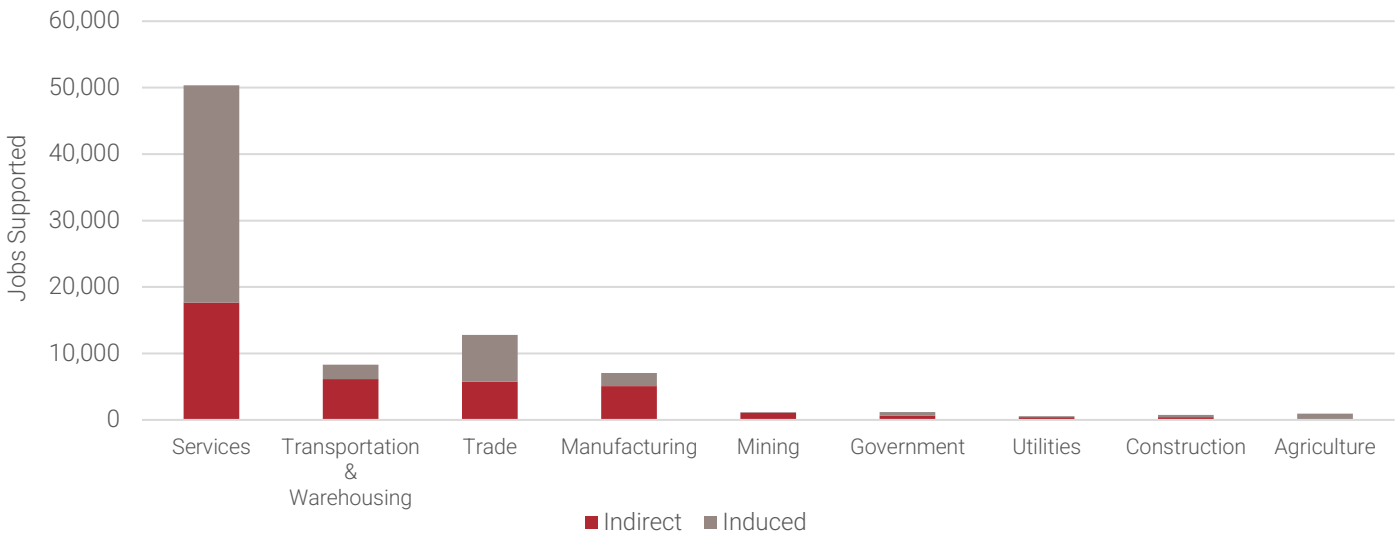


Source: Analysis by EBP based on industry survey and IMPLAN economic model for the U.S.

By purchasing goods and services from suppliers and paying wages that workers spend throughout the economy after paying taxes, the lead battery industry supports a variety of industries, shown in Figure 13. Nearly 50,400 of these supplier and worker spending jobs are in the services sector and approximately 28,200 are in manufacturing, transportation, or trade sectors.

The reason such a variety of sectors benefit from the lead battery industry is because workers at individual companies and their suppliers spend their wages on food, housing, healthcare, transportation, recreation, and other goods and services.

Figure 13. Indirect and Induced Jobs Created by the U.S. Lead Battery Industry in 2021



Source: IMPLAN analysis conducted by EBP.

Tax Revenue Contribution

By paying local, state, and federal taxes, companies in the lead battery industry contributed $2.96 billion in government revenue in 2021, as shown in the table below. The industry provided $1.81 billion in revenue to the federal government and $1.16 billion in revenue to states and localities.

Table 5. Tax Revenue Generated by the U.S. Lead Battery Industry in 2021

Revenue Type	Revenue ($B)
Federal Tax Revenue	$1.81
State and Local Tax Revenue	$1.16
Total	$2.96

Note: Some totals may not equal the exact sum of individual rows due to rounding
Source: Analysis by EBP based on the IMPLAN economic model and average rates for local, state, and federal taxes.

Conclusion

The U.S. lead battery industry is comprised of the lead battery manufacturing, recycling, transportation and distribution, services such as installation and maintenance, and mining sectors. The industry is also supported by numerous suppliers, retailers, and marketing companies. In 2021, the lead battery industry directly supported 37,490 manufacturing, recycling, mining, transportation and distribution, and services jobs plus an additional 742 R&D jobs and had a total payroll of $3 billion.

Production by the lead battery industry also generated indirect impacts through transactions with their suppliers, and induced impacts through workers at both member companies and suppliers spending their earnings on goods and services. When direct, supplier, and worker spending impacts are combined, the industry contributed the following to the national economy in 2021:

- **120,610 jobs plus 742 R&D jobs;**
- **$8.5 billion in labor income;**
- **$13.7 billion in GDP; and**
- **$32.9 billion in output.**

These impacts are spread across a variety of industries, with services, trade, manufacturing, and transportation benefiting the most. Finally, by paying local, state and federal taxes, the lead battery industry contributes $1.81 billion annually in federal tax revenue and $1.16 billion annually in state and local tax revenue.

About EBP

EBP US is an American company that provides superior, cutting-edge economic expertise, tools, and analysis to help our clients make better decisions on policies, programs, and investments in the transportation, energy, environment, and economic development sectors. We shape the future through innovative and best-of-class solutions to public and private sector challenges to create a more sustainable world.

Founded in 1996 in Boston as Economic Development Research Group (EDR Group), we changed our name to EBP in 2020 to reflect our membership in the EBP Global family of firms, with full-service offices in the United States, Switzerland, Germany, China, Brazil, and Chile.

About Battery Council International

Battery Council International (BCI) will soon celebrate its 100-year anniversary as the leading trade association of the North American battery industry representing more than 125 member companies. Formed in 1924, BCI joins together battery manufacturers and recyclers, marketers and retailers, suppliers of raw materials and equipment, and battery distributors from across North America and around the world. BCI members are committed to responsible manufacturing and recycling processes, and serve as a unified voice for environmental, health and safety stewardship. The organization continues to unite members within the lead industry to successfully communicate and protect through education, science, and government efforts the most successful circular economy on the planet. With 99% of used lead batteries collected and recycled in the U.S. and the typical new lead battery containing 80% or more of recycled content, BCI supports the path toward similar sustainability goals for all other battery chemistries. For more information visit www.batterycouncil.org .

Appendix

Methodology

This analysis was conducted based on 2021 industry data and using the 2019 IMPLAN economic model for the U.S. All results are in 2021 dollars. A survey process was used to collect limited but key annual data from BCI member companies.[13] Compilation of the survey-derived and supplemental information represents direct impacts. The survey probed annual employment, payroll, and sales revenue information by industry. The corresponding direct output (business sales or value of production) was estimated using national output-to-jobs ratios from IMPLAN before aggregating direct effects across companies within each of the subsectors comprising the BCI membership. There were several instances where direct payroll or direct employment were

[13] Some of these companies have multiple establishments, hence the distribution across 27 states. While participating companies in this study represent direct activity in 27 states, BCI members have direct business activity in 38 states.

estimated using national employee compensation-to-jobs ratios because survey respondents chose not to report annual payroll or employment.

Differences in Responses from Previous Study

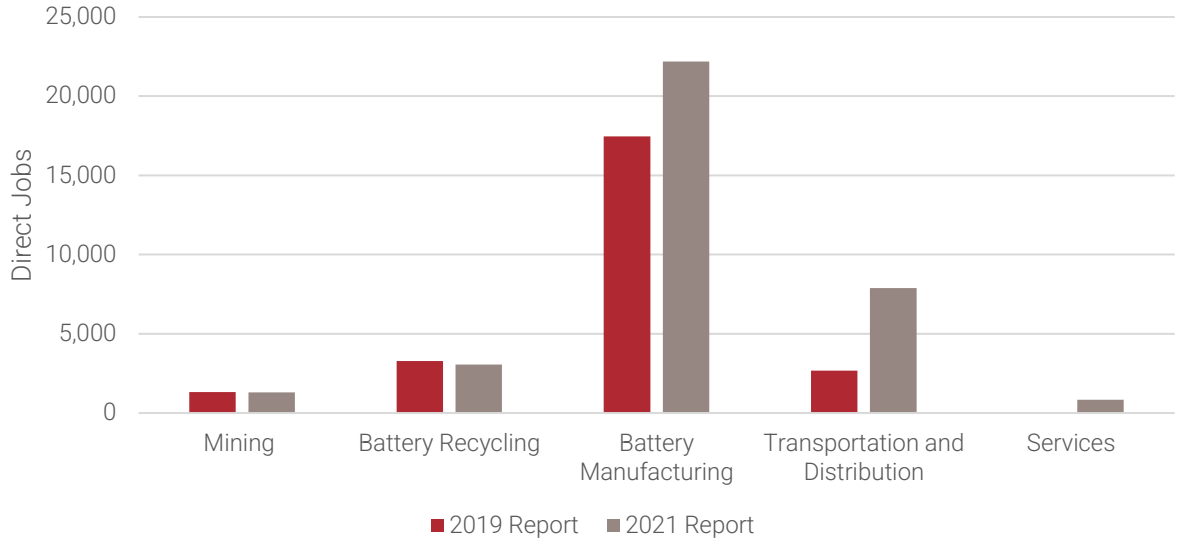
It is important to note that results in this study differ from the previous economic impact of the lead battery industry study conducted in 2019 due to differences in the makeup of survey responses from BCI member companies. Differences in responses can be attributed to the following key reasons:

1. As a result of the pandemic, companies in the lead battery industry may have undergone changes in operations, closed facilities, opened new facilities.
2. There are some differences in the BCI member companies themselves that responded to the surveys for the two studies both in terms of companies which did not respond, as well as new membership now participating in the survey.
3. Not all respondents were able or willing to provide state-by-state level information on their business.

These changes affect the geographic distribution of lead battery industry activity that could be captured, direct jobs by industry, and the multiplier effects of these jobs throughout the wider U.S. economy.

Figure 14 shows a visual comparison of the direct jobs being reported in the previous study compared with the current study. As depicted, more battery manufacturing, transportation, and services industry jobs are being reported, and slightly fewer mining and recycling jobs are being reported when compared with the previous study. For consistent survey participants between years, there has been continued growth in battery manufacturing indicating a strong, continued demand for lead battery applications despite market disruption due to COVID-19.

Figure 14. Change in Reported Survey Results (Jobs Measurement)



Definition of Terms

Input-output models are commonly used to conduct economic impact analysis. There are several input-output models available, including IMPLAN.[14] Many economists use IMPLAN for economic contribution analyses because the tool measures output and employment impacts, is available on a county-by-county basis and is flexible for the user. IMPLAN has some limitations and qualifications, but it is one of the best tools available to economists for input-output modeling. Understanding the IMPLAN tool, its capabilities and its limitations helps ensure the best results from the model. The national IMPLAN model used for this study estimates economic and tax revenue impacts at a statewide level. Tax revenue impacts include local, state and federal revenue, estimated using average tax rates for each jurisdiction.

Several IMPLAN-specific definitions are essential to properly interpreting the results of an IMPLAN analysis. These definitions follow, with some quoted from the IMPLAN glossary.[15]

Economic Contribution

Economic contribution represents a "gross change in economic activity associated with an industry, event or policy in an existing regional economy."[16] This is different from an economic impact, which represents a net change in economic activity.

[14] See www.implan.com for more information.
[15] https://implanhelp.zendesk.com/hc/en-us/categories/115001507908-Knowledge-Base
[16] Determining Economic Contributions and Impacts: What is the Difference and Why Do We Care? *The Journal of Regional Analysis and Policy 37*(2): 1-15, 2007.

Jobs

An IMPLAN job equals the annual average of monthly jobs in that industry (this is the same definition used by several government sources). Thus, one job lasting 12 months equals two jobs lasting six months each or three jobs lasting four months each. A job can be full-time or part-time.

Labor Income

Labor income includes all forms of employment income, including employee compensation (wages and benefits) and proprietor income. Proprietor income consists of payments received by self-employed individuals and unincorporated business owners.

Value Added (GSP/GDP)

Value added or gross state/domestic product (GSP/GDP) represents the difference between an industry's total output and the cost of its intermediate inputs (consumption of goods and services purchased from other industries or imported). Value added consists of employee compensation, taxes on production and imports less subsidies and gross operating surplus.

Output

Output represents the value of industry production. In IMPLAN these are annual production estimates for the year of the data set. For manufacturers, output equals sales plus or minus the change in inventory. For service sectors output equals sales. For retail and wholesale, trade output equals the gross margin and not gross sales.

Direct Impact

Direct impacts represent changes in industry production or expenditures resulting from companies. These initial changes are determined by an analyst to be a result of a specific activity (e.g., sales made by a given company). Applying these initial changes to the multipliers in an IMPLAN model will then display how the region will respond economically to these initial changes.

Indirect Impact (Supplier Impact)

Indirect impacts result from local industries buying goods and services from local supplier industries. As a company increases its production it will require more inputs from local suppliers, in turn increasing the production at those supplier companies. This indirect impact is calculated by applying direct effects to what are called Type I Multipliers.

Induced Impact (Worker Spending Impact)

Induced impacts represent the response of an economy to an initial (direct) change that occurs through re-spending of income. This money is recirculated through household spending patterns causing further local economic activity. A variety of industries benefit from induced impacts because workers at companies experiencing the initial change in production, plus workers at their local supplier companies, spend their wages on food, housing, transportation, recreation and other goods and services.

Total Impact

The total impact is the summation of the direct, indirect, and induced impacts.