United States Lead Battery Industry Segment Economic Contribution in 2023

BATTERY COUNCIL INTERNATIONAL

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EBPO

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Executive Summary

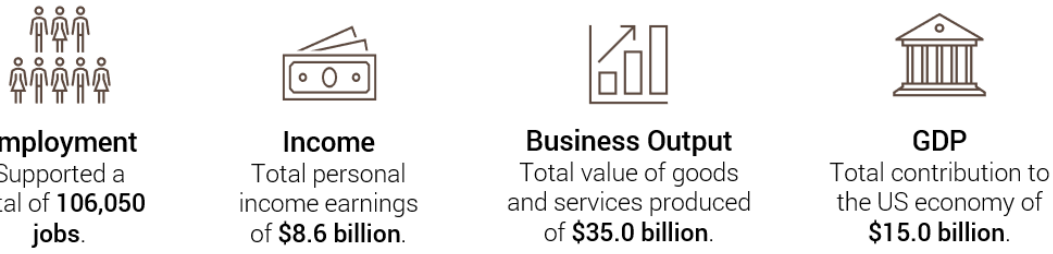
The United States is home to a significant amount of lead battery manufacturing, recycling, and mining activity. This activity generates economic impacts which ripple through the national economy triggering growth in industry and supporting a wide range of jobs in the following ways:

1. When battery manufacturing, recycling, and mining companies employ workers and generate business income. This represents **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 segment also employ workers in **transportation and distribution** and **battery services** such as installation and maintenance. These activities further add to the industry segment's impact.

The US lead battery industry segment is comprised of the following activities: lead battery manufacturing, recycling, transportation and distribution, services such as installation and maintenance, and mining. The segment is also supported by numerous suppliers, retailers, and marketing companies. In 2023, the lead battery industry segment supported **28,300 direct jobs** in the manufacturing, recycling, mining, transportation and distribution, and services activities. Direct jobs in the lead battery industry segment had a total payroll of $2.5 billion.

Production by the lead battery industry segment 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. Figure 1 illustrates the combined direct, supplier, and worker spending impacts of the lead battery industry segment on the US economy in 2023.

Figure 1. Total Economic Contribution of Lead Battery Industry Segment on US Economy, 2023



Source: EBP Survey of Battery Council International member companies and IMPLAN analysis.

Study Overview

This study measures the national economic contribution of the US lead battery industry segment in calendar year 2023. Using a methodology adopted in 2024, this study is self-contained and should not be directly compared to prior studies due to year-to-year changes in survey participation, which could result in sampling bias and affect the comparability of findings. The analysis was conducted using the IMPLAN economic impact model. A survey was used to collect data including annual employment, sales, and payroll information from 24 Battery Council International (BCI) member companies that contribute to direct lead battery industry segment jobs across the nation. 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 segment to the US economy.

Lead Battery Industry Segment 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 percent. The typical new lead battery is comprised of more than 80 percent recycled material. The lead battery industry segment uses a circular economy model, which means nearly all the materials used to produce batteries are either reused by the companies in the industry segment or recycled into other products, as shown in Figure 2. 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.

Figure 2. Circular Economy of Lead Batteries

Global Lead Battery Landscape

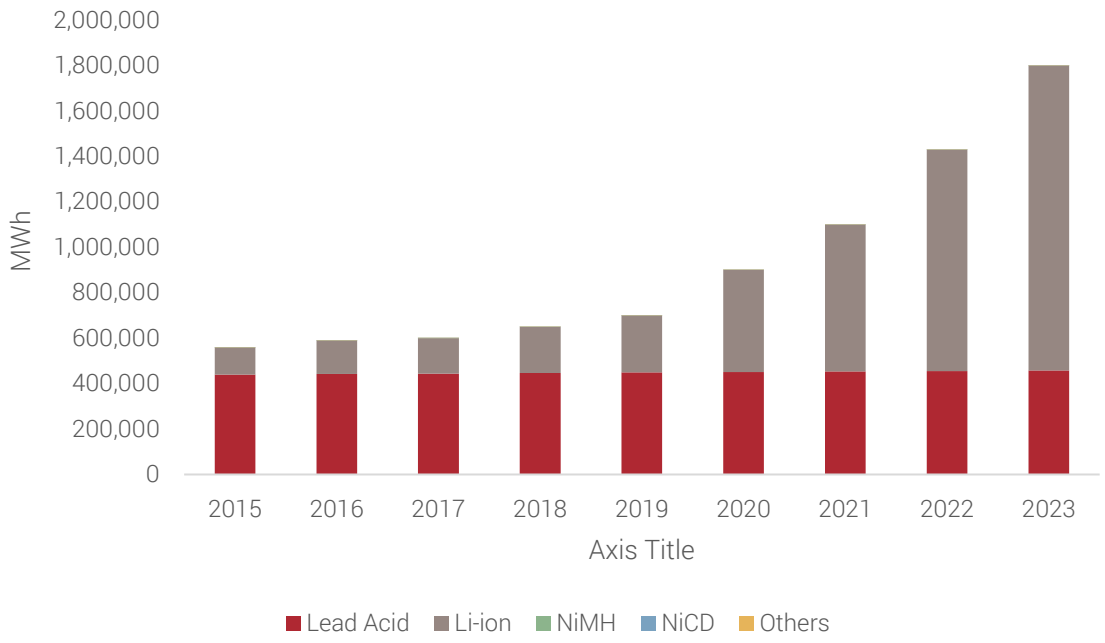
While this study primarily focuses on the impacts of the lead battery industry segment in the US, understanding the global context of lead as an internationally traded raw material is essential for a comprehensive view of trends and outlook. Global dynamics, including supply, demand, and green energy targets influence the US market and shape its development.

Lead Battery Market Outlook to 2030

Globally, lead batteries hold more than 30 percent of the market, even with Lithium-Ion batteries growing in popularity[1]. Worldwide lead battery capacity grew by 5.6 percent from 2020 to 2023. SLI (Starting, Lighting, and Ignition) batteries hold the greatest portion of the lead battery market at 47 percent, followed by stationary (37 percent), motive (6 percent), and E-bike (2 percent) batteries, with other types totaling 8 percent of the market in 2023 [2]. Looking out to 2030, 12 volt and stationary batteries are the expected primary applications. The entire lead battery market is expected to grow 1.2 percent with a capacity of 594 GWh globally by 2030[3]. The growth of lead, li-ion, NiMH, NiCD, and other battery types is shown below in Figure 3.

[1] Avicenne Energy, The Rechargeable Battery Market and Main Trends, 2024
[2] Avicenne Energy, The Rechargeable Battery Market and Main Trends, 2024
[3] Avicenne Energy, The Rechargeable Battery Market and Main Trends, 2024

Figure 3. Worldwide Rechargeable Battery Market by Chemistry, 2015-2023



Source: Avicenne Energy 2024

Supply and Demand of Lead

Lead prices have remained relatively stable compared to other battery metals due to the strength of its 'closed loop' recycling system, which ensures a steady flow of material to meet ongoing needs for battery replacements. This efficient recycling infrastructure helps maintain market equilibrium, reducing the volatility often seen in other metals. While demand for lead remains steady, driven by the need for replacement batteries in existing vehicles, its supply is less affected by global production fluctuations, thanks to the high proportion of recycled content. In contrast, other metals experience greater price volatility due to larger shifts in production and consumption, which are less pronounced in the lead market.

Lead's Place in the Green Energy Transition

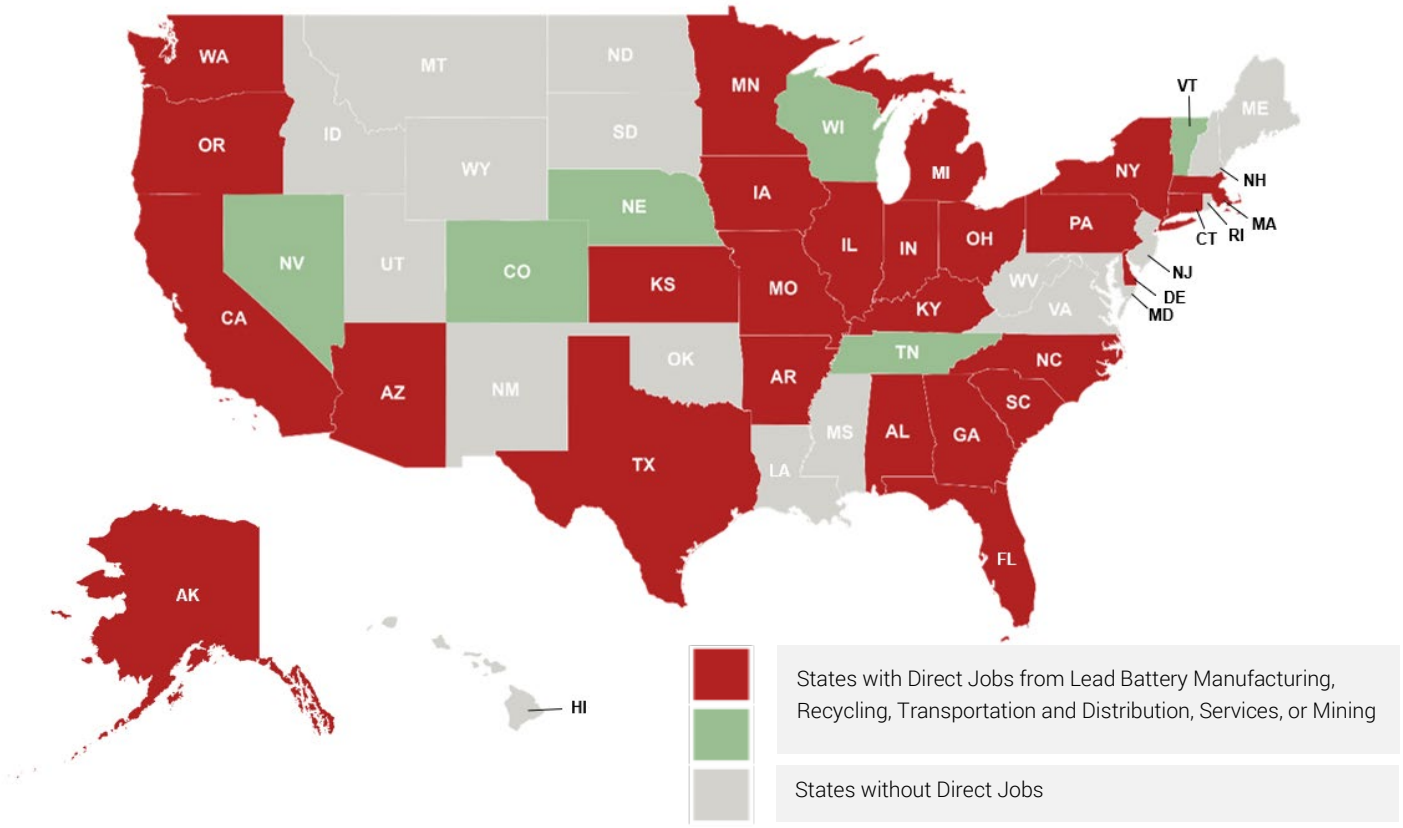
As the transition to greener energy solutions accelerates, the lead battery industry segment faces both challenges and opportunities. While the shift from internal combustion engine (ICE) vehicles to battery electric vehicles (BEVs) is expected to increase demand for lithium batteries, the need for 12V lead-based batteries for starter and auxiliary functions in vehicles remains steady, driven by the existing vehicle population and the ongoing need for battery replacements. Furthermore, the growing reliance on renewable energy sources is expected to significantly boost demand for Battery Energy Storage Systems (BESS), providing an opportunity for lead batteries to expand their market share alongside lithium and emerging alternatives. Although

lead batteries face competition from newer technologies, their role in energy storage and their strong position in vehicle maintenance and replacement applications position them to continue contributing to the energy transition, even as the global energy landscape evolves.

United States Lead Battery Landscape

In 2023, companies in the lead battery industry segment reported direct operations in 26 states, as shown in Figure 4.

Figure 4. States with Direct Lead Battery Activity, 2023



Note: Map shows all US states with BCI members' manufacturing facilities (green states not reported in the survey)
Source: EBP Survey of BCI member companies.

Lead Battery Research & Development Activities

Research and development activities within the lead battery industry segment are dynamic and multifaceted, focusing on enhancing battery performance and sustainability through innovative technologies and strategic partnerships. Key R&D efforts include the development of new

additives and advanced materials aimed at improving recharge times and controlling stratification, thus enhancing the overall efficiency and lifecycle of batteries. Collaborations with institutions like Argonne National Laboratory and partnerships with governmental agencies such as the Department of Defense (DOD), Department of Energy (DOE), and the National Science Foundation (NSF) play a pivotal role in these advancements. Additionally, BCI has received a $5 million grant from the US Department of Energy to establish the Consortium for Lead Battery Leadership in Long Duration Energy Storage (LDES) as part of the DOE's Storage Innovations 2030 initiative. The consortium will unite BCI, the Consortium for Battery Innovation (CBI), eight US lead battery manufacturers, and three national laboratories to focus on pre-competitive research to enhance lead battery technology. The project aims to develop lead batteries that can provide over 10 hours of storage and achieve a Levelized Cost of Storage of $0.05/kWh by 2030.[4]

Improving Battery Performance

The lead battery industry segment is investing in research and development to push the boundaries of battery performance. This involves the development of new additives and technologies that improve recharge times and control stratification (reduction of homogeneity in the electrolyte within a lead-acid battery), which are crucial for enhancing the battery lifespan. Efforts also extend to the exploration of advanced materials, alloys, polymers, as well as formulations for separator materials that contribute to better battery safety and effectiveness. Other R&D activities include development of vanadium redox flow batteries – rechargeable flow batteries that store energy using vanadium ions. Moreover, the industry segment is focused on engineering new machines and processes that facilitate battery manufacturing, incorporating advancements like automation and metallurgical improvements. These enhancements aim to meet growing energy storage demands and adapt to evolving market needs with higher performance standards.

Opportunities in Waste Reduction

The lead battery industry segment places a strong emphasis on enhancing recycling processes as part of its research and development efforts. A primary focus of these efforts includes improving safety, environmental impact, and productivity. Key initiatives feature multi-metals recovery from lead battery recycling and black mass beneficiation, a process designed to extract metals from black mass, a residual material from the recycling process. Additionally, the industry segment is dedicated to improving furnace performance, which aids in minimizing waste and reducing energy consumption during battery production. These waste reduction efforts are

[4] BCI, Battery Council International to Launch Consortium for Lead Battery Leadership, 2024

especially important as new use cases for lead batteries emerge, such as energy storage systems (ESS), another heavily researched area in the industry segment.

Lead Battery Industry Segment Risk

While the lead battery industry segment remains strong, there are several risk factors that could impact demand and operations of lead batteries in the next few years. These stem from a range of economic, workforce, regulatory, competitive, geopolitical, and public health-related challenges.

- **Economy**: Economic fluctuations, such as the macro volatility in lead pricing and global economic conditions, create uncertainties in cost and demand expectations. An economic downturn, particularly within the US economy, could severely impact aftermarket sales of automotive batteries.
- **Workforce Needs**: Labor shortages are another point of industry segment concern. Across the entire battery industry, workforce shortages were reportedly high across all sectors with upstream organizations having the highest labor shortages, followed by downstream and complementary sectors, respectively[5].
- **Compliance measures**: Players in the industry segment have voiced concern over stringent regulatory requirements, including governmental and environmental compliance.
- **Global Competition:** Competitive pressures are also intensifying, with Chinese manufacturers and other foreign competitors using alternative chemistries and capturing market share.
- **Geopolitics**: The geopolitical climate adds another layer of complexity, influencing supply chains and international operations.
- **Public Health**: Public health epidemics or outbreaks pose unforeseen challenges as well, disrupting workforce availability and impacting both production and global market demand.

Historical Trends in Battery Shipments

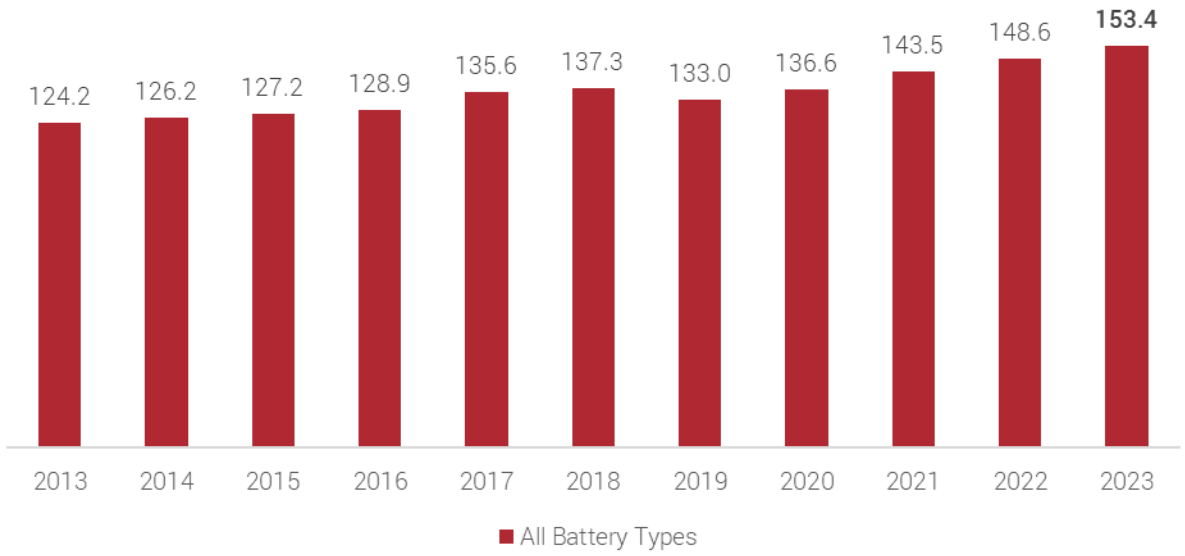
The lead battery industry segment plays a vital role in supporting national security, transportation, communications, and climate resilience. As a proven and reliable technology, lead batteries remain essential in powering critical infrastructure, from backup power for

[5] Center for Automotive Research, Examining Workforce Needs for North America: Battery Industry Education and Training Needs Assessment (BIETNA), 2024

telecommunications and data centers to energy storage for utilities and renewable energy. In transportation alone, every mass-produced vehicle in the US – including electric vehicles – relies on lead batteries proving their indispensable role in both traditional and emerging mobility solutions. With ongoing research and innovation, lead batteries continue to evolve and meet the growing demand for reliable energy storage, which is reflected in historical trends in battery shipments.

Battery shipments in North America, which represent all battery technologies but a significant portion of which represent lead batteries, have shown steady growth over the past decade. This growth reflects both sustained demand for replacement batteries and the increasing role of batteries in new product manufacturing. Figure 5 illustrates historical battery shipments (all battery types) in North America between 2013 and 2023. Battery shipments grew at an average annual rate of 1.6 percent over the last decade, with 15 percent attributed to original equipment shipments supported by growth in vehicle production and the expanding use of batteries in new manufacturing applications. The remaining 85 percent for replacement parts (in passenger vehicles, heavy duty vehicles, RVs, and marine vehicles). More than 80 percent of the batteries shipped for replacement parts went to passenger vehicles underscoring the steady turnover of automotive batteries due to wear, seasonal temperature effects, and consumer maintenance habits.

Figure 5. North America Battery Units Shipments, 2013-2023



Source: EBP Analysis of BCI Shipments Data for 2013-2023.

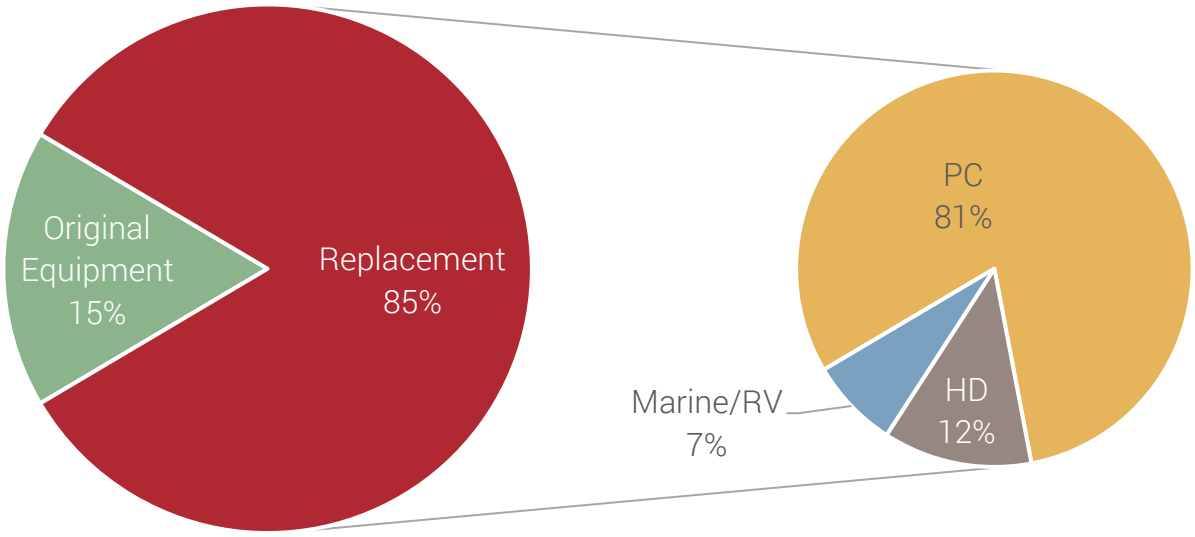
Lead Battery Shipments in 2023

Lead batteries are already a dominant force in critical applications: they provide 88 percent of the backup power needed for 24/7 telecommunications and meet 90 percent of the demand for uninterruptible power supply systems, ensuring reliable energy during emergencies. Every car and truck produced in the US, including electric vehicles, depends on lead batteries, as do 60 percent of forklifts and nearly all motive power applications. With the 12V lead battery automotive market expected to grow by 3 percent between 2020 and 2030, reaching a market value of $30.1 billion, the lead battery industry segment remains a key player in powering transportation, protecting infrastructure, and supporting the transition to a low-carbon future.[6]

In 2023, lead battery manufacturing shipments were predominantly for replacement purposes, accounting for 85 percent of the total, while original equipment shipments made up the remaining 15 percent reinforcing the industry segment's role in supporting transportation, logistics, and industrial applications. Among the original equipment replacement shipments, 78 percent were for passenger vehicles (PC), with heavy-duty vehicles (HD) comprising the other 22 percent. Replacement shipments were more varied, with 81 percent directed toward PC, 12 percent for HD vehicles, and 7 percent for marine and RV applications. These figures highlight the significant demand for replacement batteries, particularly in the passenger car segment. Figure 6 illustrates the dominant role of replacement batteries in the lead battery manufacturing market in 2023, with PC driving both original equipment and replacement demand. As demand for backup power, grid resiliency, and sustainable energy solutions expands, lead batteries remain a critical link in the nation's energy infrastructure.

[6] Battery Council International, https://batterycouncil.org/resource/u-s-lead-battery-industry-by-the-numbers/

Figure 6. Shares of Lead Battery Shipments by Type and Category, 2023



Source: EBP Analysis of BCI Shipments Data for 2023.

Economic Contribution of the US Lead Battery Industry Segment

Types of Economic Impacts

The lead battery industry segment creates jobs and generates business activity throughout the US economy. The total economic impacts of lead battery industry segment include activity directly supported by companies within the lead battery industry segment as well as additional multiplier effects on suppliers throughout the country and on businesses where workers spend their income. This can be described in three types of impacts: direct, indirect and induced, as shown in Figure 7.

Figure 7. Direct and Multiplier (Indirect and Induced) Impacts Generated by the Lead Battery Industry Segment

Direct impacts refer to immediate effects of BCI's member companies on industry segment output. For example, when a member firm manufactures lead batteries, the direct impact includes economic output and jobs from construction, operation, and manufacturing of the equipment.

Indirect impacts are the result of the supply chain activity related to the batteries. Industries that provide goods and services to battery companies, like transportation or raw materials, will see increased demand. For example, a lead battery manufacturer might purchase more sulfuric acid, triggering increased production in the sectors supplying that raw material.

Finally, induced impacts stem from increased spending by workers whose income has been boosted by the direct and indirect activities. When workers employed by battery companies or in the lead battery supply chain spend their earnings on housing, food, or entertainment, for example, this spending stimulates further economic activity in different sectors of the economy, known as the induced impact.

Total Economic Contribution

The US lead battery industry segment generated the following impacts nationally in calendar year 2023:

- **Employment:** The industry segment sustained **106,050 jobs**, including both full-time and part-time positions, in manufacturing, recycling, transportation and distribution, services such as installation and maintenance, and mining industries, as well as indirect or supplier impacts such as automotive repair and maintenance, and induced jobs supported by workers spending their income.
- **Personal Income:** The total economic activity generated resulted in **$8.6 billion** in income earnings such as wages, salaries, and other income earned by employees and households. This highlights the significant financial impact on workers and communities.

- **Business Output:** The total value of goods and services produced reached **$35.0 billion** reflecting the robust economic activity generated across activities.
- **Gross Domestic Product (GDP)**[7]**:** The industry segment contributed **$15.0 billion** to the US GDP representing the net economic value added through production, labor, and other activities within the nation.

Table 1 illustrates the full economic impact of the US lead battery manufacturing in 2023 on the national economy.

Table 1. Economic Impacts of the US Lead Battery Industry Segment, 2023

Economic Impact	Employment	Income ($B)	Output ($B)	GDP ($B)
Direct	28,300	$2.5	$14.1	$4.3
Indirect (Suppliers)	39,600	$3.5	$12.9	$6.0
Induced (Worker Spending)	38,150	$2.5	$7.9	$4.7
Total	**106,050**	**$8.6**	**$35.0**	**$15.0**

Source: EBP Survey of BCI member companies and IMPLAN analysis. Income, Output, GDP expressed as 2023 USD billions.

Lead Battery Wages and Occupations

Companies in the lead battery industry segment reported paying their employees an average of $81,600 across all activities in 2023, higher than the national average income of $72,300 across all US industries in 2023.[8] Table 2 details average payroll per employee reported by lead battery companies. The highest reported wages in the lead battery industry segment were in the battery recycling activity, paying workers an average of $119,700 per employee, followed by lead mining activity, which paid workers an average of $113,000.

[7] Gross Domestic Product (GDP) represents the total value of goods and services produced by the US lead battery industry segment. Output represents total business sales made by the firms in the industry segment. GDP is smaller than output because it excludes intermediary goods and services quantified by payroll, profits, and the cost of supplies. Labor income is included in GDP.

[8] US Bureau of Labor Statistics, Quarterly Census of Employment and Wages, 2023.

Table 2. Direct Jobs and Payroll at US Lead Battery Companies, 2023

Activity	Employment	Labor Income ($M)	Payroll per Employee
Battery Manufacturing	20,060	$1,632	$70,100
Battery Recycling*	3,040	$374	$119,700
Transportation and Distribution	2,700	$229	$96,600
Lead Mining	1,800	$220	$113,000
Battery Services (e.g. installation)	750	$93	$89,300
Total	**28,350**	**$2,549**	**$81,600**

Source: EBP Survey of BCI member companies and IMPLAN analysis.
*Includes Secondary Smelting.

The lead battery industry pays high wages relative to some other sectors such as construction and private industry sectors, as shown in Table 3. Average payroll-per-worker among US battery companies is $81,600, which is higher than the average across all private sector industries, construction and maintenance, retail and wholesale trade, and agriculture.

Table 3. Payroll-per-Worker in the US Lead Battery Industry Segment and Other Sectors, 2023

Activity or Sector	Average Annual Wage
Lead Battery Recycling	$119,700
Lead Mining	$113,000
Professional Services	$85,800
All Lead Battery Companies	$81,600
Construction & Maintenance	$73,150
All private sector industries	$72,600
Lead Battery Manufacturing	$70,100
Retail & Wholesale Trade	$63,800
Agriculture	$46,800

Source: EBP survey of BCI member companies for bolded industries. IMPLAN US Data for non-bolded industries.
Note: All Lead Battery Companies represents the average payroll-per-worker across all lead battery activities represented in the BCI member company survey.

Direct jobs in the lead battery industry segment are filled by workers in a variety of occupations, as shown in Table 4. Production occupations account for more than half of all jobs in the lead battery industry segment, while high-skilled engineers, administrators, and managers account for another quarter.

Table 4. Occupations Included in the Lead Battery Industry Segment, 2023

Occupation Category	Percent of Total Industry Workers	Average Annual Wage
Production Occupations	53.2%	$46,580
Architecture and Engineering Occupations	9.9%	$86,910
Office and Administrative Support Occupations	8.4%	$52,380
Management Occupations	7.8%	$157,110
Business and Financial Operations Occupations	5.5%	$84,680
Transportation and Material Moving Occupations	4.0%	$44,280
Installation, Maintenance, and Repair Occupations	4.0%	$63,130
Sales and Related Occupations	3.2%	$94,860
Computer and Mathematical Occupations	1.9%	$106,250
All other occupations	2.1%	$75,175
Total	**100.0%**	**$81,600**

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

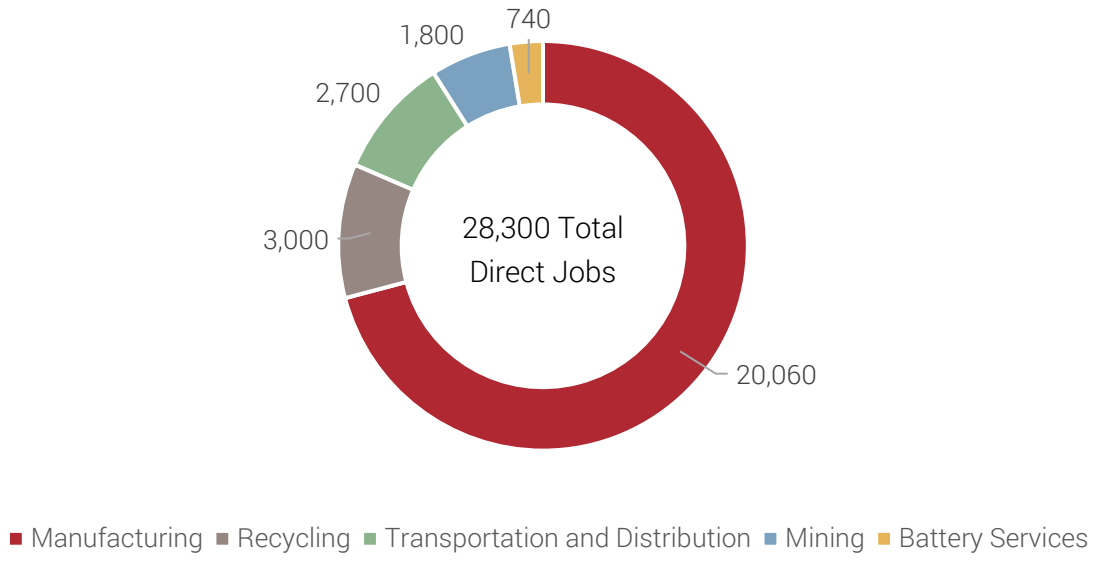
Direct Job Impacts by Sector

The US lead battery industry segment plays a crucial role in supporting employment across several sectors. The manufacturing of lead batteries directly employed more than 20,000 workers, including skilled labor production, engineering, and quality assurance. These jobs offer competitive wages and are geographically distributed, often benefiting regions with existing industrial infrastructure.

The recycling aspect of lead batteries supported 3,000 jobs in 2023, underpinning a circular economy that is vital to the industry segment's sustainability. Recycling operations involve collecting, dismantling, and reprocessing batteries, while reducing reliance on raw material extraction and mitigating environmental impacts. Approximately 2,700 jobs were tied to the transportation and distribution of lead batteries. These roles encompass logistics, warehousing, and supply chain management and ensure that batteries reach automotive, industrial, and backup power markets as efficiently as possible. As a critical upstream activity, lead mining supported 1,800 jobs in resource extraction and refinement in 2023. These positions involve operations at mining facilities that are often located in resource-rich areas and provide economic stability to local communities.

Figure 8 illustrates these interconnected jobs and highlights the broad economic impact of the lead battery industry segment from resource extraction to end-user delivery while contributing to the advancement of sustainable and reliable energy storage solutions.

Figure 8. Direct Jobs Supported by the US Lead Battery Industry Segment, 2023

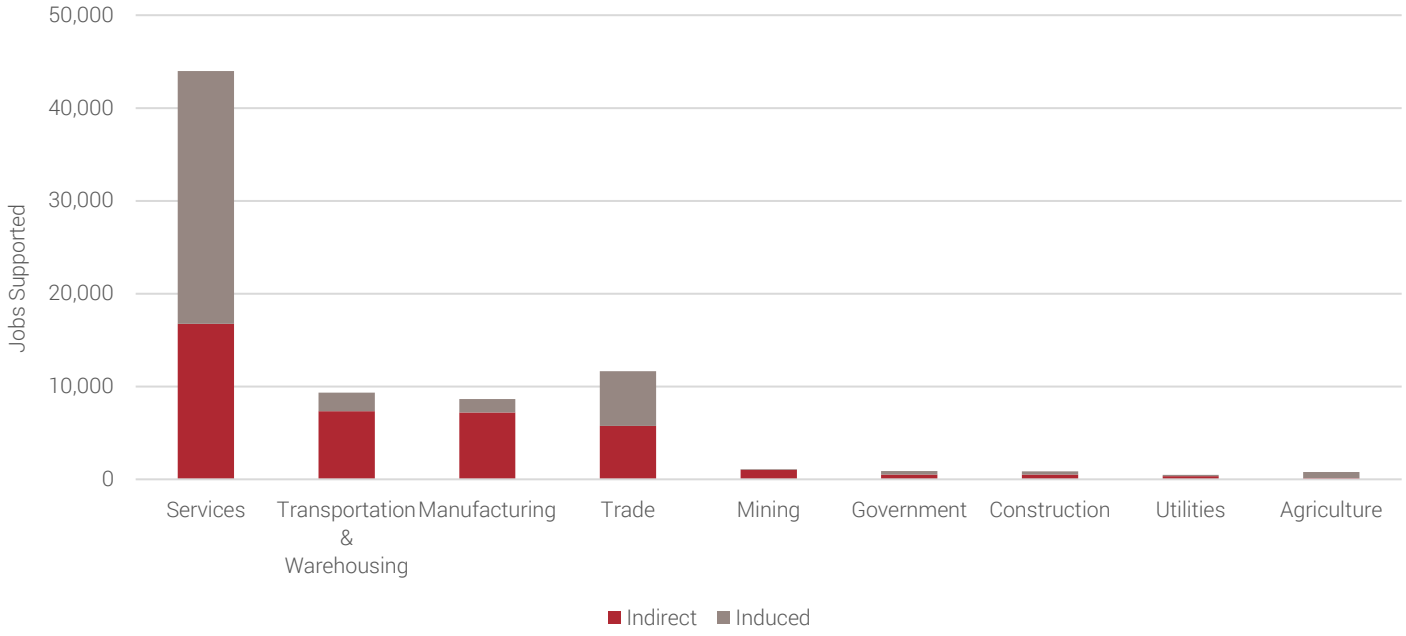


Source: EBP Survey of BCI member companies and IMPLAN analysis

Indirect and Induced Job Impacts

By purchasing goods and services from suppliers and paying wages that workers spend throughout the economy after paying taxes, the lead battery industry segment supports employment in a variety of industries, as shown in Figure 9. Nearly 44,000 of these supplier and worker spending jobs are in the services sector and approximately 30,000 are in manufacturing, transportation, or trade sectors. Figure 9 separates the count of jobs supported by the lead battery industry segment by those generated by the indirect effect (shown in red), and those by the induced effect (shown in gray).

Figure 9. Indirect and Induced Jobs Created by the US Lead Battery Industry Segment, 2023



Source: EBP Survey of BCI member companies and IMPLAN analysis

Indirect Job Impacts

The indirect effect, driven by purchases that lead battery companies from their suppliers, supports about 39,600 jobs. The top segment sub-sector supported by the indirect effect is truck transportation, in which 2,500 jobs are supported by purchases made by lead battery manufacturers and recyclers. This reflects the critical role of logistics in moving materials and products through the supply chain. Truck transportation offers average wages that exceed the national average, underscoring that the indirect impacts of battery manufacturing support not only a substantial number of jobs but also provide well-paying employment opportunities. Wholesale trade in durable goods and courier and messenger services each contribute 2,450 jobs, emphasizing the importance of wholesalers in connecting manufacturers and recyclers to downstream buyers and ensuring the efficient flow of goods and services.

Lead battery manufacturers and recyclers supports 1,600 jobs in real estate activities and 1,150 warehousing and storage operations jobs, indicating the need for operational facilities such as warehouses and further emphasizing the logistics-intensive nature of the industry segment. Supplier purchases by lead battery manufacturers and recyclers also support 1,100 custom computer programming jobs illustrating the role of technology in optimizing operations.

Induced Job Impacts

The induced effect, driven by lead battery industry segment employees spending their earned wages, supports approximately 38,150 jobs. The healthcare industry is the top industry supported by lead battery industry segment worker spending, which supports over 6,000 jobs in various healthcare industry sub-sectors, including at hospitals, doctors' offices, home health care services, nursing and community care facilities, dentists' offices, and medical laboratories and diagnostics facilities. Following healthcare, lead battery industry segment worker spending supports about 4,600 jobs in retail sub-sectors, such as grocery stores, general merchandise stores, and various other retail establishments. Lead battery industry segment workers also spend their income at full- and limited-service restaurants, supporting approximately 3,200 jobs in this sub-sector.

All together, these impacts demonstrate the extensive network of industries that benefit from the indirect and induced effects of the lead battery manufacturing, underlining its significant role as an economic driver that supports job creation.

Impacts of the Total Battery Supply Chain

The downstream effects of domestically produced batteries of all technologies extend far beyond manufacturing driving economic activity across multiple sectors. As batteries move through the supply chain, they generate demand for transportation, retail, installation, maintenance services, while also enabling technological advancements in energy storage, mobility and grid resilience. Table 5 illustrates the broader economic impact of the total battery industry's supply chain highlighting jobs, income, value added, and output in industries that benefit from a robust domestic battery supply chain.

While Manufacturing supports close to 350,000 jobs, the industry's supply chain effects extend significantly into Retail Trade (7.6 million jobs), Construction (4.7 million jobs), and Wholesale Trade (2.5 million jobs) reflecting the widespread distribution and sale of battery-powered products and infrastructure.

Beyond these direct sectors, the battery supply chain stimulates employment in services sectors such as Professional & Business (8.7 million jobs), Financial Activities (8.4 million jobs), and Education & Health (7.0 million jobs). These sectors benefit from the demand for financial investment in battery technology, research and development, and workforce training to support the industry.

Table 5. US Economic Sectors Supported by Industries in the Battery Supply Chain in 2023

Industry	Employment	Income ($M)	Value Added ($M)	Output ($M)
Agriculture & Extraction	1,163,000	$61,000	$104,000	$209,000
Construction	4,712,000	$345,000	$493,000	$900,000
Manufacturing	342,000	$45,000	$84,000	$319,000
Wholesale Trade	2,515,000	$282,000	$543,000	$970,000
Retail Trade	7,562,000	$345,000	$681,000	$918,000
Transportation	1,198,000	$113,000	$136,000	$266,000
Postal & Warehousing	1,424,000	$31,000	$57,000	$64,000
Media and Information	821,000	$106,000	$254,000	$469,000
Financial Activities	8,400,000	$519,000	$1,021,000	$1,998,000
Professional & Business	8,674,000	$840,000	$1,054,000	$1,738,000
Education & Health	6,977,000	$559,000	$613,000	$976,000
Other Services	9,875,000	$378,000	$606,000	$1,027,000
Government	367,000	$40,000	$62,000	$156,000
Total	**54,030,000**	**$3,664,000**	**$5,708,000**	**$10,010,000**

Source: IMPLAN and EBP analysis.
Note: The impacts include downstream industry effects, supported household demand, and government purchases.

Figure 10, Figure 11 illustrates the growth of battery-enabled economic activity from 2019 to 2023 and distinguishes between manufacturing-related and non-manufacturing-related economic output. The chart highlights a steady increase in total economic output over this period, driven primarily by the expansion of non-manufacturing sectors that benefit from battery adoption.

Between 2019 and 2021, economic output remained relatively stable with a slight decline, reflecting market fluctuations and supply chain disruptions during the COVID-19 pandemic. However, by 2023, there was a noticeable increase in total economic output, surpassing previous levels. This growth was largely supported by the expansion of non-manufacturing-related activities such as transportation, retail, financial services, and professional business services. While manufacturing-related economic output remained a smaller component of total battery-enabled economic activity, it still showed incremental growth over time. This suggests continued investments in battery production. The increasing contribution from non-manufacturing industries underscores the far-reaching economic impact of the total battery industry not only in production but also in the widespread adoption of battery-powered applications across multiple sectors.

Figure 11, and Figure 12 compares manufacturing-related economic output enabled by the battery industry across key industry segments from 2019 to 2023. Transportation Equipment Manufacturing remains the largest sub-sector with economic output peaking in 2019 before declining in 2021 likely due to supply chain disruptions and shifts in production due to COVID-19 pandemic. By 2023, the sub-sector rebounded nearly reaching 2019 levels reflecting the growing demand for batteries in vehicles manufacturing and other transportation applications.

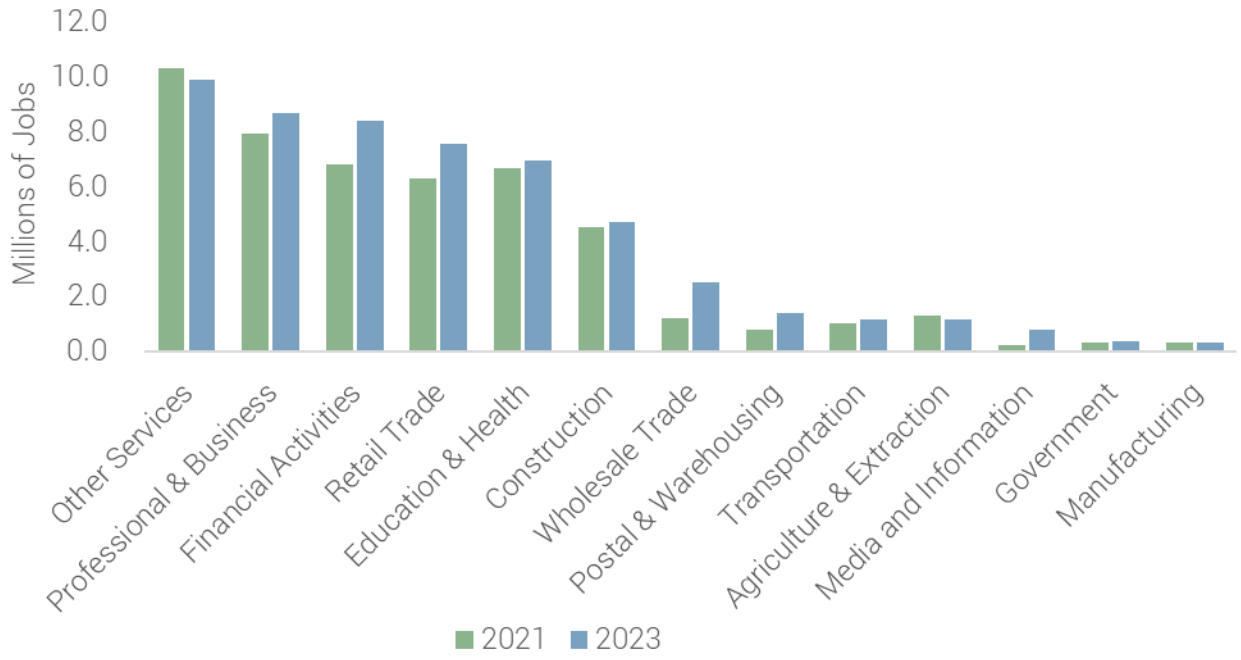
Computer and Electronic Manufacturing also saw a decline from 2019 to 2021 with output stabilizing in 2023 at levels similar to 2021. This sub-sector includes battery-powered consumer electronics, energy storage systems, and critical infrastructure for telecommunications and data centers, suggesting that while battery adoption continues, its growth has been more moderate compared to other sub-sectors. In contrast, Machinery Manufacturing experienced a decline in 2021 but saw a strong recovery by 2023 likely due to the rising use of battery technology in industrial automation, robotics, and other related equipment. Other manufacturing sub-sectors showed steady, though smaller, growth over the period, as battery technology became increasingly integrated into specialized tools, equipment, and other industrial applications.

Table 6 shows downstream impacts of the US battery industry in terms of jobs and output shares relative to national total economic activity in 2023. Retail and Wholesale Trade, and Media and Information have had an increasing share of battery-enabled economic output since 2019 reflecting growing reliance on battery technology across consumer markets and digital infrastructure.

Figure 12 provide further insight into how battery-related economic activity has expanded over the last few years.

Figure 10 compares the economic sectors supported by the battery supply chain in 2021 versus 2023 and illustrates how growth in battery adoption has fueled jobs creation across multiple industries. The largest sectors benefiting from battery-related economic activity include services such as Professional, Business, and Financial. While Other Services remained the largest employment sector, there was a slight decline in 2023 compared to 2021. In contrast, Professional & Business Services and Financial Activities grew during this time reflecting investments in battery-related research, consulting, and financial services. Similarly, Retail Trade and Education & Health saw notable gains due the expanding role of battery-powered consumer goods and the integration of battery technology in medical applications and education.

Figure 10. Economic Sectors Supported, Millions of Jobs in 2021 vs. 2023

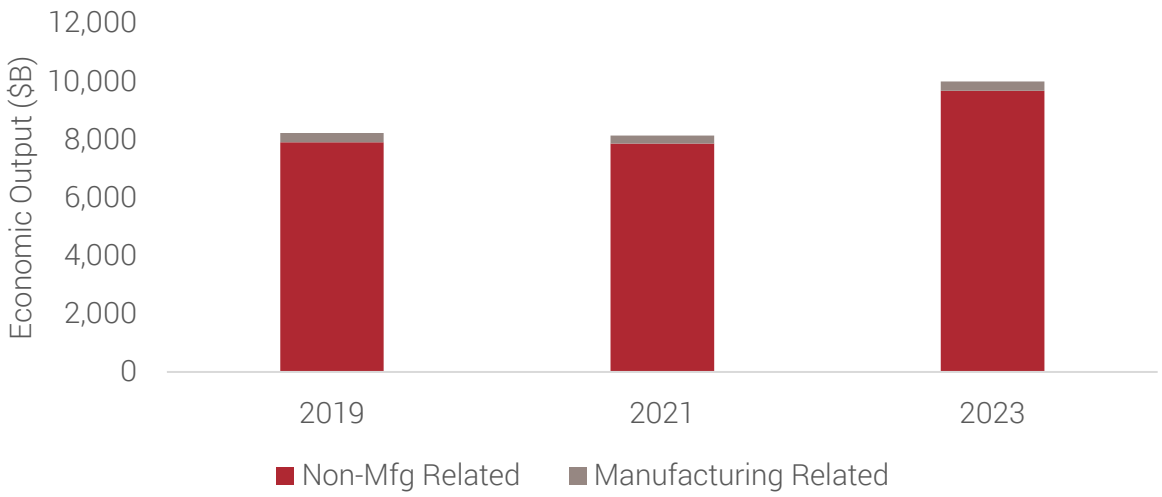


Source: IMPLAN and EBP analysis.

Figure 11 illustrates the growth of battery-enabled economic activity from 2019 to 2023 and distinguishes between manufacturing-related and non-manufacturing-related economic output. The chart highlights a steady increase in total economic output over this period, driven primarily by the expansion of non-manufacturing sectors that benefit from battery adoption.

Between 2019 and 2021, economic output remained relatively stable with a slight decline, reflecting market fluctuations and supply chain disruptions during the COVID-19 pandemic. However, by 2023, there was a noticeable increase in total economic output, surpassing previous levels. This growth was largely supported by the expansion of non-manufacturing-related activities such as transportation, retail, financial services, and professional business services. While manufacturing-related economic output remained a smaller component of total battery-enabled economic activity, it still showed incremental growth over time. This suggests continued investments in battery production. The increasing contribution from non-manufacturing industries underscores the far-reaching economic impact of the total battery industry not only in production but also in the widespread adoption of battery-powered applications across multiple sectors.

Figure 11. Battery-Enabled Economic Activity, 2019-2023



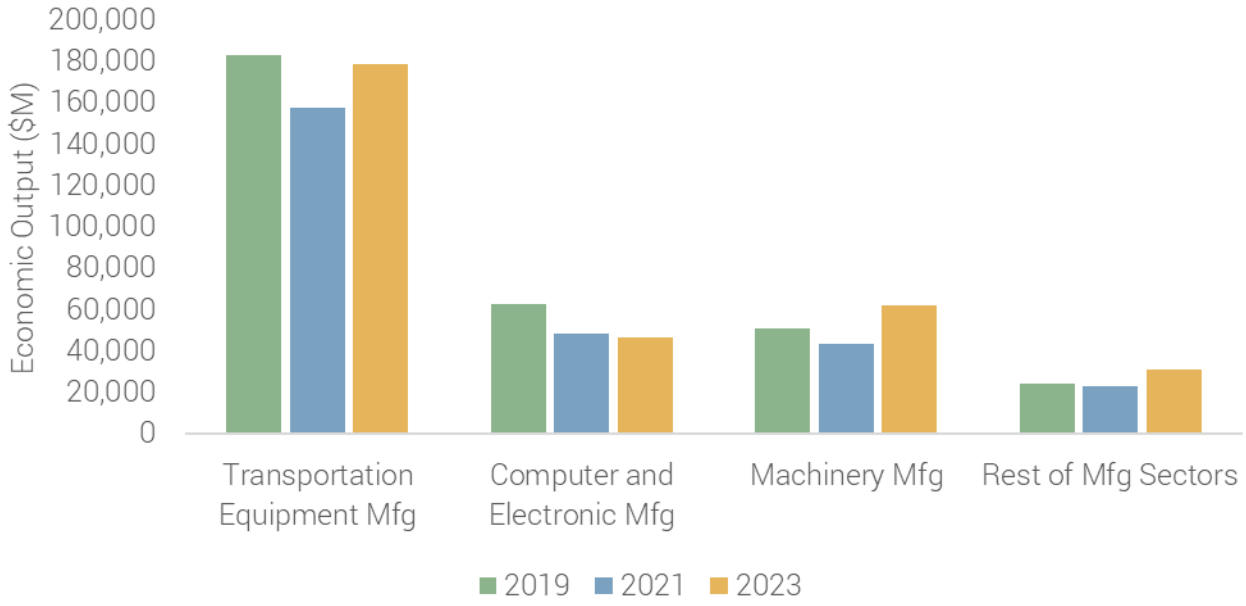
Source: IMPLAN and EBP analysis.

Figure 12 compares manufacturing-related economic output enabled by the battery industry across key industry segments from 2019 to 2023. Transportation Equipment Manufacturing remains the largest sub-sector with economic output peaking in 2019 before declining in 2021 likely due to supply chain disruptions and shifts in production due to COVID-19 pandemic. By 2023, the sub-sector rebounded nearly reaching 2019 levels reflecting the growing demand for batteries in vehicles manufacturing and other transportation applications.

Computer and Electronic Manufacturing also saw a decline from 2019 to 2021 with output stabilizing in 2023 at levels similar to 2021. This sub-sector includes battery-powered consumer electronics, energy storage systems, and critical infrastructure for telecommunications and data centers, suggesting that while battery adoption continues, its growth has been more moderate compared to other sub-sectors. In contrast, Machinery Manufacturing experienced a decline in 2021 but saw a strong recovery by 2023 likely due to the rising use of battery technology in industrial automation, robotics, and other related equipment. Other manufacturing sub-sectors showed steady, though smaller, growth over the period, as battery technology became increasingly integrated into specialized tools, equipment, and other industrial applications.

Table 6 shows downstream impacts of the US battery industry in terms of jobs and output shares relative to national total economic activity in 2023. Retail and Wholesale Trade, and Media and Information have had an increasing share of battery-enabled economic output since 2019 reflecting growing reliance on battery technology across consumer markets and digital infrastructure.

Figure 12. Battery-Enabled Manufacturing-Related Economic Output, 2019-2023



Source: IMPLAN and EBP analysis.

Table 6. Downstream Impacts of the US Battery Industry, 2023

2023 National Economic Summary						
	Battery Related		All National Activity		Battery Share of Total	
Sector	Jobs (M)	Output ($B)	Jobs (M)	Output ($B)	Jobs	Output
Agriculture & Extraction	1.2	209	4.6	1,275	25%	16%
Utilities	-	-	0.7	892	0%	0%
Construction	4.7	900	12.6	2,412	37%	37%
Manufacturing	0.3	319	13.3	8,308	3%	4%
Wholesale Trade	2.5	970	6.8	2,737	37%	35%
Retail Trade	7.6	918	17.7	2,145	43%	43%
Transportation	1.2	266	6.4	1,321	19%	20%
Postal & Warehousing	1.4	64	5.9	414	24%	15%
Media and Information	0.8	469	4.3	2,496	19%	19%
Financial Activities	8.4	1,998	24.7	8,962	34%	22%
Professional & Business	8.7	1,738	33.9	6,280	26%	28%
Education & Health	7.0	976	28.4	3,569	25%	27%
Other Services	9.9	1,027	33.7	3,424	29%	30%
Government	0.4	156	22.8	3,070	2%	5%
Total	**54.0**	**10,010**	**215.7**	**47,305**	**25%**	**21%**

Source: IMPLAN and EBP analysis.

Tax Revenue Contribution

The US lead battery industry segment contributed substantially to public finances and generated significant tax revenues in 2023 at both federal and state/local levels. The industry segment generated an estimated total of $3.01 billion in tax revenues. Federal tax revenues accounted for $2.08 billion reflecting the industry segment's contribution through corporate and payroll taxes, and other federal tax obligations related to both direct and indirect economic activities.

At the state and local level, the industry segment provided close to an additional $1.0 billion in tax revenues. These revenues include property taxes, sales taxes, and state income taxes, which directly support local communities and fund essential public services such as infrastructure, education, and public safety. The tax impacts demonstrate the broader fiscal significance of the lead battery industry segment, which not only sustains employment and economic activity but also provides critical funding to federal and local governments.

Table 7. Tax Revenue Generated by the US Lead Battery Industry Segment, 2023

Revenue Type	2023 Total ($B)
Federal Tax Revenue	$2.08
State and Local Tax Revenue	$0.93
Total	**$3.01**

Source: EBP Survey of BCI member companies and IMPLAN analysis based on average rates for local, state, and federal taxes.

Conclusion

The US lead battery industry segment is comprised of the lead battery manufacturing, recycling, mining, services including installation and maintenance, transportation and distribution activities. The industry segment is also supported by numerous suppliers, retailers, and marketing companies. In 2023, the lead battery industry segment directly supported 28,300 manufacturing, recycling, mining, transportation and distribution, and services jobs.

Production by the lead battery industry segment 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 segment contributed the following to the national economy in 2023:

Employment
Supported a total of **106,050 jobs**.

Income
Total personal income earnings of **$8.6 billion**.

Business Output
Total value of goods and services produced of **$35.0 billion**.

GDP
Total contribution to the US economy of **$15.0 billion**.

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 segment contributed $2.08 billion in federal tax revenue and $0.93 billion in state and local tax revenue in 2023.

About Battery Council International

Battery Council International (BCI) just celebrated 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 battery industry segment to successfully communicate and protect through education, science, and government efforts the most successful circular economy on the planet. With 99 percent of used lead batteries collected and recycled in the US and the typical new lead battery containing 80 percent 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.

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, Chile, and India.

Appendix

Methodology

This analysis is based on 2023 industry data and uses the 2023 IMPLAN economic model for the US All results are in 2023 dollars.

A survey process was used to collect limited but key annual data from BCI member companies. Compilation of the survey-derived and supplemental information represents direct impacts. The survey probed annual employment, payroll, and business sales revenue by battery activity: manufacturing, recycling, mining, transportation and distribution, and services such as installation and maintenance. There were several instances where direct sales revenue or payroll were estimated using national employee compensation-to-jobs ratios because survey respondents chose not to report annual payroll or employment. Reported and estimated direct impacts were then aggregated across companies at the activity-level before being uploaded into IMPLAN, an input-output (I-O) economic impact model which traces the flow of spending through the economy starting with direct impacts. Once direct impacts were fed into IMPLAN, the I-O model's linkages and multipliers were used to calculate the additional indirect and induced impacts in terms of economic output, value add, income, or employment generated for every dollar of direct spending.

Changes from Previous 2021 Study

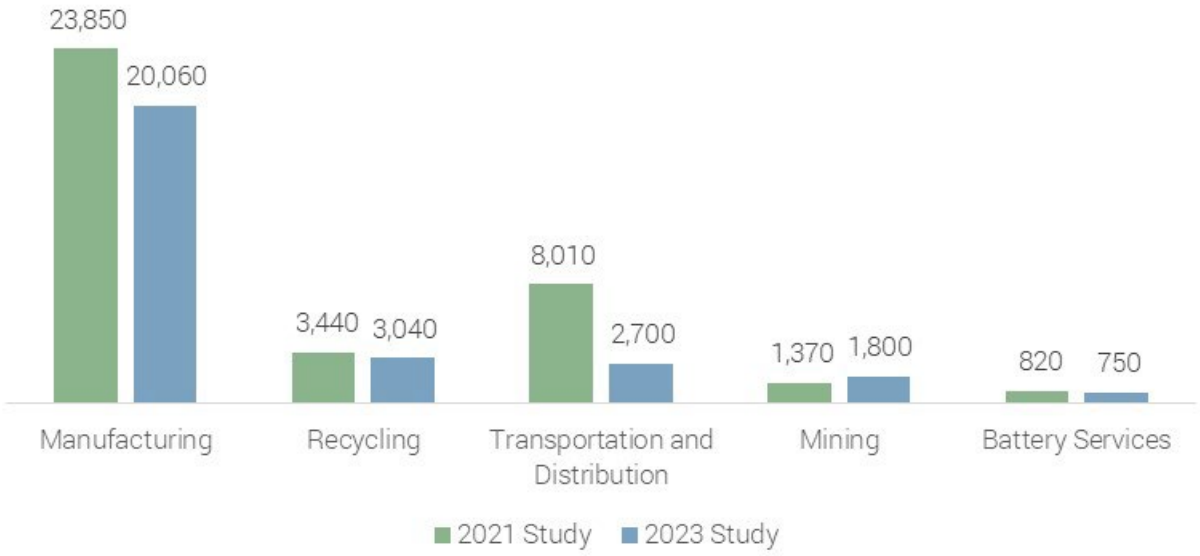
It is important to note that the results in this study differ from the previous economic impact of the lead battery industry segment study conducted in 2021 due to differences in the makeup of survey responses from BCI member companies. Differences in responses can be attributed to the following key reasons:

1. Some companies in the lead battery industry segment have continued to undergo changes in operations, closing of or opening of new facilities, and other variable effects from the COVID-19 pandemic and disruptions to supply chains.
2. The pool of survey respondents differs slightly from the respondents to the 2021 survey. There are several new respondents who participated in the 2023 study alone, as well as several member companies that responded to the 2021 survey but did not participate in the 2023 study. Additionally, several companies have changed the ways in which they classify and report certain jobs and activities in their operations.
3. Not all respondents were able or willing to provide specific employment, sales, or payroll information on their business.

These changes affect the total direct activity reported by BCI member companies, as well as the multiplier effects of this direct activity throughout the wider US economy.

Figure 13 provides a visual comparison of the direct jobs that were reported in the previous study versus those reported in the current study. As depicted, fewer jobs in the manufacturing, recycling, transportation and distribution, and battery services activities were reported in 2023 than were reported in 2021. Reasons for these decreases include changes in battery companies' operations, select company counts no longer including independent distributors, and member companies improving reporting accuracy.

Figure 13. Direct Jobs Supported by the US Lead Battery Industry Segment in 2021 vs. 2023



Source: EBP 2021 and 2023 Surveys of BCI member companies and IMPLAN analyses

Definition of Terms

Input-output models are commonly used to conduct economic impact analysis. There are several input-output models available, including IMPLAN.[9] 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

[9] See www.implan.com for more information.

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.[10]

Economic Contribution

Economic contribution represents a "gross change in economic activity associated with an industry, event or policy in an existing regional economy."[11] This is different from an economic impact, which represents a net change in economic activity.

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

[10] https://implanhelp.zendesk.com/hc/en-us/categories/115001507908-Knowledge-Base

[11] 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.

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.