Friendshoring the Lithium-Ion Battery Supply Chain

Battery Cell Manufacturing

By William A. Reinsch, Meredith Broadbent, Thibault Denamiel, and Elias Shammas

Introduction
Nearshoring the lithium-ion battery supply chain requires substantial policy efforts at every stage. Upstream inputs, such as critical minerals sourcing and processing, are concentrated in a few nations. Although many more countries engage in midstream and downstream processing of critical resources, access to this end of the supply chain is becoming less secure for U.S. manufacturers because of uncertainty in the domestic and geopolitical spheres.

Commensurate to the breadth of the challenges is the importance of overcoming them. An adequate, predictable supply of lithium-ion batteries, as well as the supply chain and raw materials, is essential to reaching green transition goals in the United States. These batteries power key products that enable a sustainable, large-scale switch away from fossil fuels essential to long-term environmental goals.

Calls to accelerate the shift to renewables are accompanied by other goals and legislation that have a significant impact on the direction of U.S. economic and trade policy. Recognizing China’s dominance over the supply of several goods critical to U.S. prosperity and security, policymakers say they intend to spur de-risking of these supply chains by diversifying import sources away from the People’s Republic of China (PRC), as well as creating redundancies to protect against potential unforeseen shocks such as pandemics. Policymakers’ de-risking agenda goes hand in hand with government measures designed to bring production of critical goods back to the United States. They perceive renewing U.S. domestic manufacturing capabilities as a geostrategic shield as well as the pathway to creating more profitable and equitable opportunities for workers.
Congress and the administration under President Joe Biden have thus undertaken several policies to simultaneously tackle three objectives that will transform the landscape of U.S. lithium-ion battery production, among other sectors. These policies aim to drastically quicken the pace of the U.S. green transition, reshore production capabilities in critical sectors, and diversify away from the PRC’s dominance in these key areas. While these three goals may all be critical to U.S. economic security in the long term, actions that enable the latter two could hamper achievement of the first. Unfortunately, measures aimed at securing the lithium-ion battery supply chain through industrial policy packages that emphasize reshoring threaten to hinder U.S. consumers’ access to this technology.

This brief, the second in a series of three, builds upon the first’s findings on refining and processing and examines the production of active materials—the next step of the lithium-ion battery supply chain. The paper first outlines the technical steps necessary for active materials production—namely, mixing, coating, calendaring, and slitting, as well as production of the separator and electrolytes. It then describes current U.S. capabilities at this stage of the supply chain relative to the global market, considering the country’s nearshoring and onshoring ambitions.

In addition, the brief addresses the Biden administration’s incentives, such as tax credits included in the **Inflation Reduction Act of 2022** (IRA) and grants programs enabled by the **Infrastructure Investment and Jobs Act** (IIJA). It continues with an examination of different regulations and their potential impact on the ability of lithium-ion battery input manufacturers to scale up their capabilities in the face of growing demand. Lastly, the report unpacks recent policy recommendations from Congress relevant to lithium-ion battery nearshoring considerations.

**Manufacturing a Battery Cell**

**ACTIVE MATERIALS PRODUCTION**

**Technical steps.** After mining or extracting the raw minerals and materials—typically, lithium, cobalt, manganese, nickel, and graphite—processors and refiners purify them. The materials are then used to create cathode and anode active battery materials, which are commonly referred to as the midstream portion of the lithium-ion battery supply chain. Noteworthily, the active material production stage requires complex processes and advanced technologies and chemistries, meaning there are few producers and significant technical barriers to entry.

As mentioned in the first paper of this series, a lithium-ion battery usually includes multiple lithium-ion cells, which function as interconnected building blocks. A **lithium-ion cell** is chiefly made up of an anode, a cathode, a separator, and an electrolyte. The anode is the negative electrode in a cell, whereas the positive side is the cathode. During charging, the lithium ions move from the cathode, through the separator, to the anode.

The cathode component of the lithium-ion battery may comprise various formulations, chemistries, and crystalline structures. Metal oxides like cobalt, nickel, manganese, aluminum, iron, and phosphate, among others, make up the formulations and chemistries known as the cathode active materials (CAMs). Binders and cognitive additives such as polyvinylidene fluoride (PVDF) are also critical to the battery’s performance, especially for safer and longer-range applications. As mentioned in the first paper of this series, graphite is paramount to anodes, though industry is searching for ways to use alternative materials such as silicon or lithium given that they present opportunities for higher energy density and power.
The process of converting a set of refined and purified critical minerals into functional components of electrodes—namely, a positively charged cathode and a negatively charged anode—may be divided into five key steps. These are mixing, coating, calendaring, slitting, and electrode making.

**Mixing.** The active materials of the cathode, lithium, nickel, manganese, and cobalt, are dry blended in a planetary vacuum mixer. The active material of the anode is blended to ensure it approaches a viscous consistency. The anode and cathode materials are blended separately to ensure they do not react with one another. A solvent is added to both mixes to increase viscosity, which is critical as the viscosity, density, and solid content of the slurry affect battery longevity and performance. An additional key concern in the mixing process is air quality: controls on moisture level can limit air particles or impurities that contaminate the electrode slurry, but if moisture is not controlled, then the nickel is likely to corrode. Adding phosphoric acid or another solvent can also prevent corrosion.

**Coating.** Coating broadly describes the process of applying the separate aluminum-cathode and copper-anode slurries onto metal foils. Once poured, the slurries are dried via an internal heater that operates between 70°C and 150°C. While warmer temperatures lead to lower production costs, there is a negative effect on the performance and overall longevity of the battery. Coating and drying are achieved via a slot die coater, which disperses the slurry through gaps onto moving metal foil. Once the slurry is dispersed, air flotation drying is used to evaporate any added solvents and provoke the sedimentation of particles, which is critical to battery performance. The newfound metal coating successfully protects the slurry from corrosion and damage. Both drying temperature and the speed at which drying occurs affect the distribution of slurry in each electrode. Generally, drying at room temperature, while slower, creates a more uniform dried slurry, thereby increasing the quality and longevity of the electrode.

**Calendaring.** Calendaring occurs through compression of the coated electrodes onto collector metal foils. This improves the energy density of the battery and further controls for dust and humidity within the electrode. This compression to a point of even thickness and density of the dried slurry increases performance. A roller calendar is used during this stage. Generally, higher calendaring pressure increases the energy density of a given battery, thereby increasing battery life.

**Slitting and electrode making.** A roller slitting machine then cuts the coated electrode into several slices. An electrode-making machine welds and cuts the electrode, and the anode, cathode, and separator are either stacked or wound into a spiral, depending on the type of battery. The machine clearly marks each side as “+ve” or “-ve,” and the electrolyte fluid (a lithium salt solution) is injected into the battery cylinder or pouch. The battery cell is then sealed and thus ready for use.

**Separator production.** Separators may be manufactured via a dry or wet process. Regardless, they are made of either polypropylene or polyethylene (types of plastic). In the dry process, either plastic type is pushed through a machine to create a thin sheet. The sheet is then heated until the plastic melts. This step controls the size and alignment of the tiny crystal structures within the sheet that allow lithium ions to pass through once the battery is functional. The sheet is then stretched again to create a set of additional slit-like holes. The stretching occurs until the sheet has a porosity of roughly 40 percent. The wet process, in contrast, involves mixing softening agents that can turn polymers into plastics once heat is applied. The heated mixture is pushed out of a machine to form a sheet, which is stretched until a network of pores is present. The softening agent is then washed out, leaving a porous surface that allows lithium ions through.
Electrolyte solution production. Electrolytes enable the conductivity of lithium-ion batteries by allowing for the movement of ions from the cathode to the anode when the battery is charging and from the anode to the cathode when the battery is in use. Electrolyte solutions are made up of soluble salts, acids, and other bases in a liquid format. When these solutions are mixed with various carbonates, such as vinylene carbonate, conductivity can increase, leading to improved battery performance.

**CURRENT U.S. CAPABILITIES**

As it stands, China dominates the active materials production portion of the lithium battery supply chain. In addition, South Korea and Japan have significant capacity. The United States finds itself a distant fourth, a position where it is likely to remain for 10 years despite significant investment. As of 2022, China produced roughly 90 percent of anodes and lithium electrolyte solutions.

China also produces 70 percent of cathodes, 74 percent of separators, 82 percent of electrolytes, and 85 percent of anodes. Japan, a secondary player in the industry, produces 14 percent of cathodes, 11 percent of anodes, 31 percent of separators, and 19 percent of electrode solutions. South Korea manufactures 15 percent of the world’s cathodes and 3 percent of anodes. The United States occupies a far more modest role in the supply chain than its peers in East Asia, responsible for roughly 7 percent of battery production. It imports most components, such as cathodes and anodes, from abroad.

One factor that hampers onshoring efforts in the United States is the high cost of production. Whereas the average lithium ferrophosphate cell factory in China costs $650 million to build, it costs roughly $865 million to build a similar facility in the United States or Europe due to differences in labor costs and supporting facilities. This difference in cost has created a global status quo that has favored, and will continue to favor, Chinese hegemony over the midstream. While the United States is predicted to see battery production increase to roughly 1.2 terawatt-hours (TWh) by 2030, corresponding increases in Chinese production will ensure most global battery production continues to occur in China. By 2030 the United States is set to produce 0.8 million metric tons of cathodes per annum, though demand will stand at 1.3 million metric tons. Domestic anode supply will also stand at roughly 500,000 metric tons per annum, with demand hovering at 700,000 metric tons. These shortfalls will therefore drive the importation of cell components, such as cathodes and anodes, for locally produced batteries. Nonetheless, domestic demand for battery cells in the 2030s will likely outstrip the supply of battery active materials despite increases in domestic manufacturing.

---

**The PRC’s Influence over Commodity Prices**

China’s dominance over commodities critical to the lithium-ion battery supply chain—along with the PRC’s internal demand for lithium-ion battery products, chief among them electric vehicles (EVs)—has a marked effect on the global prices of these commodities. In recent years, an annual doubling of Chinese demand for EVs has caused prices of key minerals and battery components to remain elevated. While demand is still increasing as of 2023, the rate of increase has slowed to only 30 percent. Analysts predict this leveling off of demand will continue in the coming years and that the era of annual doubling has ended.
This reduction in demand has led to a 50 percent decrease in nickel futures since December 2022 and an 80 percent decrease in lithium carbonate prices. The oversupply of critical minerals resulting from the relative drop in Chinese demand is further exacerbated by the fact that nations that produce critical minerals used in EVs—such as those in the Lithium Triangle (Chile, Argentina, and Bolivia) and Indonesia, which produces nickel—have drastically increased their investment in mines in the hope that demand would continue to double annually for the coming few years. To that end, annual lithium production increased by 23 percent worldwide in 2023, while nickel output grew by 10 percent, according to U.S. Geological Survey estimates.

In response to this decrease in prices, China’s government is planning to increase the size of its strategic stockpiles of cobalt by buying up 3,000 tons of privately owned cobalt from producers to add to the nation’s commodity stockpile. China added 5,000 tons of cobalt to its stockpile in July, representing another opportunity to take advantage of low cobalt prices, which have decreased by 60 percent since May 2022 due to rising supplies from the Democratic Republic of the Congo and Indonesia. These stockpiles are being expanded to protect domestic producers and military manufacturers from supply and price shocks.

While S&P Global projects that commodity prices will stabilize in the coming years, existing price volatility poses a challenge for new firms entering the industry. Firms that are profitable while commodity prices are low, for example, may be forced to shut down prematurely if prices of lithium carbonate spike. Both nascent and long-standing firms therefore require some protection from the ebbs and flows of the market.

To that end, China acts to protect its domestic battery industry from external shocks by enforcing export license requirements on graphite, which is regarded as the most critical mineral for battery anodes. Given the market for graphite is expected to triple in the next five years and that China produces more than 90 percent of spherical graphite—the type primarily used in batteries—export licensing efforts give China leverage over the price and global supply of both graphite and anodes. Adoption of the export license requirement comes on the heels of an August 2023 rule that requires export licenses for rare earth elements gallium and germanium, which are both primarily used in semiconductors, though they have applications in EVs as well. For instance, gallium nitride can handle a lot of power without generating heat, making it ideal for onboard chargers and inverters. The new export license requirement led to a sharp increase of 25 percent in gallium prices, which has remained constant since. More critically, these curbs highlight China’s willingness to use export license requirements as a means to control the supply and price of key minerals in the supply chains of electric appliance components.

This export licensing effort serves two PRC objectives. The first is a means of geopolitical leverage, especially against nations that have tense relations with China despite significant trade, such as the United States. The second is an attempt to boost the competitiveness of China’s domestic high-value industries. To that end, Beijing increased the number of restrictions on critical raw materials needed for electric cars and renewable energy, such as lithium, cobalt, and manganese, by a factor of nine between 2009 and 2020.
RECYCLING
As the demand for lithium-ion batteries continues to grow, efficient recycling methods become increasingly relevant. The minerals and raw materials involved in producing a lithium-ion battery can be scarce and costly to extract and refine. Recycling lithium-ion batteries is therefore less energy intensive than producing new batteries from raw minerals. A thriving recycling industry enables lithium-ion battery manufacturers to bypass the challenges of the upstream stages of the supply chain and closes the loop of the circular economy by enabling additional cell production.

With their easily separable and durable components, traditional lead-acid batteries are relatively simple to recycle. Over 90 percent of lead-acid batteries are recycled as a result. The recycling process for lithium-ion batteries, however, is substantially more complex since lithium is highly reactive (flammable). Typically, devices that contain lithium-ion batteries are collected by the original retailers, an e-waste collector, or a business that specializes in collecting used electronics.

Battery packs are sorted and shipped to collection and processing facilities. Some packs are designated for repair or reuse. Those that are not undergo a process called shredding, through which the battery is chopped into pieces, creating a “black mass”—granular material made up of the dismembered cathodes and anodes of batteries. According to the U.S. Environmental Protection Agency (EPA), there are currently no industry standards defining the exact components of black mass from which valuable metals like cobalt and nickel are extracted. The shredding and extraction processes require a relatively high amount of energy, decreasing the extracted components’ value and creating some disincentives for reprocessing. Additionally, the lack of common regulations or standards for EV battery recycling, particularly advanced chemical processes for recycling as well as restrictions on the trade of used batteries, serve as additional limiting incentives for reprocessing and recycling efforts.

In response to these issues, the U.S. Department of Energy has devoted $62 million in funding set forth in the Bipartisan Infrastructure Law toward efforts that entice consumers to engage in battery recycling and improve the overall economic viability of private recycling efforts. Examples of these investments include $14.4 million in student education and outreach programs that will strengthen collection efforts for end-of-life electronics and $40 million toward projects that generate “greater market demand for recycling consumer electronics batteries” through cost-savings approaches within the preprocessing and sorting sectors. Government and private sector efforts to establish battery drop-off programs also received $7.2 million in funding.

Promoting Active Materials Production
Key to U.S. economic security is the assurance that critical goods—among which lithium-ion batteries are included given their importance to the green transition—have resilient and secure supply chains. The lithium-ion battery supply chain is currently dominated by countries of concern and a just-in-time model that can withstand neither geopolitical fragmentation nor black swan economic shocks. In particular, U.S. dependence on PRC inputs reflects a long-term risk to national security that should be addressed. U.S. economic partners and allies are currently in a better position to satisfy demand for active materials: nearshoring and friendshoring efforts therefore represent a necessary step toward countering such dependence. Another important piece of the puzzle is to promote domestic
production. The Biden administration and Congress have leveraged several policy tools to spur the latter, such as tax incentives, grants, and loans.

\[
\text{The lithium-ion battery supply chain is currently dominated by countries of concern and a just-in-time model that can withstand neither geopolitical fragmentation nor black swan economic shocks.}
\]

**Biden Administration Policies**

**Tax Incentives.** Current tax incentives included in recent industrial policy packages—chief among them the IRA—aim to provide a launchpad for domestic manufacturers. They are meant to spur production of multiple goods necessary to the green transition, including the active materials production stage of the lithium-ion battery supply chain.

When it comes to producing electrode materials, such as anodes and cathodes, the IRA's 45X advanced manufacturing production tax credit (PTC) is a boon for U.S. manufacturers. With eligible materials receiving a credit of 10 percent of the cost of production, the PTC is designed to support development of the active materials production stage of the supply chain. The tax credit applies to both equipment and minerals produced in the United States and sold between December 31, 2022, and December 31, 2032. Further, the produced equipment must be sold to an unrelated party as part of the taxpayer's trade or business. There is a credit amount phaseout beginning in 2030 for only the manufactured components, but credits for critical minerals will expire without phasing out over time.

However, the effectiveness of this tax credit is somewhat limited as it applies to specific production costs only. It does not cover direct or indirect material costs, nor does it include expenses related to the extraction, production, or acquisition of raw materials. These exclusions limit the overall utility of the credit in boosting domestic production of electrode active materials and instead ensure that it is only an impetus for production for firms at the margins.

Another supply-side incentive the IRA provides is the 48C investment credit, awarded by the Department of Treasury in partnership with the Department of Energy. It awards credits of up to 30 percent of capital investment, provided the relevant project satisfies wage and apprenticeship requirements. This incentive has more regulatory barriers than the 45X credit, as project developers must apply to the Department of Energy and receive a decision from the Internal Revenue Service. In addition, total financing for the investment credit is capped at $10 billion.

The 48C investment credit is geared toward bridging the gap between the required capital expenditures to develop factories in the United States and China. According to Columbia University's Center on Global Energy Policy, the capital expenditure intensity in the United States averages around $90 million per gigawatt-hour (GWh), about a third higher than the $60 million per GWh capital expenditure required in the PRC. China clearly maintains the dominant position in access to raw materials, processing capabilities, and active materials production. Nevertheless, the investment credit helps enhance U.S. competitiveness. U.S. gigafactory capacity in the pipeline through 2030 has
increased by roughly 70 percent, from around 700 GWh in July 2022 (before the IRA) to just over 1.2 TWh in July 2023.

**Grants and loans.** While the United States is currently not a major player in refining and active material assembly, significant amounts of onshore capacity are expected to come online in the coming years. Spurred by government-backed loans and private investments totaling $1.6 billion, firms such as **Our Next Energy** are set to begin producing 20 GWh of cathode materials and battery cells in a Michigan plant set to come online in late 2024. Plans for the gigafactory were announced in **October 2022**, giving it an ambitious timeline of roughly two years between the announcement of additional capacity and that capacity coming online.

The two-to-three-year timeline also applies to gigafactory projects that Redwood Materials, Tesla, and Gotion are currently pursuing. These factories, which will focus on cathode production, anode manufacturing, and lithium refining, respectively, will collectively amount to 200 GWh in capacity once operational.

However, the rollout of these gigafactories is already experiencing some setbacks. Ford announced it would pause development of a 35 GWh plant worth $3.5 billion in Michigan. Delays in battery cell factories coming online arise largely due to shortages in skilled labor, efficiency limitations, and unforeseen price increases for active materials. In recent years, pricing hurdles were driven by a surge in lithium carbonate prices from roughly $6 per kilogram in 2020 to $70 per kilogram in November of 2022. Since cathode active materials represent roughly 50 percent of total manufacturing costs for battery cells, such increases have placed barriers to entry on expanding battery cell manufacturing capacity. Yet in the last two years, these increases have largely reversed, and prices have plummeted back to $14.50 per kilogram. While this value is almost three times higher than in 2020, the effect of pricing concerns on gigafactory rollout is far more modest than it was in 2022.

Additionally, U.S. workers may lack the necessary manufacturing experience, effectively ensuring that even when plants and gigafactories come online, they will not produce active materials with high efficiency. Gigafactory construction requires a set of competencies related to “equipment maintenance [and] troubleshooting production” not widely available within the U.S. workforce. Additionally, once factories have begun producing materials and finished cells, they also face assembly line staff shortages, as the U.S. workforce is largely trained in **internal combustion engine** manufacturing rather than in battery production. Ohio, for instance, has 58,000 open roles related to EV manufacturing. Aside from competencies, another cause of this labor shortage is the relatively low compensation levels compared to the broader automotive sector. The starting wage at a GM battery cell plant in Ohio is **$16.50 an hour**, while the average assembly line worker at a United Auto Workers plant makes roughly **$28 an hour**. While lower wages serve as a hedge against active material price increases, they also ensure labor shortages going forward.

Initial production yields for battery cell lines among new entrants to the sector in the United States are often as low as 50 percent. As shown by the Center on Global Energy Policy, projections through 2032 clearly show North America will have the gigafactories to satisfy cell demand but will not have the local supply of cathodes and anodes to construct those cells.
The Biden administration’s EPA sees lithium-ion battery recycling and repurposing as a means of domesticating this lithium-ion battery supply chain, particularly since U.S. lithium reserves make up just 4 percent of the world total. In the near term, the EPA seeks to take the following steps to encourage these processes:

1. Foster the design of battery packs for ease of second use and recycling.
2. Establish successful methods for collecting, sorting, transporting, and processing recycled lithium-ion battery materials, with a focus on reducing costs.
3. Increase recovery rates of key materials such as cobalt, lithium, nickel, and graphite.
4. Develop processing technologies to reintroduce these materials into the supply chain.
5. Develop methodologies for proper sorting, testing, and balancing for second-use applications.
6. Establish federal recycling policies to promote collection, reuse, and recycling of lithium-ion batteries.

The IIJA grant disbursement notes that the focus of the funding is primarily on lithium processing, with nickel and graphite processors also receiving some grant money. The IIJA guidebook provides a comprehensive overview of all IIJA programs and grants, including several focused on active materials production and battery recycling:

1. Battery Manufacturing and Recycling Grants ($3 billion total)
2. Battery and Critical Mineral Recycling ($125 million total)
3. Lithium-Ion Recycling Prize ($10 million total)
4. Battery Recycling Best Practices ($10 million total)
5. Electric Drive Vehicle Battery Recycling and Second Life Applications ($200 million total)

The U.S. Department of Energy also announced $192 million in funding in June 2023 to expand battery recycling research and development, calling the investments “essential” to the advancement of a domestic supply chain of critical materials for the energy transition.

However, the Biden administration’s investments in recycling capabilities may face similar roadblocks as the active materials production hubs. In October 2023, Li-Cycle Holdings Corp., which was set to receive significant backing from the Biden administration, saw its share price cut by almost 50 percent after announcing it would pause construction on a lithium-ion battery recycling plant. Li-Cycle assessed that it was facing escalating costs in attempting to operationalize its fabrication plant.

While battery recycling is a relatively new market in North America, more mature firms abroad are also encountering issues. In the PRC, for instance, there are too many recyclers and not enough materials to go around, making many businesses’ operations currently untenable. It may take several years for recycling to become a viable industry in the United States: there are still relatively few EVs on the road, and other electronics that contain lithium-ion batteries are challenging to collect and too few in number to meet the needs of budding lithium-ion battery demand. Thus, the sector may encounter losses before becoming sustainable.
CONGRESSIONAL CONSIDERATIONS

A report by the House Select Committee on Strategic Competition between the United States and the Chinese Communist Party, released in December 2023, offers some insight into the bipartisan ad hoc committee’s thinking on diversifying the lithium-ion battery supply chain. The report’s recommendations may be split into two categories: those that pertain to critical minerals and those that pertain to battery manufacturing.

When it comes to critical minerals, the committee’s report recommends enacting legislation to “encourage sectoral agreements with key trading partners and allies with strong rules of origin and high standards on critical minerals,” in addition to sourcing critical minerals and materials domestically and from friendly nations. This demonstrated openness to ensuring U.S. partners and allies become a stronger part of the country’s critical minerals supply chain, instead of solely focusing on onshoring, could enable lithium-ion battery manufacturers to scale up their production capabilities.

However, the report recommends incentives with domestic content requirement guardrails that partially defeat the friendshoring purpose of the overarching recommendations. Limiting the sourcing of necessary minerals and materials to U.S. production in part negates the diversification objectives in these tax credits. The enhanced recycling measures the report recommends—such as requiring the Defense Logistics Agency Strategic Material Recovery and Reuse Program to pilot a recovery program to extract strategic and critical materials from end-of-life government hard disk drives—would likely not make up, in time or amount, for the production capabilities of U.S. partners.

The report’s recommendations about batteries pose a similar issue, as its proposals largely emphasize the need to “encourage a domestic battery recycling industry.” Ramping up recycling efforts could help the U.S. lithium-ion battery industry become self-sufficient as more batteries are retired, while limiting incentives to domestic efforts would curtail U.S. access to additional lithium-ion battery materials. In addition, recycling is a technically challenging, labor-intensive process. Given the difficulties, it would not wholly replace production of original active materials.

Instead, coordinating the ramping up of recycling operations with economic partners and allies who are also aiming to enhance their capabilities in this sector would enable more effective diversification results. U.S. efforts are not occurring in isolation: the EU lithium-ion battery recycling market is set to increase to 130 GWh, or 700 kilotons, by 2030. In addition, the EU market is set to expand again, threefold, by 2040 to 2,100 kilotons. Japan and South Korea are also aiming to expand their battery recycling industries. For instance, key Japanese firms have collaborated with the New Energy and Industrial Technology Development Organization, a state-owned energy research agency, to develop technology that increases their capacity to extract recyclable materials from used batteries. This initiative is set to enable a recycling ratio of 70 percent for lithium, 95 percent for nickel, and 95 percent for cobalt by 2030. South Korea is also investing some 40 trillion won ($30 billion) to facilitate recycling efforts and second-life applications for used battery components. A U.S. strategy that prioritizes working with partners who are also investing in their own capabilities would improve the likelihood of successful diversification away from China and an effective transition to renewables.
Conclusion
The second stage of the lithium-ion battery supply chain examined in this paper—active materials production destined for cathodes and anodes—poses challenges to current onshoring policies. It demands physical capital and labor to accomplish technical work. Active materials production involves several steps—namely, mixing, coating, calendaring, slitting, and electrode making—in addition to producing the separator and electrolyte solution key to the functioning of a lithium-ion battery.

As noted, China largely dominates this portion of the lithium battery supply chain, followed by South Korea and Japan. China’s dominance is strengthened by its sway over the production of inputs higher up the supply chain, as well as its strong influence over the global prices of key commodities. The United States is also limited by higher costs in penetrating the market, given its relative dearth of operational manufacturing capabilities and challenges in obtaining workers, which stem both from more robust labor standards and the lack of a sufficiently trained workforce.

Policies that emphasize onshoring capabilities in the active materials production stage of the lithium-ion battery supply chain are already confronted with the limitations of U.S. capacity. Projects launched by grants and loans under the IIJA and IRA are facing various hurdles, such as inadequacies in the domestic labor market as well as difficulties in making a nascent recycling industry profitable. These barriers are in part self-imposed by restrictions around domestic content requirements.

Likewise, current congressional considerations and recommendations on providing the sector with additional launchpads also turn largely inward, hindering the green transition and impeding the country’s ability to successfully diversify away from Chinese manufacturing dominance. Given that other large players at this stage—namely, Japan and South Korea—are valuable partners in achieving long-term U.S. geostrategic objectives, U.S. policymakers should revisit the limitations set on incentives designed to spur active materials production. In addition, the United States should recognize that foreign direct investment from partners and allies has played an essential role in stimulating the domestic battery sector. Further efforts should be made to deepen ties with these nations and encourage additional investment. Ideally, policymakers should turn to negotiating plurilateral agreements with major players to secure this stage of the battery manufacturing supply chain. More ambitious agreements would enable partners to coordinate industrial policy efforts, enhance information sharing for research and development efforts in the field to improve manufacturing efficiency, and eliminate trade barriers in critical goods.

The business community is currently engaged in reassessing the risk of doing business with the PRC given potential supply chain resiliency risks. In light of current geopolitical tensions, private entities now are striving to create redundancies in supply sources to mitigate the consequences of large-scale shocks on current choke points. The United States, along with economic partners and allies, is also
moving to de-risk supply chains, but the cornerstone of the Biden administration strategy is to spur domestic production anchored by industrial policy initiatives.

These efforts overlap with the push to spur a green transition, for which the lithium-ion battery is a key technology. However, if diversifying supply chains away from China occurs too soon, achieving enough domestic capabilities to effectively spur the green transition in the United States will not be possible. Likewise, a diversification strategy that does not consider the benefits of nearshoring will prove lengthy and costly. In addition, the United States should develop an effective materials management policy that incentivizes development of additional supply chains and regulatory cooperation with like-minded countries. This policy should be pursued in a manner that does not hamper domestic manufacturers from investing or commercializing products.

In short, the United States is pursuing three goals: accelerating the transition to renewables; reshoring production capabilities in key sectors, which include several items necessary to the green transition; and diversifying away from China in these critical areas. Policies that prioritize one of these goals get in the way of the other two.

Finally, nearshoring and friendshoring considerations lead to questions of what it means to be “near” and a “friend.” In addition, lithium-ion batteries are the current bedrock of a transition to renewables, but there are numerous research projects underway aiming to find more efficient alternatives. The final paper of this series will discuss both of these issues, in addition to describing policy challenges surrounding the final stage of the lithium-ion battery supply chain—the assembly of battery cells into modules, packed and sold to manufacturers of various end products.

William Reinsch holds the Scholl Chair in International Business at the Center for Strategic and International Studies (CSIS) in Washington, D.C. Meredith Broadbent is a senior adviser (non-resident) with the Scholl Chair in International Business at CSIS. Thibault Denamiel is an associate fellow with the Scholl Chair in International Business at CSIS. Elias Shammas is a former research intern with the Scholl Chair in International Business at CSIS.

This report is made possible through generous support from the American Clean Power Association, the Consumer Technology Association, the American Chemistry Council, the Cobalt Institute, and Autos Drive America.

This report is produced by the Center for Strategic and International Studies (CSIS), a private, tax-exempt institution focusing on international public policy issues. Its research is nonpartisan and nonproprietary. CSIS does not take specific policy positions. Accordingly, all views, positions, and conclusions expressed in this publication should be understood to be solely those of the author(s).

© 2024 by the Center for Strategic and International Studies. All rights reserved.