The Forgotten Middle: Manufactured Inputs for Electric Vehicle (EV) Batteries

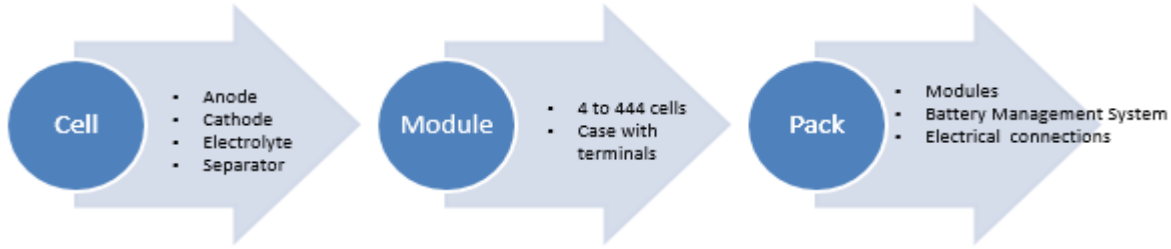
David Coffin, Office of Industries, David.Coffin@usitc.gov

The United States produces each major manufactured input for lithium-ion battery cells but is not one of the largest producers of any of them. Existing USITC research focused on either raw materials or downstream products in the EV battery supply chain, but lack of capacity in manufactured inputs is also important. This lack of capacity could be a risk to the U.S. EV battery supply chain, as disruptions in China could negatively impact U.S. battery production or increase input prices.

Overview

Many expect EVs to make up a significant share of motor vehicle sales in the 2020s. With this change will come shifts in the automotive supply chain, including potentially where suppliers produce inputs. This EBOT briefly describes the manufactured intermediate inputs, including anodes, cathodes, electrolyte salts and solutions, and separators, that go into lithium-ion cells, country-by-country production capacity of those inputs, and which companies have capacity in the United States. The final section discusses supply chain risks owing to a large share of production occurring in China. The EV battery supply chain begins with raw materials and goes through several production stages before becoming a battery pack that can power an electric vehicle (figure 1).

Figure 1: The EV Battery Supply Chain



Source: Created by USITC staff.

Global Manufactured Input Capacity

Global capacity for manufactured inputs is primarily in Asia (table 1). China is the leading producer of each input, possessing the majority of the production capacity for four of the five inputs listed, and Japan and South Korea are also producers. According to one industry representative, these inputs tend to be produced in close proximity to their end users in Asia, as manufacturers have focused on shorter supply chains. As U.S. EV battery production increases, it will make a better business case for manufacturers of inputs to invest in U.S. production as well.

Table 1: Global Production Capacity of EV Battery Manufactured Inputs (2019)

	Battery	**Manufactured Intermediate Inputs**				
	Battery cell	Cathodes	Anodes	Electrolyte Salts	Electrolyte Solution	Separators
Country/Region	**GWh**	**Tons**	**Tons**	**Tons**	**Tons**	**Millions of sq meters**
China	236	324,200	267,200	49,900	339,000	1,987
Japan	10	168,900	77,300	7,200	50,300	944
South Korea	21	51,200	24,000	2,200	63,000	1,267
United States	35	7,002	40,000	1,500	39,000	260
EU	14	41,250			10,000	100
Other	3	35,860			15,000	5
Total	319	628,412	408,500	60,800	516,300	4,563

Source: BNEF, "Production Components," (accessed May 30, 2019); and BNEF, "Battery Manufacturing," May 30, 2019.

The United States is the only non-Asian country with some capacity in each manufactured input, but it is no higher than the third-largest manufacturer of any single input. This lack of capacity forces the U.S. EV battery manufacturing industry to rely on imported inputs from Asia, particularly China. None of the inputs have their own ten-digit statistical reporting number, so it is difficult to estimate trade values. However, since China is a major supplier of U.S. imports in the basket categories that include these manufactured inputs, and has the most global capacity in each input, it's likely that inputs imported from China make up a significant share of manufactured inputs used to produce EV batteries in the United States.

A variety of manufacturers across the United States produce manufactured inputs for EV batteries. The cathode is the most important of the manufactured inputs because it determines the type of battery cell and is the largest driver of cell cost. There is only limited production in the United States. Cathodes tend to be produced in close proximity to battery manufacturers, which are mostly in China. The material used in the cathode determines the type of battery cell. There are two cathode material manufacturers with production facilities in the United States, BASF (Germany) produces cathodes in Elyria, Ohio, and Toda Kogyo (Japan) produces cathode materials in Battle Creek, Michigan. These two formed a joint venture in 2017 called BASF Toda America LLC to focus on U.S. cathode material production. The United States has limited anode production and imports significant volumes. Anodes are typically made of graphite. The average electric vehicle battery has 30kg of graphite anode. Pyrotek (United States) produces graphite anodes in Sanborn, NY, and Novonix will soon produce synthetic graphite anodes in Chattanooga, TN. Honeywell is the only U.S. producer of electrolyte salts. Separators make up 15 to 20 percent of the cost of a lithium-ion battery cell. Separators are placed between the anode and the cathode, allowing ions to travel freely between them, but can act as a fuse if a battery overheats and shut down the reaction. There are three U.S. producers of separators, Celgard, Entek, and DuPont.

Supply Chain Risks

Having a large share of the capacity for these manufactured inputs centered in China could present challenges for U.S. EV battery manufacturers. First, any disruption in production of these inputs in China could affect production of battery cells in the United States. Second, Chinese capacity can have a significant effect on prices for these inputs. If there were overcapacity in China, then prices for these inputs could decline, making it difficult for manufacturers of these inputs in other countries to compete. Conversely, if there were not enough production capacity globally, the Chinese government could limit exports to ensure domestic battery producers have adequate supplies of inputs. Additional production capacity in the United States or other trade partners would help to mitigate many of these risks, but not oversupply.

Sources: Chemicals Technology, "BASF Cathode Material Production Plant, Elyria, Ohio, US," (accessed November 30, 2020); BASF, "BASF and TODA further strengthen their collaboration and increase investments in Cathode Materials to enable e-mobility," December 14, 2017; Danylenko, "What Materials are Behind the EV Battery Revolution?" August 10, 2018; Global Trade Alert, "$27 million grant to Honeywell International," (accessed November 30, 2020); Berry, "Another Way to Think About Lithium," March 15, 2016; U.S. Department of Energy, "Pytrotek Graphitization Project," May 16, 2012; Industry representative, telephone interview with USITC staff, December 3, 2020; Battery University, "What is the Function of a Separator?" (accessed December 28, 2020); Novonix, "Pure Graphite" (accessed January 27, 2021); Foldy and Elliot, "Shift to Electric Vehicles Spurs Bid to Make More Batteries in U.S." January 26, 2021.