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Electrification May Disrupt the Automotive Supply Chain

Introduction

The global market for vehicle electrification is expanding. In 2018, more than 1.7 million plug-in and battery electric vehicles were sold worldwide, a nearly 40% increase over 2017. These account for about 2% of all passenger vehicle sales, both worldwide and in the United States. Demand for electric vehicles is expected to continue to grow, as some industrial countries have called for a complete shift away from sales of new fossil-fuel-powered vehicles by 2030.

The shift to electric vehicles and away from internal combustion engines is likely to have significant consequences for the U.S. automobile assembly and parts manufacturing industries. A widespread shift to electric vehicles has the potential to eliminate large numbers of jobs in vehicle and parts production, even if the vehicles are assembled in the United States. Congress may wish to explore these possible economic impacts and consider steps to mitigate them.

The EV Market

Electric vehicles come in two basic varieties. Plug-in hybrids use both an electric motor and an internal combustion engine; battery electric vehicles use only batteries. Both draw electricity from an external source.

The first contemporary electric vehicle models came to market in 2010, but demand grew slowly: 157,000 were sold in the United States in 2016. Sales were limited due both to price—battery-powered vehicles cost far more than gasoline-powered vehicles of similar size—and to car buyers' concerns about "range," the distance a vehicle can travel between battery charges. However, the costs of producing electric vehicles appear to be falling as manufacturers achieve greater scale, and networks of high-speed charging stations are being installed in a number of U.S. urban areas and along major Interstate Highway corridors to allay drivers' fear of running out of power. Recent actions by several auto manufacturers indicate they believe electric vehicles are becoming a mainstream product.

Now, nearly all global automakers manufacture both plug-in hybrid and battery electric vehicles. McKinsey, a business consulting firm, forecasts global production of 3.5 million battery electric vehicles in 2020 and 14.8 million by 2025. China leads in both electric vehicle production and sales. Of the 42 different electric vehicle models sold in the United States in 2018, 10 were made at seven U.S. plants. U.S. sales of electric vehicles rose by 80% from 2017 to 2018, led by Tesla and Toyota. More than one million plug-in hybrid and battery electric vehicles are now on U.S. roads.

At the time of its November 2018 announcement that it may shutter five assembly plants, General Motors (GM) said that it would introduce 20 new battery electric vehicles by 2023. Ford has indicated that it is doubling its investment in electrification and plans to produce 16 fully electric vehicles by 2022. Volkswagen Group has announced plans to build electric vehicles in Tennessee starting in 2022.

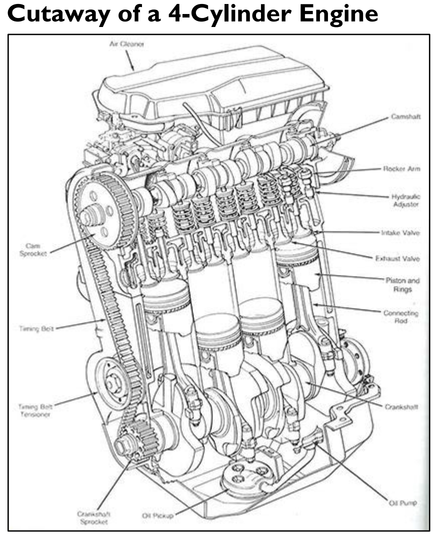
The Powertrain Difference

The powertrain, the system that propels the vehicle, is significantly different in conventional and electric vehicles. As a result, production of an electric vehicle is likely to require far less labor than production of a similar vehicle with either a gasoline or diesel engine.

In a conventional vehicle, the powertrain includes the engine, the drivetrain—the components and system that provide power to the wheels—as well as other associated components, such as the transmission, engine cooling and exhaust systems, and emissions control. Most passenger vehicles on the road today have an internal combustion engine, fueled by gasoline or diesel.

It has been estimated that the powertrain adds more value to a vehicle than any of its other systems. The engine and transmission are two of the most complex components in a gasoline-powered vehicle. A cutaway of a passenger car engine illustrates the many parts that are manufactured for this part of the powertrain (**Figure 1**). Most of these parts are made of metals that can withstand temperatures of 2,000 degrees Fahrenheit generated through internal combustion.

Figure 1. Cutaway of a 4-Cylinder Engine



Source: John B. Heywood, "Engine Types and Their Operation," in *Internal Combustion Fundamentals*, 2nd ed. (New York: McGraw Hill Education, 2018), p. 12. With permission of the publisher.

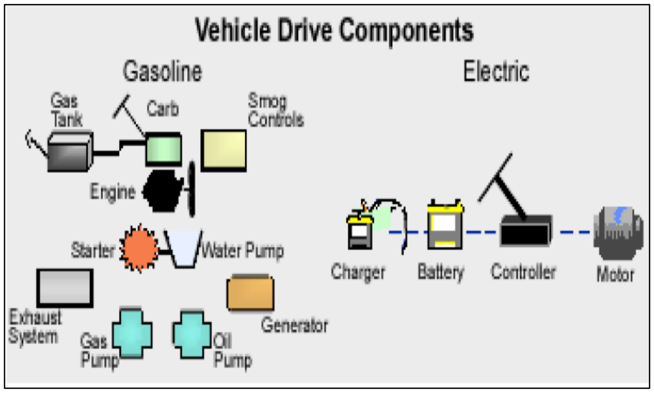
The powertrain is an essential feature because it is responsible for vehicle performance—getting driver and passengers to their destinations—and also differentiates vehicles. For example, the large engine in a Chevrolet Corvette gives the vehicle much different speed and acceleration than the smaller engine typically installed in a Chevrolet Sonic. Powertrain components are manufactured by the large automakers as well as supplier firms, usually in plants separate from those that assemble cars and trucks. The production facilities are generally located near the major assembly plants in the Midwest and South.

Ernst & Young has estimated that vehicles with conventional powertrains have as many as 2,000 components in their powertrains. That number rises when parts used for engine cooling and exhaust and sensors used in emissions control systems are considered. Of the nearly 590,000 U.S. employees engaged in motor vehicle parts manufacturing, about one-quarter—nearly 150,000—make components for internal combustion powertrains.

Electric vehicle powertrains differ substantially from those in conventional vehicles. Instead of the hundreds of moving parts built into a conventional powertrain, an electric vehicle powertrain has only a few. For example, Tesla has said its drivetrain has 17 moving parts, including two in the motor.

The other powertrain parts in a battery-powered vehicle are a very large lithium ion battery pack, which supplies the energy to run the vehicle; a controller that governs speed and acceleration and keeps batteries from overheating; and a converter that distributes power to accessories such as windshield wipers. Software is also a key component in managing battery cooling and connecting the power source to vehicle applications. No emissions are generated, so all-electric vehicles do not have exhaust systems, mufflers, catalytic converters and tailpipes (**Figure 2**). Electric vehicle powertrains are also cheaper to maintain and, unlike many internal combustion engines that may deteriorate over time, electric vehicle motors may have lower maintenance costs.

Figure 2. Comparison of Gasoline and Electric Powertrains



Source: Idaho National Laboratory, *How Do Gasoline & Electric Vehicles Compare?*, https://avt.inl.gov/sites/default/files/pdf/fsev/compare.pdf.

Should electric powertrains displace those used by gasoline over the next decade and beyond, it is likely that both production and engineering jobs will be affected. Electric vehicle powertrains, if built domestically and not imported, would generate production employment, but fewer employees may be needed than at present because vehicle battery packs have relatively few components and are less complicated to assemble than internal combustion engine powertrains. Electric vehicles utilize a large number of electronic sensors, but these devices require little labor to produce and assemble.

Much of the mechanical and materials engineering work undertaken by automobile and parts manufacturers could be replaced by jobs requiring different skillsets such as chemical, battery, and software engineering or by imports of lithium ion batteries. Few U.S. universities offer degrees in battery engineering, a skill set that is in short supply even today.

U.S. Policy Choices

Congress may address through hearings and legislation the supply-chain transition from internal combustion engines to electric batteries and motors. Congress has in the past demonstrated a strong interest in encouraging the domestic development and production of advanced technology vehicles, including electric and hybrid passenger cars. Recent precedents include the following:

- In the Energy Independence and Security Act of 2007 (P.L. 110-140), which raised fuel economy standards for the first time in several decades, Congress established the $25 billion Advanced Technology Vehicles Manufacturing program. It has supported technological development by automakers, including at Ford, Tesla, and Nissan plants. The $16 billion remaining authority could be focused on converting internal combustion engine capacity to electric vehicle capacity.

- The American Recovery and Reinvestment Act of 2009 (P.L. 111-5) provided grants of $2.4 billion to support the establishment of U.S. lithium-ion battery manufacturing facilities. These grants anticipated a more rapid acceptance of electric vehicles, and the capacity they envisioned has not been fully utilized. Similar investments today may find wider applicability.

Congress could address changing skills needs through the existing Workforce Innovation and Opportunity Act (P.L. 113-128), which makes grants to the states to identify workforce needs at the local level. Workers who today manufacture parts for gasoline or diesel engines could be retrained to make parts for electric vehicle motors and the lithium-ion batteries that power them, although there may be significantly fewer such jobs than exist in automotive supply chains today.

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