U.S. Light Truck Electrification: Economic and Jobs Impact Study

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Evaluating the Economic and Employment Impacts of the Development of an Electric Light Truck Manufacturing Facility in the United States

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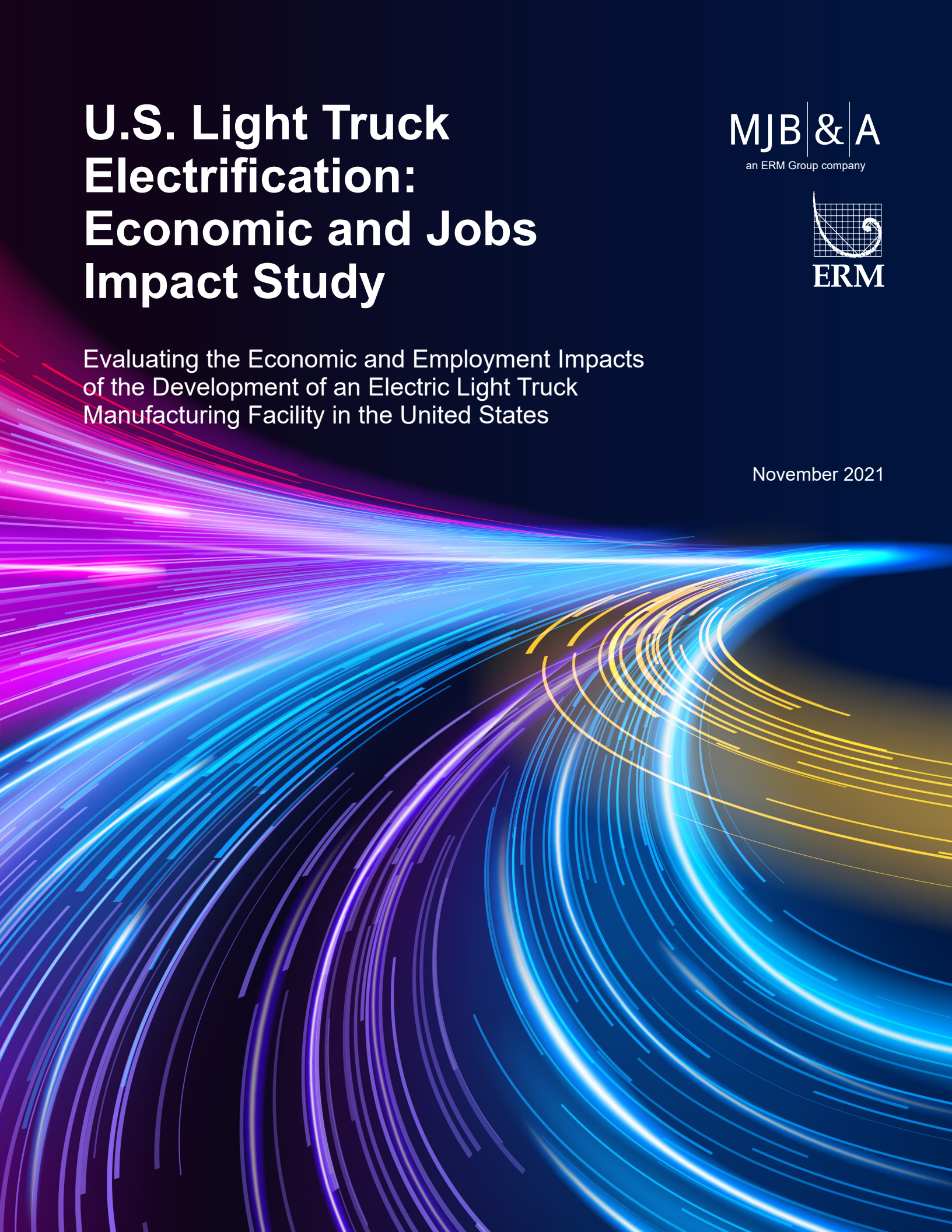

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Acknowledgements

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This study focuses on the economic and job implications of producing electric F-Series light trucks, including the recently announced Ford F-150 Lightning, as a case study for the broader electric vehicle (EV) manufacturing sector within the U.S. The findings of this study also illustrate the potential impact on U.S. jobs and gross domestic product (GDP) associated with growth of the domestic EV supply chain.

This report was developed by M.J. Bradley & Associates (MJB&A) for the Environmental Defense Fund (EDF). Ford provided inputs and data consistent with Ford's public announcements and consulted with EDF and MJB&A on the reasonableness of the assumptions used in the analysis.

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About M.J. Bradley & Associates

MJB&A, an ERM Group company, provides strategic consulting services to address energy and environmental issues for the private, public, and non-profit sectors. MJB&A creates value and addresses risks with a comprehensive approach to strategy and implementation, ensuring clients have timely access to information and the tools to use it to their advantage. Our approach fuses private sector strategy with public policy in air quality, energy, climate change, environmental markets, energy efficiency, renewable energy, transportation, and advanced technologies. Our international client base includes electric and natural gas utilities, major transportation fleet operators, investors, clean technology firms, environmental groups and government agencies. Our seasoned team brings a multi-sector perspective, informed expertise, and creative solutions to each client, capitalizing on extensive experience in energy markets, environmental policy, law, engineering, economics and business. For more information we encourage you to visit our website, www.mjbradley.com.

Executive Summary

Transportation is the largest source of greenhouse gas (GHG) emissions in the United States. Transportation electrification is widely recognized as one of the best strategies for significantly reducing these emissions. Numerous manufacturers have publicly signaled their commitment to an electric vehicle (EV) future and Ford, GM, and Stellantis have collectively committed to invest over $100 billion in zero emitting vehicle technologies globally by 2025. In the last few months alone, manufacturers have announced nine new models for sale within the next three years, with several companies announcing plans to make electric vehicles a larger portion of their available vehicle models across light-, medium-, and heavy-duty vehicle segments within the next several years.* In the U.S. alone, there were 64 EV models in 2021 which will grow to at least 82 by 2023.[1] These commitments have been matched by consumer demand. Despite the pandemic, sales of electric vehicles within the U.S. grew in 2020 by four percent while overall car sales decreased 15 percent.[2]

Increasing momentum from manufacturers has been spurred and matched by governments around the world that have implemented more protective vehicle emission standards and EV sales targets, as well as supporting consumer incentives and infrastructure investments.

In the U.S., the Biden Administration has made a zero-emission transportation sector a core part of its climate agenda—announcing its goal that 50 percent of all new vehicles sold by 2030 are zero emitting. In addition, Congress, as part of the reconciliation and infrastructure packages, is considering numerous consumer incentives and infrastructure and manufacturing investments that would help to further support rapid EV deployment. For example, Congress has proposed tax credits for the retooling and expansion of U.S. manufacturing, which could support the development of a domestic EV supply chain.

Not only will transportation electrification reduce climate warming emissions and air pollutants like nitrogen oxide (NOx) and particulate matter (PM), leading to improved air quality within communities across the country, but it also has the potential—if developed strategically and in partnership with stakeholders across the vehicle value chain—to lead to significant increases in high-quality jobs across the United States. When paired with policies that would support domestic manufacturing and high-quality job growth, like those Congress is now considering, the impact can be even more significant.

* For more information on these targets and announcements see the M.J. Bradley & Associates Electric Vehicle Market Status Report: https://mjbradley.com/reports/electric-vehicle-market-status-update-0

There have been several recent studies on the economy wide impacts of the transition to electric vehicles. There have also been many manufacturer announcements of direct jobs associated with particular plant investments. This study aims to build on the existing literature by evaluating the impact the direct jobs associated with producing an electric vehicle will have within the community and beyond.†

In particular, this study focuses on the broader economic and employment effects associated with the production of electric F-Series light trucks, including the recently announced Ford F-150 Lightning, as a case study for the broader electric vehicle manufacturing sector within the U.S. For the purposes of this study, Ford provided data consistent with their recent public announcements and consulted with EDF and MJB&A on the reasonableness of the assumptions used in the analysis.

The findings of this report show that EV manufacturing in the U.S. has the potential to support significant positive job and GDP impacts. These impacts are magnified when a larger share of the broader EV supply chain is assumed to be located within the U.S. Future local, state, and federal policies could incentivize such shifts in the U.S. EV supply chain by including provisions to aid the development of U.S.-based manufacturing of batteries and electric drivetrain components. For example, the infrastructure and reconciliation package includes a number of provisions that would provide support for the development of a domestic U.S. EV supply chain.*

† See Table 1 for a listing of the key assumptions under the Primary Scenario. Note also that this analysis evaluates the annual employment and economic impacts of operating an EV assembly plant. It does not assess any impacts of capital investments that may be associated with the construction of a new EV assembly plant

* This analysis does not separately evaluate the impacts of battery production. However, it does assume that all batteries needed for vehicle assembly are sourced domestically and the analysis includes their production as part of the indirect impacts. Note that batteries assembled or sourced domestically may still include some proportion of imported components.

Developing an EV Manufacturing Presence in the U.S.

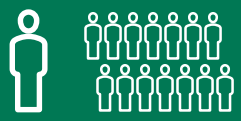
In recent years, numerous auto manufacturers have publicly signaled their commitment to an electric vehicle future. Senior executives from major companies such as Ford, Volvo, General Motors, and Volkswagen, have all publicly committed to driving towards an electric vehicle future by establishing electric vehicle sales targets, making major investments in vehicle electrification, and developing a wide range of electric vehicle models across vehicle classes.[3,4,5,6]

Key Economic and Employment Impacts from the Analysis

Producing electric vehicles using U.S.-sourced EV components[1] could support the following economic and employment benefits:

Provide $97 million in direct income and $1 billion in direct, indirect and induced labor income benefits for every 1,000 direct jobs

$1.6 billion in gross domestic product (GDP) for every 1,000 direct jobs



13 to 14 U.S. jobs for each direct job

A plant supporting 3,300 jobs, as recently announced by Ford, could result in 44 thousand jobs in the wider economy, providing $319 million in direct income and over $3.2 billion in direct, indirect, and induced labor income benefits.

Analysis results provided above reflect estimated employment and GDP impacts of electric F-Series light truck production normalized by the number of direct jobs. Higher direct employment levels, which would indicate larger vehicle production volumes, would result in proportionately higher employment and GDP impacts if produced using a similar U.S.-based EV supply chain.

[1] Electric motors, storage batteries, and converters are domestically assembled or sourced. Components assembled or sourced domestically may still include some proportion of imported parts.

In support of President Biden's Executive Order, Ford, GM, and Stellantis sent a letter to the administration setting forth an aspiration that 40-50 percent of the new vehicles they sold by 2030 would be zero-emitting. Major auto manufacturers associations such as the Alliance for Automotive Innovation (Auto Innovators) have also supported increased electric vehicle deployments. In March 2021, Auto Innovators submitted a joint letter to President Biden with the United Autoworkers International Union and the Motor & Equipment Manufacturers Association committing to collaborating with the Biden Administration on crafting and implementing a comprehensive plan focused on consumers; infrastructure; and innovation, manufacturing, and supply chain.[7] Members of Congress, understanding the importance of developing an EV market and a supply chain to support it, have also included important investments that strongly tie to domestic manufacturing and jobs in both the proposed budget reconciliation package and the Infrastructure and Jobs Act.

The impact that this vehicle will have on electric vehicle awareness and sales could have lasting implications for the future U.S. vehicle market. Since Ford announced the model, it has received over 150,000 resesrvations.

These commitments represent an understanding from the federal government and companies across the vehicle value chain that an electrified future could not only lower emissions from the transportation sector, improving public health and the environment, but also could have other important societal impacts including increased high-quality jobs across the country. In 2020, nearly 132,000 individuals were employed in EV related jobs across the U.S., with employment growing more than six percent, the biggest increase of any clean energy category.[8]

California, Michigan, and Texas supply the majority of current EV jobs, though manufacturers have announced investments across the country including investments in light-duty factories in Tennessee; medium- and heavy-duty factories in Colorado, Indiana, and North Carolina; and battery factories in Georgia, Massachusetts, Michigan, Ohio, and Tennessee. LG Energy Solution—one of the world's largest battery manufacturers—announced it will invest more than $4.5 billion in its U.S. business to expand its battery production capacity, potentially adding 10,000 additional jobs, and it has partnered with SK Innovation to develop a $2.6 billion Georgia manufacturing plant.[9] These announcements represent a few of dozens of recent investments. While only a sample, the job implications of these announcements alone could have a significant impact on workers across the U.S., though the precise impacts of these jobs have yet to be fully evaluated.

Given these shared commitments to transition to zero-emitting vehicles, this study aims to provide insights to aid the understanding of the magnitude of economic and job impacts that such a transition may be able to support if large shares of the associated supply chains were located within the U.S. Specifically, this study focuses on the economic and job implications associated with the electric F-Series, including the recently announced Ford F-150 Lightning and its associated production operations. The electric Ford F-Series was chosen as the primary vehicle for this analysis for several reasons, outlined below.

The potential impact that an electric F-Series light truck could have on the U.S. electric vehicle market is significant. The F-Series has been the bestselling light truck in the U.S. for the last 44 years and represents a vehicle that is familiar to American consumers.[10] The stated capabilities of the vehicle —Ford has said that the electric F-150 will be its most powerful in the series—has the potential to open the EV market to consumers who may have never considered an EV previously.[11] The impact that this vehicle will have on electric vehicle awareness and sales could have lasting implications for the future U.S. vehicle market. Since Ford announced the model, it has received over 150,000 reservations.

Ford is a major American company with significant manufacturing within the U.S. that is making electrification a focus for the future of its brand. The F-150 Lightning represents one of several significant announcements that Ford has made as part of its electrification strategy. In September 2021, Ford announced plans to invest over $11 billion in new U.S. facilities to produce batteries and electric vehicles and had previously announced plans to spend over $30 billion on electrification through 2025. Ford will manufacture the F-150 Lightning at its Rouge facility in Michigan and electric F-series vehicles at a new plant in Tennessee. Ford has also committed to making its European passenger vehicle line zero emission capable by mid-2026, moving to all-electric by 2030; its European commercial vehicles zero emission capable by 2024; and is expecting two-thirds of sales to be battery electric vehicles (BEV) or plug-in hybrid vehicles (PHEV) by 2030. This analysis evaluates the job impact of the electric F-Series, including the F-150 Lightning, to put into context the magnitude of these additional announcements and can serve as a case study for the American vehicle market as a whole.

Evaluating a specific vehicle provides an opportunity to consider a range of policy options. By studying the job impacts of a specific vehicle, this analysis provides insights to assist the exploration of policy changes that could support domestic job growth, including emission standards and investments to 1) accelerate the introduction of these vehicles; and 2) support a greater share of their manufacturing supply chain to be domestically sourced. Congress and the Biden Administration are currently evaluating a number of important policies related to the transportation sector, including bills that would aim to expand funding for EVs and electric vehicle infrastructure, and develop a stronger domestic EV supply chain and manufacturing presence in the U.S. Further, the Administration is considering several regulatory standards that would require the increased development of low- and zero-emitting vehicles. The intent of this analysis is to help inform these deliberations and policy considerations.

The following sections provide an overview of the study approach and highlight key findings and conclusions from the analysis.

Study Approach

This analysis uses planned vehicle manufacturing plant information from public announcements Ford has made concerning the Rouge assembly plant and a Tennessee manufacturing facility to investigate the economic and employment impacts of manufacturing the electric F-Series, including the F-150 Lightning,* could have on the U.S. economy.

Using the economic input-output IMPLAN model (See **Figure 1** for an overview of the IMPLAN modelling process), this analysis uses a combination of industry supplied inputs and IMPLAN industry averages, and assumes the EV parts of the supply chain (i.e., electric motor, converter, and storage battery) would be sourced domestically to varying degrees. Specifically, the analysis uses announced direct jobs to evaluate the economic and employment impacts of producing electric F-Series trucks.

This analysis made several additional key assumptions and modelling design choices that are outlined below.

IMPLAN was run at the national level and was used to calculate economic changes to the domestic (U.S.) economy. Industry spending often includes some "leakage" due to imports of equipment and supplies from other countries—i.e., some of the industry spending results in job, wage, and GDP changes in these exporting economies and is not included in the IMPLAN results, which are exclusive to the U.S. economy. The amount of leakage depends on the industry; for example, based on current industry structure, IMPLAN assumes that 80 percent of U.S. demand for commodities produced by the industry "Power, distribution, and specialty transformer manufacturing" is met by U.S. production, but only 50 percent of demand for commodities produced by the industries "Storage batteries" and "Motor and generator manufacturing" is sourced from within the U.S.

Battery production is not modeled separately, but is included in the EV production impact results. This analysis assumes that all batteries required for EV assembly will be sourced domestically, and the battery production impacts are included in the indirect impacts.

The model uses the national average supply chain for light trucks and utility vehicles. For sections of the supply chain that are not adapted to reflect an EV supply chain, this analysis assumes the national average supply chain for light trucks and utility vehicles. It further assumes that the supply chain is not specific to any particular region of the U.S. or any particular company, beyond the inputs explicitly provided for this analysis.

IMPLAN only estimates changes in economic activity that flow directly from changes in spending within the affected industries—it does not assess potential secondary effects from major structural changes in the economy. IMPLAN does not estimate how significant changes in demand for a commodity will affect the market price of that commodity, or how market price changes will affect economic activity. For example, IMPLAN assumes that more storage batteries for EVs can

*In particular, Ford has recently announced an additional 450 direct jobs at the Rouge facility in Michigan and between 3,200 and 3,300 direct jobs at its new Tennessee plant.

be produced without affecting labor or resource markets and will be produced and purchased by auto manufacturers at the current market price. It does not model any changes in labor or resource prices due to increased demand, or structural changes to commodity markets (e.g., the battery market). Similarly, IMPLAN does not model how adoption of a new technology may affect consumers. For example, because EVs can be cheaper to operate on a day-to-day basis, EV-owning households may see monthly savings relative to operating a fossil fuel-powered vehicle. If they choose to spend these savings on unrelated products and services in the wider economy, there may be additional induced job- and GDP-related impacts that are not captured in this analysis. Finally, this analysis does not include any impacts from potential longer-term structural changes in the supply chain of the U.S. automotive sector or the broader U.S. economy as a result of higher EV adoption.

Default IMPLAN light truck supply chain is representative of the existing U.S. light truck manufacturing sector. In order to evaluate EV manufacturing, this analysis uses relative cost structure tables of key gasoline vehicle and EV cost components to adjust the IMPLAN supply chain for the drivetrain differences. The supply chain for the rest of the vehicle remains the same. Specifically, this analysis makes the following changes:

- Removes transmission, gas engine, engine equipment
- Adds electric motor, converter, battery
- Adjusts cost proportions

This analysis uses a primary scenario and a sensitivity scenario to evaluate the potential economic and employment impacts associated with varying degrees of domestic supply chain usage. These two modeling runs are outlined below:

Scenario	Key Assumptions
Primary Scenario: U.S.-based EV Supply Chain*	• Electric motors, storage batteries, and converters are domestically sourced or produced. • All other supply components do not change; they are sourced at their current levels.
Sensitivity Scenario	• All assumptions in primary scenario. • The key element in the supply chain of EV batteries, nonferrous metal smelting and refining, is domestically sourced or produced. • Additional vehicle components (i.e., motor vehicle electrical and electronic equipment; motor vehicle seating and interior trim; motor vehicle stamped metal; other motor vehicle parts; motor vehicle steering, suspension, brake systems) are domestically sourced or produced.

Table 1

*Note that each domestically-sourced component still has its own supply chain that include some proportion of imported components.

IMPLAN Modeling Process

This study used the IMPLAN input-output model to conduct the economic impact assessment. IMPLAN is a proprietary input-output modeling system that uses data from the U.S. Bureau of Economic Analysis, Bureau of Labor Statistics, U.S. Census Bureau, and other sources. Private companies, governmental agencies and academic institutions regularly use IMPLAN to evaluate the macro-economic effects of policies, programs and specific infrastructure investments.

IMPLAN assigns each industrial or service activity (e.g., agriculture, mining, manufacturing, trade, services) to an economic sector. The number of sectors is determined by the level of desired detail. Using detailed U.S. Department of Commerce information, IMPLAN relates the purchases of goods and services each industry makes from other industries to the value of output in each industry. As such, IMPLAN describes the supply chain of each industry in terms of output, value added, labor income, employment levels, and state and local tax revenue.

For example, when a firm opens a new manufacturing facility, it hires local labor and contractors and purchases manufacturing components and materials from other in-state and out-of-state suppliers. Those suppliers have their own associated expenses and wages that spread the money throughout the economy. IMPLAN models these transactions throughout the economy to calculate the total economic impact of the investment.

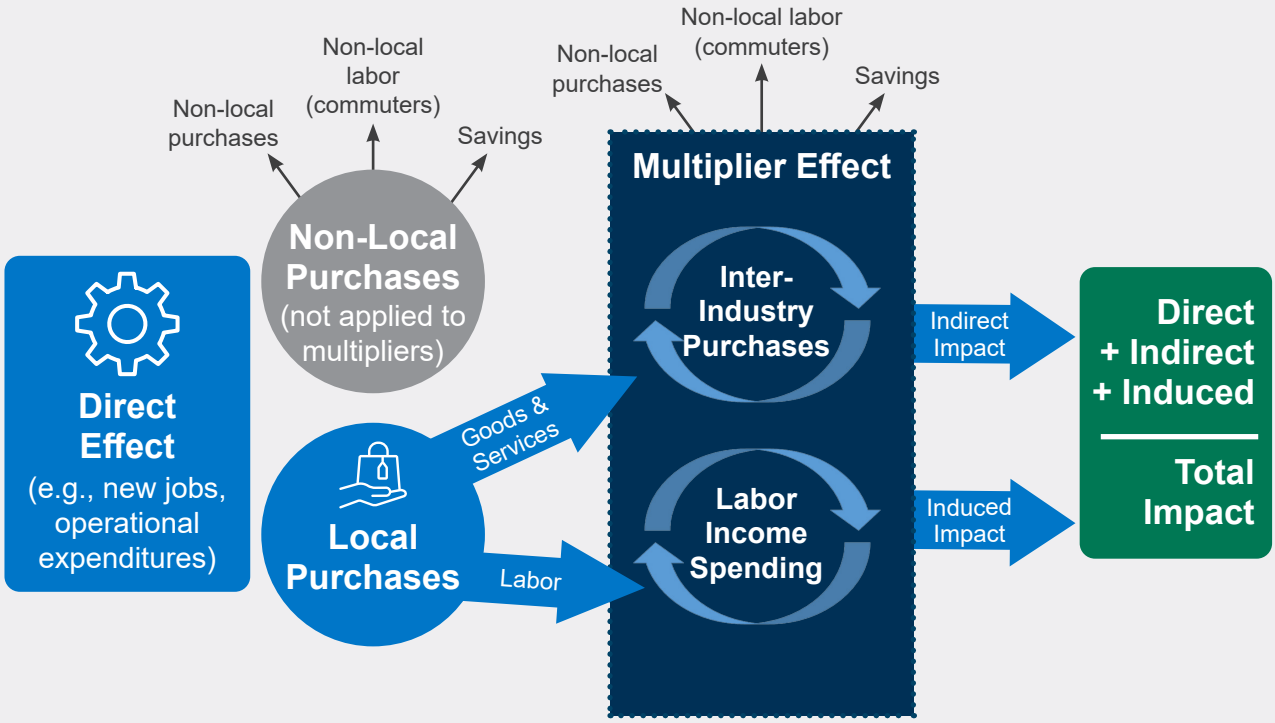
As depicted below, IMPLAN estimates three types of impacts, which are combined to estimate the total impact of each modeled scenario:

Figure 1

IMPLAN Modeling Process (continued)

This analysis estimates changes to three national level macro-economic metrics from operating an EV manufacturing plant:

- ***Employment*** - A job in IMPLAN is equal to the annual average of monthly jobs in an industry. One job lasting 12 months equals two jobs lasting six months; each equals three jobs lasting four months. A job can be full time or part time.
- ***Labor Income*** - Labor income includes all forms of employment income, such as employee compensation (wages and benefits) and proprietor income.
- ***Gross Domestic Product (GDP)*** – Also known as value added, this result captures the compensation of employees, proprietor income, taxes on production and imports less subsidies (previously indirect business taxes and non-tax payments) and gross operating surplus. Value added is the value of output less the value of intermediate consumption; it is a measure of the contribution to GDP made by an individual producer, industry or sector.



Source: AKRF (2013): IMPLAN, RIMS-II, and REMI Economic Impact Models

Summary Findings

The results of this analysis highlight the potential impacts that electric vehicle manufacturing and supply chain development could have on the U.S. economy and job market.

Specifically, the analysis finds that a single direct job associated with the production of electric F-Series vehicles could support 13 to 14 jobs in the wider U.S. economy. And every 1,000 such direct electric F-Series production-related jobs would support $1 billion in direct, indirect, and induced labor income benefits and $1.6 billion in U.S. GDP.

The results show that a plant supporting 3,300 jobs* could result in 44 thousand jobs in the wider economy, providing $319 million in direct income and over $3.2 billion in direct, indirect, and induced labor income benefits. These impacts could support $5.2 billion in U.S. GDP, all else being equal.

These estimated impacts are larger under the additional sensitivity scenario considered in this analysis, which assumes higher domestic shares of the EV supply (see scenario table on page 9 for more details on assumptions). Under this sensitivity scenario, the same plant with 3,300 direct jobs could support more than 49,000 total jobs in the wider economy, $3.6 billion in direct, indirect, and induced labor income, and nearly $6 billion in U.S. GDP.

Importantly, this analysis provides normalized employment and GDP impacts that may be used to derive high-level estimates of proportionately greater employment and GDP impacts of larger EV production quantities and higher direct employment levels. For example, due to a strong preorder demand, Ford recently announced that it will double its F-150 electric production target rate and is evaluating opportunities to increase production volumes further in the future.

IMPLAN Results for an EV Plant Supporting 3,300 Direct Jobs

Primary Scenario

Impact	Employment (000s)	Labor Income (billions)	Value Added/GDP Impact (billions)
Direct	3.3	$0.32	$0.35
Indirect	22.9	$1.90	$3.02
Induced	18.0	$1.04	$1.85
	44.2	$3.26	$5.23

Source: MJBA Analysis

Table 2

* Recent Ford announcements suggest that its new EV plant in Tennessee would support between 3,200 and 3,300 direct jobs.

Economic Impacts of an EV Plant Supporting 3,300 Direct Jobs

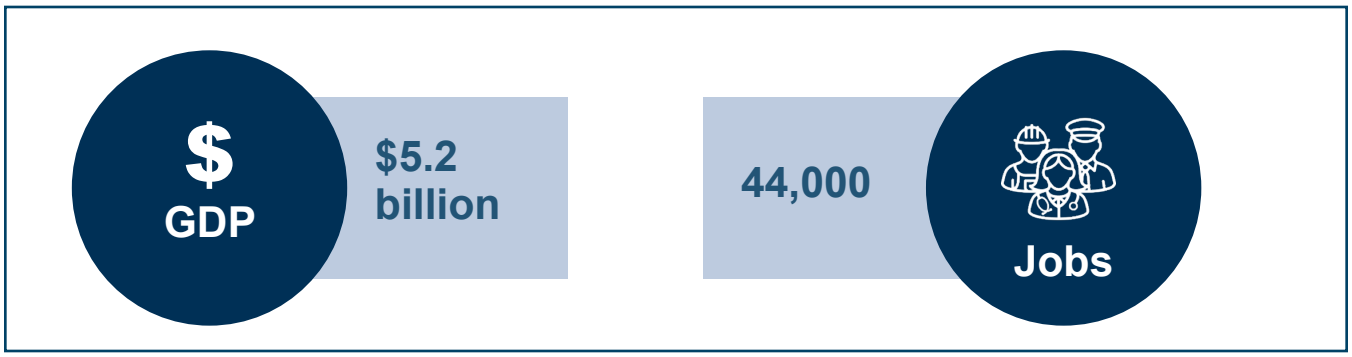


Figure 2 *Source: MJB&A Analysis*

Conclusions

As electric vehicles become a larger portion of vehicles on the road globally and domestically, investment in the U.S. EV supply chain and manufacturing is likely to increase. The Biden Administration is currently evaluating a number of important policies related to the transportation sector, including bills that would aim to expand funding for EVs and electric vehicle infrastructure, increase support for domestic electric vehicle manufacturing, and support workforce development.

This analysis provides normalized employment and GDP impact figures and highlights the economic impact that a single EV manufacturing facility with 3,300 direct jobs could support within the wider U.S. economy. Increasing EV production volumes could produce proportionately larger employment and GDP impacts. The findings of this analysis can provide useful inputs to federal, state and local governments across the country as they assess the benefits and costs of investing in domestically-produced electric vehicles.

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