ECONOMIC IMPACT OF STIMULUS INVESTMENT IN TRANSPORTATION ELECTRIFICATION

AN ECONOMIC ASSESSMENT OF APPLYING STIMULUS FUNDS TO SPUR ELECTRIFICATION OF THE TRANSPORTATION SECTOR IN THE UNITED STATES

Prepared by Paul Hibbard and Pavel Darling

ANALYSIS GROUP

JUNE 2021

Each dollar of public investment in electric transportation generates $2.60 of additional direct private investment.
***That's** the power of now.*

The Power of NOW | ADVANCED ENERGY ECONOMY

San Francisco | Washington D.C. | Boston
aee.net | powersuite.aee.net | @aeenet

ACKNOWLEDGMENTS

This report was prepared at the request of Advanced Energy Economy to review the potential economic impacts of public and private investment in electrification of the transportation sector that will be vital for ultimately meeting national energy, economic, and climate policy goals. This is an independent report by Paul Hibbard, Pavel Darling, and Jeffrey Monson of Analysis Group. The authors would like to thank Scott Ario, Luke Daniels, Hannah Krovetz, and Emma Solomon of Analysis Group for their assistance with research and analysis, and Ryan Katofsky, Ryan Gallentine, Robert Keough, Leah Rubin Shen, and Claire Alford of Advanced Energy Economy for their input on the report. However, the observations and conclusions in the report are those of the authors and do not necessarily reflect the views of Advanced Energy Economy.

ABOUT ANALYSIS GROUP

Analysis Group is one of the largest international economics consulting firms, with more than 1,000 professionals across 14 offices in North America, Europe, and Asia. Since 1981, Analysis Group has provided expertise in economics, finance, health care analytics, and strategy to top law firms, Fortune Global 500 companies, government agencies, and other clients worldwide.

ABOUT ADVANCED ENERGY ECONOMY

Advanced Energy Economy (AEE) is a national association of businesses that are making the energy we use secure, clean, and affordable. AEE is the only industry association in the U.S. that represents the full range of advanced energy technologies and services, both grid-scale and distributed. Advanced energy includes energy efficiency, demand response, energy storage, wind, solar, hydro, nuclear, electric vehicles, and more. AEE's mission is to transform public policy to enable rapid growth of advanced energy businesses. Engaged at the federal level and in more than a dozen states around the country, AEE represents more than 100 companies in the $240 billion U.S. advanced energy industry, which employs 3.2 million U.S. workers. Learn more at www.aee.net, track the latest news @AEEnet.

EXECUTIVE SUMMARY

Many efforts by states and the federal government over the past year have focused on investment of government dollars to help recover from the COVID-19 pandemic and to get the economy moving again. Recent stimulus proposals along these lines include significant investment in advanced energy technologies, with a strong focus on electrification of the transportation sector through support for the purchase of electric vehicles (EVs) by government, businesses, and the general public, as well as investments to spur rapid deployment of EV charging infrastructure. These investments would be designed to induce coincident private investment and jumpstart a rapid transition to the adoption of EVs by individuals, municipalities (including school districts and transit agencies), state and federal government agencies, and businesses with large vehicle fleets.

This report analyzes the potential allocation of federal stimulus dollars to electrification of the transportation sector and its resulting economic impact. Recent policy proposals inform a hypothetical level of stimulus spending and its allocation to a range of electrification applications: charging infrastructure (residential/commercial and public), EV purchases (individual consumer, commercial, and government fleet), manufacturing and supply chain, workforce training, and research and development (R&D). The stimulus investments prompt additional investments by the private sector (homeowners, businesses, and investors) for vehicle purchases and vehicle charging infrastructure.

The starting point for the analysis is a hypothetical $274 billion of economic stimulus investment, spread across a range of electrification technologies, infrastructure, and support (as described in Section II). This level of funding is based on proposed stimulus in the American Jobs Plan, limited to funding categories that are relevant to EVs.[1] Allocation of this investment is weighted toward industry sectors and programs in a manner consistent with recent policy proposals. The economic impact of these stimulus and private investments in electrification is estimated using an industry-standard macroeconomic model, IMPLAN.

$274 B in Stimulus Produces

$1.3 T added to the national GDP

$231 B in additional tax revenue

10.7 M jobs created (in job-years)

$19 B in annual consumer, governmental, and business savings

For The U.S.

The results demonstrate the magnitude and nature of the potential impact on the national economy from switching to EVs, in boosting U.S. Gross Domestic Product (GDP),

[1] Explained further in Section III.A. See The White House, *Fact Sheet: The American Jobs Plan*, March 31, 2021, available at https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/ (hereafter, "American Jobs Plan").

creating jobs, and generating savings for consumers, governments and businesses. In short, we find significant economic benefits from federal investment in electrification of the transportation sector: an **investment of $274 billion** would produce the following economic benefits:

- **$1.3 trillion** added to the national GDP – a nearly **five-times return on public investment**;
- **10.7 million jobs created**, measured in job-years, including positions in vehicle and battery manufacturing;
- **$231 billion of additional tax revenue** to federal, state, and local governments; and
- **$19 billion in consumer, governmental, and business savings,** annually, from switching to EVs.[2]

Further, we find that, based on the investment categories modeled, EV stimulus investment prompts substantial private investment, **with each $1 of public investment generating $2.60 of direct private investment.**

A greater or lesser level of stimulus investment would result in roughly proportional impact, larger or smaller. But our analysis finds that stimulus investments in electrification of the transportation sector can generate important and positive economic benefits across the U.S., adding substantial value to the economy, creating millions of jobs, and sending additional revenue to federal, state, and local governments.

TABLE OF CONTENTS

[2] These are referred to as consumer savings for the remainder of this report.

I. OVERVIEW & FINDINGS

Discussions are underway in the nation's capital around a major economic stimulus package, in part to bolster economic growth in the wake of the pandemic, and in part tied to the infrastructure-related policy goals of the Biden administration. Further, interest in mitigating climate change has increased the focus of infrastructure investments on technologies, programs, and investments that can ramp up adoption of advanced energy technologies in general, and electrification of the transportation sector in particular.[3] This focus comes at a time when EVs are more practical and accessible than ever before, with new EVs for commercial applications following the trend of light-duty vehicles, and expansion of charging infrastructure making EVs in general more appealing for consumers and fleet operators.

In this context, the allocation of stimulus dollars toward vehicle electrification could be a vital component of both economic and climate policy. Estimating the potential economic effects of EV-focused stimulus investments can help shed light on the impact of this transformation on the U.S. economy. Various options have been considered for EV-related stimulus investment, including the following:

- **Charging Infrastructure –** at homes and businesses, and in service stations or other publicly accessible locations;
- **Vehicle Purchases –** for various vehicle classes, through tax credits and government procurement;
- **Manufacturing & Domestic Supply Chain** – including EV supply chain, batteries, and components;
- **Workforce Training**; and
- **Research & Development (R&D)**.

The economic impact of these stimulus and private investments in electrification is estimated using an industry-standard macroeconomic model, IMPLAN, with a focus on a number of key questions:

---

[3] President Biden's proposed stimulus package includes significant support for electric vehicle purchases, charging infrastructure, and incentives for manufacturing and research and development related to electrification of the transportation sector. See, *e.g.*, American Jobs Plan.

- How would public investments in EVs, charging infrastructure, workforce training, manufacturing and supply chain, and R&D affect the U.S. economy, and generate jobs and tax revenues?

- To what extent would public spending in these areas stimulate private investment, and amplify the economic impacts of the stimulus spending?

- How do the results in overall economic activity, job growth, and other economic benefits vary across the categories of investment in electrification of the transportation sector?

The starting point for the analysis is a hypothetical stimulus investment of $274 billion, based on recent policy proposals. These funds are spread across a range of electrification technologies, infrastructure, and support, described further in Section II. Allocation of these dollars is weighted toward categories consistent with ongoing policy discussions on potential stimulus investments.

The model demonstrates that **$274 billion stimulus investment in transportation electrification** would generate the following magnitude and types of economic benefits:

- **$1.3 trillion** added to the national GDP – a nearly **five-times return on public investment**;

- **10.7 million jobs created,** measured in job-years, including positions in vehicle and battery manufacturing;

- **$231 billion of additional tax revenue** to federal, state, and local governments; and

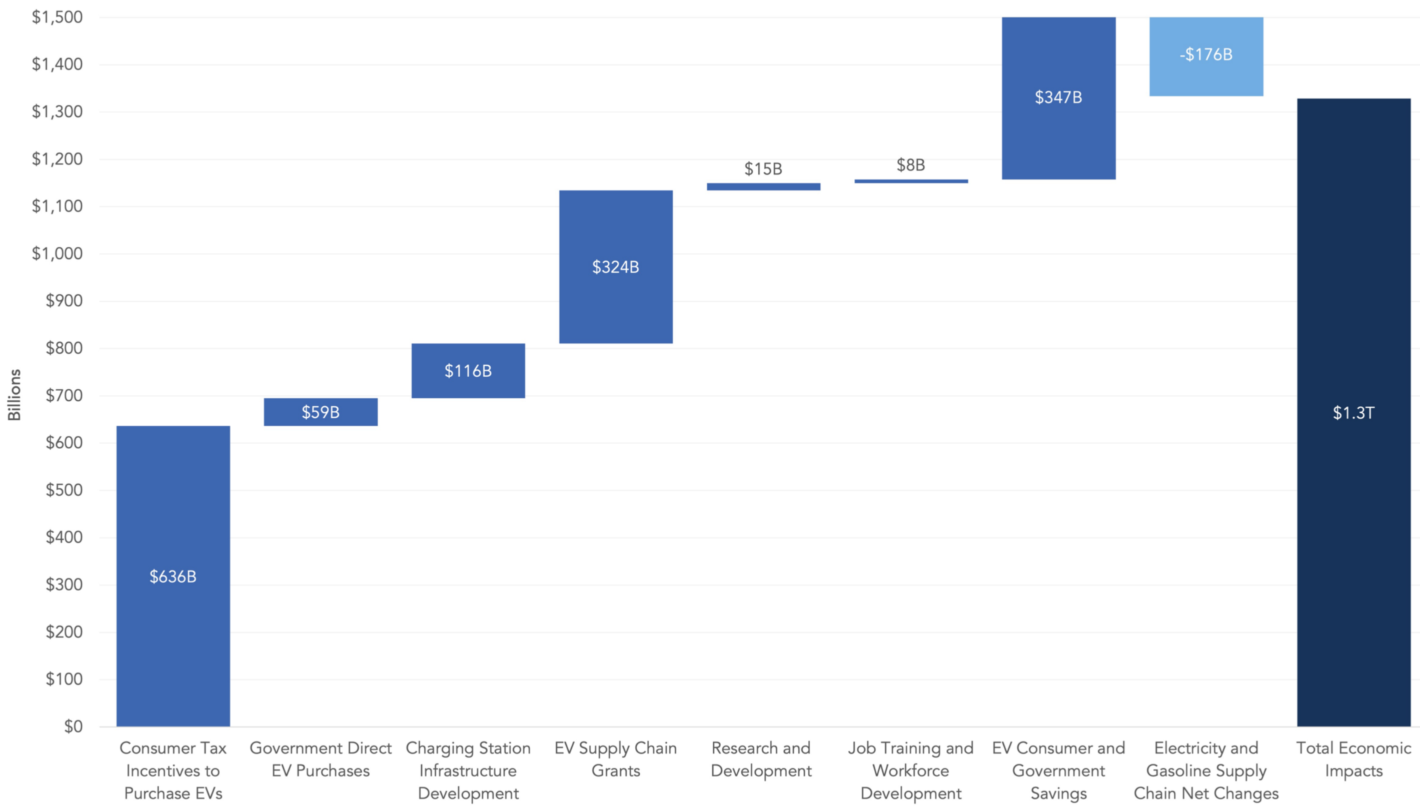
- **$19 billion in consumer savings**, annually, from switching to EVs.

All categories of stimulus spending on electrification generate positive impact on the economy, jobs, and tax revenue. The overall benefits accrue due to the direct impact of stimulus spending and private investment, which is incremental to the status quo, as well as additional economic activity induced by the increased flow of dollars in the economy.

Figures 1 and 2 show how the allocation of $274 billion in stimulus funds—which is representative rather than prescriptive—translates into economic activity for each investment category, measured by overall economic impact (addition to GDP) and job creation. The results show modest net negative impacts in the commodity supply chains for gasoline and electricity, but these impacts are overwhelmed by the strongly positive economic impacts in every other category of spending.

Based on the assumed allocation of stimulus funds and the expected associated private sector investment, EV purchase investment creates the greatest overall boost to the national economy, totaling $695 billion in GDP including both private and public sector purchases. The next biggest impact comes from EV manufacturing and supply chain investment, totaling $324 billion, followed by charging infrastructure, with $116 billion in economic activity. R&D contributes $15 billion and workforce training another $8 billion. (See Figure 1)

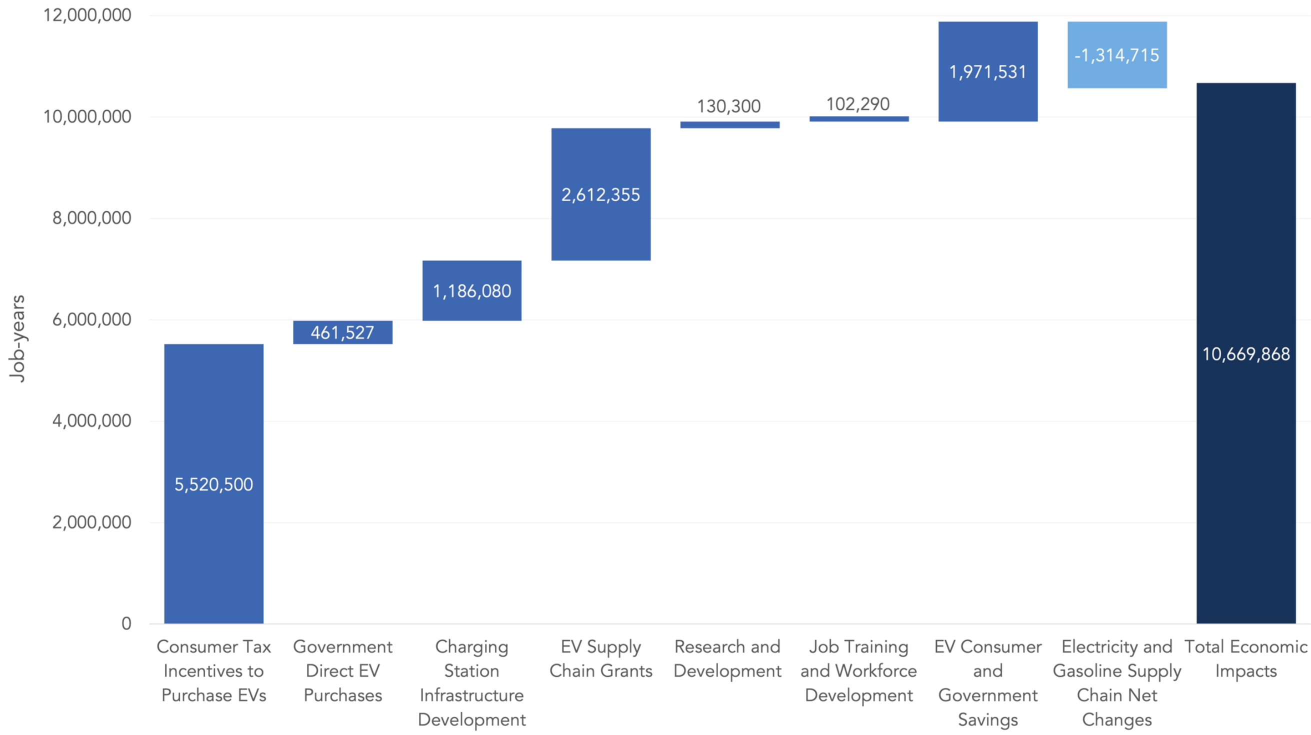
Figure 1. Total Economic Impact of $274 Billion Stimulus Investment on the U.S. Economy (GDP)



Analysis Group for AEE: *Economic Impact of Stimulus Investment in Advanced Energy*

In terms of jobs, EV purchase investment creates 6 million jobs, calculated in job-years (i.e., a job created by stimulus spending that lasts one year equals one job-year; a new job that is supported by the spending for three years equals three job-years) and results in a mix of short-term construction or installation employment and more ongoing positions. Investments in EV manufacturing and supply chain produce 2.6 million job-years, and charging infrastructure creates 1.2 million job-years. R&D creates 130,000 job-years and workforce training generates over 100,000 job-years. (See Figure 2)

Figure 2. Impact of $274 Billion Stimulus Investment on the U.S. Employment (Job-years)



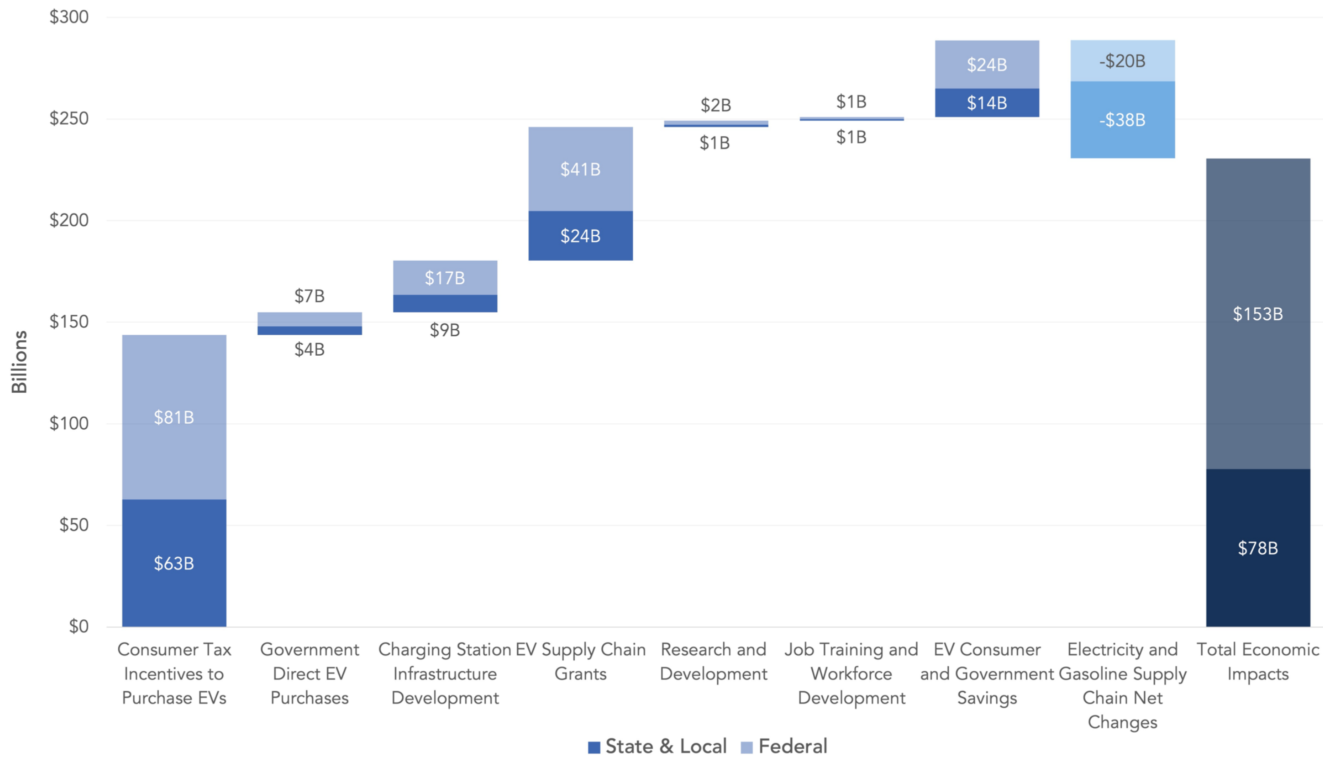
Analysis Group for AEE: *Economic Impact of Stimulus Investment in Advanced Energy*

In addition, certain transportation electrification investments provide direct savings to purchasers associated with reduced fuel and vehicle maintenance costs.[4] Based on our representative allocation of $274 billion of stimulus funds, direct savings would come to $18.6 billion annually. Of this total, $18.1 billion in savings would come from fuel savings and $456 million from reduced maintenance.

Finally, the additional economic activity created by $274 billion in transportation electrification stimulus results in an increase in tax revenues for federal, state, and local governments, with the federal government receiving an incremental $153 billion and state and local governments receiving another $78 billion. (See Figure 3)

[4] For electric vehicle operation and maintenance consumer savings, the reduced fuel cost is equal to savings on gasoline net of the cost of electricity for EV charging. The reduced maintenance cost relies on the per-mile conventional vehicle maintenance cost less the per-mile EV maintenance cost.

Figure 3. Total Tax Impact of $274 Billion Stimulus Investment (Local, State, and Federal Governments)



Analysis Group for AEE: *Economic Impact of Stimulus Investment in Advanced Energy*

Section II provides more detail on the analytic method and economic model behind these results, including input data and assumptions.

II. ANALYTIC METHOD

The economic impact of stimulus spending is estimated with an industry-standard macroeconomic input-output model, IMPLAN.[5] Recent policy proposals and historical stimulus investments in transportation electrification serve as a basis for developing a postulated level of stimulus spend for the analysis, as well as the allocation to various categories of potential electrification investments (e.g., EV purchases, charging infrastructure, manufacturing and supply chain, workforce training, and R&D).[6] We estimate a public-private spending ratio (PPR) for each category of investment based on a review of current policies, technology cost estimates, and historic relationships between public and private spending. IMPLAN uses the allocated funds and PPRs to estimate economic impact, including GDP, job creation, tax revenues, and consumer savings. Each step is discussed in greater detail below.

Public Spending Level and Allocation

The first step in the analysis is to postulate a level and distribution of public stimulus dollars directed towards electrification of the transportation sector. While we ground this postulated stimulus level and allocation on recent policy proposals and actual investments, it is important to note that the stimulus amount is an assumption made for the purpose of modeling economic impact. It is not possible to know yet exactly what the level of actual stimulus spending may be, if any. Nevertheless, the analysis provides an indication of the nature and direction of the economic impact of stimulus investments—all else equal, if the stimulus spending is more, the economic benefits would be greater; if less, the benefits would be lower.

Our primary basis for the postulated stimulus is tied to the American Jobs Plan proposal from the Biden administration, which proposes to use infrastructure stimulus funding in part for a major expansion of electric vehicles and associated infrastructure in the U.S.[7] Specifically, $174 billion has been proposed for specific investment to spur electrification of the transportation sector. The plan also proposes $300 billion for manufacturing, of which $46 billion is for federal procurement of domestically produced clean energy technologies (which includes vehicle and charger purchases).

---

[5] IMPLAN is described further in Section III.C.

[6] The proposed American Jobs Plan allocates $174 billion of investment in support for electric vehicle markets, including supply chain and domestic manufacturing, EV purchases, and charging infrastructure. Other categories of stimulus support EVs as well, including clean energy manufacturing, clean energy R&D, federal procurement, and workforce training. Similarly, The American Recovery and Reinvestment Act of 2009 allocated over $6 billion to EVs, providing grants and cost-sharing for domestic batteries and EV manufacturing, EV purchase tax credits, and federal vehicle fleet procurement. See American Jobs Plan; and U.S. Government, *American Recovery and Reinvestment Act of 2009*, available at https://www.congress.gov/111/plaws/publ5/PLAW-111publ5.pdf (hereafter, "ARRA").

[7] See American Jobs Plan.

Further, $35 billion is proposed for climate-related research and development (which includes EV/charging R&D) and $100 billion for workforce training. Assuming a portion of the manufacturing, R&D, and workforce funds are allocated to transportation electrification, we postulate a total federal transportation electrification stimulus of $274 billion.

Similarly, we looked to recent policy proposals and previous federal EV stimulus policy to allocate stimulus funds across categories of spending. As with the level of stimulus spending, the allocation of stimulus dollars across electrification investment categories is grounded in current policies and past investments but is just one of a number of different ways to allocate electrification stimulus dollars. To settle on a final allocation, we considered the following factors:

- The stated investments in specific categories from the Biden administration's proposal; and
- Allocations from the American Recovery and Reinvestment Act (ARRA) of 2009, which included transportation electrification.

Based on these sources and considerations, we allocated the postulated $274 billion of transportation electrification stimulus dollars to the following categories, in the following amounts:

- **Vehicle Purchases—$160 billion.** Incentives for the purchase of EVs are included based on recent proposals that discuss both rebates and tax incentives for American-made EVs, and proposed federal procurement spend on EVs. Given proposals to transition the federal vehicle fleet to EVs, we split EV purchases into two categories: tax incentives for consumers and businesses ($110 billion) and direct government purchases ($50 billion).[8]

- **Manufacturing & Domestic Supply Chain—$75 billion.** The EV value chain includes vehicle components, batteries, manufacturing, and retail functions, and recent proposals intend to "spur domestic supply chains from raw materials to parts, retool factories to compete globally, and support American workers to make batteries and EVs."[9]

- **Charging Infrastructure—$24 billion.** The Biden administration proposes a national network of 500,000 EV chargers by 2030, supports tax credits for charging infrastructure, and allocates

---

[8] The $110 billion for consumers and businesses represents the $100 billion towards consumer rebates for EV purchases outlined in the American Jobs Plan and $10 billion towards medium- and heavy-duty vehicles. The $50 billion for direct government purchases is based on the $25 billion to transit buses and $20 billion to school buses outlined in the American Jobs Plan, plus an additional $5 billion, an estimated allocation from the $46 billion for federal procurement. See American Jobs Plan ("$46 billion investment in federal buying power"); and Bloomberg, *Biden Infrastructure Plan Seeks $571 Billion in Transport Funds*, April 7, 2021, available at https://www.bloomberg.com/news/articles/2021-04-07/biden-infrastructure-plan-seeks-571-billion-in-transport-funds ("$100 billion for rebates to electric car consumers, $25 billion for zero emission transit vehicles and $20 billion for school bus electrification").

[9] $75 billion allocates an additional portion of the $300 billion for manufacturing in the American Jobs Plan to EVs (beyond what is already allocated as part of the $46 billion for federal procurement). See American Jobs Plan ("President Biden is calling on Congress to invest $300 billion in […] manufacturing").

federal procurement spend towards EVs.[10] Proposed funding suggests a greater share of stimulus funds to public, rather than residential, charging. Charging infrastructure is viewed as necessary for a transition to EVs, and there is evidence that investment in EV infrastructure encourages EV adoption.[11]

- **Workforce Training—$5 billion.** Recent proposals and historical clean energy stimulus include workforce training.[12] Allocating stimulus funds to workforce training is consistent with the emphasis on domestic labor, and historical stimulus funding for this category included grants for job training, partnerships among labor organization and employers, and improved understanding of clean technology.

- **Research & Development—$10 billion.** Recent proposals and historical clean energy stimulus include research and development for EVs. These funds support innovation in batteries, as well as EV components and manufacturing.[13]

---

[10] The $24 billion towards charging infrastructure is made up of $22 billion for public and $2 billion for residential charging infrastructure. $22 billion of public charging includes $15 billion proposed for 500,000 charging stations in the American Jobs Plan, an allocation of $2 billion from the 30C tax credit to promote charging infrastructure, and an allocation of $5 billion from federal procurement. An additional allocation of $2 billion from the 30C tax credit also funds residential charging. See American Jobs Plan ("grant and incentive programs for state and local governments and the private sector to build a national network of 500,000 EV chargers by 2030" and "$46 billion investment in federal buying power"); and Bloomberg, *Biden Infrastructure Plan Seeks $571 Billion in Transport Funds*, April 7, 2021, available at https://www.bloomberg.com/news/articles/2021-04-07/biden-infrastructure-plan-seeks-571-billion-in-transport-funds ("$15 billion for building a network of 500,000 electric car charging stations").

[11] See, *e.g.*, Levinson and West, *Impact of Public Electric Vehicle Charging Infrastructure*, *Transportation Research*, available at https://www.osti.gov/pages/servlets/purl/1399883 (hereafter, "Levinson and West").

[12] $5 billion allocates a portion of the $100 billion for workforce training in the American Jobs Plan to EVs, including training programs like the Electric Vehicle Infrastructure Training Program. See American Jobs Plan ("President Biden is calling on Congress to invest $100 billion in proven workforce development programs"). Similarly, the ARRA included funds for Green Innovation and Job Training. See Council of Economic Advisers, *A Retrospective Assessment of Clean Energy Investments in the Recovery Act*, February 2016, p. 48, available at https://obamawhitehouse.archives.gov/sites/default/files/page/files/20160225_cea_final_clean_energy_report.pdf (hereafter, "ARRA Retrospective Assessment").

[13] $35 billion is proposed towards clean energy R&D, including investments in EVs, in the American Jobs Plan. This analysis assumes a minority of these funds are allocated towards EVs. See American Jobs Plan ("Establish the United States as a leader in climate science, innovation, and R&D. The President is calling on Congress to invest $35 billion in the full range of solutions needed to achieve technology breakthroughs that address the climate crisis and position America as the global leader in clean energy technology and clean energy jobs.").

Private Investment Motivated by Public Spending and Total Investment

To calculate the economic impact of public stimulus spending on EVs, it is necessary to estimate the additional investments by private actors that would not occur *but for* the stimulus. For example, the Biden-Harris campaign proposed that their proposed $1.7 trillion clean energy stimulus plan would lead to over $5 trillion of private investment. Additionally, ARRA's $90 billion in clean energy stimulus funding included $46 billion that had private co-investment opportunities, and this $46 billion led to an additional $150 billion in private investment.[14]

These factors are used to develop appropriate Private-Public Ratios (PPR) for each category of investment in electrification of the transportation sector. PPRs are used to estimate a level of private investment for each dollar of public stimulus funding. For example, for an EV investment category with a PPR of 2, each dollar of public stimulus funding would spur two dollars of private investment that would not otherwise occur. PPRs are applied to each category of investment as follows:

- **Vehicle Purchases—4:1.** The EV purchase PPR is derived from the ratio of federal subsidy to vehicle price. The current federal tax credit for purchasing a light-duty EV is $7,500.[15] A sample of best-selling EVs is used to derive the price of a representative light-duty, mass market EV.[16] Purchase prices for heavy-duty and commercial buses are based on currently available vehicles—yet this will likely change significantly given the current level of innovation in this area.[17] Federal stimulus incentives are assumed to have the same proportion to average vehicle price as in the light-duty category.

- **Manufacturing & Domestic Supply Chain—3:1.** The manufacturing and supply chain PPR is derived from an overall PPR for the clean energy stimulus proposed by the current administration

---

[14] See ARRA Retrospective Assessment, p. 12. Note that state and local investments are aggregated with private investments.

[15] The current tax credit applies to passenger vehicles and light trucks, starting at $2,500 and increasing with the vehicle's battery capacity up to $7,500. The credit begins to phase out when a threshold of a manufacturer's vehicles is reached. For this report, credit is set to $7,500 for every vehicle and no unit limit is applied. See, *e.g.*, Office of Energy Efficiency & Renewable Energy, *Federal Tax Credits for New All-Electric and Plug-in Hybrid Vehicles*, available at https://www.fueleconomy.gov/feg/taxevb.shtml; and IRS, *Plug-In Electric Drive Vehicle Credit (IRC 30D)*, available at https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d, (collectively hereafter, "EV Purchase Incentives").

[16] A representative, "mass market" price of $37,022 is derived from the base MSRP of the ten top-selling consumer EVs in 2020, after removing Audi, Porsche, and higher-priced Tesla models (Model X and S). See Statista, *Best-selling plug-in electric cars in the United States in 2020, based on new registrations*, April 2021, available at https://www.statista.com/statistics/257966/best-selling-electric-cars-in-the-united-states/.

[17] An EV bus purchase price is assumed at $579,000. Transit EV bus prices can range from $579,000 to $1,200,000, while school buses, which cost closer to $350,000, are less expensive. To choose a price that weighs both bus types, the lowest-cost EV transit bus is used. See NREL, *Financial Analysis of Battery Electric Transit Buses*, available at https://afdc.energy.gov/files/u/publication/financial_analysis_be_transit_buses.pdf. An EV heavy duty purchase price is assumed at $200,000. Heavy-duty EVs can range from $100,000 to more than $300,000 depending on the vehicle's weight class. See ACT News, *Calculating TCO for EVs: Where to Find the Greatest Long-Term Cost Savings for Medium- and Heavy-Duty Vehicles*, available at https://www.act-news.com/news/calculating-tco-for-medium-and-heavy-duty-evs/.

in their campaign plan.[18] This is comparable to the PPR found from ARRA clean energy stimulus with a co-investment component.[19]

- **Charging Infrastructure—2.5:1.** Similar to EV purchases, the charging infrastructure PPR is derived from the stimulus incentive's share of the purchase price. The incentive is based on a current tax credit of 30%.[20]

- **Research & Development—no incremental private funding.** We assume no direct private co-investment for R&D resulting from the public investment.

- Based on these PPRs, **$274 billion in public stimulus spending** results in an additional **$725 billion in private investment – or $2.60 of private investment for every $1 of public spending.**

The combined public and private investments factor into the IMPLAN model in two parts. First, the total direct investment is modeled as it flows through the national economy. Second, consumer and business operation and maintenance (O&M) savings from EV investment are modeled as additional usable income, using the following estimation methods:

- **Operation (Fuel) Cost Savings—**Savings from replacing internal combustion engine ("ICE") vehicles with EVs are calculated from the reduction in spending on gasoline or diesel fuel, net of an increase in electricity costs from EV charging:

    - Increase in Electricity Demand = New EVs x Average EV Electricity Consumption[21]

    - Increase in Electricity Expenditures = (1) x Avg. Retail Electricity Price[22]

---

[18] "Biden's climate and environmental justice proposal will make a federal investment of $1.7 trillion over the next ten years, leveraging additional private sector and state and local investments to total to more than $5 trillion." Plan for Clean Energy.

[19] See ARRA Retrospective Assessment, p. 12.

[20] The current tax credit has a limit of $30,000 for commercial and $1,000 for residential charging stations. See IRS, *Alternative Fuel Vehicle Refueling Property Credit*, available at https://www.irs.gov/forms-pubs/about-form-8911.

[21] Average electricity consumed by EVs is calculated based on fuel economy estimates for light- and heavy-duty EVs and electric buses, as well as average vehicle miles traveled. Light-duty fuel economy is estimated from Union of Concerned Scientists, *State of Charge: Electric Vehicles Global Warming Emissions and Fuel-Cost Savings across the United States*, p. 5, available at https://www.ucsusa.org/sites/default/files/2019-09/electric-car-global-warming-emissions-report.pdf. Heavy-duty and bus fuel economy is estimated by comparing fuel economy for light-duty ICE vehicles with heavy-duty ICE vehicles and buses. For average VMT, see also Federal Highway Administration, *Annual Vehicle Distance Traveled in Miles and Related Data - 2018*, available at https://www.fhwa.dot.gov/policyinformation/statistics/2018/vm1.cfm.

[22] The average retail electricity price is estimated from a national average retail rate for 2019. See EIA, *State Electricity Profiles*, available at https://www.eia.gov/electricity/state/.

- Decrease in Fuel Demand = Vehicles Replaced x Avg. Gallon Consumed[23]
- Decrease in Fuel Expenditures = (3) x Avg. Price of Fuel[24]
- Consumer Savings = (4) – (2)

- **Maintenance Cost Savings—**EVs typically have lower maintenance costs due to simpler drivetrains, fewer fluids, and decreased brake wear from regenerative braking.[25] These are estimated as:
  - O&M Savings Per Mile = ICE Maintenance Costs Per Mile – EV Maintenance Costs Per Mile
  - O&M Savings = New EV x Avg. Vehicle Miles Traveled x (1)

Fuel savings and maintenance savings are combined to determine total savings. Savings are calculated separately by vehicle class as miles traveled, fuel economy, fuel prices, and charging costs vary by class. Further, stimulus investment will lead to different levels of vehicle replacement by vehicle class. Consumer savings are based on recurring annual savings for ten years, adjusted for inflation. Effects of EV incentives on used car purchases are encapsulated in the length of the savings period, as vehicles typically change owners well before ten years after the initial purchase.[26]

Macroeconomic Model

As noted above in Section II, investments in transportation electrification are modeled in two parts. First, when public and private dollars fund an activity (such as installing a charging station), create a purchase that would not otherwise occur (purchase of an EV), or develop a resource or technology (R&D leading to improved battery technology), those investments lead to the purchase of goods and

[23] Fuel consumption is calculated based on an estimate of average miles per gallon and average vehicle miles traveled. Fuel economy is estimated from NEPIS, *Light Duty Automotive Technology and Fuel Economy Trends: 1975-2008*, available at https://nepis.epa.gov/Exe/ZyPDF.cgi/P1004N5Y.PDF?Dockey=P1004N5Y.PDF. For average VMT, see also Federal Highway Administration, *Annual Vehicle Distance Traveled in Miles and Related Data - 2018*, available at https://www.fhwa.dot.gov/policyinformation/statistics/2018/vm1.cfm.

[24] Average fuel prices are based on average retail gasoline and diesel prices. See EIA, Weekly Retail Gasoline & Diesel Prices, available at https://www.eia.gov/dnav/pet/PET_PRI_GND_DCUS_NUS_A.htm.

[25] See, *e.g.*, DOE, *Maintenance and Safety of Hybrid and Plug-In Electric Vehicles*, available at: https://afdc.energy.gov/vehicles/electric_maintenance.html. For estimates of maintenance savings, see, *e.g.*, NYSERDA, *Benefit-Cost Analysis of Electric Vehicle Deployment in New York State*, available at https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Transportation/19-07-Benefit-Cost-Analysis-EV-Deployment-NYS.pdf; see also AAA, *True Cost of Electric Vehicles*, available at https://www.aaa.com/autorepair/articles/true-cost-of-ev; and Consumer Reports, *Cost of Ownership Analysis*, available at https://advocacy.consumerreports.org/press_release/new-analysis-from-cr-finds-that-the-most-popular-electric-vehicles-cost-less-to-own-than-the-best-selling-gas-powered-vehicles-in-their-class/.

[26] New consumer cars are often owned for approximately six years. See, *e.g.*, Car and Driver, *Understanding the Ownership Costs of Cars: Quick Guide*, available at https://www.caranddriver.com/research/a33235649/ownership-costs-of-cars/#:~:text=In%20a%20study%20in%20The,or%20right%20around%20six%20years.

services in the economy. Second, investments in EVs lead to consumer savings from reduced fuel and maintenance costs.

IMPLAN is a social accounting, input-output model that seeks to replicate the structure of a specific economy (in this case, the U.S. economy). It is widely used in economic impact analyses, both in the public and private sector. With IMPLAN, the impact on an economy from a given change in economic activity can be estimated, by using information from economic survey data, to construct economic relationships between businesses and consumers. Because IMPLAN tracks dollars spent in a region—transfer of funds from consumers to producers, purchases of goods and services from outside of the specific economy being modeled, and payments to parties outside of the specific economy—intra-economy flow of funds can be modelled along with inflows and outflows. Economic variables modeled in IMPLAN include:

- **Gross Domestic Product—**change in economic valued added;
- **Employment—**jobs created or lost;
- **Income—**change in employee income; and
- **Taxes—**additional tax revenue.

Economic impact, measured in these variables, reflects the following:

1. **Direct Effects:** Initial inputs introduced into the economy; any direct effect from stimulus and matching private investments towards transportation electrification on consumers and businesses and on the purchase of goods and services in the economy.

2. **Indirect Effects:** Additional demand for local goods and services, as well as jobs, resulting from Direct Effects. Indirect Effects can include, for example, increased economic activity in component manufacturing due to increased EV auto manufacturing.

3. **Induced Effects:** Increased spending due to additional available income, earned from direct and indirect economic activity.

IMPLAN also captures "leakages" that occur when spending leaves the U.S., such as when materials are purchased from outside the U.S. While the American Jobs Plan, and our modeling, aims to direct spending to domestic producers where possible, some amount of money invariably "leaks" out of the U.S. as the initial direct investments trickle through the economy.

III. FINAL OBSERVATIONS

The following observations can be made, based on the EV stimulus investments modeling for the U.S.:

Stimulus investments in electrifying transportation can generate positive and significant benefits in the U.S., adding value to the national economy, creating millions of jobs, generating tax revenue, and creating consumer savings. The results strongly support including investments in electrification of the transportation sector in federal stimulus; the hypothesized $274 billion in federal spending grows GDP by $1.3 trillion, creates jobs and increases revenues for federal, state, and local governments. These benefits accrue from direct investment of stimulus dollars, private investment spurred by public stimulus, consumer savings from transitioning to EVs, and other economic activity indirectly generated or induced by the flow of funds through the economy from stimulus investments.

Transportation electrification-related stimulus investment primes the pump for substantial private investment in EV and charging technologies. Stimulus spending on EV purchases, charging infrastructure, and EV manufacturing attracts substantial private investment. In aggregate and based on the allocation of stimulus funds across investment categories modeled, we find that each dollar of public investment generates $2.60 of additional direct private investment.

In addition to direct public and private investment, transportation electrification investments stimulate economic activity through consumer and business savings that flow back into the economy. EV stimulus investment generates long-run benefits to consumers and businesses. EV investments lower the cost of transportation through fuel savings, as well as lower vehicle maintenance costs. The investment in EV manufacturing and batteries can lead to even greater savings from EVs over ICE vehicles, especially as medium- and heavy-duty EVs and commercial EV fleets become more common.

All categories of transportation electrification stimulus investment are shown to generate positive economic growth. The analysis demonstrates the potential impact of the investments themselves—including that most stimulus dollars stay within the national economy[27], there is strong potential for inducing private investment, and the resulting economic benefits are almost five times the amount of direct public stimulus.

---

[27] The EV supply chains modeled in IMPLAN use an approximately 60 percent local purchase percentage of materials from within the United States. Approximately 90 percent of all transportation-related spending (including investments in R&D, charging infrastructure, and electric vehicles) is directed to within the national economy, based on the local purchase percentages of the modeled industries.

Transportation electrification investments help reduce energy and economic supply chain risk and more equitably disperse economic activity associated with the transportation sector. Investment in EV technologies may increase domestic manufacturing and materials production,[28] reducing supply chain risks and reliance on concentrated energy/fuel supply sectors. Less reliance on gasoline and diesel fuel also increases the country's energy independence.[29] Increased EV adoption can lead to less geographic concentration of the fuels and industries needed to meet demand, providing opportunities to more equitably disperse the economic activity supporting transportation.

Transportation electrification stimulus investments are aligned with national energy, environmental, and climate policies. Although the analysis models economic impacts of investments in transportation sector electrification, other benefits accrue. Investment in electrifying transportation supports decarbonization of the transportation sector and is considered critical for meeting U.S. climate objectives. Further, transportation electrification investments, by reducing the combustion of fossil fuels, significantly improve air quality. This is likely to be particularly true in urban areas and environmental justice communities. Improved air quality leads to improved health outcomes and decreased medical costs, adding to the economic and social benefits of EV investment.[30] Therefore, directing stimulus funds to EVs also supports climate and social objectives while creating economic growth.

---

[28] Stimulus proposals and recent orders emphasize the goal of increasing domestic manufacturing and materials. The American Jobs Plan "will require that goods and materials are made in America and shipped on U.S.-flag, U.S.-crewed vessels" and that manufacturing stimulus goes to domestic manufacturers only. Additionally, the "Made in America Laws" executive order passed by the Biden-Harris Administration in January 2021, mandates "United States Government should, whenever possible, procure goods, products, materials, and services from sources that will help American businesses compete in strategic industries and help America's workers thrive." See The American Jobs Plan. See also, The White House, *Executive Order on Ensuring the Future Is Made in All of America by All of America's Workers*, January 25, 2021, available at https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/25/executive-order-on-ensuring-the-future-is-made-in-all-of-america-by-all-of-americas-workers/.

[29] *See, e.g.*, Alternative Fuels Data Center, *Electric Vehicle Benefits and Considerations*, available at https://afdc.energy.gov/fuels/electricity_benefits.html. Prior initiatives at increasing energy independence through reduced fuel consumption include, *e.g.*, Alternative Fuels Data Center, *Energy Independence and Security Act of 2007*, available at https://afdc.energy.gov/laws/eisa.

[30] *See, e.g.*, American Lung Association Reports, *The Road to Clean Air*, September 20, 2020, available at https://docs.house.gov/meetings/IF/IF18/20200916/111008/HHRG-116-IF18-20200916-SD005.pdf.