ECONOMIC IMPACT OF STIMULUS INVESTMENT IN ADVANCED ENERGY FOR AMERICA

AN ECONOMIC ASSESSMENT OF APPLYING STIMULUS TO ADVANCED ENERGY TECHNOLOGIES, PRODUCTS, AND SERVICES IN THE UNITED STATES

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ADVANCED ENERGY ECONOMY

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This report was prepared at the request of Advanced Energy Economy to review the potential economic impacts of public and private investment of energy technologies that will be vital for meeting U.S. energy, economic, and environmental 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, Emma Solomon, and Hannah Krovetz of Analysis Group for their assistance with research and analysis, and Ryan Katofsky, Robert Keough, Shelby Stults, Leah Rubin Shen, J.R. Tolbert, and Cayli Baker 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 and track the latest news on Twitter @AEEnet.

EXECUTIVE SUMMARY

Over the past year, the federal government has enacted programs that invest government dollars to provide Americans with economic relief, recover from the COVID-19 pandemic, and get the economy moving. Recent federal stimulus and infrastructure proposals have looked toward longer-term economic growth, and have included major investments in various advanced energy technologies.

This report focuses on the potential economic impact of such investment in advanced energy technologies. Focusing stimulus spending on deployment, manufacturing, and training programs for advanced energy technologies can generate economic activity and create good jobs across the U.S.

$591 B in Stimulus Produces

$3.5 T added to the U.S. economy

$631 B in additional tax revenue

29 M new jobs created (in job-years)

$75 B in annual consumer, governmental, and business savings

For The U.S.

For the purpose of this analysis, we postulate a level of stimulus spending based in part on President Biden's American Jobs Plan, invested across a range of advanced energy technologies and services: energy efficiency, renewable energy (solar and wind), electrification of buildings, electrification of transportation (electric vehicles and charging infrastructure), energy storage, grid modernization (smart meters, microgrids), high-voltage transmission, and job training.

We then estimate the economic impact of these investments using an industry-standard macroeconomic model (IMPLAN), focusing on the overall contribution of the investments to the U.S. economy, the level of private spending and investment stimulated by the investments, jobs created, and consumer savings on energy costs.

The results of the analysis point to strong economic benefits associated with advanced energy technology investments. In short, **an advanced energy stimulus investment of nearly $600 billion** across the U.S. would produce the following economic benefits:

- **Over $3.5 trillion** added to the U.S. economy;
- **Over 28 million new jobs,** measured in job-years, resulting in a mix of short-term construction or installation employment and more ongoing positions;
- **Over $631 billion in additional tax revenue** to local, state, and federal governments; and
- **Over $74 billion in annual consumer savings.**

A greater or lesser level of stimulus investment would result in greater or lesser economic impact. But our analysis finds that advanced energy stimulus investments can generate **a return on investment on the order of six times the level of public expenditure** for the U.S. as a whole, adding substantial value to the economy, helping workers in current energy sectors transition to emerging energy sectors, creating tens of millions of new jobs, and sending additional revenue to local, state, and federal governments.

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I. OVERVIEW & FINDINGS

As of June 2021, over 197 countries have responded to the worldwide coronavirus pandemic with some form of economic relief and stimulus funding.[1] The specifics vary widely, but the basic idea is the same: introduce public money to bolster health care efforts, support people's ability to meet basic needs, help businesses that are threatened, and stimulate economic activity to support the recovery and generate income and jobs.

In the United States, both the federal government and individual states have responded to the public health crisis with emergency spending measures, and now are pursuing investments designed to promote longer-term economic recovery. On March 31, President Biden proposed the American Jobs Plan (AJP),[2] which is focused on bolstering the care economy, investing in infrastructure, and addressing climate change. Up to half of the AJP's proposed investment could ultimately go towards long-term growth in sectors that are related to climate and environmental justice, including investments in many programs to spur the rapid development and deployment of advanced energy technologies.[3] As the AJP continues to be debated in Washington, the U.S. has important decisions to make about how to focus investments in a way that both meet public policy goals and stimulate economic growth.

In this report we focus on potential federal government investments in advanced energy technologies, based in part on programs outlined in the AJP. Focusing stimulus spending on deployment, manufacturing, and training programs for advanced energy technologies, and retraining workers to participate in this growth, can generate economic activity while also helping the U.S. achieve its energy policy goals. The advanced energy technologies and supporting investments considered for the analysis include:

- Energy efficiency (EE) measures and programs;
- Manufacturing and deployment of renewable electric generating resources (solar, wind);

[1] International Monetary Fund, *Policy Responses to COVID-19*, updated as of June 4, available at: https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19.

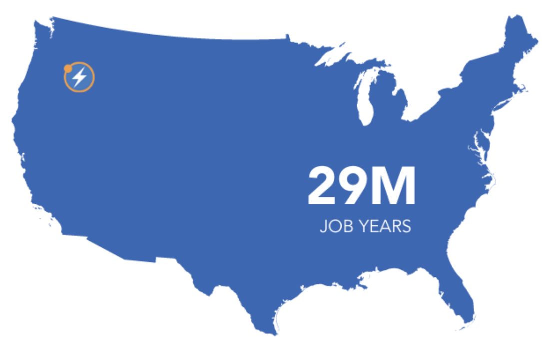
[2] See, e.g., The White House, *Fact Sheet: The American Jobs Plan*, March 31, 2021, available at https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/ (hereafter, "American Jobs Plan").

[3] Joel Jaeger, Katrina McLaughlin, Jillian Neuberger and Carrie Dellesky, *Does Biden's American Jobs Plan Stack Up on Climate and Jobs?*, World Resources Institute, April 1, 2021.

- Job training (support for technical training programs, industry-specific employment resources, and other vocational education-related infrastructure);
- Electrification of buildings (electric heating, cooling, and appliance installations);
- Electrification of transportation (public investment in or support for private or commercial vehicle charging infrastructure, and manufacturing and support for the purchase of electric vehicles);
- Energy storage manufacturing and installation;
- Grid modernization and distributed grid resources (e.g., smart meters, microgrids, combined heat and power, and other integrated distribution system technologies); and
- High-voltage transmission to access remote renewable resources (e.g., new wind resources).

The analysis sets a hypothetical level of stimulus spending and allocates the stimulus dollars across advanced energy technologies. It then estimates the economic impacts of these investments using an industry-standard macroeconomic model (IMPLAN), focusing on a number of key questions:

- How would public investments in a range of advanced energy technologies 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 technologies and programs?



The starting point for the analysis is a hypothetical $591 billion of economic stimulus investment spread across a range of advanced energy technologies. This figure is based on an analysis of the portions of each funding category in the AJP that could be reasonably assigned to advanced energy technologies. As described further in Section II, relevant AJP funding includes categories such as electric vehicles and grid modernization, as well as other categories, such as workforce development programs, where a portion of funds are allocated towards advanced energy technologies. Allocation of this $591 billion investment is weighted toward technologies and products that, based on historical experience, are likely to generate significant economic activity and have proven capacity to attract participation from customers and investors, thereby adding private investment to the overall economic impact.

The results of the analysis point to advanced energy stimulus spending as a strong pump-primer for private investment, job creation, and economic growth. In short, **$591 billion of advanced energy stimulus investment** across the U.S. would generate the following economic benefits:

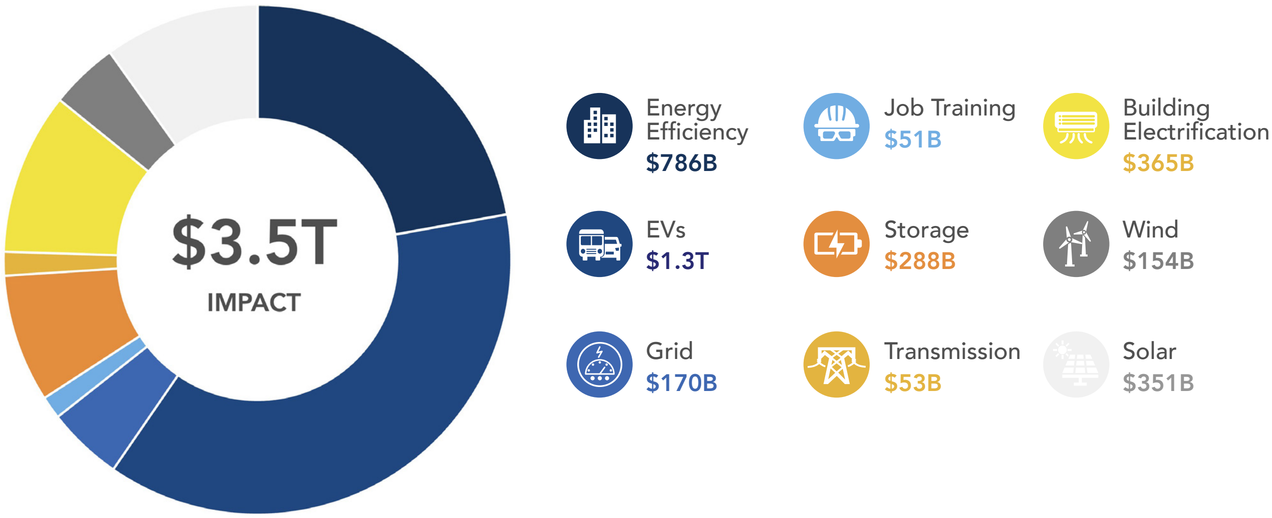
- **Over $3.5 trillion** added to the U.S. economy – a six-fold return on the public investment;
- **Over 28 million new jobs**, measured in job-years, representing a mix of short-term construction/installation employment and more ongoing positions;
- **Over $631 billion in additional tax revenue** to local, state, and federal governments; and
- **Over $74 billion in annual consumer savings.**

All categories of advanced energy stimulus spending 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, as well as additional economic activity induced by the additional flow of dollars in the economy.

Figures 1 and 2 show how our allocation of $591 billion in stimulus – which is representative rather than prescriptive – translates into economic activity on a technology-by-technology basis, as measured by overall economic impact (addition to Gross Domestic Product, or GDP) and jobs created. In total, **$591 billion of advanced energy stimulus results in $1.4 trillion in complementary private investment, $3.5 trillion in overall economic activity, and an increase in employment of over 28 million jobs, measured in job-years, for the U.S. as a whole.**

Electrification of transportation investments give the greatest overall boost to the economy, totaling $1.3 trillion in GDP. This incorporates the net positive effect of transitioning away from ICE vehicles, including the positive effects of fuel and vehicle maintenance savings and the negative effects of fossil fuel supply chain impacts. The next biggest impact comes from energy efficiency investments, totaling $786 billion, followed by renewable energy generation (solar and wind), with over $504 billion in economic activity. Building electrification adds another $365 billion in GDP. Energy storage contributes another $288 billion, transmission and grid modernization combine for another $224 billion, and job training adds an additional $51 billion. (See Figure 1.)

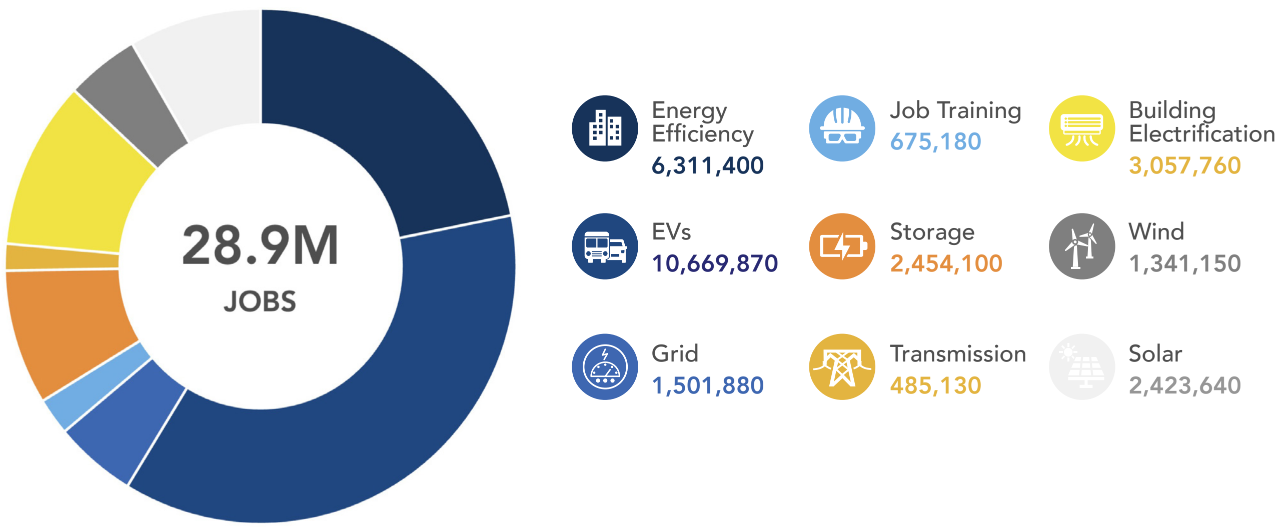
Figure 1. Total Impact of $591 Billion Stimulus Investment on the U.S. Economy (GDP) by Technology



Analysis Group for AEE

In terms of jobs, electrification of transportation creates over 10 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 resulting in a mix of short-term construction or installation employment and more ongoing positions. Energy efficiency investments produce 6 million jobs and renewable energy investments produce nearly 4 million. Building electrification creates 3 million jobs; nearly 2.5 million jobs result from energy storage, 2 million jobs result from transmission and grid modernization investments, and over 675,000 jobs are generated from vocational training investments. (See Figure 2.)

Figure 2. Impact of $591 Billion Stimulus Investment on U.S. Employment (job-years), by Technology



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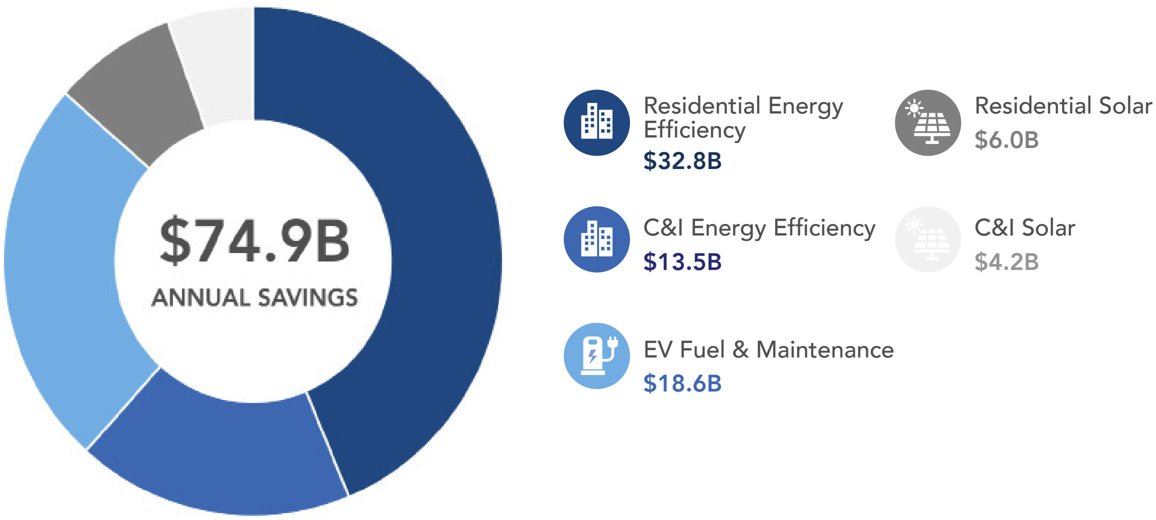
In addition, certain advanced energy investments provide direct savings to consumers associated with reduced electricity consumption, increased savings from onsite solar production, and reduced fuel and maintenance costs by use of electric vehicles.[4] Based on our representative allocation of $591 billion of stimulus funds across the U.S., total savings would come to over $74 billion annually. Of this total, $33 billion in savings would come from residential energy efficiency, $6 billion from residential rooftop solar, $19 billion from EV fuel and maintenance savings, and $18 billion from commercial energy efficiency and onsite solar. (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. Impact of $591 Billion Stimulus Investment on U.S. Consumer Savings (annual), by Technology



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Finally, the additional economic activity created by $591 billion in advanced energy stimulus is projected to **increase tax revenues for local, state, and federal governments by over $631 billion.**

A greater or lesser level of stimulus investment would result in greater or lesser economic impact. But our analysis finds that advanced energy stimulus investments can generate important and positive economic benefits across the U.S. on the order of **six times the level of public investment**, adding substantial value to the economy, creating tens of millions of jobs (as measured in job-years), and sending additional revenue to local, state, and federal governments.

In Section II we provide more detail on the analytic method and economic model behind this analysis, the data and assumptions applied, and the various modeling inputs and outputs resulting from the analysis.

II. ANALYTIC METHOD

In this report, the economic impacts of stimulus spending are modeled by running a scenario through an industry-standard macroeconomic input-output model, IMPLAN. We first hypothesize an overall level of stimulus spending in the U.S. based on a review of the American Jobs Plan. Next, we identify advanced energy technologies and products as potential candidates for stimulus spending and apportion the overall stimulus budget among the advanced energy options on a representative, rather than prescriptive, basis. We then estimate a level of private investment in each technology/product category based on the level of public investment, historic relationships between public and private spending, and current technology cost estimates. We then run the total dollars of investment (combining public and private) through IMPLAN, generating results for key economic metrics (Gross Domestic Product, jobs, tax revenues, and consumer savings). Each of these steps is described below.

Public Spending Level and Allocation

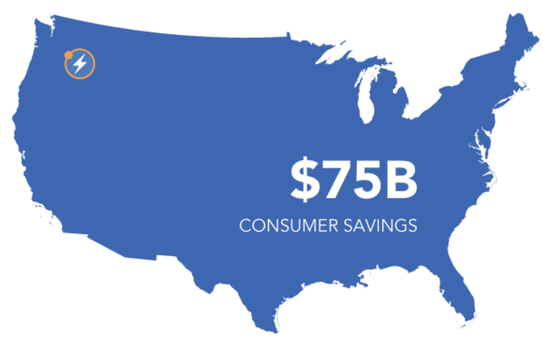
The first step in the analysis is to identify an overall level of stimulus spending, and then allocate the total amount among the various advanced energy technology/product options. The specific level of stimulus/infrastructure spending and the allocation of such investments to advanced energy technologies is currently under debate. We therefore make an assumption about a potential level of spending based on a review of the American Jobs Plan. Thus, the starting point level of stimulus spending is an assumption made for the purpose of modeling the resulting economic impact. Specifically, we postulate a total public investment of $591 billion on advanced energy technologies and presume it to be spent over a three year period.[5]

The next step is to identify how such a stimulus could be allocated across advanced energy technologies and products. To inform an allocation scenario we could treat as representative, rather than prescriptive, we reviewed descriptions in the AJP regarding the allocation of proposed stimulus dollars, both those that are specific to advanced energy sectors (e.g., electric vehicles), and those that may be directed to other sectors, but include spending on advanced energy within those sectors (e.g., spending on energy efficiency within the funding proposed for upgrading public school buildings). As with the overall level of stimulus spending, the allocation of stimulus dollars across

[5] The AJP proposes over $2 trillion in investments with a focus on infrastructure. Each funding category in the AJP was reviewed for if and how much it applies to advanced energy technologies. Funding categories assumed to have applicability towards advanced energy technologies include Manufacturing, Electric Vehicles, Affordable Housing, Grid Modernization, Job Training, Research and Development, and Building Upgrades. The assumed public investment of $591 billion is the sum of the proportion of each relevant funding category assumed toward advanced energy technologies.

technologies should be viewed as an assumption, based on our review of the AJP, and considering the following additional factors:

- the technical potential and feasibility of advanced energy technology development in the U.S.;
- the current status of the technologies in terms of development, commercialization, and consumer uptake;
- technology economics and the current/historic level of subsidies supporting installations in the U.S.;
- the goal of spreading the stimulus across a number of technologies to promote diversity in energy resources, and to provide for transitional job training for workers in current energy sectors;
- the degree to which the technologies or products involve or could involve U.S. manufacturing;
- the potential for consumer savings and the freeing up of consumer income from reduced energy bills, as well as associated benefits, such as the wide geographic dispersion of energy efficiency investments;
- the extent to which public investment would require or likely induce complementary private investment; and
- existing laws, regulations, and policy in the energy/climate arena, and any focus on specific advanced energy technologies in the U.S.



For this analysis, we developed the following as a representative allocation totaling $591 billion in stimulus spending in the United States across advanced energy technologies:

- **Renewable Resources –** Renewables receive 11% of the public funding, with an equal split of 5.5% ($33 billion) going to solar and 5.5% ($33 billion) to wind. We assume that these public funds are used as financial incentives for the development of additional grid-connected wind and solar facilities and behind-the-meter solar installations.
- **Energy Efficiency –** Energy efficiency is allocated 8% of the total stimulus dollars assumed, or $48 billion. It is assumed that these investments are incremental to what would otherwise be spent on energy efficiency through existing programs, and would be focused on a subset of programs and measures that in past practice tend to require or induce additional private spend by homeowners and businesses (e.g., high-efficiency appliances; heating, ventilation and air conditioning (HVAC) upgrades; and whole-home retrofits).

- **Job Training –** Job training receives $33 billion (6%) of the total public dollars. Funds could be used, for example, to assist dislocated workers in gaining new skills to find in-demand jobs, including clean energy sector-based training, apprenticeships, and partnerships between educational institutions, unions, and employers.

- **Electric Vehicles –** Electric vehicles (EVs) receive 46%, or $274 billion, of the total public dollars. EV investments, as a proportion of the total advanced energy stimulus, are divided as follows: 27%, or $160 billion, towards purchasing EVs; 4%, or $24 billion, to support the installation of EV charging in residences and businesses; and 13% ($75 billion), 1% ($5 billion), and 2% ($10 billion) to EV-related manufacturing, workforce training, and research and development, respectively.[6]

- **Grid Modernization –** Grid modernization receives 8% of the public funding, or $45 billion. Grid modernization investments could include technologies, products, and software for residential and commercial energy management, microgrid management, and other improvements to the efficiency of power system distribution.

- **Energy Storage –** Energy Storage is allocated 7% of the public funding, or $43 billion. Energy storage contributions defray the cost of grid-connected and behind-the-meter battery applications.

- **High Voltage Transmission –** Transmission receives 4% of the public funding, or $24 billion. This would provide incentives for the development of new transmission to access additional grid-connected renewable resources that are distant from load centers, and that are incremental to the renewable resources that would be developed due to the stimulus dollars targeted specifically to renewables (see above).

- **Building Electrification –** Building electrification is allocated 10% of the public funding ($58 billion). Investments of public money for building electrification would be designed to reduce the cost of switching to high-efficiency electric heating and appliances, separate from the energy efficiency spending described above.

[6] Electric vehicle allocations are based on a prior Analysis Group report, which analyzed the economic impact of potential EV stimulus spending. See Analysis Group, *Economic Impact of Stimulus Investment in Electrification of the Transportation Sector*, June 2021.

Private Investment Motivated by Public Spending and Total Investment

In calculating the economic impact of public stimulus spending on advanced energy technologies, it is also necessary to estimate the additional investments by private actors that would not occur *but for* the stimulus. For this purpose, we reviewed current technology costs, current and historic levels of public incentives for advanced energy technologies, and the private investment that has accompanied those incentives.

This analysis was used to develop approximate Public-Private Ratios (PPR) for each technology. The PPRs represent an expected level of private investment for each dollar of stimulus funding. For example, a PPR of 1:2 indicates that for every dollar of stimulus funding, we would expect two dollars of private investment that would not otherwise occur. The PPRs applied for each technology and the basis for the estimated PPRs is as follows:

- **Energy Efficiency and Grid Modernization –** The PPR for energy efficiency and grid modernization is based on a comparison of the cost of saved electricity for program administrators (PA) versus participants, using select program data from Lawrence Berkeley National Laboratory (LBNL).[7] For example, for HVAC programs, the PA pays an average of $0.072 per kilowatt-hour (kWh) compared to $0.067 per kWh for the participant. For new construction, the PA pays $0.046 per kWh compared to $0.041 per kWh for the participant on average. Comparing the administrator cost for HVAC and new construction, the analysis assumes a 1:1 PPR for energy efficiency. For grid modernization/smart grid/demand response, the analysis assumes a 1:1.5 PPR, which is based on a review of the public/private sharing of costs associated with ARRA stimulus spending on similar technologies.[8]

- **Renewable Resources –** The PPR for wind and solar investments are determined based on a comparison of the levelized costs of electricity (LCOE) for renewable resources to available tax credits and rebates. The analysis assumes an average LCOE for onshore wind of $0.040 per kWh and residential/commercial and industrial (C&I) rooftop solar of $0.10 per kWh.[9] For wind, the 1:2.5 PPR assumption is based upon a comparison of the LCOE with an average federal production tax credit for onshore wind of $0.0125 per kWh.[10] The PPR for solar is 1:3 based on a

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[7] The Cost of Saving Electricity Through Energy Efficiency Programs Funded by Utility Customers: 2009-2015, Lawrence Berkeley National Laboratory, page 44, available at: https://eta-publications.lbl.gov/sites/default/files/cose_final_report_20200429.pdf.

[8] American Recovery and Reinvestment Act of 2009, Smart Grid Investment Grant Program Progress Report, U.S. DOE Office of Electricity Delivery & Energy Reliability, July 2012, page 12, available at: https://www.smartgrid.gov/document/smart_grid_investment_grant_progress_report.

[9] Lazard's Levelized Cost of Energy Analysis - Version 14.0, Lazard, October 2020, page 2, available at: https://www.lazard.com/perspective/lcoe2020.

[10] Advancing the Growth of the US Wind Industry: Federal Incentives, Funding, and Partnership Opportunities, DOE Office of Energy Efficiency & Renewable Energy, available at: https://www.energy.gov/sites/prod/files/2020/02/f71/weto-funding-factsheet-2020.pdf.

comparison of the LCOE with a 26% investment tax credit for rooftop solar installation costs and a review of other state-level incentives and rebates.[11]

- **Energy Storage –** The PPR assumption for battery storage is 1:5 based on a comparison of battery storage project costs with corresponding incentive spending. For example, the New York State Energy Resource and Development Authority (NYSERDA) bulk-incentive spending totaled $78 million across nine battery storage projects with a total cost of $430 million.[12] In addition, NREL estimates the cost of storage to be between $750 and $1,500 per kWh, and NYSERDA's current retail storage incentive is set at $250 per kWh.[13]

- **Transmission –** The PPR assumption for transmission is 1:0. For transmission to access renewable resources over and above those developed due to direct wind/solar investment in this stimulus program, development and construction costs for the utility or merchant developer are ultimately collected from consumers through regional transmission rates, and thus do not represent incremental private investment. However, the availability of additional transmission spurs incremental private investment in wind, with the resulting private investment in renewables estimated based on (1) the carrying capacity of the transmission (at an NREL estimate of transmission at $128/kW), (2) an average onshore wind capacity factor from EIA of 34.8%, and (3) a levelized cost of onshore wind from Lazard ($26/MWh).[14]

- **Electrification –** For electrification investments, the PPR is assumed to be 1:4 for consumer electric vehicle purchases, 1:0 for government EV purchases, 1:2.5 for EV home and commercial charging stations, and 1:4 for building electrification. The 1:4 PPR for EV purchases is based on a comparison of EV costs to public funding for EVs. We base this on an estimated price for a standard light-duty EV of $37,000 to the standard federal tax credit for the purchase of an EV ($7,500).[15] The 1:0 for government EV purchases reflects that there is no private co-investment for these purchases. The 1:2.5 PPR for EV home and commercial charging stations is based on

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[11] Solar Energy Tax Credit (ITC), Solar Energy Industry Associates, available at https://www.seia.org/initiatives/solar-investment-tax-credit-itc. For California state-specific rebates and incentives, see California's solar incentives and tax credits put solar power within reach, EnergySage, available at: https://www.energysage.com/local-data/solar-rebates-incentives/ca/.

[12] Two Years In New York's Storage Market Has Grown Faster Than Expected, Green Tech Media, available at: https://www.greentechmedia.com/articles/read/two-years-in-new-york-storage-market-has-grown-faster-than-we-expected.

[13] Solar Plus: A review of the end-user economics of solar PV integration with storage and load control in residential buildings (2018), NREL, available at: https://www.osti.gov/biblio/1465658. See also Retail Storage Incentives (2020), NYSERDA, available at: https://www.nyserda.ny.gov/All-Programs/Programs/Energy-Storage/Developers-Contractors-and-Vendors/Retail-Incentive-Offer/Incentive-Dashboard.

[14] Aaron Bloom, Interconnections Seam Study, Presented to TransGrid-X Symposium, 2018, available at: https://wiresgroup.com/wp-content/uploads/2020/05/2019-03-06-Brattle-Group-The-Coming-Electrification-of-the-NA-Economy.pdf; see also Table 6.07.B. Capacity Factors for Utility Scale Generators Primarily Using Non-Fossil Fuels, Electric Power Monthly, EIA, available at: https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b. The levelized cost of onshore wind incorporates Production Tax Credit (PTC) estimates. See page 3, Lazard LCOE Analysis - Version 14.0.

[15] 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/. State and Federal Electric Vehicle Incentives, California Clean Vehicle Rebate Project, available at: https://cleanvehiclerebate.org/eng/ev/incentives/state-and-federal.

the current 30% federal tax credit with a limit up to $30,000 for commercial charging stations, and $1,000 for home charging stations.[16] The 1:4 PPR for building electrification is based on a comparison of the average unsubsidized cost of a 65-gallon Heat Pump Water Heater ($7,500) to the average incentive provided by the California Self-Generation Incentive Program (SGIP) for such a purchase ($1,850).[17] The analysis uses California's SGIP as a method to estimate a reasonable PPR nationwide.

On the basis of these PPRs, we estimate that **$591 billion in public stimulus spending** results in an **additional $1.4 trillion in incremental private investment.**

These investments are factored into the IMPLAN model in two ways. First, the actual level of investment is included in the model consistent with how the dollars would flow through the U.S. economy. Second, for certain categories of investments (i.e., energy efficiency, behind-the-meter solar, and EVs), we estimate the total reduction in consumer spending on energy that flows from the investments. This is included in the model as additional consumer usable income, using the following estimation methods:

- **Residential/C&I Energy Efficiency –** The calculation of consumer savings from residential and C&I energy efficiency investments is derived from national savings rates (dollars of EE spending to kWh savings) from ACEEE's 2020 State Energy Efficiency Scorecard.[18] The total public/private investment in EE is multiplied by the savings rate to determine the total reduction in electricity demand for residential and C&I customers. The reduction in total electricity demand is multiplied by an annual average customer cost of electricity ($/kWh) to determine annual consumer savings.[19] The total consumer savings reflect a recurring annual consumer savings (through 10 years), adjusted for inflation.

- **Electric Vehicle Replacement of ICE Vehicles –** Fuel savings and maintenance savings are combined to determine total savings. Fuel savings from EV replacement of internal combustion engine (ICE) vehicles are calculated by comparing the cost of increased electricity demand with reduced demand for gasoline and diesel fuel. The increase in electricity is calculated as the number of new EVs multiplied by the average annual electricity consumption of an EV.[20] The cost

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[16] Electric Car Tax Credits Explained, Green Energy Consumers Alliance, available at: https://blog.greenenergyconsumers.org/blog/electric-car-tax-credits-explained.

[17] CPUC Equity Considerations for Heat Pump Water Heaters (2020), California Public Utilities Commission, available at: https://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy/Energy_Programs/Demand_Side_Management/Customer_Gen_and_Storage/SGIP.HPWH.Workshop.Part2.pdf.

[18] Berg, W., et al., The 2020 State Energy Efficiency Scorecard, American Council for an Energy-Efficient Economy, December 2020, available at: https://www.aceee.org/sites/default/files/pdfs/u2011.pdf.

[19] EIA-861, Table 2.10. Average Price of Electricity to Ultimate Customers by End-Use Sector, EIA, available at: https://www.eia.gov/electricity/annual/html/epa_02_10.html.

[20] Average electricity consumed by a light-duty EV is calculated based on an estimate of 0.3 kWh per mile and 11,520 average vehicle miles traveled. Consumption for other EV classes is scaled from relative fuel economy of each ICE vehicle class. Fuel economy is estimated from State of Charge:

of increased electricity demand is calculated as the increase in electricity demand multiplied by an average electricity cost for the U.S.[21] Total reduction in fuel consumption is calculated as the number of vehicles replaced multiplied by annual average gallons consumed by a standard vehicle, for each vehicle class.[22] The decrease in cost from reduced fuel consumption is calculated as total gallons saved multiplied by the average price of fuel.[23] EVs typically have lower maintenance costs due to simpler drivetrains, fewer fluids, and decreased brake wear from regenerative braking.[24] Final consumer savings are equal to maintenance savings plus total fuel savings minus the cost of increased electricity consumption. The total consumer savings reflect the recurring annual consumer savings (through 10 years), adjusted for inflation.

- **Residential and C&I Rooftop Solar –** The calculation of savings from residential and C&I rooftop solar is derived from the average mix of residential versus C&I rooftop solar, levelized capital cost of rooftop solar estimates, and average annual customer electricity costs. The total public and private investment is split as two-thirds residential and one-third commercial based on an estimate of the current rooftop solar mix in the U.S.[25] These investments are then translated into annual electricity savings (kWh) using capital costs for residential rooftop ($2,675 per kW) and commercial rooftop ($2,225 per kW) solar, and average capacity factors.[26] The final dollar value of the consumer savings is then calculated by multiplying the electricity savings by the average annual customer electricity cost for residential and commercial and industrial customers.[27] The

Electric Vehicles Global Warming Emissions and Fuel-Cost Savings Across the United States, page 5, Union of Concerned Scientists, available at: https://www.ucsusa.org/sites/default/files/2019-09/electric-car-global-warming-emissions-report.pdf. For average VMT, see also Annual Vehicle Distance Traveled in Miles and Related Data - 2019, Federal Highway Administration, available at: https://www.fhwa.dot.gov/policyinformation/statistics/2019/vm1.cfm.

[21] Average retail price of electricity, State Electricity Profiles, EIA, available at https://www.eia.gov/electricity/state/.

[22] Average gallons consumed by a light-duty vehicle is calculated based on an estimate of 22.2 average miles per gallon and 11,520 average vehicle miles traveled. Fuel economy is estimated from Light Duty Automotive Technology and Fuel Economy Trends: 1975-2008, NEPIS, available at https://nepis.epa.gov/Exe/ZyPDF.cgi/P1004N5Y.PDF?Dockey=P1004N5Y.PDF. For average VMT, see also Annual Vehicle Distance Traveled in Miles and Related Data - 2019, Federal Highway Administration, available at: https://www.fhwa.dot.gov/policyinformation/statistics/2019/vm1.cfm.

[23] Average fuel price is based on national average retail gasoline prices. See EIA, *Weekly Retail Gasoline & Diesel Prices*, available at: https://www.eia.gov/dnav/pet/PET_PRI_GND_DCUS_NUS_A.htm.

[24] 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/.

[25] Solar Market Insight Report 2020 Year in Review, Solar Energy Industries Association, available at: https://www.seia.org/research-resources/solar-market-insight-report-2020-year-review.

[26] Lazard's Levelized Cost of Storage Analysis - Version 6.0, Lazard, October 2020, page 2, available at: https://www.lazard.com/perspective/lcoe2020.

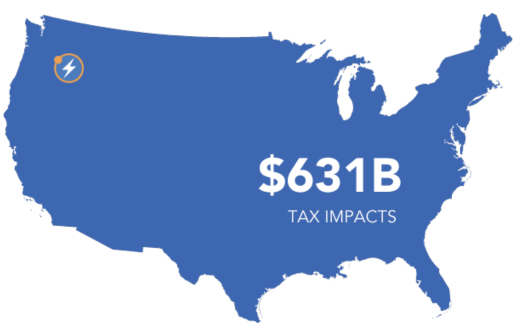
[27] EIA-861, Table 2.10. Average Price of Electricity to Ultimate Customers by End-Use Sector, EIA, available at: https://www.eia.gov/electricity/annual/html/epa_02_10.html.

total consumer savings reflect the annual consumer savings (through 10 years), adjusted for inflation.

Macroeconomic Model

Investments in energy technologies can affect the economy in multiple ways. In our analysis, we pay attention to two key factors. First, when public and private dollars are spent to fund an activity (like a home energy audit), make a purchase that otherwise would not occur (like an electric heat pump) or develop a resource or technology (such as a new renewable resource), those investments result in purchases of goods and services in the economy. Second, investments in certain advanced energy technologies generate consumer savings on energy (e.g., reduced consumption of electricity or heating fuel due to energy efficiency, or lower fuel costs when switching from an ICE vehicle to an electric vehicle).

IMPLAN is a social accounting/input-output model that attempts to replicate the structure and functioning of a specific economy (in this case, the U.S. economy), and is widely used in public and private sector economic impact analyses. It estimates the effects on a regional economy of a change in economic activity by using baseline information capturing the relationships among businesses and consumers in the economy based on historical economic survey data. IMPLAN tracks dollars spent in a region, including dollars that circulate within it (e.g., transfers of dollars from consumers to producers), dollars that flow into it (e.g., purchases of goods and services from outside the local economy), and dollars that flow out of it (e.g., payments to the federal government). The model thus examines inflows, outflows, and interactions within the economy under study.



The IMPLAN model allows one to investigate interactions across the U.S., and to calculate various economic impacts in the economy when a new activity (such as investments in energy efficiency or new construction of energy infrastructure or lost revenues for owners of power plants) involves money flowing around the economy. Specifically, the model captures various impacts, including:

- Employment impacts (total number of jobs created or lost);
- Gross Domestic Product impacts (total economic value added to the economy, which reflects the gross economic output of the U.S. less the cost of the inputs); and
- Tax impacts (total change in tax receipts to local, state and federal governments).

These economic impacts reflect the following:

1. **Direct Effects:** the initial set of inputs that are being introduced into the economy. In our study, these include the direct effects of the stimulus and private investments on energy markets and energy consumers (e.g., end users of electricity and natural gas), and on the purchase of goods and services in the economy (e.g., investment in energy efficiency, construction services, manufacturing).

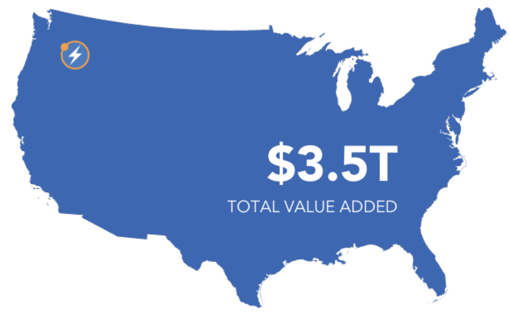
2. **Indirect Effects:** the new demand for local goods, services, and jobs that result from the new activity. This would include, for example, the spending on materials to retrofit buildings with energy efficiency measures. Some stimulus investments lead to payments to suppliers located outside the U.S. (e.g., the purchase of efficient lighting equipment); IMPLAN traces those dollars that do not stay within the U.S. economy as the initial investment "ripples" through the U.S. economy. Since our focus is on the U.S., we do not report on the positive economic impacts of stimulus spending on other countries.

3. **Induced Effects:** the economic impacts of the increased spending of workers resulting from income earned from direct and indirect economic activity (e.g., spending on local dining and other purchases from construction workers).

In this analysis, the inputs to the IMPLAN model include the total dollars invested in the economy that otherwise would not have been spent on advanced energy technologies, and the increases in consumer income that flow from the investments.

III. FINAL OBSERVATIONS

Based on our analysis and modeling of energy-focused stimulus investments in the U.S. economy, we make the following additional observations:



Advanced energy stimulus investments can generate important and positive economic benefits across the U.S., adding substantial value to the U.S. economy, creating tens of millions of new jobs, and sending additional revenue to local, state, and federal governments. Our results strongly support a focus on advanced energy technologies and products within the federal stimulus funds proposed in the AJP, based on economics alone. Such investment would generate meaningful economic activity across the country, create jobs across a wide range of skills and industries, increase revenues for local, state, and federal governments, and save households and businesses money. The benefits flow from the direct investment of stimulus dollars, an associated influx of private investment spurred by the structure of incentives in a potential advanced energy stimulus package, consumer savings that flow from the impact of new advanced energy products and technologies on energy supply and use, and economic activity induced by changes in the flow of dollars due to stimulus investments.

Energy-related stimulus investments can prime the pump for substantial private investments in these technologies. Stimulus spending on advanced energy technologies, products, and services would attract a significant amount of private investment: each public dollar spent would lead to approximately 2.5 dollars of private investment.

Stimulus investments in job training can help ensure that workers in traditional energy industries can transition to newer energy industries and technologies. A critically important component of stimulus investment can be directed towards job training and placement programs to help ensure that increased advanced energy technology utilization across the U.S. is accompanied by an increase in qualified workers and can accommodate employment transitions from adjacent sectors and technologies. Moreover, across the broader investment categories there are large increases in manufacturing resulting from the incremental spending in industries that rely on U.S. manufactured goods.

Advanced energy investments stimulate economic activity not only through public and private investment, but also through consumer savings that flow back into the economy. Many forms of investment in advanced energy can generate long-run benefits to business and residential consumers. Spending on energy efficiency and onsite renewable resources lowers consumer energy bills and can reduce utility spending on transmission and distribution system infrastructure.

Supporting adoption of electric vehicles can lower consumer spending on fuel and reduce fleet costs for small and large businesses. Similarly, the installation of electric heat pumps and/or electric appliances may reduce consumer costs over time.

All forms of advanced energy stimulus investments appear effective in generating strong, positive economic growth. Weighted as it is with consideration toward technologies and products likely to maximize the economic benefits of the public stimulus spending, our analysis shows both the potential economic impact of the investments themselves (e.g., investments that tend to keep more of the money in the U.S. economy, sending less to manufacturers in other countries) and the potential for inducing private investment (i.e., products which involve significant cost sharing with customers or private investors), resulting in economic benefits on the order of six times the public stimulus investment.

Advanced energy technology stimulus investments are aligned with energy, environmental, and economic policies. While this report focuses on economic impacts of advanced energy investments, there are clear and substantial additional benefits in directing stimulus dollars in this way. The primary and most obvious of these is the contribution of such investments to the transitioning of our country's energy systems to those using advanced energy technologies, and the resulting benefits to jobs and Gross Domestic Product, including those benefitting U.S. manufacturing. Virtually every dollar of investment studied in this report – public and private – increases the production and use of energy based on newer technologies and builds an energy system infrastructure that can progress toward an advanced energy economy. In addition, advanced energy investments help to address climate change – an explicit priority of AJP – and can lead to significant improvements in air quality, particularly in heavily industrialized communities.[28] Directing stimulus dollars in this way can help the U.S. meet its economic and social objectives while also realizing the economic productivity and jobs benefits of stimulus spending.

[28] The American Jobs Plan states that "the President's plan will unify and mobilize the country to meet the great challenges of our time: the climate crisis." Additionally, as part of the transportation infrastructure and resilience funding, the plan seeks to "improve air quality, limit greenhouse gas emissions, and reduce congestion." See American Jobs Plan.