

ECONOMIC IMPACT OF STIMULUS INVESTMENT IN CLEAN ENERGY

AN ECONOMIC ASSESSMENT OF APPLYING STIMULUS
FUNDS TO CLEAN ENERGY TECHNOLOGIES, PRODUCTS,
AND SERVICES IN MINNESOTA

Prepared by Paul Hibbard and Pavel Darling



October 2020

ACKNOWLEDGMENTS

This is an independent report prepared for Clean Energy Economy Minnesota by Paul Hibbard, Principal, and Pavel Darling, Vice President, of Analysis Group. The authors would like to thank Scott Ario, Luke Daniels, and Emma Solomon of Analysis Group for their assistance with research and analysis. However, the observations and conclusions in the report are those of the authors alone.

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 CLEAN ENERGY ECONOMY MINNESOTA

Clean Energy Economy MN (CEEM) provides the business voice for energy efficiency and clean energy in Minnesota. As an industry-led, nonprofit organization we educate the public and policymakers at all levels of government about how the business case for energy efficiency and clean energy drives innovation and expands market opportunities. CEEM has more than 40 member-businesses ranging from start-up businesses to Fortune 100 and 500 corporations that employ thousands of Minnesotans across the state. CEEM works across industries and between the aisle to support a prosperous clean energy economy for all Minnesotans.



EXECUTIVE SUMMARY

In the wake of the coronavirus pandemic, states will need to make decisions about where and how to invest government dollars – namely potential stimulus funding from the federal government – to get their economies moving again.

This report focuses on one way in which government stimulus dollars could be put to work in the state of Minnesota – investment in clean energy technologies. Focusing stimulus spending on programs and infrastructure in clean energy technologies can generate economic activity while also helping Minnesota achieve its energy and climate goals.

For the purpose of this analysis, we postulate a hypothetical level of stimulus spending invested across a range of clean 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), and high-voltage transmission.

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

The results of the analysis point to strong economic benefits associated with clean energy technology investments. In short, **a clean energy stimulus investment of \$15 billion** in Minnesota would produce the following economic benefits:

- ⦿ **Over \$117 billion** added to the Minnesota economy, a nearly 8x return on investment;
- ⦿ **Over 750,000 new jobs**, measured in job-years¹, resulting in a mix of shorter-term construction or installation employment and more long-term positions;
- ⦿ **Nearly \$7 billion of additional tax revenue** to local and state governments; and
- ⦿ **\$5.5 billion in annual consumer energy savings.**

A greater or lesser level of stimulus investment would result in greater or lesser economic impact. Our analysis finds that clean energy stimulus investments can generate **a return on investment on the order of nearly eight times the level of public expenditure** for the state of Minnesota, adding



¹ Job years: The industry standard consistent measure of the economic impact of investments when it comes to employment. It represents the number of jobs supported if they all lasted a year. Investments produce a mix of shorter-term and longer-term jobs.

substantial value to the Minnesota economy, creating three-quarters of a million jobs, and sending additional revenue to state and local governments.

TABLE OF CONTENTS

- I. OVERVIEW & FINDINGS 1
- II. ANALYTIC METHOD 6
 - Public Spending Level and Allocation 6
 - Private Investment Motivated by Public Spending and Total Investment 9
 - Macroeconomic Model 12
- III. FINAL OBSERVATIONS 14



I. OVERVIEW & FINDINGS

As of September, over 190 countries have responded to the worldwide coronavirus pandemic with some form of economic relief.² 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 generate income and jobs.

In the U.S., individual states have also had to respond to the public health crisis with emergency spending measures. Going forward, they too will be faced with the challenge of jumpstarting their economies in its wake. In the event that the U.S. government provides federal stimulus funding to states to boost economic growth, states will need to make decisions about how to deploy those dollars.

In this report we focus on one way in which government stimulus dollars could be put to use in the state of Minnesota – investment in clean energy technologies. Focusing stimulus spending on programs and infrastructure in clean energy technologies can generate economic activity while also helping Minnesota achieve its energy and climate goals. The clean energy technologies considered for the analysis include:

- ⦿ Energy efficiency (EE) measures and programs;
- ⦿ Renewable electric generating resources (solar, wind);
- ⦿ 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 support for the purchase of electric vehicles (EV));
- ⦿ Energy storage installation;
- ⦿ Grid modernization and distributed grid resources (e.g., smart meters, microgrids, combined heat and power, and other integrated distribution system technologies);
- ⦿ High-voltage transmission to access remote renewable resources (e.g., new wind resources); and
- ⦿ Other low/zero-carbon fuel sources.

² International Monetary Fund, *Policy Responses to COVID-19*, updated as of August 28, 2020. <https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19>.

The analysis sets a hypothetical level of stimulus spending and allocates the stimulus dollars across clean 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 clean energy technologies affect the state’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 \$15 billion of economic stimulus investment, spread across a range of clean energy technologies (as described in Section II). Allocation of this investment is weighted toward technologies and products that based on historical experience are likely to generate significant in-state economic activity, with 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 clean energy stimulus spending as a strong pump-primer for private investment, job creation, and economic growth. In short, **\$15 billion of clean energy stimulus investment** in Minnesota would generate the following Minnesota benefits:

- ⦿ **Over \$117 billion** added to the Minnesota economy;
- ⦿ **Over 750,000 new jobs**, measured in job-years³, resulting in a mix of shorter-term construction/installation employment and more ongoing positions;
- ⦿ **Nearly \$7 billion of additional tax revenue** to local and state governments; and
- ⦿ **\$5.5 billion in annual consumer savings.**

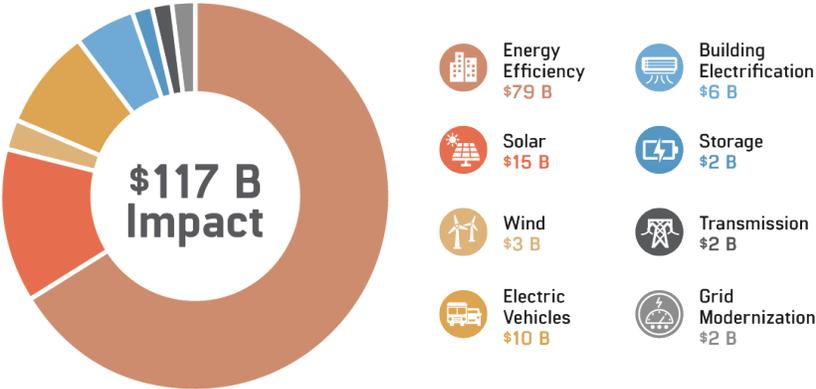
All categories of clean energy stimulus spending generate positive impact on the economy, jobs, and tax revenue. The overall benefits accrue due to the direct impact of stimulus spending and private investment, as well as additional economic activity induced by the additional flow of dollars in the economy.

³ Job years: The industry standard consistent measure of the economic impact of investments when it comes to employment. It represents the number of jobs supported if they all lasted a year. Investments produce a mix of shorter-term and longer-term jobs.

Figures 1 and 2 show how our allocation of \$15 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 State Product or GSP) and jobs created. In total, **\$15 billion of clean energy stimulus results in \$37 billion in complementary private investment, \$117 billion in overall economic activity, and increase in employment of 777,000 jobs, measured in job-years, for Minnesota.**

Energy efficiency investments give the greatest overall boost to the Minnesota economy, totaling \$79 billion in GSP. The next biggest impact comes from renewable energy generation (solar and wind), totaling \$18 billion, followed by electrification of transportation, with \$9.8 billion in economic activity. Building electrification contributes \$5.6 billion and transmission and grid modernization combine for another \$3.1 billion. Energy storage investments result in \$1.9 billion in GSP. (See Figure 1.)

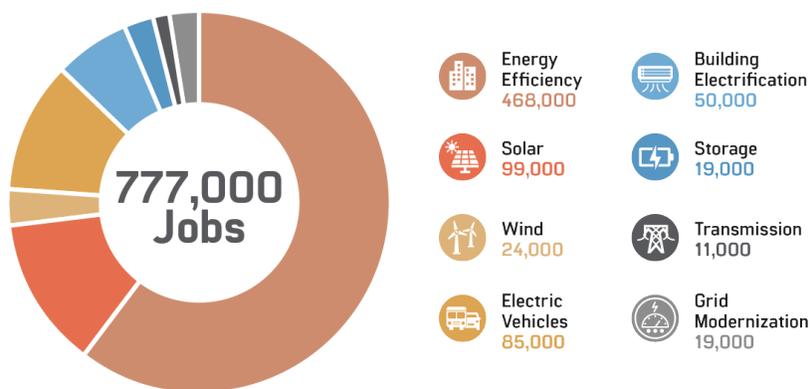
Figure 1. Total Impact of \$15 Billion Stimulus Investment on the Minnesota Economy (GSP), by Technology



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

In terms of jobs, energy efficiency creates 468,000 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. Renewable energy investments produce 123,000 jobs, and electric vehicles 85,000. Building electrification creates 50,000 jobs and transmission and grid modernization generate nearly 31,000; energy storage investments lead to another 19,000 new jobs. (See Figure 2, next page.)

Figure 2. Impact of \$15 Billion Stimulus Investment on Minnesota Employment (job-years), by Technology



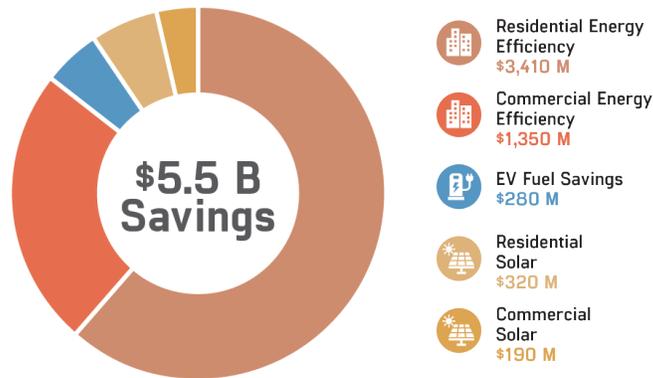
Analysis Group for AEE: Economic Impact of Stimulus Investment in Clean Energy

In addition, certain clean energy investments provide direct savings to consumers associated with reduced electricity consumption, increased savings from onsite solar production, and reduced fuel costs by use of electric vehicles.⁴ Based on our representative allocation of \$15 billion of stimulus funds for Minnesota, energy savings would come to \$5.5 billion annually. Of this total, \$3.4 billion in savings would come from residential energy efficiency, \$320 million from residential rooftop solar, \$280 million from EV fuel savings, and \$1.5 billion from commercial energy efficiency and onsite solar. (See Figure 3, next page.)

Finally, the additional economic activity created by \$15 billion in clean energy stimulus is projected to **increase tax revenues for state and local government by \$6.7 billion.**

⁴ For electric vehicle consumer savings, the reduced fuel cost is equal to savings on gasoline net of the cost of electricity to charge the EV.

Figure 3. Impact of \$15 Billion Stimulus Investment on Minnesota Consumer Savings (annual), by Technology



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

A greater or lesser level of stimulus investment would result in greater or lesser economic impact. But our analysis finds that clean energy stimulus investments can generate **a return on investment on the order of nearly eight times the level of public expenditure** for the state of Minnesota, adding substantial value to the Minnesota economy, creating millions of jobs, and sending additional revenue to state and local 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 Minnesota based on a review of recent proposals and historical stimulus spending. Next, we identify clean energy technologies and products as potential candidates for stimulus spending and apportion the overall stimulus budget among the clean 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 State Product, jobs, tax revenues, and customer 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 to allocate the total amount among the various clean energy technology/product options. There presently is no specific commitment to a stimulus amount by the state of Minnesota or commitment at the federal level, nor a commitment to direct some or all of a stimulus package toward the energy sector. So we make an assumption about a potential level of spending based on a review of past stimulus spending at the state and federal level as well as current federal discussions around potential stimulus packages.

The source of stimulus funding is presumed to be a federal stimulus package, a Minnesota-specific package, or some combination of the two. Moreover, the level of stimulus spending could be from a single package or the total across multiple stimulus bills over some period of time (e.g., two years). Thus, the starting point level of stimulus spending is an assumption made for the purpose of modeling the resulting economic impact.

Considering the level of economic dislocation (reduced economic activity and increased unemployment) caused by the pandemic and discussions at the federal level of a potential \$2 trillion stimulus package, our analysis starts with total COVID-related stimulus spending of roughly three times the stimulus level under the American Recovery and Reinvestment Act (ARRA). We then estimate an amount of stimulus spending in Minnesota based on Minnesota's portion of the federal ARRA funding. We thus postulate a hypothetical investment in Minnesota of \$15 billion, whether from state funds or federal, on clean energy technologies over one to two years.

The next step is to identify how such a stimulus amount could be allocated across clean energy technologies and products. To inform an allocation scenario we could treat as representative, rather than prescriptive, we reviewed state-specific industries, technologies, and policies in the energy

sector and ongoing discussions among energy industry stakeholders with respect to interest and investment in clean energy technologies and products. As with the overall level of stimulus spending, the allocation of stimulus dollars across technologies is an assumption, based on all of the above, and considering the following factors:

- ⦿ the technical potential and feasibility of clean energy technology development in the state;
- ⦿ 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 state;
- ⦿ the goal of spreading the stimulus across a number of technologies to promote diversity in energy resources;
- ⦿ the degree to which the technologies or products involve in-state manufacturing;
- ⦿ the potential for consumer savings and the freeing up of consumer income from lower 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;
- ⦿ existing laws, regulations, and policy in the energy/climate arena, and any focus on specific clean energy technologies in the state; and
- ⦿ any unique technical or cost circumstances in the state related to energy supply and use in the power, transportation, and building sectors.

For this analysis, we decided on the following as a representative allocation of \$15 billion in total stimulus spending in Minnesota across clean energy technologies:

- ⦿ **Renewable Resources** – Renewables receive 30% of the public funding, with 20% (\$3 billion) going to solar and 10% (\$1.5 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 one-quarter of the total stimulus dollars assumed, or \$3.75 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).

- ⦿ **Electric Vehicles** – Electric vehicles 20%, or \$3 billion, of the total public dollars. EV investments are divided as follows: 10%, or \$1.5 billion, to defray the cost of purchasing EVs (including both light-duty and medium- and heavy-duty vehicles); 5%, or \$750 million, to support the installation of EV charging in residences and businesses; and 5% (\$750 million) as incentive for the development of commercial charging stations.
- ⦿ **Grid Modernization** – Grid modernization receives 5% of the public funding, or \$750 million. Grid modernization investments could include technologies, products, and software development for residential and commercial energy management, microgrid management, and other improvements the efficiency of power system distribution.
- ⦿ **Energy Storage** – Energy Storage is allocated 5% of the public funding, or \$750 million. Energy storage contributions defray the cost of grid-connected and behind-the-meter battery applications.
- ⦿ **High Voltage Transmission** – Transmission also receives 5% of the public funding, or \$750 million. 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 (\$1.5 billion). Investments of public money for building electrification would be designed to reduce the cost of switching to electric heating and appliances.

Private Investment Motivated by Public Spending and Total Investment

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

This analysis was used to develop approximate Private-Public 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 2.0 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).⁵ For example, for HVAC programs, the PA pays on average \$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.⁶
- ⦿ **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 \$0.041 per kWh and residential/commercial and industrial (C&I) rooftop solar of \$0.10 per kWh.⁷ 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.⁸ The PPR for solar is 1:3 based on a comparison of the LCOE with a 26% investment tax credit for rooftop solar installation costs and other state-level incentives and rebates.⁹

⁵ 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.

⁶ 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

⁷ Lazard's Levelized Cost of Energy Analysis - Version 13.0, Lazard, November 2019, page 2, available at <https://www.lazard.com/perspective/lcoe2019>.

⁸ 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>.

⁹ Solar Energy Tax Credit (ITC), Solar Energy Industry Associates, available at <https://www.seia.org/initiatives/solar-investment-tax-credit-itc>. For Minnesota state-specific rebates and incentives, see Minnesota's solar incentives and tax credits put solar power within reach, EnergySage, available at <https://www.energysage.com/local-data/solar-rebates-incentives/mn/>.

- ⊙ **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.¹⁰ In addition, NREL estimates the cost of storage to be between \$750 and \$1,500 per kWh, and NYSEDA’s current retail storage incentive is set at \$250 per kWh.¹¹
- ⊙ **Transmission** – 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 (\$28/MWh).¹²
- ⊙ **Electrification** – For electrification investments, the PPR is assumed 1:3 for electric vehicles, 1:2.5 for EV charging stations, and 1:4 for building electrification. The 1:3 PPR for EVs 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 \$30,000 to the standard federal tax credit for the purchase of an EV (\$7,500).¹³ Absent comparable funding program data for medium and heavy duty EVs, we assume the same PPR across all classes of vehicles. The 1:2.5 PPR for EV charging stations is based on the current 30% federal tax credit with a limit up to \$30,000 for commercial charging stations, and \$1,000 for home charging stations.¹⁴ 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 for such a purchase (\$1,850).¹⁵

¹⁰ 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>.

¹¹ 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), NYSEDA, available at <https://www.nyserda.ny.gov/All-Programs/Programs/Energy-Storage/Developers-Contractors-and-Vendors/Retail-Incentive-Offer/Incentive-Dashboard>.

¹² 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. See also Lazard LCOE Analysis - Version 13.0.

¹³ State and Federal Electric Vehicle Incentives, California Clean Vehicle Rebate Project, available at <https://cleanvehiclerebate.org/eng/ev/incentives/state-and-federal>.

¹⁴ Electric Car Tax Credits Explained, Green Energy Consumers Alliance, available at <https://blog.greenenergyconsumers.org/blog/electric-car-tax-credits-explained>.

¹⁵ 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.

On the basis of these PPRs, we find that **\$15 billion in public stimulus spending** results in an **additional \$37 billion in private investment**.

These investments are factored into the IMPLAN model (as described below) in two ways. First, the actual level of investment is included in the model consistent with how the dollars would flow through the Minnesota 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 savings rates (dollars of EE spending to kWh savings) from ACEEE's 2019 State Energy Efficiency Scorecard.¹⁶ For each state, the total public/private investment in EE is multiplied by the savings rate to determine the total reduction in electricity demand for residential and commercial customers. The reduction in total electricity demand is multiplied by an annual average customer cost of electricity (\$/kWh) to determine annual consumer savings.¹⁷ The total consumer savings reflect a recurring annual consumer savings (through 10 years), adjusted for inflation.
- ⊙ **Electric Vehicle Replacement of Gasoline Vehicles** – Savings from EV replacement of gasoline vehicles is calculated by comparing the cost of increased electricity demand with reduced gasoline demand. The increase in electricity is calculated as the number of new EVs multiplied by average annual electricity consumption by a standard EV (3,330 kWh).¹⁸ The cost of increased electricity demand is calculated as the increase in electricity demand multiplied by an average electricity cost for Minnesota.¹⁹ Total reduction in gasoline consumption is calculated as the number of vehicles replaced multiplied by annual average gallons consumed by a standard light-duty vehicle (534).²⁰ The decrease in cost from reduced gasoline consumption is calculated as total gallons of gasoline saved multiplied by the average price of gasoline (\$3.25).²¹ Final consumer savings is equal to total gas savings minus the cost of increased electricity consumption. The total consumer savings reflect the recurring annual consumer savings (through 10 years), adjusted for inflation.

¹⁶ Berg, W., et al., The 2019 State Energy Efficiency Scorecard, American Council for and Energy –Efficient Economy, October 2019, available at: <https://www.aceee.org/sites/default/files/publications/researchreports/u1908.pdf>.

¹⁷ 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.

¹⁸ Average electricity consumed by an EV is calculated based on an estimate of 0.3 kWh per mile and 11,101 average vehicle miles traveled. Fuel economy is estimated from State of Charge: 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 - 2018, Federal Highway Administration, available at <https://www.fhwa.dot.gov/policyinformation/statistics/2018/vm1.cfm>.

¹⁹ Average retail price of electricity, State Electricity Profiles, EIA, available at <https://www.eia.gov/electricity/state/>.

²⁰ Average gallons consumed by a LDV is calculated based on an estimate of 20.8 average miles per gallon and 11,101 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 - 2018, Federal Highway Administration, available at <https://www.fhwa.dot.gov/policyinformation/statistics/2018/vm1.cfm>.

²¹ Over the last decade, gasoline prices have generally fluctuated between \$2 and \$4.50 per gallon. See US All Grades All Formulations Retail Gas Prices (Dollars Per Gallons), EIA, available at https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pets&s=emm_epm0_pte_nus_dpg&f=m.

- ⦿ **Residential and C&I Rooftop Solar** – The calculation of savings from residential and commercial & industrial 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 67% residential and 33% commercial based on the current rooftop solar mix.²² These investments are then translated into annual electricity savings (kWh) using capital costs for residential rooftop (\$2,875 per kW) and commercial rooftop (\$2,350 per kW) solar, and average capacity factors.²³ 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 & industrial customers.²⁴ The 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 clean 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 a gasoline-powered 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, Minnesota), 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 outside 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 in Minnesota, and to calculate various economic impacts in the state's 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 flows around the economy. Specifically, the model captures various impacts, including:

²² Solar Industry Research Data, Solar Energy Industries Association, available at <https://www.seia.org/solar-industry-research-data>.

²³ Lazard's Levelized Cost of Energy Analysis - Version 13.0, Lazard, November 2019, page 2, available at <https://www.lazard.com/perspective/lcoe2019>.

²⁴ 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.

- ⦿ Employment impacts (total number of jobs created or lost);
- ⦿ Income impacts (total change in income to employees that results from the economic activity); and
- ⦿ Gross State Product impacts (total economic value added to the economy, which reflects the gross economic output of the state less the cost of the inputs).

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, etc.).
2. **Indirect effects:** the new demand for local goods, services and jobs that result from the new activity. Examples include the spending on labor to retrofit buildings with energy efficiency measures, or to train workers in these skills. Some stimulus investments lead to payments to suppliers located outside the state of Minnesota (e.g., the purchase of efficient lighting equipment or solar panels manufactured outside of the state); IMPLAN traces those dollars that do not stay within the local economy. Since our focus is on the state of Minnesota, we do not report on the positive economic impacts of stimulus spending on neighboring states.
3. **Induced effects:** the economic impacts of the increased spending of workers resulting from income earned from direct and indirect economic activity.

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 clean 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 Minnesota economy, we make the following additional observations:

Clean energy stimulus investments can generate important and positive economic benefits in the state of Minnesota, adding substantial value to the Minnesota economy, creating millions of jobs, and sending additional revenue to state and local governments. Our results strongly support a focus on clean energy technologies and products for the spending of federal stimulus funds in Minnesota based on economics alone. Such investment would generate meaningful economic activity in Minnesota, create jobs across a wide range of skills and industries, increase revenues for state and local government, 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 clean energy stimulus package, consumer savings that flow from the impact of new clean 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 clean energy technologies, products, and services would attract a significant amount of private investment.

Clean 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 clean 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 clean energy stimulus investments appear effective in generating strong, positive economic growth. Weighted as it is 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 local economy, sending less to out-of-state manufacturers), and on 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 eight times the public stimulus investment.

Clean energy technology investments can help reduce energy and economic supply chain risk and more equitably disperse economic activity associated with the energy sector. Growth in clean energy technologies may open the door to the development of energy sources and technologies that

rely primarily on domestic manufacturing and materials industries, reducing supply chain risks and reliance on concentrated energy/fuel supply sectors. With an economy operating on clean energy technologies, there is far less geographic concentration of the fuels and industries needed to meet demand, providing opportunities to more equitably disperse the economic activity driving energy supply and infrastructure.

Clean energy technology stimulus investments are aligned with state energy, environmental, and climate policies. While this report focuses on economic impacts of alternative 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 decarbonization of Minnesota's energy systems. Virtually every dollar of investment studied in this report – public and private – increases the production and use of energy without emissions of greenhouse gases, and builds the energy system infrastructure needed to continue progress toward a carbon-free economy. In addition, clean energy investments help reduce the combustion of fossil fuels, leading to significant improvements in air quality, particularly in heavily industrialized environmental justice communities. Directing stimulus dollars in a way that hits this target while inducing private investment that can help the state meet its climate and social objectives in a way that maintains and grows economic productivity and jobs.