

# Investing in U.S. Energy Efficiency and Infrastructure Creates More Nationally Distributed Jobs while Saving Money and Protecting the Climate

*John A. “Skip” Laitner, Economic and Human Dimensions Research Associates  
Stephen O. Andersen, Gabrielle B. Dreyfus, and Kristen N. Taddonio, Institute for  
Governance & Sustainable Development*

## ABSTRACT

This paper presents a summary of indicative analytics or working estimates of the job creation that can be stimulated by new U.S. investments in end-use energy efficiency, decarbonization, and clean energy systems compared to new investments in traditional fossil fuel technologies. The analysis finds that mobilizing a cumulative investment of \$1.2 trillion over the years 2022 through 2040 can reduce electricity end-use costs by 40 percent in the year 2040, or an average 20 percent over the entire 19-year period. This investment stimulates an average net employment benefit of 2.8 million new jobs *per year* as the nation’s GDP might increase more than \$580 billion by the year 2040. A corresponding 40 percent reduction of greenhouse gas emissions and air pollution would yield an average annual benefit of a further \$112 billion in avoided air pollution and health costs. The cumulative benefit of this economic transformation would be on the order of \$2.1 trillion through 2040, with even greater benefits possible with yet larger emissions reduction. The full 48-page report with elaborated methodology, delineated assumptions, and sector-by-sector descriptions is accessible from Laitner et al. (2021).

## Introduction

With limited time to achieve significant reductions in the emissions of short-lived climate pollutants (SLCPs)<sup>1</sup> and carbon dioxide (CO<sub>2</sub>) emissions (see IPCC 2018; Ripple et al. 2019; Plumer 2020; Naik et al. 2021; and IGSD 2021), the evidence also suggests that the economy is showing signs of erosion together with a less resilient infrastructure. The reasons are three-fold: (i) a lagging and a less productive infrastructure (Pollin et al. 2009; ASCE 2016; Corfee-Morlot et al. 2016; Bivens 2017; BRT 2019; ASCE 2020a; and ASCE 2020b); (ii) an insufficiently trained workforce with a set of skills which do not yet match critical tasks or upgrades in clean energy supply and energy efficiency (Muro et al. 2019) as well as the need for workforce education and retraining more broadly (Adecco 2016; Giffi and Wellener et al. 2018; and UAW 2020) and (iii) the inefficient use of fossil fuels and other natural resources (Ayres and Warr 2009; Kümmel 2011; Kümmel 2013; and Laitner 2015).

This analytical narrative explores how the transition to the more productive use of electricity—and by extension all other energy and resources—enables a more robust and sustainable economy which supports an even greater number of jobs within the United States compared to almost any business as usual (BAU) scenario, whether the *Annual Energy Outlook* (EIA 2021) or the Woods and Poole (2021) projections through 2050.

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<sup>1</sup> Short-lived climate pollutants (SLCPs) include hydrofluorocarbons (HFCs), methane, tropospheric ozone, and black carbon (soot).

## Critical Building Blocks and Jobs

Simultaneously enhancing energy productivity and transitioning to clean energy will require a substantial upgrade in existing, but also new capital stock and infrastructure, to enable greater economic productivity (Laitner et al. 2012, and 2018; Jadun et al. 2018; IRENA 2019; Kutscher, Logan, and Coburn 2020; and Griffith and Calisch 2020). Underpinning that transition is an array of information and communication technologies which will be necessary to support a highly productive electrification of the economy.

Following the logic of a U.S. economy-wide energy productivity improvement by the year 2050, documented in an earlier ACEEE study (Laitner et al. 2012), a significant energy-productivity upgrade suggests a total investment on the order of a 4 to 8 percent of one year's GDP to achieve a 37 to 53 percent reduction in conventional energy demand for the generation of electricity. In the indicative assessment that follows here, we find that a 6 percent share of GDP, or ~\$1.2 trillion cumulative investment through the year 2040, can reduce both costs and consumption in ways that reduce overall electricity bills by 40 percent by 2040. More critically, as suggested by IRENA (2019), higher energy efficiency improvements and conversion to carbon-free renewable electricity generate between \$3 and \$7 in savings for every dollar invested through 2050.

### Exploring the Jobs Creation Benefits

With a current oil and gas industry supporting about 10.3 million direct, indirect and induced jobs in the United States (Western Energy Alliance 2020), the question becomes which combination of clean energy and energy efficiency investments might best support the largest number net gain of permanent jobs? Critical to the explanation that follows is understanding that energy productivity, or what we might also call “aggregate efficiency,” is the result of 3 key drivers, including: (i) greater levels of end-use energy efficiency; (ii) the move to clean renewable energy technologies which eliminates the need for significant magnitudes of primary energy otherwise lost in the conventional combustion process; and (iii) an improved use of capital, materials, water, and food—further reducing energy needs as part of the production process.

Figure 1, on the following page, presents what are called sector-based “total job coefficients” for the U.S. economy in 2019. As described in more detail in Table 2, which also follows, these coefficients are drawn from national-level data sets provided by IMPLAN (Impact Analysis for PLANning) which, in turn, relies on public data made available through a variety of agencies and institutions (IMPLAN 2021). In a quick summary of the findings shown in Figure 1, for each one billion dollars that might be spent for an average basket of goods and services within a given year, the nation's economy supports an average of 18,200 total jobs. Hence, for every one billion dollars of electricity bill savings today, made possible by cost-effective energy efficiency improvements or by investments in cost-effective clean energy technologies—whether they benefit households or businesses—the national economy will gain a net increase of 7,400 new jobs ( $18,200/\$billion - 10,800/\$billion = 7,400$  net increase in jobs.), as long as those savings are spent within the U.S. economy.

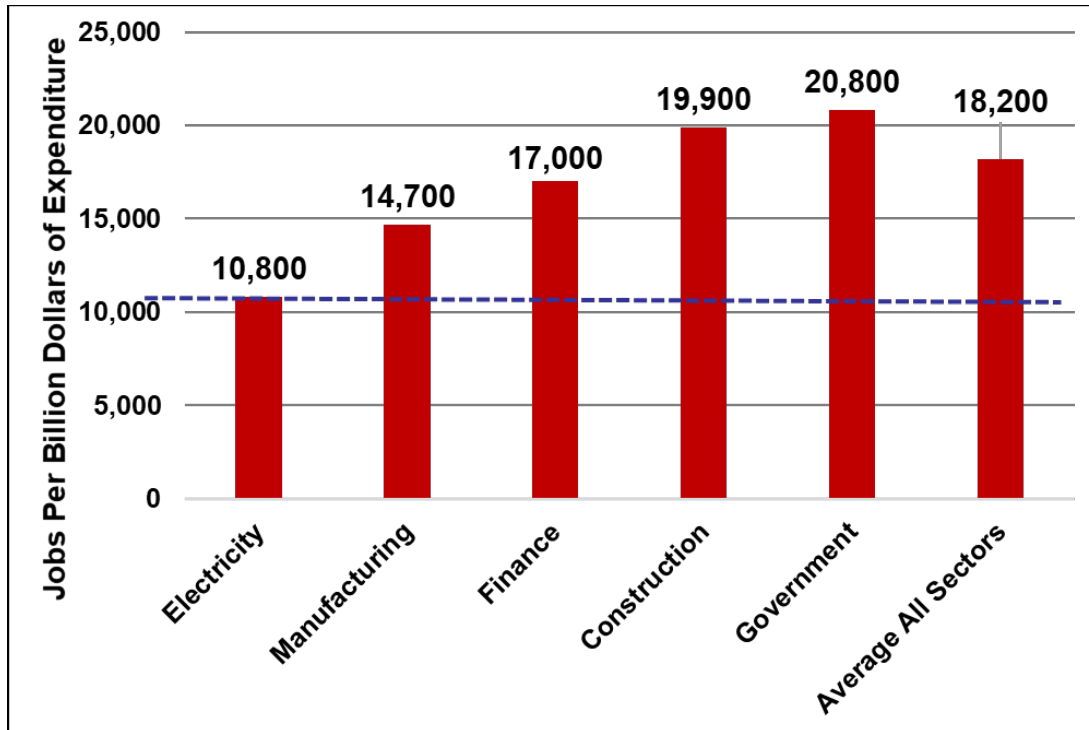


Figure 1. Total labor intensities for key sectors within the United States economy  
Source: J. Laitner, using IMPLAN 2019 Data for the United States (January 2021).

## Understanding the Major Drivers of Employment and Economic Benefits

As explained below, Table 1 outlines seven interactive drivers that can positively or negatively shape the nation's long-term social and economic well-being, as well as the nation's future job markets.

Table 1. Seven major drivers of employment and economic benefits

| Driver                | Primary Impact                                                               |
|-----------------------|------------------------------------------------------------------------------|
| Intensity Shift       | Moving away from capital-intensive to labor-intensive activities             |
| Supply Chain Build Up | Building up greater local production and local services                      |
| Energy Cost Reduction | Both unit cost and total cost savings for efficiency and non-efficiency      |
| Productivity Boost    | Expanding non-energy benefits                                                |
| Managing Volatility   | Smoothing out price shocks                                                   |
| Minimizing Disruption | Avoiding interruption of electricity and product supply                      |
| Innovating Plus       | Cost and services breakthroughs in the delivery of energy and other services |

**(1) Intensity Shift:** Just as each form of energy has a different intensity of greenhouse gas emissions per million Btus of use, each sector of the economy also has different scale of income and employment intensities. More capital-intensive energy sources tend to support fewer jobs than almost all other sectors within the U.S. economy.

**(2) Supply Chain Build Up:** The United States generates value-added from the intermediate goods and services that it produces or purchases (IMPLAN 2021). Increasing local production capacity for key goods and services will increase both the resilience and vitality of

the nation’s economy. Fostering the local supply of energy efficiency, clean energy, infrastructure, and materials further enhances local economic development.

**(3) Energy Cost Reduction:** Investments in energy efficiency and clean energy now cost far less than fossil fuel or nuclear energy (see, for example, Nadel and Ungar 2019; and Lazard 2021). For the majority of coal plants in the country, it would be cheaper to replace them with clean energy than to keep paying the fuel and maintenance costs. Additionally, reduced demand for energy as a consequence of increased energy efficiency puts downward pressure on the price of traditional energy, further spreading the cost benefits of clean energy nationwide. This is often referenced as the “Demand Reduction Induced Price Effects—DRIPE” (Taylor, Hedman and Goldberg 2015).

**(4) Productivity Boost:** Investments in industrial processes can reduce energy demand, which lowers requirements for chemical feedstocks and water, even as overall operating and maintenance costs decrease (Worrell et al. 2003; Campbell et al. 2014; Rasmussen 2017; Wagner et al. 2020; and Cooremans 2021). Thus, the non-energy benefits of investment in energy efficiency and clean energy can have an important catalytic effect on job growth and prosperity.

**(5) Managing Price Volatility and (6) Minimizing Supply Disruption:** Although not reflected in this analysis, a more productive economy that uses fewer and less-costly energy and other resources will enjoy a reduced exposure to unexpected market risks and price volatilities.

**(7) Innovation Plus:** The greater employment and economic benefits that result from a productivity-anchored energy transition stimulates continuous learning and new innovations.

## Direct, indirect, and induced Job Creation

Each of the seven economic drivers creates direct, indirect, and induced jobs quantified in Table 2 for six aggregated sectors within the entire U.S. economy for 2019.

Table 2. Jobs per one billion 2019 dollars for key sectors of the U.S. economy

| Key Sectors        | Direct Jobs | Indirect Jobs | Induced Jobs | Total Jobs | Average Gains in Labor Productivity/Year |
|--------------------|-------------|---------------|--------------|------------|------------------------------------------|
| Construction       | 6,700       | 3,100         | 10,200       | 19,900     | 0.91%                                    |
| Manufacturing      | 2,100       | 4,100         | 8,500        | 14,700     | 1.89%                                    |
| Electric Utilities | 800         | 1,900         | 8,100        | 10,800     | 2.62%                                    |
| Finance            | 3,000       | 4,000         | 10,000       | 17,000     | 1.32%                                    |
| Government         | 8,800       | 500           | 11,500       | 20,800     | 0.91%                                    |
| All Sectors        | 5,300       | 3,200         | 9,700        | 18,200     | 1.47%                                    |

Source: IMPLAN U.S. 2019 data and BLS 2020 estimates of labor productivity improvements (January 2021).

Note: totals may not add because of rounding.

**Direct** on-site jobs are created by any given investment and include construction contractors and subcontractors. For each \$1 billion dollars spent, for example, building a new utility-scale clean energy system, a total of 6,700 people are on average employed. For Manufacturing it would be 2,100 jobs while for the electric utility industry as a whole, it would be about 800 direct jobs.

**Indirect** off-site jobs are jobs such as the staff of vendors who supply and deliver equipment, bankers who finances a project, an accountant who keeps the books for the vendor, component and materials manufacturers, and wholesale suppliers who provide other goods and services. For the construction sector these indirect jobs add up to 3,100 jobs per billion dollars received.

**Induced** jobs are created when people who are directly and indirectly employed by the project spend their income within their communities. For the construction sector these induced jobs add up to 10,200 jobs for each billion dollars spent.

The **Total Job Effect** adds up to 19,900 jobs supported by an aggregate construction expenditure of \$1 billion. A final category of impact is the anticipated rate of sector labor productivity as drawn from the BLS (2020) data. The analysis is still incomplete since it only accounts for the direct, indirect and induced job effects of the investment upgrade itself.

Table 3. Key results of 40% electricity savings for selected years of the U.S. economy

| Expenditures (Billion 2019 \$)         | 2022    | 2025   | 2030    | 2035    | 2040    | Average/<br>Year |
|----------------------------------------|---------|--------|---------|---------|---------|------------------|
| Policy and Program Costs               | \$3.1   | \$8.9  | \$8.2   | \$7.5   | \$7.9   | \$7.0            |
| Investment                             | \$47.6  | \$52.3 | \$61.0  | \$71.2  | \$98.2  | \$61.4           |
| Loan Payment                           | \$3.2   | \$13.4 | \$32.7  | \$55.2  | \$82.5  | \$37.0           |
| Energy & Non-Energy Benefits           | \$0.0   | \$40.0 | \$106.7 | \$173.4 | \$240.0 | \$117.6          |
| Net Consumer Savings                   | (\$6.3) | \$17.7 | \$65.8  | \$110.7 | \$149.7 | \$70.0           |
| Benefit Cost Ratio                     |         |        |         |         |         | 2.59             |
| <b>Employment Benefits (thousands)</b> |         |        |         |         |         |                  |
| Net Jobs                               | 898     | 1,595  | 2,722   | 3,836   | 5,214   | 2,803            |

Source: Results from the DEEPER Lite Employment Assessment Tool as described in Laitner et al. (2021).

As summarized in Table 3, had this scenario been effectively implemented this year, the net employment gains might have risen initially to 898,000 jobs in 2022, increasing to as many as 5.2 million net jobs by 2040. Over the entire 19-year period, the net job benefits might average about 2.8 million annually.

For all practical purposes there are three main drivers of the net employment benefits shown in Table 3. The initial jobs are catalyzed by public and private sector policy and program expenditures which, in turn, drive the investment and transition. In this analysis policy and program costs average \$7 billion dollars per year. Once the programs are launched, an array of households, and businesses as well as federal, state and local governments begin to undertake a variety of cost-effective investments averaging \$61.4 billion per year. As those investments are translated into annual reimbursements with a 3 percent borrowing interest rate, the loan payments (including interest costs from borrowing the money) average \$37 billion annually.

All of these outlays continue to drive an average energy savings and/or benefits that slowly rise over time from zero in 2022 to \$240 billion per year by 2040. The net consumer savings are the benefits which remain after the policy and program expenditures and the loan repayments are made in any given year. All of these outflows and savings combine in various ways to drive the net job gains within any given year.

Table 4 shows the relatively large impact of the Enhanced Economy, which supports an estimated 63.6 percent, or almost 1.8 million of the total net annual jobs over the period 2022 through 2040. These employment opportunities refer to the induced jobs sustained by the

combined direct and indirect employment incomes supported by the Stimulus and the Transition jobs. Although the Enhanced Economy jobs are large in scale, none of those jobs would be possible without the Stimulus jobs made possible by the programs and policies, and especially the investment upgrades in the nation's electricity infrastructure.

Table 4. Job catalysts – stimulus, transition, and enhanced economy (2022-2040)

| <b>Catalysts of Job Creation</b>            | <b>Key Sectors of the Economy</b>                         | <b>Net Job Creation (Actual)</b> | <b>Average 20-Year Share</b> |
|---------------------------------------------|-----------------------------------------------------------|----------------------------------|------------------------------|
| Stimulus: Policy/Program Jobs               | Government, Education, Technical Services, Consulting     | 58,337                           | 2.1%                         |
| Stimulus: Investment/Finance Jobs           | Construction, Manufacturing, Technical Services, Finance  | 505,225                          | 18.0%                        |
| Transition: Redirected Energy Spending Jobs | All Sectors Supporting Households, Businesses, Government | 581,947                          | 20.8%                        |
| Transition: Energy Jobs                     | Mining, Production, Processing, and Utilities             | -125,851                         | -4.5%                        |
| Enhanced Economy: Induced Jobs              | All Sectors Supporting Households, Businesses, Government | 1,783,416                        | 63.6%                        |
| <b>Totals</b>                               |                                                           | <b>2,803,073</b>                 | <b>100.0%</b>                |

*Source:* Results from the DEEPER Lite Employment Assessment Tool as described in Laitner et al. (2021).

The key sectors for the stimulus jobs are the Government, Education, Technical Services, and Consulting, which support policies and programs and the Construction, Manufacturing, Technical Services, and Finance sectors which enable the investment upgrades to actually occur. These direct and indirect jobs provide a solid foundation for the Transition jobs which slowly begin to displace employment within the conventional fossil fuel electricity service sectors. As net consumer savings grow, from lower costs of clean energy and the use of more efficient appliances, those savings are spent on typical goods and services such as food, healthcare, education, and entertainment supporting Households, Businesses, and Government. The job losses occur within the Mining, Production, Processing, and Utility industries.

### 5.3 A Graphic Summary of the Estimated Benefits

The DEEPER modeling exercise (described more fully in Laitner et al. 2021) underscores the need for cumulative investment of \$1.2 trillion over the years 2022 through 2040 to reduce electricity end-use cost by 40 percent in the year 2040 would lead to an average annual employment increase of 2.8 million net new jobs even as the nation's GDP might increase more than \$580 billion (in constant 2012 dollars) by the year 2040.

In annual terms, over the period 2022 through 2040, the cumulative \$1.2 trillion investment begins with an initial \$48 billion in 2021 with increments that reach \$98 billion by 2020. The average over that period is \$61 billion annually (with all values expressed in 2019 dollars, the base year of the model). Employment quickly increases and by the year 2040 grows to a total of 5.2 million new jobs (Table 3). In effect, the resulting work that must be undertaken,

together with other benefits which also boost employment, is estimated to drive an average net gain of 2.8 million new jobs over the 20-year period.

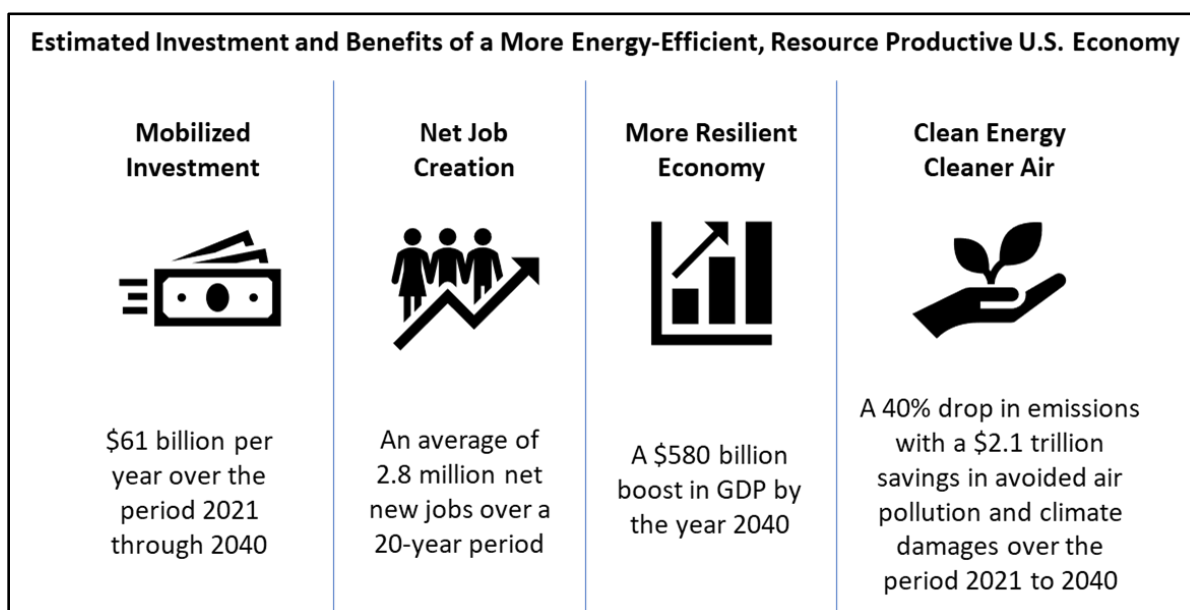


Figure 2. Estimated cost and benefits of a 40% reduction in electricity costs as described in Laitner et al. 2021.

Given the increased productivity of each job, total GDP in the year 2040 is projected to grow by \$580 billion (expressed here in constant 2012 dollars). At the same time, both greenhouse gas emissions and the array of fossil fuel air pollutants from electricity generation are expected to drop. Drawing on a variety of studies (see, for example, EPA 2011; Parry et al. 2014; EPA 2018; Ricke et al. 2018; Jacobson et al. 2019; and EPA 2019), our analysis found that if emissions dropped by a modest 40 percent by 2040, that could result in a cumulative benefit on the order of \$2.1 trillion also through 2040 (in constant 2020 dollars); if emissions drop even faster, the resulting cumulative benefits would be significantly larger.

## Policy Implications

It is significant that the induced jobs from investments in clean energy and energy efficiency are far larger than the more conspicuous direct and indirect jobs. More importantly, these induced jobs, as well as the many other benefits of the productive investments, can be more equitably distributed geographically among the population and with higher employment over a wider range of skill levels and wages. Thus, the high rates of return on clean energy and energy efficiency can accrue to the taxpayers making the investment possible, and the avoided environmental and social costs of fossil fuel exploitation can similarly benefit the entire population, but particularly to lower income communities that would otherwise be located near fossil fuel extraction, combustion, and waste.

Granting paid apprenticeships, technical and professional certification, and clinical learning credits toward academic degrees to millions of young people will provide the coming generation with the talent and skills to engage in trade, technical, and professional employment in a climate change economy increasingly focused on new resilient business models and

accompanying careers. These proposed clinical learning agencies at the state, county, and local level will also be among the first responders in climate events and disaster relief and recovery missions that will increasingly be a constant reality rather than a rare anomaly.

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