THE CLEAN ENERGY FUTURE

Protecting the Climate • Creating Jobs • Saving Money

LABOR NETWORK FOR SUSTAINABILITY

350

Synapse Energy Economics, Inc.

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Introduction and conclusion are by Labor Network for Sustainability; the body of the report is by Synapse Energy Economics. The technical appendix, providing detailed explanation of calculations described in this report, is available at http://synapse-energy.com/CEF_Appendix.

INTRODUCTION

This report presents a Clean Energy Future plan for the United States to reduce greenhouse gas [GHG] emissions 80 percent by 2050 – while adding half a million jobs and saving Americans billions of dollars on their electrical, heating, and transportation costs.

Americans have often been told that saving the climate will reduce employment and bust the budget. The Intergovernmental Panel on Climate Change (IPCC) "80x50" target for GHG reduction is often portrayed as a threat to American workers' jobs and the U.S. economy. And although President Obama has endorsed the goal of reducing greenhouse gas emissions 80 percent by 2050, even the most promising proposals in his Clean Power Plan do not approach this target.

The Clean Energy Future: Protecting the Climate, Creating Jobs and Saving Money refutes the claim that meeting the IPCC targets will cause economic devastation. Indeed, not only can these targets can be met, but meeting them will create more jobs and save money. This report, prepared by the Labor Network for Sustainability[1] (LNS) and 350.org,[2] with research conducted by a team led by economist Frank Ackerman of Synapse Energy Economics,[3] lays out an aggressive strategy for energy efficiency and renewable energy that will:

- Transform the electric system, cutting coal-fired power in half by 2030 and eliminating it by 2050; building no new nuclear plants; and reducing the use of natural gas far below business-as-usual levels.

- Reduce greenhouse gas emissions 86 percent below 1990 levels by 2050, in the sectors analyzed (which account for three-quarters of US GHG emissions).

- Save money – the cost of electricity, heating, and transportation under this plan is $78 billion less than current projections from now through 2050.

- Create new jobs – more than 500,000 per year over business as usual projections through 2050.

The plan does not depend on any new technical breakthroughs to realize these gains, only a continuation of current trends in energy efficiency and renewable energy costs.

[1] The Labor Network for Sustainability (http://www.labor4sustainabilty.org) was founded in 2009 based on an understanding that long-term sustainability cannot be achieved without environmental protection, economic fairness, and social justice. LNS believes we all need to be able to make a living on a living planet.
[2] Founded in 2008, 350.org (http://www.350.org) is building a global climate movement with online campaigns, grassroots organizing, and mass public actions coordinated by a global network active in over 188 countries.
[3] Synapse Energy Economics (http://www.synapse-energy.com) is a research and consulting firm specializing in energy, economic, and environmental topics. Since its inception in 1996, Synapse has grown to become a leader in providing rigorous analysis of the electric power sector for public interest and governmental clients.

Most of the additional jobs will be in manufacturing and construction. Such jobs tend to have higher wages and better benefits than average, providing new opportunities for American workers. Because some jobs will be lost in fossil fuel related industries, the report calls for a vigorous program to provide new, high-quality jobs and/or dignified retirement for those affected.

Manufacturing and construction also provide a high proportion of the better jobs held by people of color. Expanding these sectors will help counter the growing inequality within the American labor market. The report advocates deliberate policies to create new opportunities and job pipelines for those groups who have been most excluded from good jobs.

The study covers the entire electric system, light vehicle transportation (cars and light trucks), space heating and water heating, and waste management. It assumes conversion of all gasoline-powered light vehicles and most space heating and water heating to 100 percent renewable electricity. This strategy achieves three-fourths of the total emission reduction needed to reach the 80 percent by 2050 target. The report also cites other studies suggesting that sufficient GHG reduction can be achieved in the remaining sectors – freight and transit, industrial process emissions, and non-energy GHG emissions in agriculture – to meet the 80% by 2050 GHG reduction target. Indeed, that target requires only moderate reductions in these other sectors; accelerated reduction in these other sectors would make possible even faster and larger national progress, doing better than 80 percent by 2050.

This program will help bring together environmental and labor advocates around their common interest in putting Americans to work saving the earth's climate. Climate protection has caused significant friction between labor unions and environmentalists around whether to create jobs or address climate change. The report demonstrates that this is a false choice. For unions and other jobs advocates, climate protection is also a great jobs program. We can create many more jobs by protecting the environment than by expanding the fossil fuel infrastructure.

The report will help guide the development of state policies under the Environmental Protection Agency's (EPA's) recently issued Clean Power Plan (CPP). States can configure their CPPs to serve as first steps toward realizing the far more ambitious objectives of The Clean Energy Future. The report will help draw together a community of allies, including unions, social justice advocates, students, and environmentalists to shape and promote such a program.

The Clean Energy Future presents a practical, realistic way for the United States to stop aggravating global warming. It does not depend on international agreements, science-fiction technologies, or sacrifice of Americans' well-being. Indeed, it provides financial, health, and job benefits for American workers and consumers that include much more than climate protection.

1. THREE CHALLENGES

Economic and environmental crises challenge and constrain our choices in at least three competing directions.

- As greenhouse gases overheat the earth, our use of fossil fuels is beginning to destroy the climate conditions which have allowed human civilization to emerge and prosper.
- As good jobs continue to disappear, the prospects for a stable, middle-class life are becoming remote for more and more Americans.
- Many people cannot afford, and few seem willing to consider, expensive solutions **to economic or environmental problems**.

Each of these problems could be addressed on its own. But can they be solved at the same time? Is there a plan that reduces carbon emissions enough to stabilize the climate, creates growing numbers of good jobs, and at the same time avoids imposing new costs on consumers and taxpayers? In terms of Figure 1, it is easy to imagine plans that fall into any one of the circles. But is there any viable future that falls within all three?

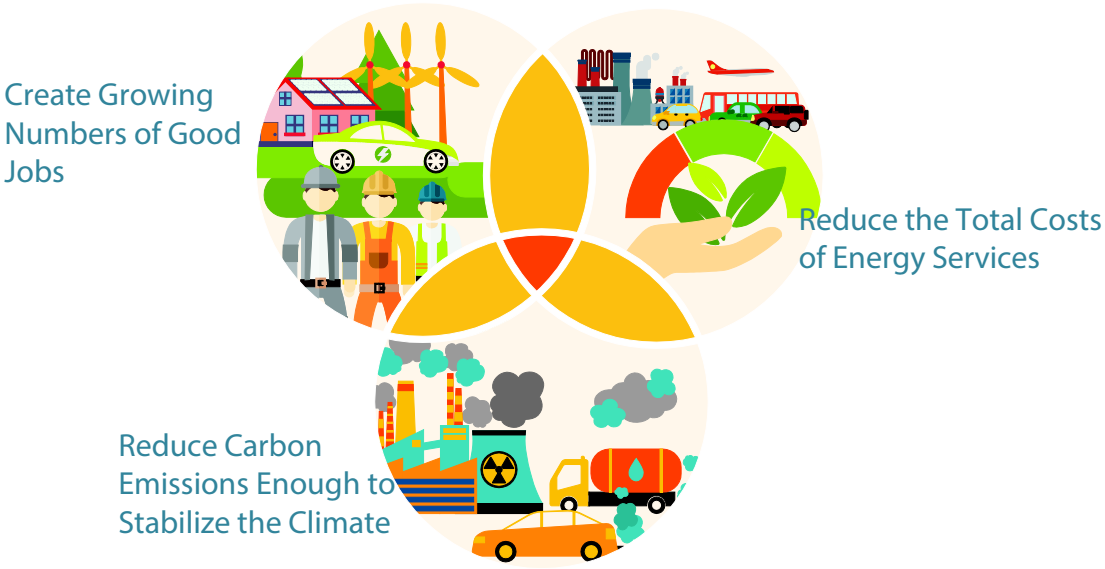

Figure 1. Do the three circles overlap?

This report demonstrates that the three objectives do, in fact, overlap. It presents an achievable future scenario that creates hundreds of thousands of new jobs, concentrated in construction and manufacturing – and lowers the cost of electricity, transportation and heating – and meets demanding goals for eliminating most carbon emissions by the year 2050. Our scenario builds on and extends previous studies of clean energy futures by Synapse Energy Economics, based on detailed modeling of energy efficiency and renewable energy options for the U.S. electric system.[4] We then calculate the jobs created by clean energy

[4] See the documentation of this analysis at http://synapse-energy.com/project/consumer-costs-low-emissions-futures.

with IMPLAN, a widely used model of employment impacts.

1.1 CLIMATE PROTECTION: 80 PERCENT BY 2050

The partisan debate surrounding the Obama administration's Clean Power Plan (CPP) could create the mistaken impression that the plan represents the outer bounds of the possible, with opponents portraying it as a controversial, utopian, and expensive policy. The CPP, calling for U.S. power plant emissions to be reduced 32 percent below 2005 levels by 2030, may be controversial – but it is neither utopian nor expensive. Our scenario is a more ambitious alternative. It reduces emissions to a much lower level than the CPP targets, and saves money in the process.

We model two detailed scenarios for the U.S. energy system. One is a **reference case**, including only policies that were in place before the Clean Power Plan, and using many assumptions from the Energy Information Administration's Annual Energy Outlook – the standard long-run projections from Energy Department researchers. The other is a **Clean Energy Future**, assuming that present trends in renewable energy continue, and are accelerated by a set of new policies. The framework of the Clean Energy Future, a combination of data projections from the National Renewable Energy Laboratory (NREL) and our own analysis, includes the following:

Energy efficiency programs expand nationwide to match the performance of the most successful existing state programs.

Wind power, already lower in cost than many fossil fuel technologies, continues a gradual decline in cost per kWh, inspiring widespread adoption.

The ongoing decline in the cost of solar power continues at a rapid rate until 2030 and more gradually until 2040; adoption of solar power spreads throughout the country.

No new nuclear plants are built; existing plants all close after 60 years of operation.

Coal-fired power is eliminated by 2050. Half of it is gone by 2030, and almost all the rest by 2040.

Total natural gas capacity shrinks, as plant retirements outweigh new construction.

Renewable energy expands enough to allow electrification of all gasoline-powered light vehicles (cars, SUVs, and light trucks) and 80 percent of space heating and water heating by 2050. Oil production and refining decline as the demand for gasoline plummets.

Ongoing progress in recycling, composting, and management of existing landfills eliminates all emissions from waste by 2050. This continues current trends: emissions from waste, largely landfill methane, fell by one-third from 1990 through 2013.

Most of the international discussion of climate targets focuses on emission reductions from a 1990 baseline, typically assuming that the United States and other high-income countries need to reach 80 percent below 1990 levels by 2050 in order to stabilize the climate. The Obama administration has endorsed this target, although it has not produced any detailed plans to achieve it.

For the sectors included in our analysis – electricity generation, cars and light trucks[5], space heating and water heating, fossil fuel supply, and waste management – the Clean Energy Future achieves an 86 percent reduction in emissions by 2050, relative to 1990 levels. This is not a plan for the whole U.S. economy, but it does most of the required heavy lifting. As Table 1 shows, reductions of only 42 percent in the remainder of U.S. emissions – from industrial (non-electricity) emissions, mass transit, freight transport, and agriculture – would be enough to achieve an overall 80 percent reduction. With more ambitious reductions in other sectors, the United States could surpass the 80 percent reduction target.

	1990	2050	Change	Percent Change
	Million Metric Tons of CO2-eq			
Clean Energy Future Sectors	3,800	544	-3,256	-86%
All Other Sectors	2,502	1,443	-1,058	-42%
Gross Emissions	6,301	1,987	-4,324	-68%
Absorption (Land Use & Forestry)	-776	-882	-106	+14%
Net Emissions	5,525	1,105	-4,420	-80%

Table 1. U.S. greenhouse gas emissions, 1990 and projected 2050
Source: 1990 values from U.S. Greenhouse Gas Inventory, 1990-2013. The 2050 estimate for Clean Energy Future sectors is developed in this report. "All other" consists primarily of industrial (non-electricity) emissions, mass transit, freight transport, and agriculture. The "all other" value for 2050 is the amount needed to achieve 80 percent reduction in net national emissions (bottom line), not a forecast for these sectors. Emission absorption from land use and forestry in 2050 is assumed equal to the reported amount for 2013.

1.2 EMPLOYMENT: 550,000 NEW JOBS

At least one member of Congress has brought a more-than-life-sized cardboard photograph of a coal miner to hearings on climate change, in order to confront witnesses with the terrible human cost he imagines that climate policies will impose.[6] But real people's livelihoods are at stake, and the workers involved deserve a three-dimensional picture that goes beyond cardboard cutouts.

Some jobs will be lost as a result of our scenario, although more will be created. Compared to the reference case, the baseline scenario of fossil-fueled business as usual, the Clean Energy Future needs fewer workers in

[5] The small category of diesel-powered cars and light trucks is not included in our analysis.

[6] Based on the experience of the lead author of this report, when testifying before a Congressional committee in 2008.

coal mining, oil and gas production, and non-renewable electricity production, such as coal-burning, gas-burning, and nuclear plants.

The Clean Energy Future requires much larger numbers of workers, however, in energy efficiency programs, renewable energy production, and auto manufacturing (making electric cars). The net effect is an average gain, above the reference case, of more than 550,000 jobs per year from 2016 to 2050, as shown in Figure 2. Net job gains increase over time, starting at a little under 200,000 per year in 2016-2020, and rising to 800,000 per year in 2046-2050.

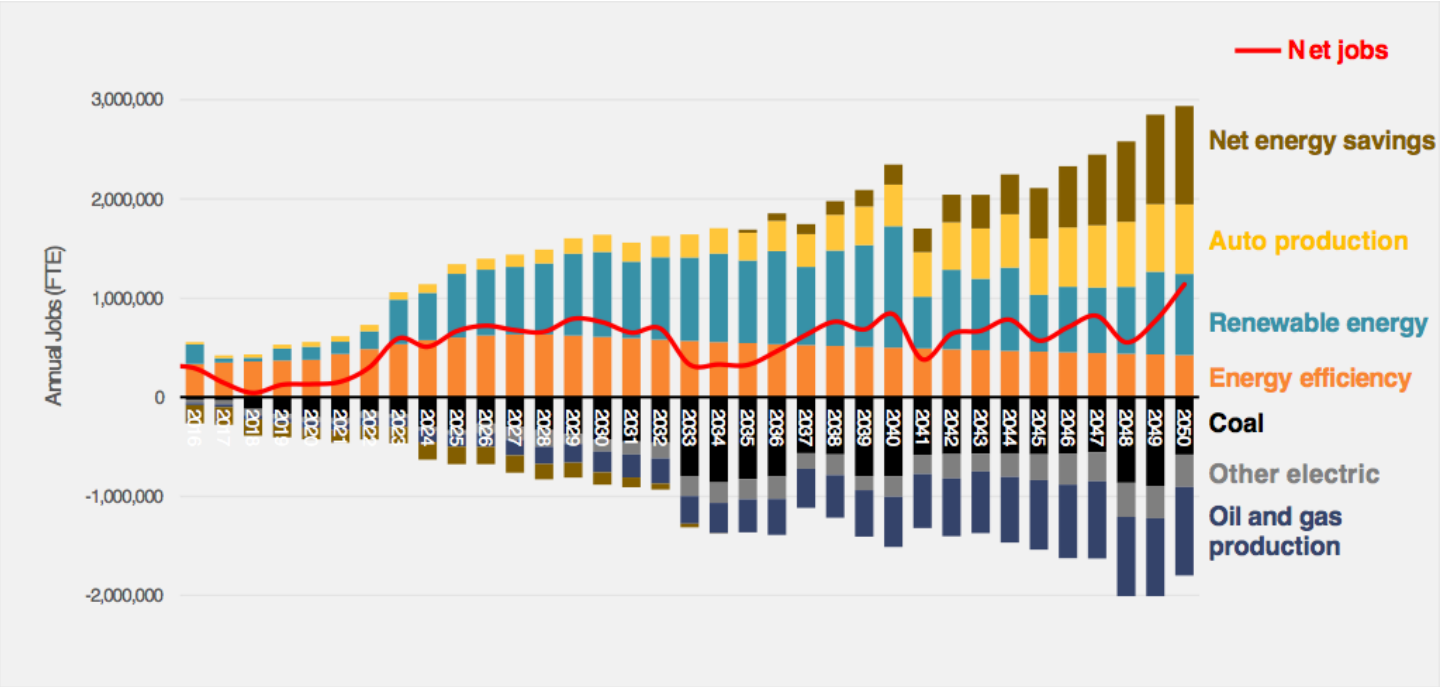

Figure 2. Job creation in the Clean Energy Future, 2016-2050
The graph shows differences between employment in the Clean Energy Future and reference case projections, by year and major category of employment. Each category includes direct, indirect and induced employment. See text for explanation.

Four major categories of new jobs can be seen in the graph. Starting at once, hundreds of thousands of jobs are created by expanded energy efficiency programs. The existing electric system is inefficient, investing far too little in cost-effective efficiency programs. Rather than burning more fuel, it is often cheaper to install more insulation, better lighting, newer appliances and motors, and countless other energy-saving measures.

A second wave of new employment arises in the 2020s, as renewable energy programs take off. Numerous workers are employed in producing, installing, and maintaining wind turbines, solar panels, and other renewable energy equipment, the core technologies of the Clean Energy Future.

Next, after about 2030, employment expands in the auto industry, as production of electric vehicles becomes essential to the later stages of the scenario. Finally, in the 2040s, jobs are created by net energy

savings, which are spent on other purchases.[7] (Each category combines direct, indirect, and induced employment. In auto production, for example, direct employment refers to jobs in the auto industry; indirect employment means jobs in industries that sell parts and supplies to auto companies; induced employment is created when auto workers and auto parts workers spend their paychecks, stimulating other industries.)

Net job creation in the Clean Energy Future, averaging 550,000 jobs per year for 35 years, may sound like a large number. It is, however, only about 0.3 percent of the expected size of the U.S. labor force from now through 2050.[8] Still, it is enough to ensure that there are jobs available for workers displaced from coal and other non-renewable energy industries – as well as opportunities for many other workers to launch promising careers in construction, manufacturing, and other industries required for the transition to clean energy.

Some of the jobs created by the Clean Energy Future are spread throughout the economy. But a majority are concentrated in just a few sectors, as shown in Table 2. Of the new jobs, 78 percent will be in manufacturing and construction. Even after subtracting the jobs lost in mining and drilling for fossil fuels, the net result is still that 59 percent of new jobs will be created in these three industrial sectors, which account for about 13 percent of total employment today.

	New Jobs Per Year, 2016-2050	Percent
Manufacturing	187,518	34%
Construction	240,126	44%
Mining, Extraction	-101,846	-18%
Subtotal: 3 Industrial Sectors	325,798	59%
All Sectors	551,371	100%

Table 2. Share of net new jobs in selected sectors. Source: Authors' calculations.

The workers displaced from fossil fuel industries are not cardboard cutouts. They have done hard, dirty and dangerous jobs that kept our lights on and our cars moving for all the years before we recognized the need for a different energy future. In addition to our thanks, they deserve a just transition, with assistance in training and placement in new jobs, or retirement with dignity.

But the transition to new ways of producing energy is not primarily a story of loss. Rather, it offers new pathways into vital roles producing and using the resources of the twenty-first century. It can rejuvenate and expand the blue-collar American work force for those who have been displaced, for their children, and for hundreds of thousands of others who have been excluded from the constricted prosperity of the recent past.

[7] Net energy savings are a small negative factor, causing job losses, through the 2020s, when energy costs are slightly higher in the Clean Energy Future than in the reference case. Net energy savings become a positive factor, causing job gains, after 2035, when energy costs are lower in the Clean Energy Future.

[8] Based on an average labor force of 178 million from now through 2050, estimated from Mitra Toossi, "Projections of the labor force to 2050: A visual essay," *Monthly Labor Review*, October, 2012 3-16.

1.3 WHY IS THIS AFFORDABLE?

Transforming our energy system, slashing emissions while creating new jobs, may sound exciting, demanding, and important – but it also sounds expensive. In an era of tax-cutting and budget-cutting, what hope is there for the Clean Energy Future?

The scenario described in this report will slightly lower the costs of electricity, transportation and heating. The cumulative cost of the Clean Energy Future is $78 billion less than the reference case.[9] Spread over 35 years, this is actually close to zero; it is a savings of about $7 per person per year. Nonetheless, it demonstrates that there is no insurmountable cost barrier – in fact, no visible cost barrier at all – to adoption of the Clean Energy Future.

The notion that any major initiative must be expensive is based on an exaggerated belief in the efficiency of markets, an unexamined residue of conventional wisdom. If markets had already achieved textbook levels of efficiency, with competition relentlessly driving costs to the lowest possible level, then the tradeoff between energy costs and carbon emissions might look like Figure 3. If energy was already being produced at the lowest possible cost, any reduction in emissions would require an increase in costs. This is the imagined world of economists talking about no free lunches, and the hidden assumption behind most cost-benefit analyses of public policies. But it is not the world of the U.S. energy system today.

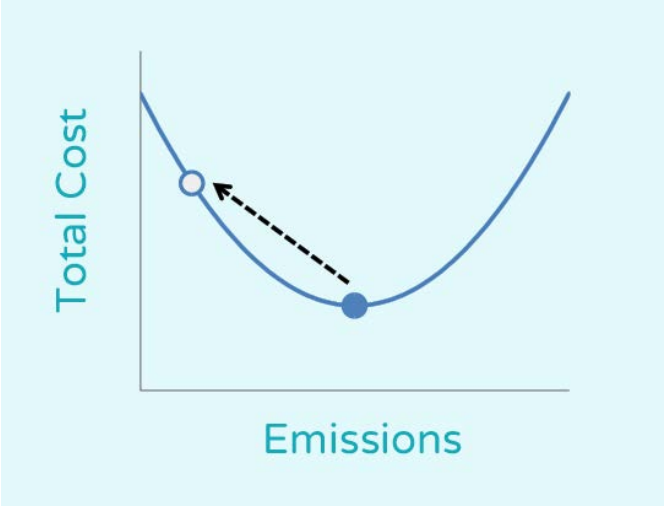

Figure 3. Cost vs. Emissions: Efficient Markets

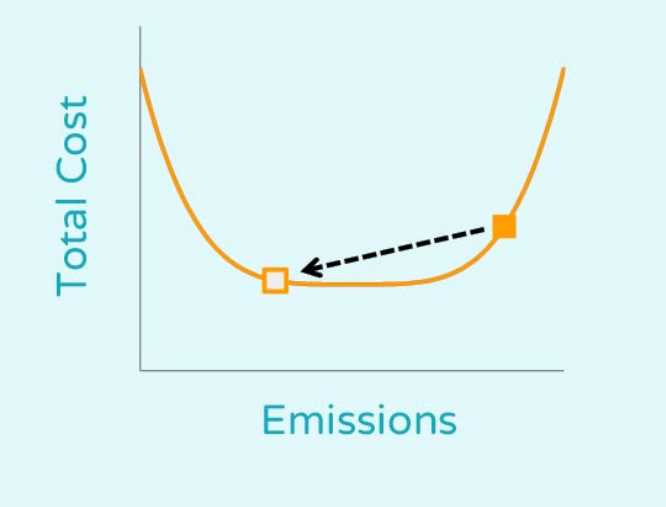

Figure 4. Cost vs. Emissions: Inefficient Markets

In the real world, competition is inhibited by the economic power of large energy companies, the natural monopoly created by electricity grids and distribution systems, the effects of government regulations, and

[9] This is the cumulative present value, at a 3 percent real discount rate, of the difference in costs between the two scenarios.

incomplete knowledge of alternatives. As a result, markets do not always reach the cost-minimizing outcome. In particular, energy markets have been slow to respond to the low costs of energy efficiency and of renewable energy, so they are stuck at a point where both costs and emissions are higher than they could be. Thus the tradeoff may look more like Figure 4 – in which a change, like the Clean Energy Future, can lead to improvements in both costs and emissions.

The Clean Energy Future spends more than the reference case on energy efficiency and renewable energy – and less on fossil fuels and on upgrades and pollution controls at existing power plants. (Closing coal plants saves money, in part, because it avoids the expense of installing pollution controls that would be required to keep the plants running.) That is, the Clean Energy Future pushes for faster adoption of the low-cost resources that the market has been underusing. Therefore, as in Figure 4, both costs and emissions can be reduced at the same time.

Changing the mix of energy resources is also the key to job creation benefits. In general, replacing fossil fuels with alternatives gives a boost to employment. Much of our oil is imported, so any jobs created are far away; and regardless of location, a large part of the price of fossil fuels ends up in the pockets of the owners of oil wells, gas wells, pipelines, and coal mines. Even the money spent on the actual process of production creates relatively fewer jobs than many other industries. Mining, drilling and oil refining rely more on expensive, long-lasting equipment, and less on labor, than most other industries, and create fewer jobs per million dollars of spending.

In contrast, energy efficiency programs hire a lot of construction workers to install insulation and other measures, and indirectly create manufacturing jobs producing efficient lighting, appliances and other devices. Renewable energy involves the production, installation, and maintenance of wind turbines and solar panels, requiring large amounts of steel and electronics, as well as workers in new, skilled occupations. Once power plants are operating, large natural gas plants create 5 jobs in operations and maintenance for every $1 million of revenue, and coal-burning plants create 9. For the same $1 million in revenue, on-shore wind turbines create 12 jobs, and photovoltaics create 14. The growth of renewable energy has already led to demand for workers with new skills; training programs for wind industry technicians have been launched in Kansas and Iowa.[10] In the Clean Energy Future, they will be joined by many more.

1.4 BACK TO THE FUTURE? CLEAN ENERGY AND THE AUTO INDUSTRY

The most surprising part of the Clean Energy Future may be its projected expansion of the auto industry. Achieving 80 percent reduction of carbon emissions by 2050 requires some form of very low- or zero-carbon transportation. Expansion of mass transit can play a role in some areas, but most of the United States has population densities so low that individual vehicles will remain essential. Electric vehicles, running on

[10] Philip Warburg (2012), Harvest the Wind: America's Journey to Jobs, Energy Independence and Climate Stability (Beacon Press).

renewable electricity, offer one of the most promising options for zero-carbon transportation.

This part of our analysis involves more uncertainty than the detailed representation of electric system options. Projection of the technologies of 2050 inevitably feels like gazing into a crystal ball. Looking at what will exist 35 years from now is comparable to anticipating today's technologies back in 1980 – a time when cellphones, personal computers, and the World Wide Web did not yet exist. Staring that far into the future, here is what we see for the auto industry.

We assume that it will be possible to expand renewable electricity production and electric vehicle production fast enough to convert 100 percent of gasoline-powered cars and light trucks to renewable electricity by 2050. Drivers who switch to electric vehicles will save money on fuel, spending much less on electricity than they previously did on gasoline. What happens to that fuel savings is crucial to the economic analysis of the Clean Energy Future.

We assume that the total cost of driving will initially be unchanged: while their fuel is cheaper, electric cars are more expensive.[11] Until 2030 the price premium for buying an electric rather than a gasoline vehicle will be exactly equal to the fuel savings. After 2030 we assume that the rapid expansion of the electric vehicle production will lead to cost reductions, so that the price premium for an electric vehicle is only 99 percent of the fuel savings in 2031, declining to 80 percent in 2050. This is a very cautious assumption; it is easy to imagine an expanding new industry reducing costs more quickly.

The increased cost of electric vehicles, reflecting the novelty and complexity of this technology, implies that manufacturing these vehicles will require more workers.[12] Recent data show that 48 percent of automobiles sold in the United States are produced domestically; we assume no change in that ratio through 2050. The increased employment due to auto production, as seen in Figure 2, results from meeting 48 percent of the new demand for electric vehicles within the United States. If the American auto industry becomes more internationally competitive, there could be even greater gains.

The Clean Energy Future will not involve DeLoreans, gull-wing doors, or time travel. But it could take America back to a future where the auto industry is one of the keys to a revitalized manufacturing sector, creating new jobs producing the zero-carbon technologies of the late twenty-first century.

2. BEYOND THE CLEAN ENERGY FUTURE

The Clean Energy Future scenario presented in this report addresses more than half of 1990 carbon emissions, and slashes them by 86 percent. It provides three-quarters of the total emission reductions needed to reach the national target of 80 percent below 1990 levels by 2050 (see Table 1, column 3). The

[11] The cost of technology to provide electric space heating and water heating is assumed to be unchanged from previous technologies; in this case, changes in fuel costs for heating are passed on to end users.

[12] Many of the new jobs may be in production of batteries and charging stations. James Hamilton (2012), "Electric vehicle careers: On the road to change," *Occupational Outlook Quarterly*, http://files.eric.ed.gov/fulltext/EJ974224.pdf.

major sectors omitted from our analysis are industry, other transportation (excluding cars and light trucks), and agriculture. To meet the 80 percent target, carbon emissions from these other sectors must be cut by at least 42 percent over the next 35 years.

While a quantitative analysis of the other sectors is beyond the scope of this report, there are many options for closing the remaining gap, using technologies that exist or are under active development.

Industry accounts for 18 percent of U.S. carbon emissions (excluding emissions from electricity used by industry). Most of these emissions come from a few energy-intensive materials industries: chemicals, primary metals, paper, and cement.[13] Individual industries and product lines will require different technologies for emission reduction, but some specific opportunities are worth noting.

- Production of recycled metals and paper requires much less energy than the corresponding virgin materials, leading to reductions in greenhouse gas emissions.

- Electricity can be substituted for use of fossil fuels in many industrial processes; if electricity is produced from renewable energy, this can eliminate emissions.

- Iron and steel industry emissions are already falling in the United States, both because domestic steel production is declining and because the ongoing shift from basic oxygen furnaces to electric arc furnaces leads to lower emissions per ton of steel. With electricity from renewable energy, an electric arc furnace could produce steel with near-zero emissions.

- One branch of the chemical industry has had very high non-fuel greenhouse emissions in recent years. The first round of replacements for ozone-depleting substances in refrigeration and air conditioning involved hydrofluorocarbons (HFCs), which protect the ozone layer but are potent greenhouse gases. Research is proceeding rapidly on climate-friendly (and ozone-layer-friendly) alternatives to HFCs, and next-generation replacements have already been developed.[14]

- In cement, a very emissions-intensive industry, it is possible to reduce emissions through more energy-efficient production processes, switching to low-carbon fuels, changing the mix of materials used, and redesigning final products to require less cement.[15]

13 Petroleum refining, often counted as one of the energy-intensive materials industries, has been included in our Clean Energy Future calculations since it supplies most of the energy used in transportation. In 2010, the primary metals, chemicals, paper and cement industries accounted for 69 percent of energy use in U.S. manufacturing (excluding petroleum refineries); calculated from the 2010 Manufacturing Energy Consumption Survey, http://www.eia.gov/consumption/manufacturing/data/2010/pdf/Table1_2.pdf. The same sectors also accounted for almost all non-energy GHG emissions from manufacturing.

14 Suely Carvalho, Stephen O. Andersen, Duncan Brack, and Nancy J. Sherman (2015), "Alternatives to High-GWP Hydrofluorocarbons", Institute for Governance and Sustainable Development, http://igsd.org/documents/HFCSharpeningReport.pdf.

15 Fischedick M., J. Roy, A. Abdel-Aziz, et al. (2014), "Industry," in Climate Change 2014: Mitigation of Climate Change [IPCC AR5 WG3; Edenhofer, O., R. Pichs-Madruga, Y. Sokona et al. (eds.)]. Cambridge University Press, Cambridge, UK and New York.

Non-car transportation represented 10 percent of U.S. carbon emissions in 1990, primarily from trucks and airplanes. A National Research Council study found that existing technologies could lead to 40 to 50 percent improvements in truck fuel efficiency by 2020; the incremental cost of a new, fuel-efficient tractor-trailer pays for itself in fuel savings as long as diesel fuel remains above $1.10 per gallon.[16] The International Energy Agency projects that fuel efficiency measures can reduce airplane emissions 43 percent below a business-as-usual baseline by 2050.[17] Additional reductions could come from shifting freight transportation from planes and trucks to trains.

Agriculture produces 7 percent of U.S. carbon emissions – largely in three areas, each of which has potential for mitigation. Nitrous oxide emissions from agricultural soils result from overuse of nitrogen fertilizers, and can be addressed by organic farming and/or more precisely targeted fertilizer applications. Methane from enteric fermentation (basically, cattle burping) can be reduced by use of more digestible feed. Methane from manure management on feedlots can be captured by digesters and used as fuel. In addition, per capita consumption of red meat is beginning to decline; continuation of that trend could lead to a reduction in livestock production, lowering emissions from cattle and feedlots.

Many strategies could contribute to emission reduction. Better urban planning and expanded mass transit, substitution of high-speed rail for flights on heavily traveled corridors, reduction in military activity, a continued decline in beef consumption – these and other possibilities for the next 35 years, none of which are included in our calculations, could also limit greenhouse gas emissions. But even without such far-reaching changes, there are numerous opportunities for emission reduction in the sectors beyond the Clean Energy Future scenario, which can help meet the target of an overall reduction in U.S. greenhouse gas emissions to 80 percent below 1990 levels by 2050.

Our evolving understanding of the climate crisis could eventually imply that even more needs to be done to reduce emissions beyond the 80 percent target. Likewise, more than 550,000 new jobs will be needed to create an inclusive and prosperous American economy. Nothing in this report is meant to suggest that the Clean Energy Future is the most we should strive for. Rather, it is the least we should consider. It shows that immense progress can be made, on both climate and employment, at no net cost. Going farther may require hard choices about budgets and resources - but going this far is free. Why would anyone want to do less?

16 National Research Council (2010), Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles. National Academies Press, Washington, D.C., http:/ /www.nap.edu/catalog.php?record_id=12845.

17 International Energy Agency (2009), *Transport, Energy and CO2: Moving Toward Sustainability*. Available at https://www.iea.org/publications/freepublications/publication/transport2009.pdf.

CONCLUSION: WHY WAIT?

While more and more people agree that reducing greenhouse gas [GHG] emissions is necessary for the future of humanity, many wonder just how it can be done and worry that it will hurt their pocketbooks and threaten their jobs.

The Clean Energy Future laid out in this report represents a practical plan to reduce GHG emissions 80 percent by 2050 – the minimum reduction that climate scientists say can limit climate catastrophe. It shows that climate protection is not only affordable, but that it can actually save Americans money. The plan will create half a million more jobs than continuing on a fossil fuel pathway, most of them well-paid, family-supporting jobs in manufacturing and construction. The report answers the question it raised at the outset – "Is there a plan that reduces carbon emissions enough to stabilize the climate, creates growing numbers of good jobs, and at the same time avoids imposing new costs on consumers and taxpayers?" – with a resounding "yes."

The Clean Energy Future plan provides a floor, not a ceiling, for what can be accomplished. It shows how we can meet climate goals with no net cost, and that doing so will create more jobs. But we can, and indeed should, do more. For example, mass transit can be expanded far faster. GHG reduction targets can be met earlier. GHG emissions can be reduced to near zero. We can achieve such goals just by accelerating and adjusting the same basic plan.

We can also achieve other goals besides climate protection as part of the same process. To achieve maximum benefit from the Clean Energy Future, we advocate four basic policies:

1. Climate protection will require the creation of tens of thousands of new jobs. But there is no guarantee that they will be good jobs. Indeed, depending on other economic trends, spending on climate protection could increase inequality and provide increasingly insecure, contingent work. Climate protection strategy should be designed to provide the maximum number of good, secure, permanent jobs with education, training, and advancement that provide maximum possible improvement in our job shortage. The deterioration in the quality of jobs is directly related to the reduction in the size and bargaining power of labor unions; reinforcing the right of workers to organize and bargain collectively should be an explicit part of public policy for climate protection.

2. Because some jobs will be lost in fossil-fuel related industries, we need a vigorous program to provide new, high-quality jobs and/or dignified retirement for workers in those industries. A Superfund to protect workers and communities from negative side effects of climate policies should be a central part of any climate program. Anything less will be unjust to workers and will undermine political support for climate protection programs.

3. The Clean Energy Future plan opens up new opportunities to counter the growing inequality and rampant racial, gender, and other injustice of our society. But many of those opportunities will be lost unless we have deliberate policies to realize them. Climate protection programs should include job pathways and strong affirmative action provisions for those groups that have been most

excluded from good jobs in the past.

4. The Clean Energy Future also opens up a wide range of opportunities for creating a more democratic economy and society. It allows for a less top-down and more distributed energy system. It provides many opportunities for local economic initiatives, ranging from energy coops to locally- and community-based enterprises of many kinds. It will reduce the wealth and power of the fossil fuel corporations that have such a dominant role within our political system. These opportunities should not be squandered.

A series of forthcoming LNS reports will address in greater detail how the Clean Energy Future can best provide for high-quality jobs, protection for fossil fuel workers, advancement for disadvantaged groups, and a more democratic society.

The Clean Energy Future represents a pathway away from climate destruction that is also far better for workers and consumers than our current pathway based on fossil fuels. Should we let greed and inertia prevent us from taking it?