# NORTH CAROLINA'S CLEAN ENERGY FUTURE

## Climate Goals & Employment Benefits

LABOR NETWORK FOR SUSTAINABILITY

Synapse Energy Economics, Inc.

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# INTRODUCTION

This report presents a Clean Energy Future plan that reduces North Carolina's greenhouse gas (GHG) emissions 80 percent below the 1990 level by 2050—while adding thousands of new jobs and saving money on electricity, heating, and transportation costs. It achieves these goals in spite of North Carolina's rapid growth, which at times has nearly doubled that of the nation as a whole.

North Carolina has often been told that doing its share to save the earth's climate will threaten its workers' jobs. "North Carolina's Clean Energy Future: Climate Goals and Employment Benefits" refutes that claim. This report lays out a climate protection plan that will produce more than 19,000 net new jobs per year over business-as-usual projections through 2050. Representing 0.4 percent of the total employment in the state, these jobs should reduce the unemployment rate by nearly one-half of a percent. Two-thirds of the jobs created will be in construction and manufacturing.

The report also indicates that North Carolina can use the burgeoning state and national demand for clean energy to create good, stable jobs in a growing climate protection sector: manufacturing jobs, jobs for those who have been marginalized in the current labor market, and jobs for skilled union workers in the construction trades.

This report was prepared by the Labor Network for Sustainability[1] (LNS) with research conducted at Synapse Energy Economics by Dr. Frank Ackerman, Tyler Comings, and Spencer Fields.[2] It is based on the national study "The Clean Energy Future: Protecting the Climate, Creating Jobs, and Saving Money."[3] That study lays out an aggressive strategy for energy efficiency and renewable energy that will:

[1] The Labor Network for Sustainability 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] Synapse Energy Economics 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.
[3] Labor Network for Sustainability, "The Clean Energy Future: Protecting the Climate, Creating Jobs, and Saving Money"

- Transform the electric system, cutting coal-fired power in half by 2030 and eliminating it altogether by 2050; building no new nuclear plants; and reducing the use of natural gas far below business-as-usual levels.
- Reduce GHG emissions 86 percent below 1990 levels by 2050, in the sectors analyzed (which account for three-quarters of U.S. 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 Clean Energy Future 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. Most of the additional jobs will be in manufacturing and construction. Such jobs tend to have higher wages and better benefits than average, thereby providing valuable 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. The report also advocates deliberate policies to create new opportunities and job pipelines for those groups who have been most excluded from good jobs.

The national 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 emissions reduction needed, nationally, to reach the 80 percent by 2050 target. "North Carolina's Clean Energy Future" shows what this plan would mean for North Carolina. It also discusses how additional reductions in areas like industrial emissions, trucking, agriculture, and electric power can make it possible for the state to reach an 80 percent reduction in GHG emissions by 2050—and often create new jobs in the process.

The Clean Energy Future presented in this report represents a floor, not a ceiling. It shows how much is achievable without increasing what we are already spending. Much more can and should be done to protect our climate, our environment, our economy, and our workers. This report provides a starting point.

The Clean Energy Future represents an enormous opportunity to protect the environment and create valuable jobs by doing so. Of course, we can ignore this opportunity and continue on our "business as usual" course. But if we do so, we place enormous risks on both our environment and our workers. Why should we not pursue the Clean Energy Future instead?

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

# 1. CUTTING NORTH CAROLINA'S CARBON EMISSIONS

Is there an inevitable tradeoff between jobs and climate protection? Fortunately, this common belief turns out to be mistaken. Traditional energy technologies are not the only source of good jobs; new, cleaner energy solutions can create even more employment, without increasing overall energy costs. As we will demonstrate, North Carolina can achieve rapid reduction in carbon emissions, while at the same time creating thousands of new jobs—primarily in construction and manufacturing.

Many researchers have concluded that the United States and other high-income countries need to reach at least 80 percent reductions below 1990 levels by 2050 in order to stabilize the climate. This begs the question: Can we cut emissions that fast without causing economic harm?

This report addresses the long-term goal of nearly eliminating GHGs from fossil fuel combustion by 2050, showing that it is possible to slash emissions while creating thousands of new jobs in the state—without increasing the overall cost of energy. Our study of North Carolina draws on our national Clean Energy Future, and should be read in conjunction with that report.[4]

The national Clean Energy Future describes a scenario with the following features:

- Energy efficiency programs are greatly expanded, matching the most successful existing state programs nationwide.
- A national renewable portfolio standard requires 70 percent renewable electricity by 2040.
- Coal is phased out nationwide—half by 2030, entirely by 2050 (in North Carolina, the pace is even faster: almost all coal plants are retired before 2030).
- No new nuclear plants are built, while existing ones are phased out after 2030.
- Electric vehicles replace all gasoline-powered cars and light trucks.
- Electric heating replaces most fossil-fueled space and water heating.

We compare this Clean Energy Future scenario to a business-as-usual Reference Case, which assumes the continuation of existing policies, but no new environmental regulations or GHG reduction initiatives. For instance, the Reference Case assumes compliance with all existing state renewable portfolio standards (REPS; often called RPS in other states). North Carolina's REPS requires investor-owned electric utilities to meet up to 12.5 percent of energy needs through renewable energy or energy efficiency measures; for rural cooperatives and municipal utilities the requirement is 10 percent.[5] The Clean Energy Future assumes compliance with a much more demanding national RPS of 70 percent renewable electricity by 2040.

A challenge for North Carolina arises from the state's rapid growth: cutting back to 80 percent below 1990 emissions is harder than in slower-growing states. From 1990 to 2013, North Carolina's population grew by 45.6 percent, compared to 25.3 percent in the United States as a whole.[6] The state's faster-than-average growth is expected to continue into the near future, which would tend to create greater emissions. North Carolina's industrial emissions have declined in recent years due to changes in technology and the shifting composition of the state's industry. However, emissions in many other sectors have increased along with population and economic growth.

North Carolina's role in the national Clean Energy Future goes a long way toward reducing state emissions by 2050. Table 1-1 shows the reduction achieved by the Clean Energy Future in electricity generation, automobile use, space heating, and waste management, assuming that emissions in

[4] As described in "The Clean Energy Future", a report from Labor Network for Sustainability, 350.org, and Synapse Energy Economics, available at http://climatejobs.labor4sustainability.org/.
[5] North Carolina Utilities Commission, "Renewable Energy and Energy Efficiency Portfolio Standard (REPS)", .
[6] Based on U.S. Census Bureau data for population.

other sectors remain unchanged at recent levels (see table notes). Under these assumptions, net emissions drop from 104 million metric tons of carbon dioxide-equivalent ($CO_2$-eq) in 1990 to 36 million, a 65 percent decline.[7]

| | $CO_2$-eq (Million Metric Tons) | | |
|---|---|---|---|
| | 1990 Emissions | Clean Energy Future, 2050 or Latest Actual | Reduction from 1990 |
| Power | 46.3 | 14.4 | 69% |
| Cars & Light Trucks | 27.8 | 0.9 | 97% |
| Residential Heating | 4.6 | 0.7 | 86% |
| Commercial Heating | 3.1 | 0.3 | 89% |
| Waste Management | 4.8 | 0.0 | 100% |
| **Total CEF Sectors** | **86.6** | **16.3** | **81%** |
| Transportation (Except Cars) | 11.9 | 14.2 | -19% |
| Industrial | 19.4 | 15.4 | 21% |
| Agriculture | 8.3 | 13.3 | -60% |
| Residential/Commercial Other | 1.3 | 1.1 | 15% |
| **Total Other Sectors** | **41.0** | **44.0** | **-7%** |
| **Global Emissions** | **127.6** | **60.2** | **53%** |
| Emission Sinks | -23.2 | -23.7 | -2% |
| **Net Emissions** | **104.4** | **36.5** | **65%** |

**Table 1-1. North Carolina GHG emissions: 1990 and projected 2050. (Data in red are latest actual figures, used where 2050 projections were not available.)**

**Sources: 1990 data from U.S. Energy Information Administration (EIA) historical data and from the latest North Carolina greenhouse gas inventory (Center for Climate Strategies, 2007, www.climatestrategies.us/library/library/download/574). Clean Energy Future data are from authors' calculations. "Latest actual" estimates are based on EIA data for 2013 (transportation, industrial fuel use emissions, and residential/commercial other) and on the NC GHG inventory data for 2005 (industrial process emissions, agriculture, and emission sinks). Emission sinks represent soil and forest absorption of atmospheric $CO_2$.**

To achieve 80 percent reduction in emissions below 1990 levels, another 15.7 million tons of emission reduction would be needed, beyond those shown in Table 1-1. Despite the considerable reductions in our Clean Energy Future, there are four sectors where emissions remain substantial: electric power generation, non-car transportation (largely trucking), industry, and agriculture. Each of these sectors has projected emissions of 13–16 million tons of $CO_2$-eq for the year 2050. Additional reductions would need to come from one or more of these sectors.

[7] All emissions data in this report are in metric tons, consistent with most data sources. Coal use is reported in short tons.

We begin with a description of the implications of the Clean Energy Future for North Carolina's energy system in Part 2 of this report, followed by employment impacts in Part 3 and the options for achieving further emission reductions in Part 4.

# 2. A CLEAN FUTURE FOR ENERGY

## a. Electricity in North Carolina: snapshots from the future

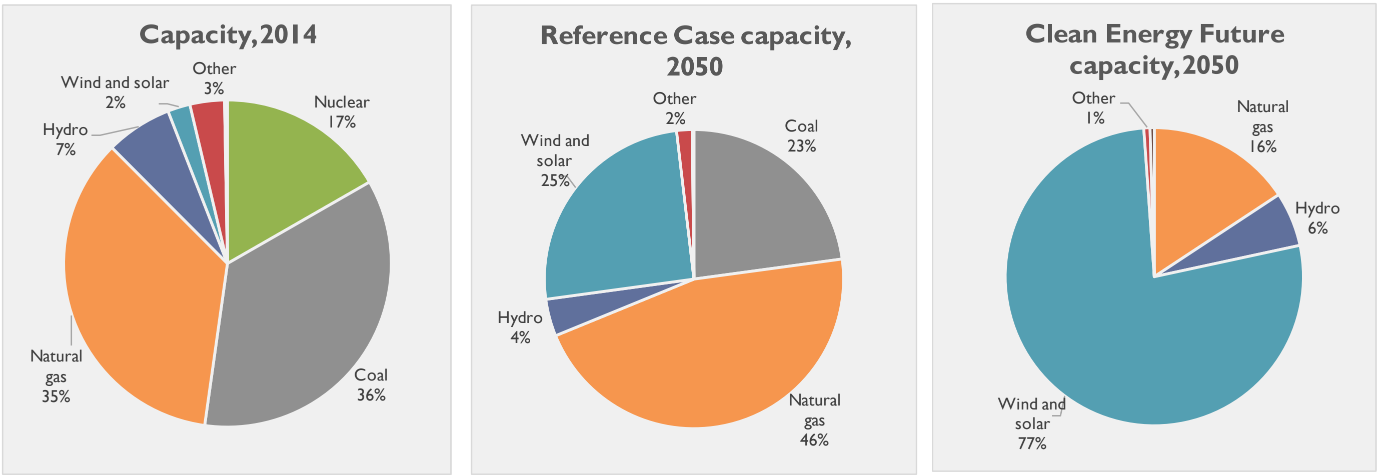


**Figure 2-1. Electric generating capacity in North Carolina, 2014 and projected 2050.**

Our two scenarios lead to very different futures for the North Carolina electricity system. Figure 2-1 compares generating capacity today with those projected for 2050 under the Reference Case and under the Clean Energy Future. Currently the state relies almost entirely on coal, natural gas, and nuclear power, with a large majority—71 percent—of capacity based on fossil fuels. In both scenarios, nuclear power disappears by 2050; we assume that nuclear plants all retire after 60 years in service, and new ones are proving so expensive that no one will build any more of them. In other respects, the two scenarios diverge.

The Reference Case retains a significant amount of coal capacity. It supplements this first with a huge expansion of natural gas plants, and secondarily with an expansion of wind and solar power. Even in the absence of new policies promoting renewables, expansion of wind and solar power is profitable—but they are not cheap enough to replace most of North Carolina's fossil fuel-burning power plants. In the Reference Case snapshot from 2050, the state's electric capacity is still 69 percent based on fossil fuels.

The Clean Energy Future sends back a different snapshot from the future: it eliminates coal as well as nuclear power, and it relies on a massive expansion of renewable energy. By 2050, 77 percent of the state's capacity is wind and solar power, with another 6 percent from hydropower. The only remnant of the former dependence on fossil fuels is the 16 percent from natural gas.

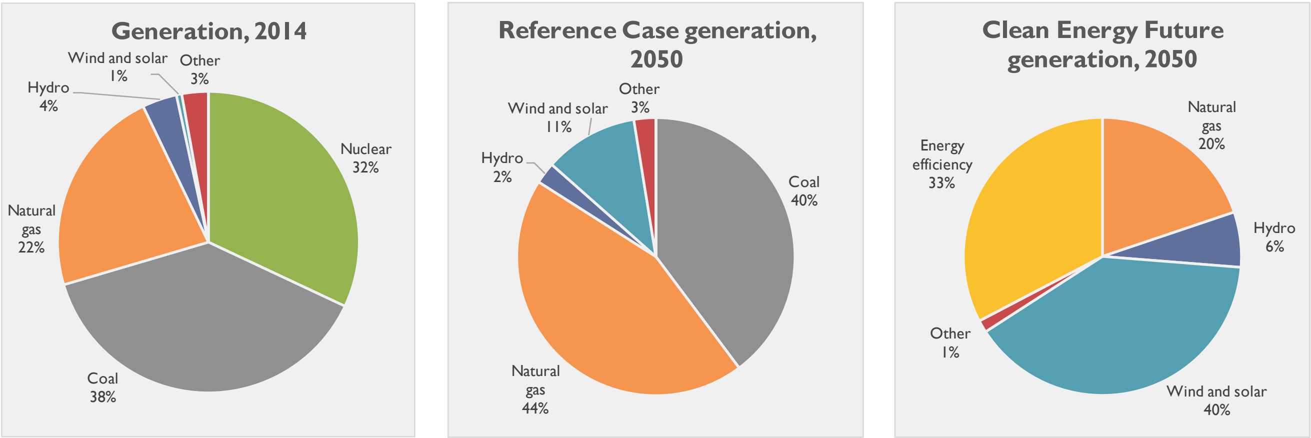


**Figure 2-2. Electricity generation in North Carolina, 2014 and projected 2050.**

The picture is similar for electricity generation, as shown in Figure 2-2. Generation in North Carolina today is almost entirely (92 percent) from coal, nuclear power, and natural gas. In the Reference Case version of 2050, coal and natural gas still account for 84 percent of generation, compared to only 13 percent from wind, solar, and hydropower.

In the Clean Energy Future version of 2050, zero-emission resources account for the great majority of North Carolina's electricity needs. Wind and solar power provide 40 percent, and hydropower another 6 percent. In addition, energy efficiency measures introduced between now and 2050 replace 33 percent of the demand for electricity. Natural gas, the remnant of the fossil fuel economy, provides 20 percent of the state's electricity.

## b. A scorecard on fossil fuel use

The Clean Energy Future extends beyond the electric system; it implies a massive reduction in fossil fuel use throughout the electricity, transportation, and heating sectors. The business-as-usual alternative, the Reference Case, forecasts growing reliance on fossil fuels, continuing at least through mid-century (the end of our projections).

In the Reference Case, coal use is greater in 2050 than in 2014. Gasoline use inches down only from about 4 billion gallons per year to 3 billion, due to gradual increases in automobile fuel efficiency.

Meanwhile, natural gas use in electric generation expands rapidly through 2050. In the broader category of natural gas use for electric generation and residential and commercial heating, there is a 120 percent increase from 2014 to 2050. This is the future toward which North Carolina would be heading, if there were no new policies to promote clean energy and reduce emissions.

In contrast, the Clean Energy Future eliminates all coal-fired power plants before 2050. Coal consumption for electric power generation drops from 20 million tons in 2014 to zero in 2050. And the Clean Energy Future eliminates all 4 billion gallons of current gasoline use, replacing it with electric vehicles. It also replaces almost all fossil fuel currently used in residential and commercial heating with electricity. There is a modest (26 percent) increase in natural gas use for electric generation, but this is more than offset by the reduction in heating use. In the overall category of natural gas use for electric generation and residential and commercial heating, there is a 14 percent decrease from 2014 to 2050.

Although the Clean Energy Future slashes total fossil fuel use and emissions, it is still not enough for long-run sustainability. Natural gas is a source of carbon emissions, and fracking—the increasingly common technique for extracting gas—causes severe local environmental damage. A 14 percent reduction is not enough; ultimately, natural gas will need to be eliminated, along with coal and gasoline. Can the transition to a fully fossil-free economy be sped up? There are at least three options for cutting energy emissions even faster and for reducing natural gas use more dramatically before 2050.

First, it is possible to do more, sooner, to introduce efficiency measures and renewable energy. The Clean Energy Future scenario does not approach the limits of what is technically feasible. Rather, it is defined as the best that can be done *without increasing overall energy costs.* If more money is available for investment in efficiency and renewables, and/or if ratepayers and customers will accept higher energy costs, then the transition can be accelerated with today's technology.

Second, our analysis does not include a notable energy-saving option that may be important in North Carolina, namely combined heat and power (CHP) plants. CHP plants capture and use what would normally be waste heat in a thermal power plant, providing steam heat for industrial processes as well as for space heating and water heating. CHP could feasibly account for a substantial share of the state's gas capacity. Widespread use of CHP would allow additional reductions in energy use and emissions beyond the Clean Energy Future projections.

Finally, a breakthrough in low-cost battery technology could push renewable energy forward, in North Carolina and everywhere else. At present, expansion of renewable energy encounters the problem of intermittency: solar and wind power drop off when the sun stops shining and the wind stops blowing. When that happens, something else must be turned on to keep electricity flowing. Quite often, that "something else" is a natural gas plant. (Both natural gas and hydropower are well suited for this role since they can turn on and off quickly, unlike coal and nuclear plants.)
In the long run, a completely fossil-free energy system will have to use batteries or other storage systems to solve the problem. This will allow energy to be stored when the sun is shining and the wind is blowing and then be withdrawn later when needed. At present, in most parts of the country, batteries are still too expensive to make this solution affordable. But if breakthroughs can be achieved, driving down storage costs, the timetable for the transition can be advanced. The rapid decline in solar power costs has made that piece of the renewable energy system affordable; what we need now is a similar decline in large-scale battery costs.

## c. Evolving energy technologies

The Clean Energy Future will transform North Carolina's energy system by mid-century, building 49,000 MW of solar power. This will come from large-scale utility solar facilities, individual rooftop panels, and other small residential and commercial installations. The state will also have over 2,700 MW of wind turbines, including both onshore and offshore developments. New storage technologies, such as high-tech batteries, will be increasingly important to make renewable energy available around the clock.

Renewable sources of electricity will supply the massive new demand from electric cars and electric heating, along with existing uses of electricity. At present North Carolina has roughly 7 million gasoline-powered cars and light trucks[8]—all of which will be replaced, in the Clean Energy Future, by electric vehicles by 2050. Meanwhile, an active energy efficiency program will reduce the demand for electricity by 2 percent every year.

That scenario is a stark contrast to the Reference Case, which assumes the continuation of existing

[8] Calculated from Federal Highway Administration data for 2014.

trends and policies and no new initiatives to promote renewable energy or reduce emissions. In terms of generation capacity, the Reference Case preserves much of existing coal capacity and expands the use of natural gas, while including moderate growth of renewables. The Clean Energy Future eliminates coal and uses much less natural gas than the Reference Case, while relying on massive investment in renewables and increased energy efficiency.

Figure 2-3 compares North Carolina's solar power capacity under the two scenarios. By 2050, the state has 48,993 MW of solar capacity in the Clean Energy Future, versus 10,390 MW in the Reference Case. Both include growth far beyond today's levels, but by 2050, the Clean Energy Future calls for installing almost five times as much solar capacity.

Even this ambitious solar agenda uses only a small fraction of the state's technical potential for solar power.[9] The additional potential for solar power means that even faster progress toward zero-carbon energy is possible—if additional funding is available for expanded solar investments. The Clean Energy Future was defined as an emission reduction scenario that would cause no net increase in overall energy costs.

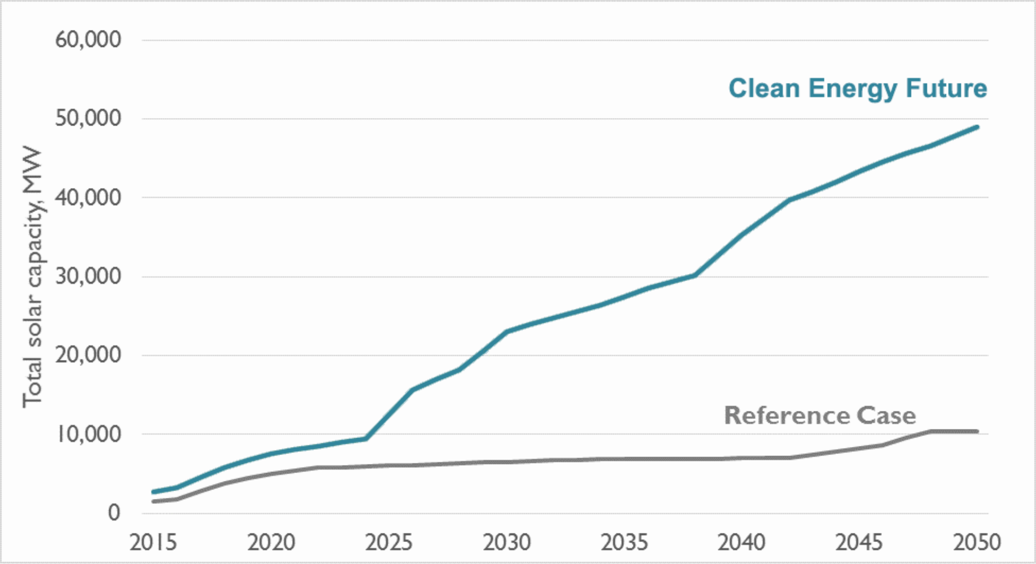


**Figure 2-3. Solar power capacity in North Carolina under two scenarios.**

A similar comparison for wind power appears in Figure 2-4. By 2050 North Carolina has 2,827 MW of wind power in the Clean Energy Future, almost half of it offshore, versus 1,394 MW in the Reference Case. Although wind power is an important component of the Clean Energy Future in North Carolina and the nation, it plays a larger role in other, windier states.

[9] According to the National Renewable Energy Laboratory (NREL), North Carolina has the technical potential for about 2,400 GW (2,400,000 MW) of photovoltaic capacity. See Anthony Lopez et al. (2012), "U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis", .

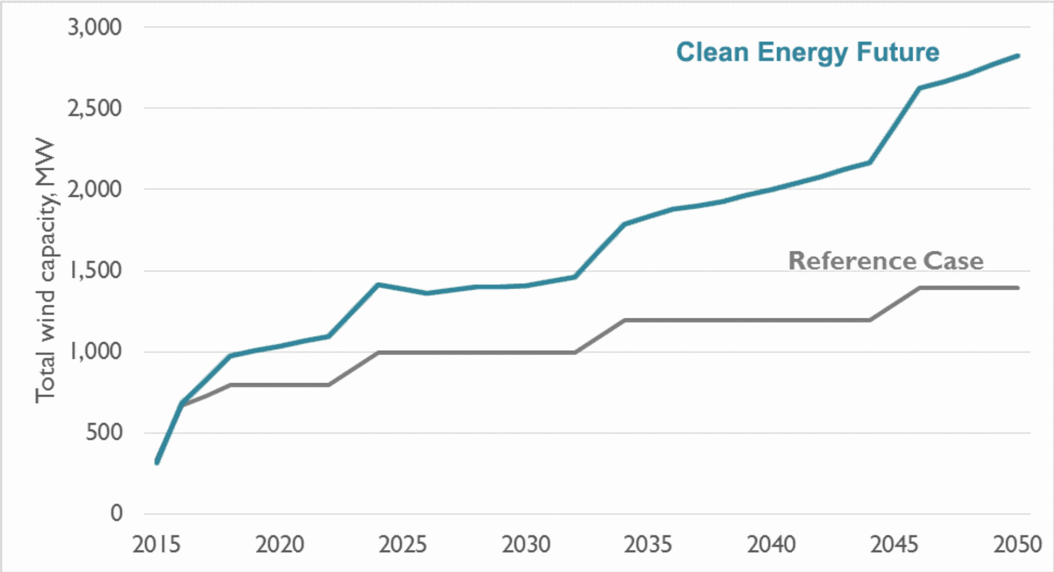


**Figure 2-4. Wind power capacity in North Carolina under two scenarios.**

Fossil generation differs greatly between the two scenarios. The Clean Energy Future retires almost 90 percent of the state's existing coal capacity in the next 10 years, and the remainder in the 2040s, as shown in Figure 2-5. Meanwhile, virtually all of today's coal capacity remains on-line through 2050 in the Reference Case.

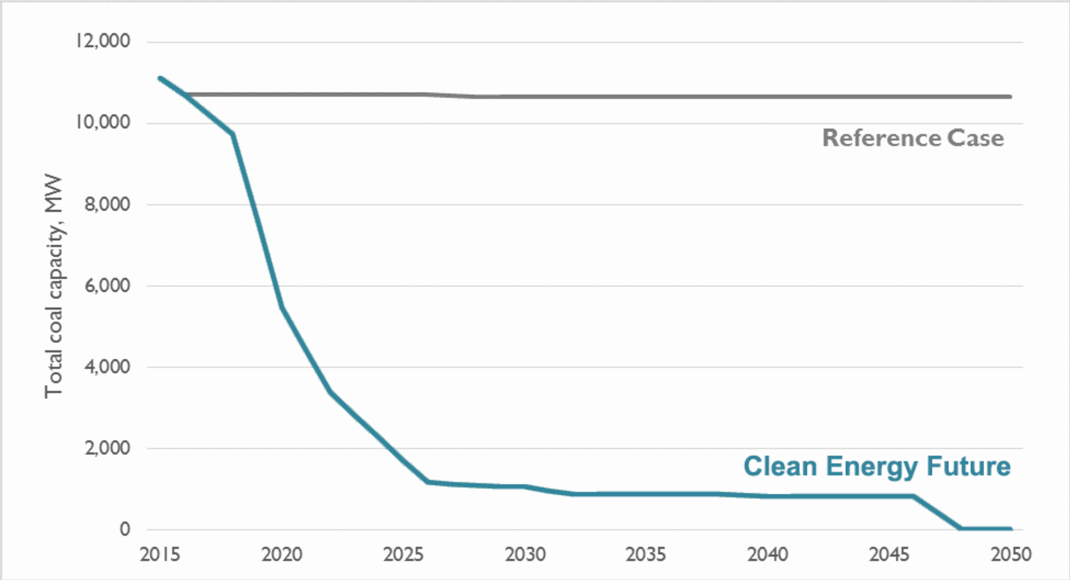


**Figure 2-5. Coal-fired generating capacity in North Carolina under two scenarios.**

In contrast, natural gas capacity in North Carolina is almost unchanged throughout the Clean Energy Future scenario, from now through 2050, as shown in Figure 2-6. The Reference Case uses much more gas: it requires additional gas capacity beginning in the 2030s, and more than doubles today's capacity by 2050.

Both scenarios assume that all nuclear plants will shut down 60 years after they began commercial operation, which implies retirement of the last of North Carolina's nuclear plants by 2047. No new nuclear plants are built in either scenario, due to the high cost of new nuclear construction.

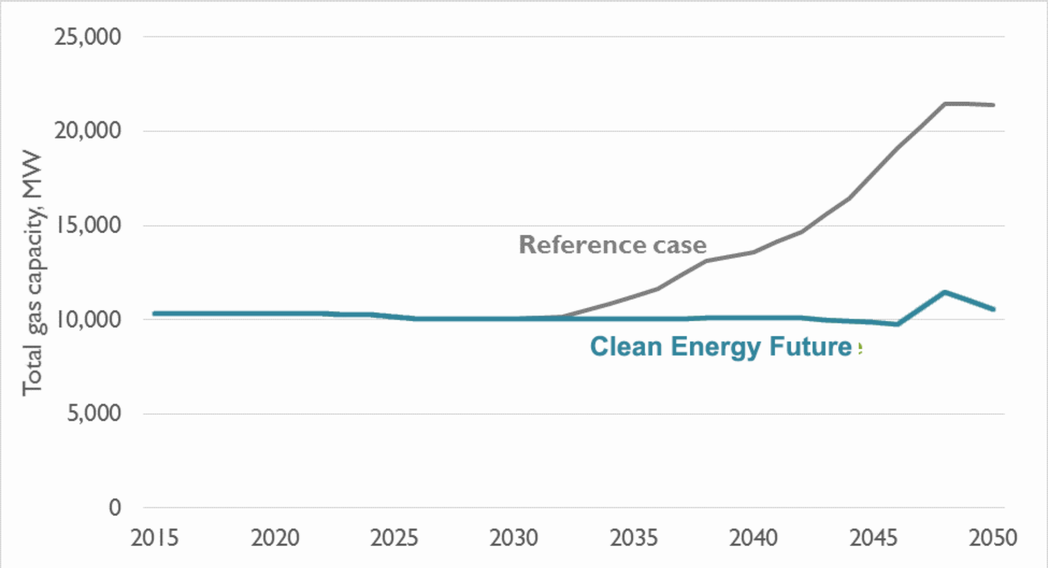


Figure 2-6. Natural gas-fired generating capacity in North Carolina under two scenarios.

The huge expansion of solar power, along with the continuation of gas generation, is needed both to replace coal and to serve the new electric vehicle and heating loads in North Carolina and the region. The Clean Energy Future involves investment in energy efficiency to reduce the demand for electricity, but this is balanced by the shift to electricity in the electric vehicle and heating markets.

A similar pace of renewable capacity expansion will be required throughout the country to create the Clean Energy Future. Indeed, the ambitious expansion plans projected for North Carolina, as described here, include less than 0.5 percent of the wind capacity and 5 percent of the solar capacity needed nationwide in 2050.

# 3. A CLEAN FUTURE FOR JOBS

The Clean Energy Future creates an annual average, from now through 2050, of 19,000 more jobs in North Carolina compared to employment in the Reference Case. This is a net gain of about 0.4 percent of total employment in the state in 2013, as shown in Table 3-1. Two-thirds of the new jobs are in construction and manufacturing, the industries with the greatest percentage increases in employment. The only economic sectors projected to have net job losses under the Clean Energy Future are utilities, and mining and extraction.

| | 2013 Employment | New Jobs in Clean Energy Future | |
|---|---|---|---|
| | | Annual Average | As Percentage of 2013 |
| Total, All Industries | 5,449,352 | 19,277 | 0.4% |
| **Above Average Growth** | | | |
| Construction | 298,536 | 7,731 | 2.6% |
| Manufacturing | 465,282 | 6,526 | 1.4% |
| Wholesale Trade | 191,325 | 1,185 | 0.6% |
| Business Management | 80,723 | 453 | 0.6% |
| **Below Average Growth** | | | |
| Agriculture, Forestry, Fishing & Hunting | 90,297 | 203 | 0.2% |
| Finance, Insurance & Real Estate | 466,989 | 930 | 0.2% |
| Health Care | 544,315 | 1,054 | 0.2% |
| Other Services | 807,993 | 1,253 | 0.2% |
| Education | 120,637 | 164 | 0.1% |
| Retail Trade | 560,178 | 610 | 0.1% |
| Professional & Technical Services | 397,870 | 322 | 0.1% |
| Accommodation & Food Services | 394,624 | 287 | 0.1% |
| Transportation & Warehousing | 148,828 | 81 | 0.05% |
| Public Administration | 859,373 | 115 | 0.01% |
| **Job Losses** | | | |
| Utilities | 13,375 | (942) | -7.0% |
| Mining & Extraction | 9,007 | (694) | -7.7% |

Table 3-1. New Jobs in North Carolina in the Clean Energy Future—all sectors.

*Source: Bureau of Economic Analysis and authors' calculations. New job figures represent annual averages (over 2016–2050) of net job increases or decreases under the Clean Energy Future, compared to the Reference Case (business-as-usual) projection.*

More than a third of the state's new jobs are in construction, both for installation of energy efficiency measures and for construction of new renewable energy facilities. Occupations with the largest increases in employment include electricians, plumbers, heating and air conditioning technicians, and supervisors of construction trades.

| | 2013 Employment | New Jobs in Clean Energy Future | |
|---|---|---|---|
| | | Annual Average | As Percentage of 2013 |
| Total, All Manufacturing | 465,282 | 6,526 | 1.4% |
| **Above Average Growth** | | | |
| Electrical Equipment & Applicances | 21,806 | 1,626 | 7.5% |
| Transportation Equipment | 29,918 | 1,410 | 4.7% |
| Primary Metals | 7,816 | 210 | 2.7% |
| Machinery | 31,850 | 782 | 2.5% |
| Fabricated Metal Products | 37,392 | 915 | 2.4% |
| Plastics & Rubber Products | 31,364 | 469 | 1.5% |
| Nonmetallic Mineral Products | 14,957 | 212 | 1.4% |
| Paper | 16,068 | 116 | 0.7% |
| Textiles & Textile Products | 45,509 | 272 | 0.6% |
| Computer & Electronics | 33,939 | 143 | 0.4% |
| **Below Average Growth** | | | |
| Chemicals | 43,638 | 143 | 0.3% |
| Printing | 12,981 | 34 | 0.3% |
| Furniture & Wood Products | 53,314 | 84 | 0.2% |
| All Other Manufacturing | 84,730 | 110 | 0.1% |

**Table 3-2. New jobs in North Carolina in the Clean Energy Future—manufacturing.**

*Note: Above-average and below-average growth are based on average employment growth in all sectors, as shown in Table 3-1.*

Table 3-2 provides more detail on manufacturing employment. Three-fourths of the new manufacturing jobs are in electrical equipment and appliances, transportation equipment, metals and metal products, and machinery. Among the branches of manufacturing shown in the table, none are projected to have job losses. Electrical equipment and appliances, the fastest-growing manufacturing sector, benefits from increased demand for new energy-efficient lighting and appliances, as well as new equipment needed by electric utilities as they adapt to renewable energy.

The Clean Energy Future will help create good jobs in North Carolina. But it alone is not enough, in the state or the country as a whole, to completely transform the economy, create good jobs for all, and end unemployment. Nevertheless, the Clean Energy Future makes a positive contribution toward achieving those goals, and it could be one of several parts of a broader jobs strategy for the 21st century.

Note that our employment estimates are the difference between the business-as-usual Reference Case and the Clean Energy Future scenario. Existing policies such as federal auto fuel economy standards and state renewable energy policies are included in both scenarios, and therefore do not affect the difference between scenarios that we report. That is, we calculate only the jobs created by going beyond current policies to a much more ambitious program of emission reduction.

Other experts have, at times, projected that job creation from a climate agenda could be larger than our estimates. Frequently this is based on assuming much greater spending to accelerate the transition to clean energy. While it is certainly possible to go faster, our analysis is not focused on that option. Our goal is to show how much can be done *with no increase in costs.* Our Clean Energy Future represents a floor, not a ceiling, on ambition. It is a demonstration of how much can be achieved for roughly the same amount that we are already spending. There are good arguments for doing more, but there is no reason at all for doing less. (Moreover, climate protection is not the only pressing social need that requires labor, effort, and creativity. Jobs can and should be created in multiple arenas in the construction of a humane, just, and sustainable society.)

## How many jobs could be created in North Carolina?

Our calculation of North Carolina employment was derived from the national Clean Energy Future study.[10] A key assumption in this calculation is that the distribution of industries among states is unchanged through 2050: North Carolina remains a leader in sectors where it is already ahead, and it never catches up in sectors where it is currently behind. With a state strategy to encourage and expand the growing industries of the future, North Carolina's employment gains could be considerably greater.

Our national study used the National Renewable Energy Laboratory's Regional Energy Deployment System (ReEDS) model to project expansion plans for the electric system. It then applied a commercial economic impact model named IMPLAN to calculate the resulting employment impacts. IMPLAN reports three categories of employment: direct jobs (such as construction workers who install wind turbines); indirect jobs created at suppliers (such as steel mill workers who make steel for the turbine blades); and induced jobs (created when the construction workers and steel mill workers spend their paychecks, thereby stimulating other industries).

For direct jobs, we used the actual location of existing and projected new energy facilities, as reported by the ReEDS model. Direct jobs are created in North Carolina to construct and operate energy facilities and to install energy efficiency measures located in the state. For indirect and induced jobs, we assumed that all jobs nationwide in each industry would be distributed in proportion to current employment. For example, North Carolina currently has about 5.5 percent of national employment in electrical equipment and appliance manufacturing. So 5.5 percent of all new indirect and induced jobs in electrical equipment and appliances are assumed to be located in North Carolina—regardless of where the demand for these products originates. Changes to this assumption, based on state industrial development strategies, could increase the number of North Carolina jobs created by clean energy.

# 4. BEYOND THE CLEAN ENERGY FUTURE

As noted above, the Clean Energy Future scenario reduces most, but not all, categories of GHG emissions. To achieve an 80 percent reduction by 2050, North Carolina would need 15.7 million tons

[10] See http://synapse-energy.com/sites/default/files/Clean-Energy-Future-15-054.pdf for the national study and http://synapse-energy.com/CEF_Appendix for the technical appendix.

of additional emission reductions, primarily in industrial emissions, trucking, agriculture, and electric power. Here we examine North Carolina's major emitters and compare the role of power plants and other sectors. We then focus on four promising areas for additional reductions: ozone-depleting substances; the paper industry; trucking; and agriculture.

## a. North Carolina's top emitters

The U.S. Environmental Protection Agency (EPA) collects and reports facility-level data from major sources of GHG emissions throughout the country.[11] In 2014, there were 149 facilities in North Carolina that reported their emissions to the EPA, almost all with emissions of at least 25,000 tons of $CO_2$-eq. The 17 power plants with emissions of more than 200,000 tons of $CO_2$-eq are identified in Table 4-1, along with totals for smaller emitters and other sectors.

The table shows a total of 67.3 million tons of emissions, about half of the state's gross emissions total from all sources. The bulk of the emissions from major sources, 56 million tons, came from the 17 large power plants listed in the table. (The top 12, accounting for 53.4 million tons of emissions, are Duke Energy facilities.) Another 4 million tons came from waste management facilities, almost all of which are for municipal rather than industrial or agricultural waste. Finally, emissions reported in all other sectors amounted to 6.6 million tons.

[11] See the EPA FLIGHT (Facility Level Information on Greenhouse gases Tool) data, http://ghgdata.epa.gov/ghgp/main.do.

| | Location | (Metric Tons of C02-eq) Facility Emissions | Total Emissions |
|---|---|---|---|
| **Power Plants** | | | **56,728,000** |
| ** Roxboro* | Semora | 11,582,000 | |
| ** Belews Creek* | Belews Creek | 11,484,000 | |
| ** Marshall* | Terrell | 8,681,000 | |
| ** Cliffside* | Cliffside | 5,159,000 | |
| Richmond County | Hamlet | 3,121,000 | |
| ** Mayo* | Roxboro | 2,660,000 | |
| H F Lee | Goldsboro | 2,377,000 | |
| ** G G Allen* | Belmont | 2,313,000 | |
| ** Asheville* | Arden | 1,600,000 | |
| L V Sutton | Wilmington | 1,540,000 | |
| Dan River | Eden | 1,467,000 | |
| Buck | Salisbury | 1,422,000 | |
| Rowan County | Salisbury | 1,079,000 | |
| ** Roanoke Valley I* | Weldon | 541,000 | |
| Cleveland County | Grover | 415,000 | |
| CPI Southport | Southport | 338,000 | |
| ** Edgecombe Genco* | Battleboro | 325,000 | |
| Next 10 plants (Less than 200,000 tons of emissions each) | | 624,000 | |
| Waste Management – 52 Facilities | | | 3,978,000 |
| All Other Sectors – 70 Facilities | | | 6,613,000 |
| All Large Facilities, Total | | | 67,319,000 |
| **Coal-burning power plants, total* | | | 44,345,000 |
| **Coal use in other sectors, Total* | | | 1,730,000 |

**Table 4-1. Top GHG emitters in North Carolina, 2014.**

*Notes: Coal-burning power plants are marked with * and shown in italics. All emissions are rounded to the nearest 1,000 tons.*

*Source: EPA FLIGHT data,* http://ghgdata.epa.gov/ghgp/main.do for all data except total coal use in other sectors, which is calculated from sources cited in footnotes *12* and *13*.

To a remarkable extent, these emissions reflect the intensive use of coal in North Carolina. In 2014, the state's power plants burned 19.5 million tons of coal, while other sectors of the economy used 0.74 million tons.[12] This means that coal used for electric power caused 45.4 million tons of $CO_2$-eq emissions statewide.[13] In Table 4-1, coal-burning power plants are marked with an asterisk (*) and shown in italics; the nine coal plants shown in the table had emissions of 44.3 million tons, accounting for almost all of the state's total emissions (smaller coal plants accounted for the remaining 1.1 million tons). Coal used in other sectors created 1.73 million tons of emissions, or 26 percent of the "all other sectors" emissions shown in the table.

The Clean Energy Future will phase out emissions from coal plants and waste management facilities, as noted earlier. This will eliminate most of the emissions from major sources, as shown in Table 4-1. However, a comprehensive plan for emission reduction will also need to address emissions from other sectors. This does *not* mean shutting down factories; any future scenario, clean or otherwise, will need paper, chemicals, glass, and metals industries (as well as universities, another large source of emissions). Indeed, employment is projected to grow more rapidly in North Carolina's paper industry than in the state as a whole due to the Clean Energy Future.[14] Rather, there is a need to develop alternative energy sources and related technologies for each industry. Successful alternatives will be industry-specific, often site-specific. And they may require more rather than less employment.

One strategy would be to replace the use of coal, outside of the electric power sector, with other fuels. Switching to natural gas, with about half the emissions of coal, could save almost 0.9 million tons of emissions per year (i.e., about half of the 1.73 million tons of emissions from non-electric sector uses of coal); switching to renewable energy could save even more.

Another strategy would be to accelerate the introduction of renewable energy, displacing more of the gas used for electric generation. Our modeling suggests that this would increase energy costs at present, but future technological development, more transmission investments, and faster than anticipated reduction in renewable energy and storage costs could make it possible to reduce our forecast for gas-fired generation. The costs of solar power have been dropping faster than anyone expected in recent years; a continuation of that trend could allow even greater cost-effective investment in renewables to replace fossil fuels.

The following subsections address other strategies for emission reduction beyond the Clean Energy

[12] U.S. Energy Information Administration (2016), *Annual Coal Report 2014*, .

[13] The emission factor for bituminous coal, 2.325 metric tonnes of $CO_2$-eq per short ton of coal, was calculated from EPA data on emission factors at .

[14] Average annual employment under the Clean Energy Future increases by 0.7 percent in the paper industry, compared to 0.4 percent for the state as a whole. See **Error! Reference source not found.**.

Future, showing that there are many more opportunities to slash North Carolina's carbon emissions by 2050.

## b. Ozone-depleting substances

Of the 5.4 million tons of non-fuel industrial process emissions identified in the North Carolina GHG inventory for 2005, almost all—4.4 million tons—represented the release of ozone-depleting substances. Rapid progress has been made in reducing these emissions, and can continue to be made at moderate cost.

This opportunity for reducing GHG emissions results from the unintended consequences of solving a different environmental problem. The threat of depletion of the ozone layer, recognized in the 1980s and addressed by the Montreal Protocol, led to the replacement of ozone-depleting substances such as those often found in refrigeration and air conditioning. The first round of replacements, beginning in the 1990s, involved chemicals such as hydrofluorocarbons (HFCs). HFCs are potent GHGs (that is, they have very high global warming potential, or "high GWP"). As a result, there is a substantial climate benefit to capturing these gases when refrigeration and air conditioning units are repaired, refilled, or discarded.

Newer chemicals are being developed that can avoid damaging either the ozone layer or the climate.[15] Phasing in these chemicals could eventually solve the climate problem of ozone-depleting emissions. Meanwhile, it is important to recover and control high GWP substances, such as refrigerants, when existing equipment containing these substances is overhauled, scrapped, or recycled. With careful efforts in this area, it seems reasonable to think that high GWP emissions could be eliminated before 2050. This would reduce North Carolina's emissions in 2050 by 4.4 million tons below the level shown in Table 1-1.

[15] Guus J.M. Velders, A.R. Ravishankara, Melanie K. Miller et al. (2012), "Preserving Montreal Protocol Climate Benefits by Limiting HFCs", *Science* vol. 335, 922-923 (24 February); 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.

## c. Industrial emissions

North Carolina's industries had emissions from on-site fuel combustion of 10 million tons of $CO_2$-eq in 2013.[16] The paper industry is one of the biggest sources of these emissions, with a total of about 2 million tons. Here we discuss technology options in the paper industry; similar discussion is needed of technology options for emission reduction in other industries as well. These options, it should be emphasized, do *not* mean shutting down or even shrinking these essential industries. In many cases, emission reduction strategies will require more, not less, labor.

Pulp and paper mills use vast quantities of steam for heating, drying, bleaching, and other stages of production, along with electricity for pumps, fans, and other motor-driven processes.[17] In chemical pulping, the process used by most of the industry, wood chips are heated for several hours in a chemical bath or "liquor" to dissolve wood fibers. The residue after the fibers are separated, "black liquor," is an energy-rich liquid filled with wood wastes, and it is almost universally burned on site to reduce the need for purchased energy. The paper industry nationwide gets 58 percent of its energy from waste fuels, primarily black liquor, and has installed nearly 3,900 MW of black liquor-fired combined heat and power capacity.[18] Questions about paper industry emissions arise from the other 42 percent of energy inputs. These are primarily fossil fuels which, at the largest paper mills, often include coal.

On the one hand, paper mill emissions could be reduced, with no other process changes, by substituting other fuels for coal. Replacing coal with natural gas, if available, could reduce emissions of $CO_2$ and other harmful air pollutants. In the long run, it might even be possible to develop a

[16] Based on EIA data; see notes to Table 1-1. The "latest available" industrial emissions in Table 1-1 are the sum of non-fuel process emissions from the 2007 inventory (5.4 million tons; see section b), plus EIA emissions from industrial fuel use.

[17] Klaus Jan Kramer, Eric Masanet, Tengfang Xu and Ernst Worrell (2009), "Energy efficiency improvement and cost saving opportunities for the pulp and paper industry", Lawrence Berkeley National Laboratory, http://www.energystar.gov/ia/business/industry/downloads/Pulp_and_Paper_Energy_Guide.pdf.

[18] US Energy Information Administration (2013), "Waste fuels are a significant energy source for U.S. manufacturers".. See also American Forest & Paper Association (2014), "2014 AF&PA Sustainability Report" p.22, for generally similar data: http://afandpa.org/docs/default-source/sust-toolkit/2014_sustainabilityreport_final.pdf?sfvrsn=2. www.eia.gov/todayinenergy/detail.cfm?id=13531#. See also American Forest & Paper Association (2014), "2014 AF&PA Sustainability Report," p.22, for generally similar data: http://afandpa.org/docs/default-source/sust-toolkit/2014_sustainabilityreport_final.pdf?sfvrsn=2.

renewable, biomass-based process to generate hydrogen as an industrial fuel, with almost no carbon emissions.

On the other hand, there are many opportunities for energy efficiency upgrades and process improvements that can reduce emissions at pulp and paper mills. Improvements are possible in the preparation of wood chips, the chemical recovery process for black liquor, paper stock and sheet formation, and other processes. More than 45 commercially available state-of-the-art technologies have been identified to reduce energy use and $CO_2$ emissions at pulp and paper mills. Additional advanced technology options include black liquor gasification and alternative drying mechanisms.[19] Detailed examination of existing operations and costs at each of North Carolina's paper mills would be needed to determine the appropriate strategy for emission reduction.

## d. Fuel efficiency in trucking

Although the Clean Energy Future scenario eliminates virtually all emissions from cars and light trucks, the remaining transportation emissions (as shown in Table 1-1, based on 2013 data) amount to more than 14 million tons of $CO_2$-eq. Most of these emissions come from trucks—particularly from the heaviest trucks on the road, Class 8 tractor-trailers ("18-wheelers"). Federal fuel efficiency standards for trucks have just begun to take effect; Phase 1 standards require 6 percent improvement in fuel efficiency by the 2017 model year.[20] Phase 2 standards, which have been proposed but not adopted, will require an additional 18 to 24 percent improvement beyond 2017 levels by 2027.[21]

Spurred by the Department of Energy's "Supertruck" program, major truck manufacturers have already demonstrated that much more can be done, even with existing technology. Tractor-trailers on the road average about 6 mpg today, and business-as-usual projections from EIA suggest only

[19] Martin, N., Anglani, N., Einstein, D., Khrushch, M., Worrell, E., and L.K. Price (2000), "Opportunities to Improve Energy Efficiency and Reduce Greenhouse Gas Emissions in the U.S. Pulp and Paper Industry," Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory. Available at: https://www.energystar.gov/ia/business/industry/LBNL-46141.pdf.

[20] EPA and NHTSA (2011), "Final Rulemaking to Establish Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles," p. 5–7. (A wide range of standards are developed for different classes of trucks; this is the $CO_2$ emission reduction required from Class 8 truck engines under Phase 1.)

[21] EPA and NHTSA (2015), "Proposed Rulemaking for Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles - Phase 2," page ES-13.

about 8 mpg in 2050. In contrast, newly designed, ultra-aerodynamic Supertruck prototypes have already achieved 10–13 mpg under fully loaded, actual highway conditions.

Other categories of trucking such as deliveries in urban areas could be converted to electric power, as could urban buses. Major cities and institutions are already testing electric buses; after successfully testing two electric buses for more than a year, the Chicago Transit Authority is now adding dozens of electric buses to its fleet.[22]

If the average tractor-trailer on the road reaches the fuel efficiency of today's Supertruck prototypes by 2050, and comparable improvements are made in other classes of trucks and buses, then emissions could be cut in half. For North Carolina, this could represent a savings of several million tons of $CO_2$-eq. With another three decades of technological development, even more could conceivably be done to improve fuel economy and lower truck emissions.

While North Carolina cannot set its own fuel economy or truck emission standards, there are steps that can be taken at the state level to reduce truck emissions. Heavy trucks often spend several hours per day idling at truck stops in order to keep air conditioning and other services running. Regulations to limit idling time, particularly if combined with facilities to provide electricity to parked trucks, could achieve reductions in emissions and improvement in local air quality.

## e. Emissions in agriculture

Agriculture was responsible for 13.3 million tons of non-fuel $CO_2$-eq emissions in North Carolina as of 2005.[23] There are three principal sources of emissions from agriculture in the United States:

- soil emissions, largely nitrous oxide emissions from nitrogen fertilizers
- methane from "enteric fermentation" (a formal name for cattle burping; the problem does not arise with other livestock such as hogs or poultry)

[22] Stephen Edelstein (2016), "Chicago Transit Authority to Add Dozens of Electric Buses after Successful Tests," *Green Car Reports*, January 31, www.greencarreports.com/news/1102130_chicago-transit-authority-to-add-dozens-of-electric-buses-after-successful-tests..
[23] See Center for Climate Strategies (2007), "Final North Carolina Greenhouse Gas Inventory and Reference Case Projections 1990-2020."

- methane escaping from manure ponds

Almost all of North Carolina agricultural emissions arise from manure management and soil emissions, according to the 2007 inventory.

Each category of emissions can be reduced by changes in agricultural practices. The first two are straightforward and non-controversial.

- For some crops, careful calibration and timing of fertilizer application can reduce nitrous oxide emissions by up to 50 percent.[24]
- Enteric fermentation can be reduced by the use of modified feed mixtures for cattle—and will naturally decline if there is a continuation of the ongoing drop in beef consumption per capita.[25]

In contrast, the issue of methane emissions from manure ponds has been controversial in North Carolina and elsewhere. The emissions are created by raising livestock in massive, crowded feedlots, leading to the need to handle huge quantities of manure in relatively small areas. Manure handling at hog feedlots has also led to water contamination, odors, and health hazards; North Carolina feedlots are disproportionately located near communities of color, which bear the brunt of these environmental impacts.[26]

Traditional agriculture, with much smaller numbers of animals per farm, did not need manure ponds. Instead, manure fell or could be spread on pastures and fields, potentially serving as fertilizer—and in any case, allowing aerobic

[24] Neville Millar, G. Philip Robertson, Peter R. Grace, Ron J. Gehl and John P. Hoben (2010), "Nitrogen fertilizer management fo r nitrous oxide ($N_2O$) mitigation in intensive corn (Maize) production: an emissions reduction protocol for US Midwest agriculture," *Mitigation and Adaptation Strategies for Global Change* 15, 185-204.

[25] U.S. beef consumption per capita peaked at 94 pounds in 1976 and has declined to about 54 pounds in 2014-2016, replaced by growth in poultry consumption (which results in lower emissions). See http://www.nationalchickencouncil.org/about-the-industry/statistics/per-capita-consumption-of-poultry-and-livestock-1965-to-estimated-2012-in-pounds/.

[26] Steve Wing and Jill Johnston (2014), "Industrial hog operations in North Carolina disproportionately impact African -Americans, Hispanics and American Indians," Department of Epidemiology, University of North Carolina, https://www.facingsouth.org/sites/default/files/wing_hogs_ej_paper.pdf.

decomposition (giving rise to less harmful emissions of $CO_2$, rather than methane.) The ideal long-run solution to the problem of manure pond methane would be to replace feedlots with smaller-scale, sustainable agriculture. With reasonable numbers of animals per farm, manure emissions would no longer be a problem, for the same reasons as in traditional farming.

In the short run, it has also been proposed that feedlots could capture and burn the methane from manure ponds (converting it to less harmful $CO_2$). While this would not eliminate any of the other problems caused by feedlots, it could, if successfully implemented, reduce the climate impacts of existing feedlots. North Carolina's state government has provided incentives for methane capture at feedlots, in the form of a mandate that part of the state's Renewable Energy and Energy Efficiency Portfolio Standard (REPS) for electric utilities must be met with feedlot methane.

However, even with incentives, feedlot methane capture has been slow to start. In 2015 the state postponed the REPS requirement for "swine waste resources" (feedlot methane), which now rises to 0.2 percent of total energy by 2020.[27] Although often described as inexpensive, it is possible that capturing feedlot methane is proving more costly than anticipated, thereby slowing its adoption.[28]
A solution is still needed to the feedlot methane problem—and the long-run solution, replacing feedlots with sustainable agriculture, remains preferable on many grounds. Through this and other changes in agriculture, it seems possible that North Carolina's GHG emissions could be reduced by several million tons per year. This would provide another opportunity for emission reductions beyond the level of the Clean Energy Future.

[27] See www.ncuc.commerce.state.nc.us/reports/repsreport2015.pdf.

[28] A detailed recent study of methane capture technologies for California dairy farms found costs ranging from a low of $28–$35 per ton of $CO_2$-equivalent for the least-cost option, up to hundreds of dollars per ton for some widely discussed alternatives. See Stephen Kaffka et al. (2016), "Evaluation of Dairy Manure Management Practices for Greenhouse Gas Emissions Mitigation in California," http://biomass.ucdavis.edu/wp-content/uploads/2016/06/ARB-Report-Final-Draft-Transmittal-Feb-26-2016.pdf.

# CONCLUSION: WHY WAIT?

North Carolina's Clean Energy Future, as 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 will produce at least 19,000 more jobs than continuing on a fossil fuel "business as usual" pathway. Most of these are well-paid, family-supporting jobs in manufacturing and construction.

The Clean Energy Future plan provides a lower bound rather than an upper limit for what can be accomplished. It shows that climate protection will create more jobs. But we can, and indeed should, do more. For example, solar, wind, and 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 path laid out here.

North Carolina can achieve many of its other goals while implementing an aggressive climate protection plan, but the realization of these "co-benefits" will require policies designed to do so:

- The Clean Energy Future will entail the creation of 19,000 new jobs in the state. But there is no guarantee that they will be good jobs. Indeed, if job conditions are determined by employers who are narrowly focused on short-run profits, spending on climate protection (or anything else) could increase inequality and provide only insecure, contingent work. We can design our climate protection plan to maximize the number of good, secure, permanent jobs with education, training, and advancement. We can institutionalize economic planning that will provide sustained, orderly development for an expanding climate protection sector and prevent boom-and-bust cycles that are devastating for workers and employers.

- Since 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.

- Because about 1,600 jobs will be lost in utilities, mining, and extraction—less than one-tenth as many as will be added in the rest of the economy—we need a vigorous program to provide new, high-quality jobs and/or dignified retirement for workers in those industries. State energy policy should require that utilities make new jobs available to any workers adversely affected by climate protection; that utilities fund a program to assist any workers they do not re-employ; and that utilities negotiate transition plans with their employees.

- The Clean Energy Future plan opens up new opportunities to counter racial, gender, geographic, and other inequalities. Climate protection programs should include job pathways, strong affirmative action provisions, and local hiring requirements for those groups that have been most excluded from good jobs in the past.
- The Clean Energy Future allows for a far more local and less top-down energy system. To evolve in that direction, North Carolina can steadily increase its Renewable Energy and Energy Efficiency Portfolio Standard for in-state electricity generation. It can end the prohibition on shared solar generation. It can rapidly modernize its electrical grid to support decentralized, distributed generation. It can provide encouragement for local economic initiatives, ranging from energy coops to locally- and community-based enterprises. Indeed, climate protection provides an opportunity for re-visioning North Carolina.

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. North Carolina can start moving now to gain its share of the benefits of the Clean Energy Future. What are we waiting for?