Working with the sun

How solar power can protect North Carolina's environment and create new jobs

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Executive Summary

Solar power can curb pollution, protecting public health and North Carolina's environment. It can also drive North Carolina's economy forward – creating jobs that can't be outsourced, and launching new companies to manufacture and install solar power equipment.

This report quantifies the benefits of developing North Carolina's solar resources on a trajectory to supply 14 percent of the state's electricity consumption by the year 2030. Achieving this benchmark would prevent the emission of millions of tons of pollution that contributes to global warming and respiratory health problems, save billions of gallons of water, and create more than 28,000 good-paying jobs.

To realize these benefits, North Carolina should nurture and expand demand for solar energy while helping to incubate local solar businesses.

Solar energy prevents pollution, protecting public health and North Carolina's environment.

- By reducing the need for electricity that otherwise would have come from fossil fuels, solar power prevents pollution. In the year 2030, if solar energy supplied 14 percent of North Carolina's electricity supply:
  - It would prevent 10 million metric tons of global warming carbon dioxide pollution – the same amount as produced by 680,000 cars and trucks in a year.
  - It would prevent 17 million pounds of smog-forming nitrogen oxide emissions, helping to meet health-based air pollution standards across the state, including in the Charlotte, Triangle, Triad, Fayetteville, Hickory, Asheville

and Rocky Mount metropolitan areas.

- It would prevent more than 400 pounds of highly toxic mercury pollution. This amount is significant – just 1/70th of a teaspoon of mercury can make the fish in a 25-acre lake unsafe to eat.

- All of the figures cited here include the benefits of solar panels that will be installed to comply with the state's existing renewable electricity standard.

Solar energy reduces the need for water for power generation.

- By 2030, solar energy would help North Carolina save 5 billion gallons of water per year that would have otherwise been consumed for steam and cooling in fossil-fired and nuclear power plants.
- That amount of water could supply the household needs of a city a little larger than Durham or Winston-Salem (about 200,000 people).

Investments in solar energy are already benefiting North Carolina's economy.

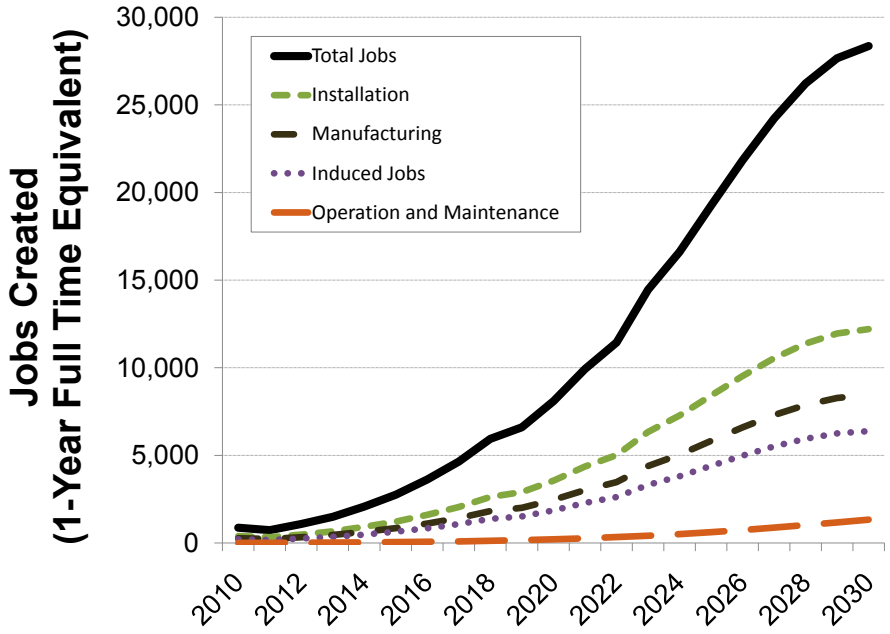
- Green electric power businesses in North Carolina – including solar, wind, biomass and energy efficiency – employed more than 10,000 workers as of 2009, generating more than $3.5 billion in revenue annually. For the year beginning July 2008, clean energy firms increased their workforce by 6 percent, despite the damaging impact of the credit crisis and the recession. These clean energy firms are expected to grow another 36 percent through July 2010.

Photo: SAS

SAS installed a 1-megawatt solar farm on the campus of its world headquarters in Cary in 2008. SunPower designed the facility and Southern Energy Management installed it.

- North Carolina is already home to more than 100 businesses that manufacture, install, or market solar energy systems. For example, Charlotte-based Sencera manufactures thin-film transistors and integrated circuits for solar photovoltaic panels. The company is now building a thin-film solar panel manufacturing plant, which will employ 65 workers by summer 2010. Durham-based Carolina Solar Energy installed a 650 kilowatt (kW) solar park at the Person County Business and Industrial Center next to U.S. Highway 501 south of Roxboro in 2009. The facility is one of the state's largest and most visible solar installations. And Vanir Energy, based in Fletcher, designed, built and operates the world's largest solar thermal heating and cooling system at the Fletcher Business Park, creating 58 jobs.
- According to researchers at the University of North Carolina at Greensboro, nearly 300 firms in the

Figure ES-1: Job Creation in North Carolina From Expanding North Carolina's Solar Photovoltaic Power Capacity to Produce 14 Percent of the State's Electricity in the Year 2030



state have the technical potential to manufacture solar energy system components. As of 2008, these businesses employed more than 16,000 people.

Expanding North Carolina's solar industry will create jobs and help drive the state's economy forward.

- Building enough solar panels to generate 14 percent of North Carolina's electricity would create an estimated 28,000 full-time equivalent jobs in North Carolina in 2030. (See Figure ES-1.)
- These jobs would pay workers $1.2 billion in wages in that year, or an average of $43,000 annually (in 2010 dollars).
- Growing at this pace, the solar industry would drive total gross investment in North Carolina of more than $2.5 billion annually by 2030 (in 2010 dollars).
- These estimates assume that the manufacturing of solar system components would happen out of state. If local manufacturers supplied components, the benefits for North Carolina would increase substantially. (See Table ES-1.)

North Carolina should develop its solar energy resources to help put the state on sound footing for the future. The state should:

- Reinstate the renewable energy manufacturing tax credit.

- Require all of the solar power that counts towards North Carolina's renewable electricity standard to be produced in state.
- Help businesses and individuals finance solar power installations by enabling buyers to pay for their investment over time in property tax assessments.
- Adopt feed-in rates that set fair and predictable prices for solar electricity produced.
- Allow solar companies to lease solar power systems to home and business owners, enabling them to use solar power without paying the upfront costs.
- Ensure that net metering policies fairly compensate home and business owners for electricity produced by their solar panels.
- Require solar power to be included or provided as an option on new houses.

Table ES-1: Economic Benefits of Expanding North Carolina's Solar Photovoltaic Power Capacity to Produce 14 Percent of the State's Electricity in the Year 2030

Benefits Achieved in the Year 2030	Solar Technology Manufactured:		
	Out of State	25 Percent In-State	50 Percent In-State
Total Jobs Created (1-Year Full Time Equivalent)	28,000	35,000	42,000
Gross Cash Flow in North Carolina (Billion 2010 Dollars)	$2.6	$3.7	$4.9
Total Wages Paid (Billion 2010 Dollars)	$1.2	$1.6	$1.9
Average Annual Wage (2010 Dollars)	$43,000	$45,000	$46,000

Introduction

North Carolina's economy needs an infusion of new energy. In 2009, more than 160,000 North Carolinians lost their jobs.[1] Nationally, the unemployment rate has climbed to its worst level in 25 years.[2]

Recovering from the downturn will be a long-term task. However, North Carolina has the resources right here at home to lay the foundation for a prosperous future.

The key is transforming our energy system.

North Carolina has no local reserves of oil or natural gas. Nor does the state host any coal or uranium mines.[3] As a result, much of the $32 billion North Carolina spends on energy each year goes to other states and countries to pay for energy imports.[4] This energy drain approaches 7 percent of gross state product, or about $2,700 per person – and it is a huge boon for coal-rich states like Wyoming and petroleum-rich countries overseas.[5]

At the same time, North Carolina's historical dependence on fossil fuels has created serious public health and environmental risks. In the Appalachian region, mining coal has flattened more than 800 square miles of mountaintops, cut down more than 7 percent of the forest, and buried or polluted more than 1,200 miles of streams.[6] Burning coal and oil has contaminated North Carolina's rivers and lakes with mercury pollution and dirtied the state's air with dangerous soot and smog. Coal ash sludge ponds threaten communities across the region, dramatically demonstrated by the Tennessee Valley Authority's catastrophic 1 billion gallon sludge spill from its Kingston, Tennessee, power plant in December 2008.[7] Burning coal also creates massive amounts of global warming pollution, which threatens North Carolina's future.

Fortunately, North Carolina's citizens and its leaders have begun to recognize that the solution lies with local clean energy resources, including using energy more efficiently and generating more energy from clean, renewable sources like wind, biomass and sunlight. The state has established a renewable electricity standard requiring utilities to obtain

Photo: Online Creative Media

12.5 percent of their electricity supplies from renewable energy and energy efficiency by 2021, and 0.2 percent from solar power by 2018.[8] The state has also established a net metering policy and a variety of incentives supporting the growth of the solar and wind energy markets and the deployment of more energy efficient buildings.[9] More than 80 percent of North Carolinians favor the installation of more solar and wind power facilities.[10]

By pursuing a new clean energy future, North Carolina is beginning to free its citizens from dependence on fossil fuels, reducing exposure to dangerous health threats, and is starting to do its part to reduce global warming. At the same time, North Carolina is giving its economy a needed boost by keeping more energy dollars in-state, creating jobs, and building new industries.

Although North Carolina is making progress toward a clean energy future, state leaders could do much more to accelerate the transition.

The solar industry in particular can become a much more important part of the clean energy landscape in the state.

Deepening North Carolina's commitment to solar energy will help the state build and diversify its economy in the 21st century. Increasing demand for solar photovoltaic panels and solar hot water systems could prompt the growth of a new manufacturing industry to supply the state with advanced technologies. It would also help set up the state to capitalize on rapidly growing regional and global demand for solar energy components.

Making a deeper commitment to solar energy will signal that North Carolina is ready to modernize its economy and take control of its energy destiny. Implementing an expanded clean energy plan will create tens of thousands of good-paying jobs and billions of dollars of economic growth, and enable significant reductions in pollution – while beginning to limit the costs, risks and liabilities of global warming.[11]

North Carolina Has Great Solar Energy Potential

Solar Energy: A Reliable Source of Electricity and Hot Water

North Carolina's abundant sunshine can be a reliable source of energy for electricity and hot water to power our homes, businesses and community institutions. North Carolina gets about 80 percent as much solar energy as Florida – the Sunshine State.[12] Converting even a small portion of this energy to electricity could power the entire state.

The amount of solar energy North Carolina could generate is limited by the amount of space in the state where solar panels could reasonably be installed. Yet even with this limitation, solar energy could provide at least 22 percent of North Carolina's electricity.

Solar Photovoltaics Transform Light Into Electricity

Solar photovoltaic (PV) panels capture the energy in sunlight and transform it into electricity. The simplicity of photovoltaic panels makes them easy to install on residential and commercial rooftops in a city, or in concentrated, utility-scale solar farms. Solar PV panels are the only electric generators without moving parts, and they require no fuel supply.

Solar panels can be installed on almost any surface, but they produce the most power when they face south and are not shaded by trees or other objects for most of the day. A building with a solar PV system will usually be tied to the electric grid. Electricity from the grid supplements the electricity from solar panels during cloudy weather or at night and

Photo: NREL

Solar photovoltaic (PV) panels transform sunlight into electricity.

absorbs extra electricity when the panels produce more than the building uses.

In a 2008 study conducted for the National Renewable Energy Laboratory, Navigant Consulting found that installing solar panels on all suitable residential and commercial rooftop space in North Carolina would result in 15,144 megawatts (MW) of solar power capacity.[13] That amount of panels could generate about 20 million MWh of electricity every year, or 15 percent of the electricity North Carolina used in 2007.[14] With additional rooftop space and better solar technology, Navigant predicts that by 2015 the state could support more than 25,000 MW of solar panels, capable of generating about a quarter of the state's 2007 electricity use.[15]

Adding utility-scale solar farms greatly expands North Carolina's solar potential. Utility-scale solar installations are arrays of solar panels installed with the purpose of producing power for the electric grid, rather than just one building or facility.

Utility-scale solar arrays can be built on most types of land, and can be a very good use of certain types of land, which may otherwise have limited uses. Other non-sensitive lands that would be well suited to having solar panels installed on them include parking lots, abandoned strip mines and barren lands. For example, a planned 1 MW solar farm in Haywood County is being built on a former landfill.[16]

Based on a simple estimate of the amount of open and unused land in North Carolina, the state could support at least 6,500 MW of solar panels, capable of producing 8.5 million MWh or about 6.5 percent of the electricity North Carolina used in 2007.[17] Including other suitable land types – such as parking lots, retired landfills, abandoned industrial sites, and highway medians – would increase this estimate.

Photo: EnCom

Solar water heating systems can reduce electricity or fossil fuel use for water heating by about two-thirds.

Solar Water Heating Systems Capture the Sun's Heat

Solar water heating systems, which use roof-mounted solar energy collectors to pre-heat water, can reduce electricity or fossil fuel use for water heating by about two-thirds.[18] Solar heating systems do not take up as much space as solar photovoltaic panels, and the requirements for orientation are less strict.[19]

If 40 percent of households and 60 percent of commercial buildings in North Carolina installed solar hot water systems, they would save close to 2 million MWh of electricity and 8.5 billion cubic feet of natural gas per year.[20] This is the equivalent of 1.5 percent of North Carolina's electricity consumption in 2007, and 8.2 percent of the natural gas used in North Carolina's residential and commercial sectors in 2007.[21] Additional energy could be saved by using solar hot water in North Carolina's industrial sector.

Solar water heating systems can also be used to heat and cool buildings. For example, the Fletcher Business Park, just south of Asheville, has the largest solar heating and cooling installation in the world, with solar power providing space heating and air conditioning for offices and a warehouse.[22]

North Carolina Can Obtain 14 Percent of Its Electricity from the Sun by 2030

In its report, *Growing Solar in North Carolina*, Environment North Carolina Research & Policy Center laid out a scenario by which the state could obtain 14 percent of its electricity supply from solar photovoltaic power by the year 2030.[23] In this scenario, North Carolina's solar market grows 50 percent annually in the early 2010s, which is comparable to the recent performance of markets in Spain, Japan, Germany, New Jersey and California. For the next decade, the rate of growth gradually declines, reaching 20 percent per year by 2030. Under this scenario, North Carolina would have more than 700,000 rooftop solar installations and an equivalent capacity in utility-scale facilities by 2030 – reaching a total solar capacity on the order of 15,000 MW.

This level of growth in renewable energy capacity has precedent. America's installed wind energy capacity has grown at an average rate of 39 percent per year from 2005 to 2010.[24] Wind power now supplies enough electricity to power nearly 10 million American homes.[25]

The rapidly falling cost of solar electricity will help fuel growth in North Carolina's solar market. Between 1998 and 2008, the installed cost of photovoltaic systems declined by 31 percent, excluding the impacts of tax incentives and subsidies.[26] During 2009, prices declined even further, with the cost of PV modules falling by roughly 20 percent.[27] Nationally, U.S. Department of Energy experts forecast that solar will equal other sources of electricity in terms of cost per kWh by 2015.[28] With effective policies supporting the growth of the solar market, new houses could come with solar panels installed, and solar arrays could become a standard feature on malls, schools and office buildings all across the state and the country.

Achieving an expansion of solar power on this scale would offer many benefits for North Carolina's environment and its economy.

Solar Energy Prevents Pollution, Protecting Public Health and North Carolina's Environment

Investing in solar power can reduce global warming pollution and help to create a cleaner, healthier future for North Carolina. By displacing electricity generated from fossil fuels, solar power can cut emissions of carbon dioxide, the leading cause of global warming, as well as speed progress in reducing soot, smog and mercury pollution, which damage public health. (See Table 1.) At the same time, solar power can help to conserve North Carolina's supplies of fresh water, reducing the amount of water that would otherwise be consumed in steam-driven power plants. (See Table 2.)

Table 1: Reduced Emissions of Air Pollution under a Scenario in Which North Carolina Generates 14 Percent of its Electricity from Solar Power by 2030

Pollution Impact	2030	2010-2030, Cumulative
Carbon Dioxide (Million Metric Tons)	10	50
Nitrogen Oxides (Million Pounds)	17	80
Mercury (Pounds)	410	2,000

Table 2: Solar Photovoltaics Have A Smaller Environmental Impact Than North Carolina's Existing Electricity Grid[29] (Impact per MWh)

	North Carolina's Power Grid	Solar Photovoltaics
Carbon Dioxide Emissions	1,331 pounds	none
Emissions of Oxides of Nitrogen	1.0 pounds	none
Sulfur Dioxide Emissions	6.2 pounds	none
Mercury Emissions	0.00003 pounds	none
Water Use in Thermoelectric Power Plants	230 gallons	minimal

Solar Energy Prevents Global Warming Pollution

On average, each megawatt-hour of electricity generated in North Carolina produces 1,331 pounds of carbon dioxide, the leading pollutant driving global warming.[30] Additionally, every therm of natural gas burned produces 11.7 pounds of carbon dioxide.[31] In contrast, solar photovoltaic and solar water heating systems have little net emissions of global warming pollution.

By displacing the need for electricity from traditional power plants in North Carolina, and by reducing consumption of natural gas, solar power prevents the emission of global warming pollution. If North Carolina generated 14 percent of its electricity from solar, it would prevent nearly 10 million metric tons of global warming carbon dioxide pollution from entering the atmosphere in 2030.[32] This impact is roughly equivalent to the annual emissions of 680,000 cars and trucks.[33]

Cumulatively, from 2010 to 2030, the solar power scenario would reduce North Carolina's electric sector emissions of global warming pollution by 50 million metric tons of carbon dioxide, or by 3.6 percent below business-as-usual over the 20-year period.

These emission cuts would help North Carolina do its fair share to mitigate the worst effects of global warming. According to climate scientists, the world as a whole must reduce carbon dioxide pollution 50 percent or more by 2050. The United States must shoulder a larger burden, as one of the leading emitters of global warming pollution – cutting pollution by at least 80 percent by mid-century.[34]

Solar power is one of many tools that will be necessary to reach this target. In addition, North Carolina can cut emissions of global warming pollution by boosting energy efficiency measures; building wind, biomass, geothermal, ocean, or other types of renewable power systems; expanding the use of alternative fuels for vehicles; increasing public transportation options; adopting compact, transit-friendly community designs; increasing waste recycling; and implementing other policies that are part of a balanced approach to reduce the degree of future warming.

Solar Energy Reduces Soot and Smog

For every megawatt-hour of electricity generated, the average North Carolina power plant emits 1 pound of smog-forming nitrogen oxides.[44] Partially because of this pollution, North Carolina's air violates health-based air quality standards in 21 of 30 counties where the state operates monitors.[45] During the summer months, unhealthy levels of smog can develop in the Charlotte, Triangle, Triad, Fayetteville, Hickory, Asheville and Rocky Mount metropolitan areas as well as some outlying areas.[46]

By displacing the need for electricity from traditional power plants in North Carolina and the surrounding region, solar power could annually prevent 17 million pounds of smog-forming nitrogen oxide emissions from entering the atmosphere by 2030. To put that in perspective, 17 million pounds is equal to 32 days' worth of pollution from every factory or power plant in North Carolina (at 2008 emission rates).[47]

Sulfur dioxide emissions from coal-fired power plants form fine soot particles in the atmosphere. For every megawatt-hour of electricity generated, the average North Carolina power plant emits 6.2 pounds of soot-forming sulfur dioxide.[48] When inhaled, these particles become lodged deep in the lungs where they cause a variety of health problems, including asthma, bronchitis, lung cancer and heart attacks.[49] Soot pollution is responsible for significant harm to public health in North Carolina, killing about 3,000 people per year – accounting for between 3 and 7 percent of all deaths not caused by violence or accidents.[50]

By displacing the need for electricity from traditional power plants in North Carolina and the surrounding region, solar power could reduce the emission of soot-forming sulfur dioxide into the atmosphere. However, because sulfur dioxide emissions are subject to a national cap under the federal acid rain prevention program, other sources could increase their emissions up to the cap in response to the emissions prevented by additional solar power. If other sources did not increase emissions however, North Caro-

Global Warming Threatens North Carolina's Future

Dependence on fossil fuels threatens the future of all North Carolinians by contributing to global warming.[35] Were North Carolina its own country, it would rank 29th in the world for emissions of global warming pollution, ahead of such nations as Belgium, Pakistan and the United Arab Emirates.[36]

Because of these emissions, North Carolina's climate is changing. North Carolina is becoming a hotter place.[37] Storms with heavy rainfall are now 16 percent more frequent in North Carolina than they were 60 years ago.[38] Hurricanes have become more intense.[39]

Should emissions of global warming pollutants continue to increase, global average temperatures could increase by another 2° to 11.5° F by the year 2100 (depending on the pace of the emissions increase).[40] As a result, sea levels could rise by as much as 6.5 feet, causing extensive coastal flooding.[41] The number of severe hurricanes (category 4 and 5) could increase from 13 to 17 worldwide per year by 2050.[42] The state could experience extended periods of hot weather and drought, punctuated by heavy downpours, interfering with water supplies and agriculture.[43]

lina's sulfur dioxide emissions would fall by 50 million pounds in 2030 – equivalent to 38 days worth of emissions from all factories and power plants in the state at 2008 emission rates.[51]

Solar Energy Prevents Mercury Pollution of Waterways

Mercury emissions from coal-fired power plants and other industrial sources are making the fish in North Carolina's lakes, rivers and streams unsafe to eat. Burning coal releases mercury into the air that eventually contaminates rivers and lakes, where bacteria convert it to a highly toxic form that bioaccumulates in fish.[52]

Mercury is a neurotoxin that is particularly damaging to the developing brain. In early 2004, EPA scientists estimated that one in six women of childbearing age in the U.S. had levels of mercury in her blood that were sufficiently high to put her baby at risk of learning disabilities, developmental delays and problems with fine motor coordination, among other health impacts.[53]

In 2005, North Carolina' coal-fired power plants emitted 3,500 pounds of mercury.[54] This pollution has contributed to local contamination, prompting North Carolina to issue general fish consumption advisories for all coastal waters, all waters east of I-85, and many inland lakes and rivers, including Gaston Lake, Lake Santeetlah and Lake Fontana.[55]

By displacing coal-fired power, solar power can help to prevent mercury contamination. In the year 2030, solar power could annually prevent the emission of 410 pounds of highly toxic mercury pollution. This amount is significant – just 1/70th of a teaspoon of mercury can make the fish in a 25-acre lake unsafe to eat.[56]

Solar Energy Saves Water

Solar photovoltaic power has the additional benefit of conserving water.

Traditional fossil-fuel-fired and nuclear power plants depend heavily on a constant supply of water to produce steam and provide cooling.[57] North Carolina's thermoelectric power plants consume more than 20 billion gallons of fresh water every year.[58] That's enough to supply every person in North Carolina with more than 6 gallons of water daily.[59] On average, every megawatt-hour of electricity generated by a thermoelectric power plant in North Carolina consumes about 230 gallons of water.[60]

In contrast, solar photovoltaic panels generate power using very little water – no more than required to periodically wash dust off of the panels.

If North Carolina sourced 14 percent of its electricity needs from solar photovoltaic power generation by 2030, in that year the state would be saving more than 4 billion gallons of water. That much water could meet the domestic needs of a city the size of Durham or Winston-Salem (about 200,000 people).[61]

Investments in Solar Energy Benefit North Carolina's Economy

Solar power can drive North Carolina's economy forward – launching new companies to manufacture and install solar power equipment. Solar power helps to replace energy expenditures for fuel or materials produced out of state with labor and materials produced at home. This keeps more of North Carolina's energy dollars in the local economy, providing a boost to overall economic productivity.

Generating 14 percent of the state's electric power with solar photovoltaic panels would create more than 35,000 one-year jobs in 2030 – jobs that can't be outsourced.

Solar Energy Creates Skilled, High-Paying Jobs

Investment in solar power directly creates quality jobs in manufacturing, construction and building trades, operation and maintenance, and finance.

Green electric power businesses in North Carolina – including solar, wind, biomass and energy efficiency – employed more than 10,000 workers as of 2009, generating more than $3.5 billion in revenue annually.[62] More than 4,400 of these workers are involved in renewable energy deployment – with solar power as the leading source of jobs.[63]

North Carolina solar industry workers help to manufacture solar panels and solar water heating systems, install the systems on-site, work to maintain the systems and – at utility-scale facilities – run the business of power generation. In turn, the money solar businesses and their workers spend in the local economy helps to support other businesses.

For the year beginning July 2008, clean energy firms increased their workforce by 6 percent, despite the damaging impact of the credit crisis and the recession.[64] In comparison, the state as a whole lost more than 200,000 jobs (or 5 percent)

over the same period.[65] These clean energy firms are expected to grow another 36 percent through July 2010.[66]

Manufacturing

Much of the work behind solar energy involves manufacturing. Building a photovoltaic panel requires creating cells from silicon and glass, installing wires and other electrical components, and assembling them into a unit. According to a 2002 analysis by University of California-Berkeley Professor Daniel Kammen, manufacturing a megawatt of solar photovoltaic panels requires approximately six full-time employees working for a year.[67] (This number is gradually declining as solar manufacturing becomes more efficient.)

In 2008, American solar manufacturers expanded their capacity by 65 percent, reaching the capacity to build more than 680 MW of solar panels each year.[68]

North Carolina is participating in this manufacturing boom. The state's extensive network of universities, experts, and skilled workers make it an ideal site for developing and manufacturing solar energy technology. According to the North Carolina Sustainable Energy Association, in 2009 the state hosted nine businesses that identified solar energy system manufacturing as their primary business activity. [69] Those companies employed on the order of 600 workers.[70] Numerous other companies manufacture solar energy components as a part of their business. North Carolina's solar manufacturing industry includes the following companies:

- Charlotte-based Sencera was founded in 2003 to manufacture thin-film transistors and integrated circuits. The company applied its technological expertise to focus on solar power in 2006.[71] The company is now building a thin-film solar panel manufacturing plant in Charlotte, which will employ 65 workers by summer 2010.[72]
- Semprius, headquartered near Research Triangle Park in Durham, is developing a new semiconductor technology to make solar panels more efficient and inexpensive, by printing high-performance materials onto virtually any material, including glass and flexible plastic.[73] The company won the *Wall Street Journal's* Technology Innovation Award in 2006 and its founder won a MacArthur Foundation Genius Grant in 2009.[74] As of 2010, the firm employs 28 people and has raised more than $10 million in venture capital.[75]
- SBM Solar, based just outside of Charlotte, manufactures solar panels using lightweight materials suitable for mounting on rooftops. Founded in 2002, the company operates a 22,000 square foot manufacturing facility and employs four workers, with plans to expand to 16 employees in 2010 and up to 60 employees by 2012 or 2013.[76]
- At a factory in Greensboro, RF Micro Devices has developed a new process for manufacturing high-performance, high-efficiency photovoltaic cells, using expertise the company has earned over many years of making radio frequency components and semiconductors. The company partnered with the National Renewable Energy Laboratory to develop the new technology in 2009, and is on track to produce PV cells at commercial scale by 2012.[77]
- DuPont, one of the world's largest chemical companies, is building a facility in Fayetteville where it will manufacture Tedlar films, used

to protect solar photovoltaic cells from weather and make them more durable. The company expects the facility to be up and running in mid-2010, helping to deliver $1 billion in expected annual photovoltaic sales for the company by 2012.[78]

- Based in Hillsborough, MegaWatt Solar Inc. focuses on building utility-scale solar installations with multiple megawatts of electricity generation capacity.[79] Founded by three UNC professors and a Chapel Hill energy entrepreneur, the company's first plant was installed in Caswell County in 2008.[80] The company expects its technology to last as long as 50 years – producing power with an average price much less than coal, oil, natural gas, or nuclear energy.[81] The company plans to license its design to utilities and engineering firms while advising local contractors on assembly, rather than mass-manufacturing the units itself.[82]
- Cardinal Glass Industries in Mooresville manufactures specialized glass for use in solar panels, high performance windows, and related products.[83] Similarly, Pilkington (a subsidiary of Nippon Sheet Glass) manufactures specialized glass at a plant in Laurinburg that employs 350 people.[84] The company expects 10 percent of its revenue to come from the solar industry in fiscal year 2011.
- Daetwyler Clean Energy manufactures racking systems for solar technologies at a factory in Huntersville, tapping into decades of expertise in building components for the printing industry.[85]
- Wake Forest-based Enertia Building Systems focuses on designing and manufacturing net-zero energy homes and buildings – structures that use energy efficiency, passive solar heating and cooling, and active solar photovoltaic systems to generate as much power as they consume over the course of the year.[86]
- K-Flex USA, based in Youngsville, manufactures a wide variety of foam insulation products, including a line specifically for residential and commercial solar water heating systems.[87]
- Sanford-based Solargenix Energy designs, manufactures and installs solar water heating and solar thermal power generation systems. The company participates in markets from residential to commercial to large-scale utilities, in North Carolina and beyond.[88]
- SunQest, based in Newton, manufactures solar water heating systems for homes and small businesses.

Photo: MegaWatt Solar

R.G. Brecheisen, CEO of Piedmont Electric Membership Corporation, and Daniel Gregory, President and CEO of Hillsborough-based MegaWatt Solar, standing in front of MegaWatt's first solar plant, located in Caswell County.

The heated water can be used for standard water supplies, pool heating, or radiant floor space heating.[89]

- Surry Solar Services, based in Mt. Airy, manufactures the Solar Hero Heat Exchanger, an adapter that connects a standard hot water tank to a solar water heating system.[90]

Solar energy system manufacturing is a global business. Companies located as far away as China, Japan and Europe are moving to ramp up their manufacturing capacity to take advantage of a growing global demand for solar energy systems. Creating local demand for solar energy products can help to promote the development of local manufacturing capacity and position local companies to take part in the coming energy revolution. The economic power of creating local demand for clean energy is already apparent in states across the country. For example, in response to state renewable electricity standards, more than 70 new wind energy manufacturing facilities came online, were announced, or expanded in 2007 and 2008 – representing 16,000 manufacturing jobs.[91]

Photo: Alternative Energy Concepts

Alternative Energy Concepts installs solar energy equipment for residential and commercial customers in the Eastern North Carolina Piedmont Area.

North Carolina has the intellectual assets and business infrastructure to take part in the global market for solar energy systems. Many North Carolina businesses have the technical capability to participate in the solar power manufacturing supply chain, expanding their business and hiring more employees. According to researchers at the University of North Carolina in Greensboro, nearly 300 firms in the state could manufacture solar energy system components. As of 2008, these businesses employed more than 16,000 people.[92] Three-quarters of these businesses are located in the Charlotte, Research Triangle and Piedmont Triad regions.[93]

By increasing local demand for solar energy systems, North Carolina can encourage the launch of new businesses and the expansion of existing businesses into the solar market. For example, the Renewable Energy Policy Project (REPP) estimates that national efforts to build 9,000 MW of solar energy capacity by 2015 would bring a $700 million investment to North Carolina and create nearly 900 manufacturing jobs.[94] REPP ranks North Carolina 10th among all U.S. states in terms of its overall potential to benefit from solar photovoltaic manufacturing.

Building Trades, Construction and Installation

Installation of solar energy systems requires local construction firms and general contractors, boosting local economies. These jobs are difficult or impossible to outsource.

North Carolina is home to nearly 100 businesses involved in solar system marketing, installation or project development, including First Light Solar Energy (FLS Energy), Southern Energy Manage-

ment, Appalachian Solar Technologies, Blue Ridge Energy Solutions, Cape Fear Solar Systems, Carolina Solar Energy, and Sundance Power Systems.[95] These companies help utilities, businesses and homeowners plan solar projects, then do the work of installing the solar panels and associated infrastructure, and connecting the systems to the larger electric grid.

Durham-based Carolina Solar Energy is a good example of the type of business that could grow and employ local North Carolina workers if the state expanded its commitment to solar energy. The company, which focuses on commercial and utility-scale solar systems, won the 2009 Renewable Energy Business of the Year award from the North Carolina Sustainable Energy Association.[96] Since 2004, the company has installed more than 1 MW of solar electric capacity in the state.[97]

In 2009, Carolina Solar Energy installed a 650 kilowatt (kW) solar park at the Person County Business and Industrial Center next to U.S. Highway 501 south of Roxboro. The facility is now one of the state's most visible solar installations. The company prioritized local labor for the project.[98]

Richard Harkrader, CEO of the Carolina Solar Energy, told *Resource Week* upon the announcement of the project, "Photovoltaic solar technology has come a long way in the past few decades and there is no longer any doubt that solar power is becoming a viable investment in North Carolina."[99]

Vanir Energy, based in Fletcher (just south of Asheville), is another good example of a local solar energy business providing jobs. Vanir Energy designs, builds and operates solar thermal heating and cooling systems for commercial, industrial and government customers. Vanir designed, built, and operates the world's largest solar thermal heating and cooling system at the Fletcher Business Park. The Fletcher Business Park system created 58 jobs, requiring metal fabricators, plumbers, welders, engineers and other workers.[100] These workers installed a 27,000 gallon water storage tank, 1.5 miles of steel piping, and 640 solar thermal panels.[101]

Southern Energy Management, based in Morrisville, is another successful residential and commercial solar system installer, also offering comprehensive energy efficiency services. The company worked on the installation of two of the largest solar farms in the state, and in the entire Southeast: the 1 MW solar farm at the headquarters of SAS in Cary, and a 1 MW solar farm in Rocky Mount to provide electricity for rural co-ops through the utility QVC. The company has installed solar PV and solar hot water systems in many locations, from the North Carolina Zoo to the Cherry Point Marine Corps Air Station.[102]

Additionally, in 2009, a former Sencera employee launched a new company called O_2 Energies, based in Cornelius, north of Charlotte. The company plans to develop large-scale ground-mounted solar PV installations of 1 to 20 MW for large investors.[103]

Spillover Effects

Each dollar spent on solar energy creates impacts that ripple outward through the local economy, extending far beyond the direct creation of jobs at energy facilities.

For example, workers at a manufacturing plant need raw materials and equipment. Their work in assembling solar panels and inverters supports jobs in equipment manufacturing and component supply. Contractors at a construction site need concrete, scaffolding and heavy equipment, and their work supports additional jobs supplying these needs. In addition to these indirect jobs, workers

spend much of their wages in the local economy, purchasing goods and services like groceries and housing, supporting additional workers.

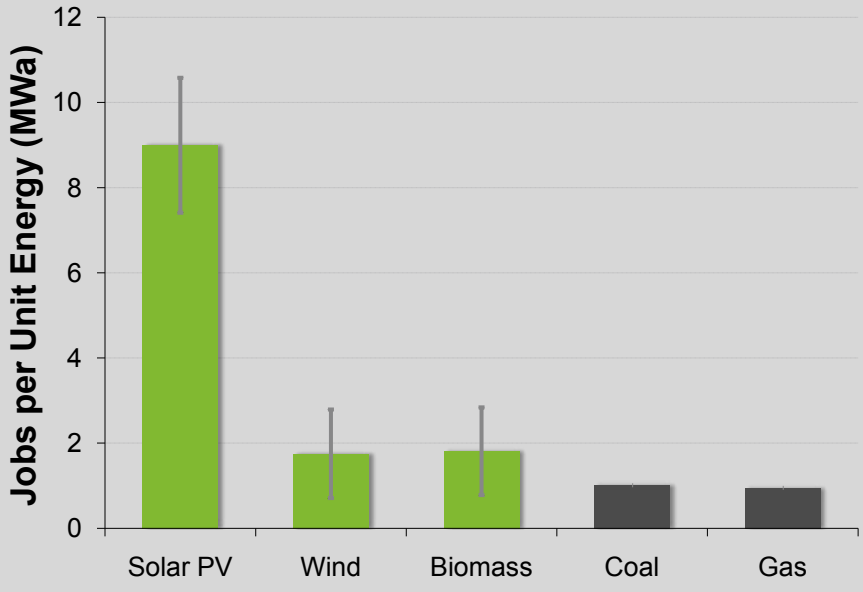
Other forecasts concur that clean energy is an effective tool to stimulate the economy:

- In 2009, the University of Massachusetts, Amherst, and the Center for American Progress estimated that a national investment of $100 billion over two years in clean energy technologies including energy efficiency, wind, solar, biofuel, and geothermal power, could create 62,000 jobs in North Carolina.[104]
- In 2005, the Appalachian State University Energy Center performed a study for the North Carolina Energy Policy Council, showing that a state renewable electricity standard of 20 percent by 2020 would create a net of 5,100 jobs and increase personal income by $2.4 billion over the period.[105]

Renewable Energy Facilities Have Larger Direct Economic Impact than Coal or Gas-Fired Power Plants

A variety of studies confirm that renewable energy generates more total jobs per unit energy produced than fossil-fuel technologies.[109] (See Figure 1, which presents the total number of direct jobs created per unit of energy for selected renewable and fossil technologies, including manufacturing, installation, fuel extraction, and operation and maintenance.) Solar energy creates on the order of nine times as many jobs compared with coal- and gas-fired power. This figure will decrease as the volume of the solar market increases and costs decline, but solar employment per unit energy will remain substantially higher than fossil fuel employment.

Figure 1: Jobs per Unit of Energy from Renewable and Fossil Technologies, U.S.[110]



- The American Council for an Energy-Efficient Economy estimated in 2010 that a broad suite of energy efficiency measures could create 38,000 net jobs in 2025 and save North Carolinians a net of $3.6 billion on utility bills through that year.[106]
- According to the Union of Concerned Scientists, generating 25 percent of America's electricity from renewable sources by 2025 would create three times as many jobs as producing that energy through conventional fossil fuels. A renewable electricity standard would provide a net benefit of more than 200,000 jobs – with more than 40,000 in the manufacturing sector.[107] This action would save North Carolinians nearly a billion dollars through 2025 on electricity and natural gas bills.[108]

Solar Energy Can Boost Economic Output and Enhance Local Economies

Investments in renewable energy, dollar for dollar, produce a greater net benefit for North Carolina's economy than traditional technologies.

Renewable energy policies improve economic output because they increase the amount of money kept within the local economy, replacing expenditures for fuel from out of state with expenditures for labor and materials obtained from home. For example, in 2005, the Appalachian State University Energy Center performed a study for the North Carolina Energy Policy Council showing that a state renewable electricity standard of 20 percent by 2020 would increase gross state product by more than $4 billion.[111]

Expanding North Carolina's Solar Market Can Help Drive the State Economy Forward

If North Carolina took action to expand the market for solar-generated electricity, such that solar reached 14 percent of the state's electricity supply by 2030, investment dollars would flow into the state – creating jobs and increasing wages.

In this section of the report, we use the National Renewable Energy Laboratory's Jobs and Economic Development Model (JEDI) to estimate the economic impact of developing North Carolina's solar power market. The model focuses in on the sectors of the economy where spending on solar technology would occur, estimating gross impacts. It does

Defining a "Job"

In estimating possible future impacts of solar development in North Carolina, this report uses the word "job" to mean full-time equivalent employment, based on a 2,080-hour work-year. Under this definition, one job could mean one person working full time for a year; two people working half time for a year, four people working full time for three months, or any employment scenario adding up to 2,080 work hours in a year.

not look at net impacts across the entire state economy.[112]

The degree to which manufacturing activity happens locally is an important factor in the overall magnitude of the results. First, we present an estimate of the economic impact of solar photovoltaic capacity expansion assuming that all manufacturing activity happens out of state. Then, on page 25, we discuss the range of the potential economic benefit spanning up to 50 percent local manufacturing. For more details on how the results were generated, see the Methodology section on page 34.

Employment Gains

Investing in solar power would bring jobs to North Carolina by replacing expenditures for fossil fuel produced out of state with expenditures for labor and materials produced at home.

Building enough solar panels to generate 14 percent of North Carolina's electricity would create an estimated 28,000 jobs in North Carolina by 2030, assuming that solar system components largely come from out-of-state suppliers. Currently, a little more than 40 percent of the total jobs created by solar are in manufacturing, with just under 30 percent in system design and installation and 3 percent in system operation and maintenance. (As manufacturing costs decline and processes become more efficient over time, more of the jobs will be in installation and less in manufacturing.) The remaining jobs would be induced in other industries by the ripple effects of spending through the local economy. (See Figure 2.)

Figure 2: Job Creation in North Carolina From Expanding North Carolina's Solar Photovoltaic Power Capacity to Produce 14 Percent of the State's Electricity in the Year 2030

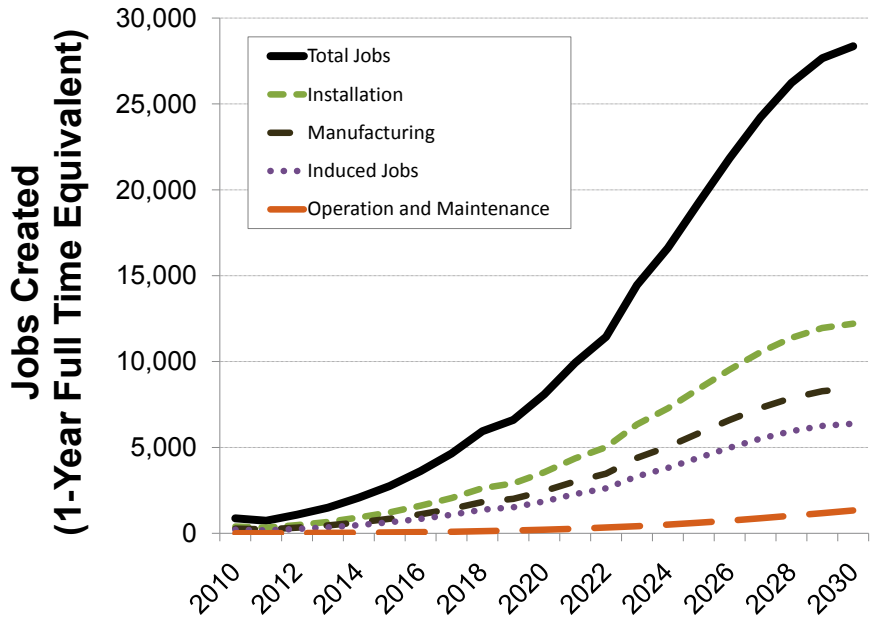
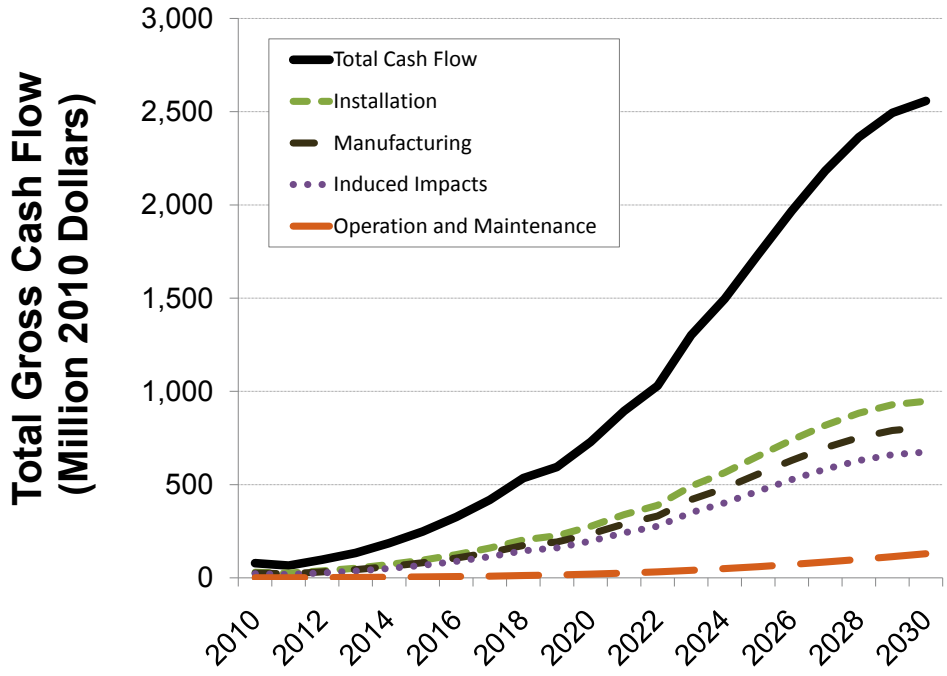


Figure 3: Gross Cash Flow Driven by Solar Photovoltaic Market Expansion



In total, these jobs would pay workers $1.2 billion in wages in the year 2030, or an average of $43,000 (in 2010 dollars). Table 3 presents the average wage by type of job.

Growing Investment in North Carolina

Expanding North Carolina's solar market to reach 14 percent of the state's electricity supply by 2030 would attract investment dollars. By the year 2030, this level of activity in the solar market would drive a total gross cash flow of $2.6 billion per year (2010 dollars).

Over the entire period from 2010 to 2030, expanding the state's solar market at this pace would stimulate gross investment of more than $20 billion.

The Impact of Local Manufacturing

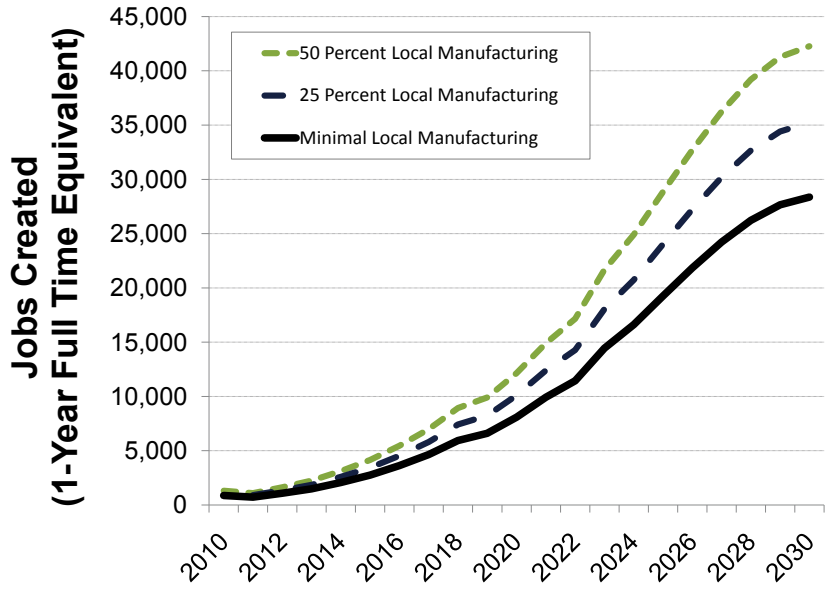
In calculating these results, we assumed that no solar components would be obtained from local manufacturers. Since component manufacturing is a global business, North Carolina solar installations could obtain solar panels from suppliers in other states or abroad.

Table 3: Average Wage in 2030 by Type of Work (2010 Dollars per 1-Year Full Time Equivalent Job)

Manufacturing*	$33,458
Development and Installation	$53,638
Operations and Maintenance	$49,122
Induced Jobs	$33,453

*Assuming most manufactured goods are purchased from out-of-state suppliers. Increased in-state manufacturing leads to increased average salary for manufacturing jobs.

Figure 4: Sensitivity of Job Creation to Local Manufacturing Activity



However, the state is home to component manufacturers that could supply needed technologies, supporting local jobs. To the extent that local component manufacturers participate in developing North Carolina's solar resources, job creation and local investment will be higher.

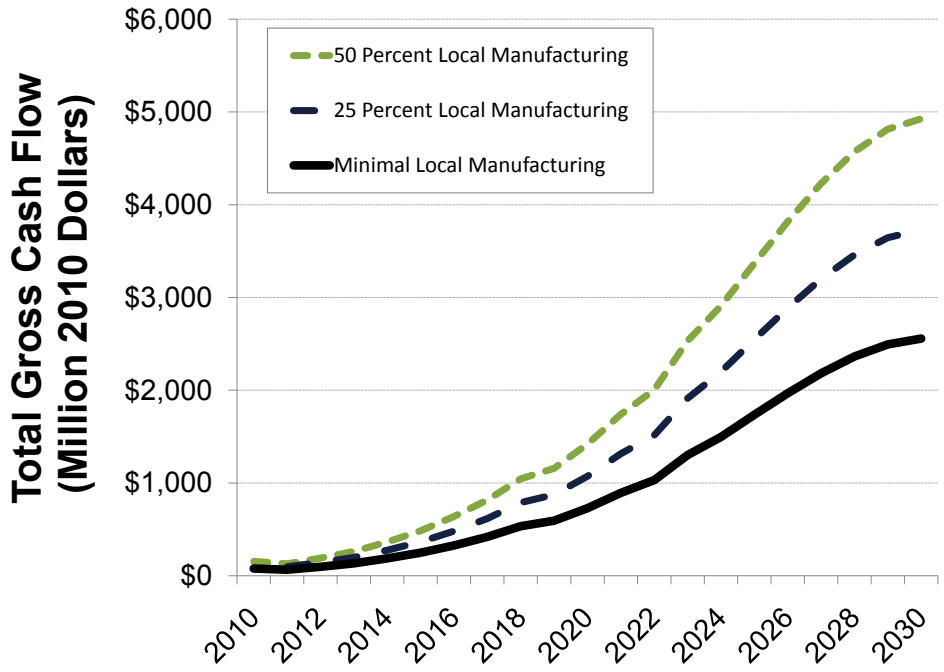
In this section, we calculate the range of economic impacts that could be expected from expanding the state's solar electric generating capacity to reach 14 percent of the state's electricity supply by 2030, assuming that 25 percent and 50 percent of components come from local manufacturers.

Figure 4 and Figure 5 present the trajectory of gross job creation and gross cash flow in North Carolina under these ranges of local manufacturing. Table 4 presents a range of possible economic benefits that North Carolina could

The Impact of North Carolina's Existing Solar Carve-Out

The report calculates job impacts relative to where the solar industry is today. Some of these jobs will be created by existing policies. For example, the solar carve-out in the state's renewable electricity standard policy, which requires utilities to generate 0.2 percent of their electricity from solar power by 2018, will prevent 80,000 metric tons of global warming pollution and create about 1,000 jobs per year through 2020 (full-time equivalent). Accelerating the solar industry beyond this minimal first step according to the trajectory modeled in this report would produce more than 5 times the benefit by 2020 and nearly 30 times the benefit by 2030.

Figure 5: Sensitivity of Gross Cash Flow to Local Manufacturing Activity



achieve in the year 2030 under different assumptions of the degree of local manufacturing.

These results show that encouraging the development of a local manufacturing base for solar energy systems (or any other kind of clean energy technology) can position the state to reap the benefits of an increase in global demand for clean energy.

Table 4: Economic Benefits of Expanding North Carolina's Solar Photovoltaic Power Capacity Under Different Degrees of Local Manufacturing

Benefits Achieved in the Year 2030	Solar Technology Manufactured:		
	Out of State	25 Percent In-State	50 Percent In-State
Total Jobs Created (1-Year Full Time Equivalent)	28,000	35,000	42,000
Gross Cash Flow in North Carolina (Billion 2010 Dollars)	$2.6	$3.7	$4.9
Total Wages Paid (Billion 2010 Dollars)	$1.2	$1.6	$1.9
Average Annual Wage (2010 Dollars)	$43,000	$45,000	$46,000

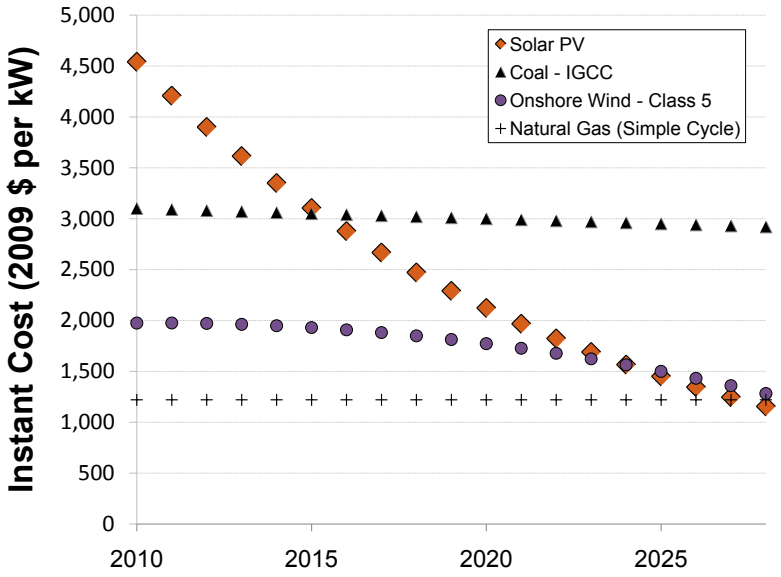
Policy Recommendations

To enable solar technologies to compete on equal footing with more established technologies such as coal-, gas-, or nuclear-fired power plants, North Carolina should act to encourage the deployment of more solar capacity. As the market for solar technologies increases, the cost of solar will decline. When the cost of electricity from solar photovoltaics can match the cost of power from other new power plants plus the cost of transmitting the electricity, the need for financial incentives to drive the expansion of the solar market will fade.

The cost of solar technology is rapidly approaching this milestone. Between 1998 and 2008, the installed cost of photovoltaic systems declined by 31 percent, excluding the impacts of tax incentives and subsidies.[113] During 2009, prices declined even further, with the cost of PV modules falling by more than 40 percent.[114] The investment firm Lazard predicts that by 2012, thin-film solar panels will be able to produce electricity for 8.7 cents per kWh and crystalline solar panels for 11.6 cents per kWh.[115] This is compared to North Carolina's current average retail electricity price of about 8 cents per kWh.[116] Nationally, U.S. Department of Energy experts forecast that solar will equal other sources of electricity in terms of cost per kWh by 2015.[117] The cost of solar photovoltaics is dropping faster than any competing technology. (See Figure 6.)

By simplifying rules, extending incentives and expanding the state's solar electricity standard, North Carolina can make solar power cheaper, faster – enabling solar power to compete with other technologies on more equal footing and bringing great benefits to the state. By nurturing and expanding

Figure 6: The Cost of Solar Is Projected to Fall Faster than Any Other Technology[118]



demand for solar energy while helping to incubate local solar businesses, North Carolina can improve its environment and protect public health – all while boosting its economy. While North Carolina has no fossil fuel or uranium reserves, the state is blessed with ample solar energy resources. By capturing more of these resources, North Carolina can keep more of its dollars local, providing new energy for the state's economy.

However, the solar market faces several important barriers limiting the speed of its expansion. These barriers include:

- **High up-front costs and long payback times.** Many property owners would purchase solar panels and solar hot water systems if not for the up-front costs and fear of being unable to recover costs should the property be sold. Paying for the equivalent of 20 years of electricity bills at once is difficult for most families and small businesses. Most of the cost of solar energy reflects the initial manufacturing and installation of the system. Once in place, the panels operate with zero fuel expenditures, since sunlight is free.
- **Missing incentives and externalities.** Every consumer who generates solar power reduces demand for electricity from the larger electricity grid, which prevents pollution and lowers the cost of energy for everyone. However, individuals or businesses who pursue clean energy changes are rarely compensated for the benefits they deliver to the rest of society.
- **The "chicken and egg" problem.** Billions of dollars have been invested over the years in building up North Carolina's energy infrastructure. These historical investments can make it difficult for new technologies like solar power to compete

on equal footing. For example, few people will demand a solar-powered home if builders are not producing and marketing them. But builders won't produce them unless they perceive adequate demand.

- **Restrictions and red tape.** Solar power installations can be limited by rules and red tape not applied to other energy technologies. For example, utilities can charge solar system owners large fees to connect to the power grid, or reimburse a solar system owner for excess power generated at a rate less than the power is worth.

Public policy can play a critical role in surmounting these market barriers to the spread of solar energy technology. Government can establish solar energy requirements, thus setting a high "floor" for the penetration of solar energy in the economy. Government can also offer financial incentives, public education programs, and technical assistance to help individuals and businesses take advantage of their clean energy potential.

North Carolina took a step in the right direction in 2009 by extending the 35 percent investment tax credit for installation of renewable energy technologies, including solar panels.[119] While this was an important step, there are many more policies the state can put in place to ensure the growth of solar power in North Carolina.

With the right mix of incentives and policies, North Carolina can give the solar market the kick-start it needs to accelerate its growth. A small investment now could bring billions to the state over the next decade. With growth in demand, economies of scale will help make solar energy affordable for everybody, and deliver widespread benefits to all of North Carolina – cleaner air, less global warming, savings on energy, and less vulnerability to fossil fuel price spikes.

To unlock the potential of solar power, North Carolina state policy should work to overcome market barriers and encourage the spread of solar power systems.

Ensure That North Carolina's Renewable Energy Standard Stays Strong

In 2009, the North Carolina Utilities Commission (NCUC) ruled that 25 percent of the solar requirement in the state's renewable electricity standard (RES) can come from other states. North Carolina will see the most benefit from its RES if it is used to encourage the state's own solar industry. More local solar generation will increase in-state economic impacts. It will also help to displace harmful air pollutants from local power plants, rather than send those air quality benefits to distant states. North Carolina leaders should clarify the purpose of the solar carve-out in the state's renewable electricity standard, emphasizing the intent to encourage in-state solar development.

Additionally, North Carolina should expand its renewable electricity standard to require a greater fraction of the state's electricity supplies to come from clean, renewable sources of energy. As a part of this expansion, the state should increase the size of the carve-out specifically aimed at increasing electricity generation from solar technologies.

Reinstate the Renewable Energy Manufacturing Tax Credit

North Carolina's renewable energy manufacturing tax credit expired in 2006. North Carolina should reinstate the tax credit to build the state's solar industry.

The solar industry has been growing in North Carolina over the past decade,

and the state should be encouraging this trend. Companies like Sencera, a solar technology developer and manufacturer in Charlotte, have plans to grow and expand production in the coming years.[120]

Building the solar manufacturing industry will help lower the cost of solar energy systems as well. The cost of solar technology is directly related to the level of production – the more systems produced, the cheaper they are. Accelerating the growth of North Carolina's growing solar industry, combined with the growing solar industry across the United States and the world, will bring solar technology to widespread mass production more quickly, making it cheaper to produce and more attractive for utilities installing new electric generation or homeowners considering installing solar panels or solar hot water systems on their roofs.

Provide New Solar Financing Options for Homeowners and Businesses

Barriers to solar market expansion posed by sticker shock and long payback times can be addressed through policies that provide effective financing options for homeowners and businesses to facilitate the purchase of solar energy equipment.

Leading states and cities across the country are now pioneering a model policy called Property Assessed Clean Energy ("PACE") financing, which allows local governments to use their borrowing power to help businesses and individuals finance solar energy systems and other clean energy improvements. Under PACE financing, a municipality issues bonds to raise money to cover the capital costs of a solar energy system, and a property owner pays off the cost of the improvements through property taxes over a span of up to 20 years.[121] PACE financing can enable the expansion of the solar market without any additional cost to the state or to local governments.

Integrating the loan into property taxes means that homeowners who plan to move in the next 20 years or businesses that expect to change buildings before the loan is paid off will not be deterred from installing solar power. In the event that the owner sells the property before the debt is paid off, the new property owner would continue paying for the solar panels through tax assessments. Structuring loans in this way also enables individual homeowners and small businesses to benefit from the fact that municipalities have greater access to financing and can borrow money at lower interest rates.

Fifteen states passed PACE enabling legislation in 2008 and 2009. In 2009, North Carolina adopted legislation allowing local governments to create loan programs for residents to purchase solar energy and other renewable energy equipment. The state should build on this progress by adopting PACE legislation.

Allow Regulators to Set a Fair and Predictable Price for Solar Power Produced

In order to truly integrate distributed solar generation into North Carolina's electricity system, solar providers must be paid an economic, fair and predictable rate for the electricity they generate. A "feed-in rate" policy could accomplish this goal. Such policy has rapidly advanced solar power production in Germany and Spain. North Carolina should follow suit.

A feed-in rate would grant a certain and fair price over an extended time, encouraging individuals and businesses to make substantial investments in solar technology. The policy also has the advantage of simplicity compared to many other types of incentives.

A feed-in rate would help to compensate solar owners for the benefits they provide to the rest of society. Consumers who invest in solar power actually *save money* for other electricity consumers. With more solar power in the system, utilities need to invest less in transmission lines and expensive "peaking" power plants that only run when demand for electricity is very high. And the pollution that is avoided by installing solar panels also has economic value in the form of reduced public health impacts from air pollution and less danger from global warming.

With a feed-in rate, small businesses and homeowners are instead paid a fair rate for every kWh of electricity they produce. This rate is guaranteed for a long enough period of time, 15 to 25 years, to allow those considering installing solar panels to be sure what the lifetime net cost will be for the panels.[122] Regulators can set the price at whatever level they determine will stimulate the growth of solar power in the state. The ideal rate reflects the current cost of a technology while providing an adequate and predictable rate of return for project investors. Rates should be high enough to attract the desired amount of renewable energy capacity without providing excessive economic windfall to projects.

Feed-in rates encourage solar installations by setting competitive prices for solar electricity produced. Feed-in rates also provide an incentive for home and business owners to build rooftop solar PV systems with excess capacity, rather than just large enough to supply electricity for their own buildings. With feed-in rates, homeowners and businesses that install solar panels will not only eliminate their monthly electricity bill, but receive payments for the power they are producing.

The cost of a feed-in rate program can be managed through program or project size limits, by technology eligibility, or through capacity block pricing. Program capacity levels can be limited on both an annual and a cumulative basis to prevent over-heated markets and boom-and-bust cycles while managing ratepayer impact.

Gainesville, Florida, recently approved a feed-in rate policy for solar power, which is designed to give those who install solar panels on their building a 5 percent return on investment after taxes with a 20-year contract. The city has already reached its cap on solar installations covered under the program for this year and next, which is set at 4 MW installed per year.[123]

Establishing a feed-in rate in North Carolina would enlarge the market for solar power, increasing the growth rate of installed solar power and boosting the solar industry.

Allow Building Owners to Lease Solar Panels

North Carolina should allow solar companies to lease solar energy systems to home and business owners, enabling them to use solar power without paying the upfront costs.

Some solar companies specialize in installing solar systems at the facilities of large businesses, charging for energy usage from the system over time, rather than selling the system to the business outright. These types of arrangements happen through a "power purchase agreement," or PPA, which establishes a fixed price for the electricity for a decade or longer. These agreements allow property owners to use solar power without the hassle of purchasing a system, while protecting against electricity price increases.

Currently, however, only utilities can establish this sort of agreement with building owners in North Carolina. If a solar company wants to establish a PPA program, state law requires that it be regulated as a utility, effectively prohibiting this type of financing in North Carolina by non-utilities. Laws requiring utility regulation were created before companies started using PPAs, however, and PPAs do not create the risks that utility regulation guards against. This type of financing has the potential to speed up solar power installation in North Carolina.

State law should exempt renewable energy PPA programs from utility regulation.

Make Net Metering Work for Home and Business Owners

North Carolina law allows utilities to charge commercial net metered solar generators standby charges. Residential systems under 20 kW and commercial systems under 100 kW are exempt, but above this, systems up to 500 kW can face steep charges each month for having their system connected to the grid.[124] These standby charges are limiting the size of solar PV systems in North Carolina and should be eliminated.

Renewable energy generators create "renewable energy credits" (RECs) when they generate electricity. These credits are in high demand from utilities seeking to comply with renewable electricity standards and companies who purchase them to boost their "green" credibility, and the proceeds can help solar panel owners to finance their systems. However, North Carolina's net metering laws give utilities the right to claim RECs for the excess generation produced by any solar panels their customers connect to the grid. The credits should always be owned by the generator.

North Carolina should simplify its net metering rules and ensure that all solar owners are fairly compensated for the electricity they produce.

Require Solar Panels in New Home Design and Construction

One of the most efficient ways to increase the amount of solar power is to require new homes to come with solar photovoltaic and solar water heating systems, or with the option of installing solar energy systems. By planning solar energy into new homes, builders can ensure that homes are oriented properly, with un-shaded roof space for the panels. Including solar energy technologies in new homes also costs about 25-33 percent less than retrofitting an existing home for solar.[125] And building in solar technology while the house is under construction makes it easier for homeowners to choose and finance solar power – solar energy then becomes a standard option, similar to granite countertops, in a project already underway.

A growing number of states have solar requirements for new homes. New Jersey requires builders to offer solar panels in new developments of more than 25 homes. New homes in New Mexico must be wired for solar power.[126] Hawaii requires new single-family homes to come with solar water heating systems.[127]

North Carolina should require home builders to offer solar photovoltaic and solar water heating systems as a standard feature in new homes, and to provide ready access for wiring and pipes to connect to rooftop solar systems. This would ensure a growing market for solar energy in North Carolina, help the state's growing solar industry, and make it easier for homeowners to capture and use the power of the sun.

Methodology

Solar Expansion Scenario

Figure 7 shows the growth of solar photovoltaic capacity underlying all of the estimates for environmental and economic benefits calculated in this report. The scenario was developed for the 2009 Environment North Carolina Research & Policy Center report, *Growing Solar in North Carolina*.[128]

In this scenario, North Carolina's solar market grows at rates comparable to the markets in Spain, Japan, Germany, New Jersey and California – beginning at 50 percent annually in 2010 – declining to 20 percent annually by 2030.

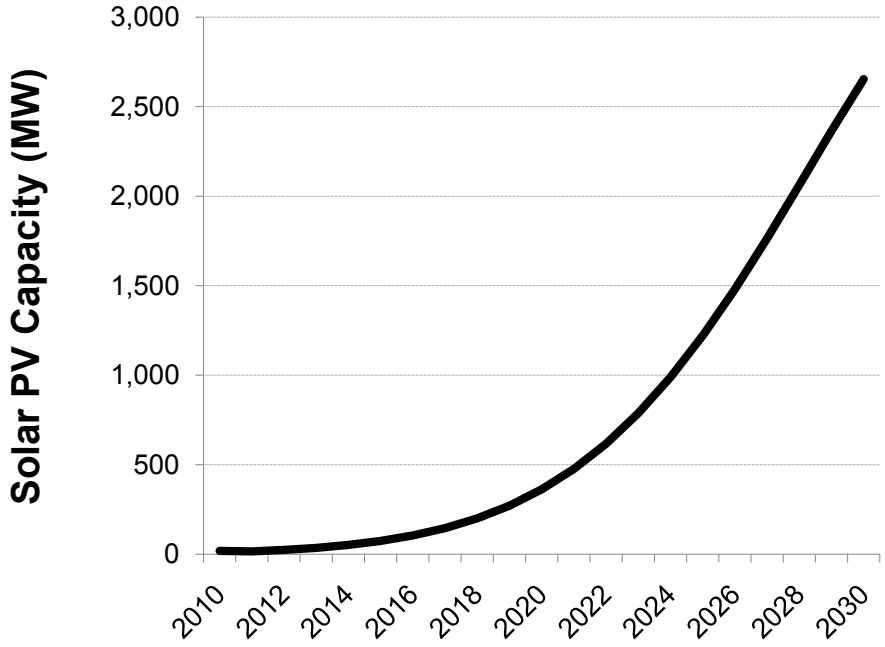
Over the past 10 years, California's installed solar power has increased by an average of 54 percent a year, and Germany's has increased by an average of 60 percent a year.[129] In the past few years, New Jersey has seen similar rates of solar installation, with installed solar power growing 75 percent in 2007 and 47 percent in 2008.[130] And installed solar power in the entire world has increased by an average of 31 percent a year from 1998-2008.[131]

The scenario results in a total rooftop solar capacity comparable to a 2008 Navigant Consulting estimate of the result of installing solar panels on all currently available suitable residential and commercial rooftop space in North Carolina.[132]

Calculating Environmental Benefits

We calculated avoided pollution and water use by determining how much electricity production could be replaced by electricity generated by solar power, according to the above scenario, using an estimated statewide capacity factor of 15 percent.[133] This amount of solar capacity would produce the equivalent of

Figure 7: A Scenario for Solar Photovoltaic Capacity Expansion in North Carolina Through 2030



about 14 percent of the state's projected electricity consumption in 2030.

In 2001, the average line loss of electric power during transmission was about 10 percent.[134] Distributed solar, because it is sited near where the power is consumed, can reduce line losses. If half of the solar power capacity installed in North Carolina through 2030 were distributed on rooftops and half were in large centralized solar farms, line losses for the power displaced by solar would be on the order of 5 percent. Accordingly, we treated a kilowatt-hour of solar generation in our scenario as equivalent to 1.05 kilowatt-hours generated by the state's existing electric power system.

We applied the amount of displaced business-as-usual electricity generation in 2030 to forecast emission rates and water use rates per megawatt-hour of generation to determine avoided emissions and water savings. We obtained actual emission rates per megawatt-hour of North Carolina power plants in 2005 from the U.S. Environmental Protection Agency's *E-Grid* database.[135] We then forecast emissions from 2010 to 2030 by scaling these actual emission rates to projected emissions rates for the regional electric grid (the SERC region) from the U.S. Department of Energy's *Annual Energy Outlook 2010*.[136] We obtained figures for water use per megawatt-hour in North Carolina from the National Renewable Energy Laboratory – which, for simplicity's sake, we assumed would not change over time.[137]

Calculating Economic Benefits

We calculated economic benefits using the National Renewable Energy Laboratory's *Jobs and Economic Development Model* (JEDI) for solar photovoltaics.[138] The JEDI model was designed to estimate the

economic impact of discrete photovoltaic projects, using a set of default assumptions developed to characterize a typical solar development. We adapted the model for use in calculating the impact of our solar development scenario as follows:

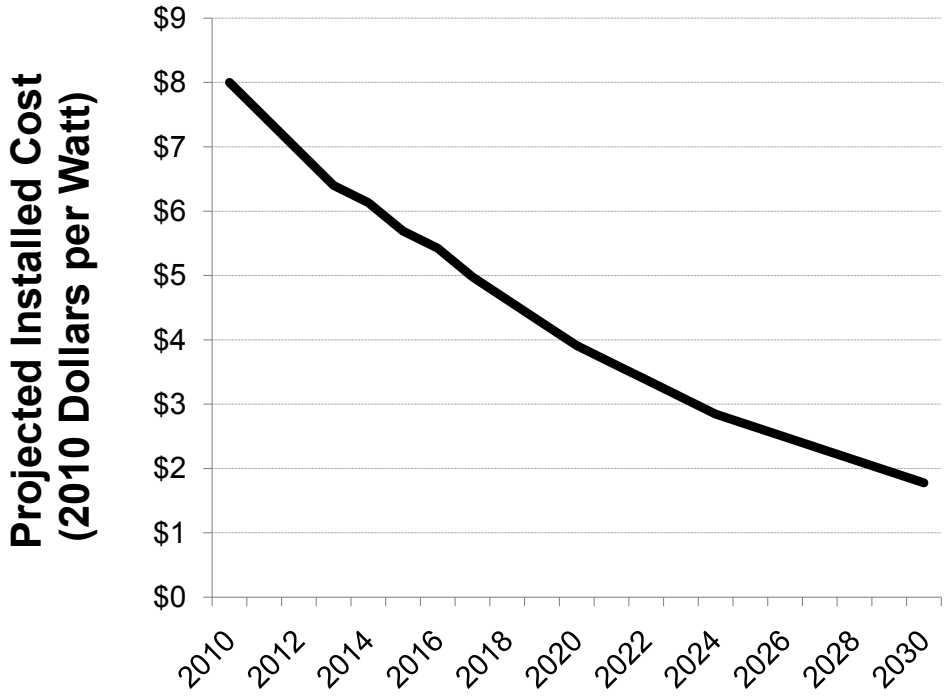
First, we developed a trajectory for installed costs for photovoltaic systems over time, starting with an approximate installed cost of $8 per watt in 2010 (close to prevailing market rates in the 2008-2009 period, but likely higher than actual installed costs in 2010), per analysis by the Lawrence Berkeley National Laboratory.[139] Next, we applied a downward cost curve over time, based on an estimate produced by the California Energy Commission.[140] The cost curve does not include the impact of tax credits or other incentives – which are important from the consumer perspective, but do not affect the overall amount of money from all sources going into solar investments, or the jobs created per unit of solar installation. Figure 8 shows this cost curve.

For each year of our solar market expansion scenario, we input both the total quantity of solar capacity installed in that year and the projected installed cost of that capacity into the JEDI model.

To make our results conservative, we assumed that all manufacturing would happen outside of North Carolina, and that all components would be purchased from out of state suppliers. Manufacturers are the least tied to local markets, since manufactured technologies can be shipped to other locations.

In contrast, installers tend to be in-state. According to a North Carolina Sustainable Energy Association survey, more than 70 percent of all energy efficiency and renewable energy firms in North Carolina report that the final

Figure 8: Projected Cost Curve for Solar Photovoltaic Installations in North Carolina through 2030



destination of the majority of their products and services is in-state.[141] For the purposes of our modeling, we assumed that 100 percent of project development, installation, operation and maintenance labor would be local.

We also calculated impacts assuming that 25 percent and 50 percent of components would be supplied by in-state manufacturers to determine the sensitivity of our estimate to the degree of local manufacturing.

Using economic multipliers derived from the IMPLAN input-output economic modeling system, the JEDI model translated spending on solar photovoltaic systems to yield an estimate of gross jobs created in full-time equivalent terms, gross wages paid, and gross cash flow stimulated. We report all dollar figures in 2010 terms, without applying a discount factor.

The JEDI Model

According to the National Renewable Energy Laboratory:[142]

The intent of Jobs and Economic Development Impact (JEDI) is to construct a reasonable profile of investments (e.g., solar plant construction and operating costs) to demonstrate the employment and economic impacts that will likely result during the construction and operating periods. Given fluctuations in power plant costs and changes in industry and personal consumption patterns, the analysis does not provide a precise forecast, but rather an estimate of overall economic impacts from specific scenarios.

The JEDI model uses basic input-output methodology. That is, dollars spent on a power generation project in a state, county or region are analyzed to determine their employment and economic impact within the local area. Local spending results from using:

- *local labor (e.g., concrete pouring jobs),*
- *services (e.g., engineering, design, legal),*
- *materials (e.g., wind turbine blades),*
- *or other components (e.g., nuts and bolts).*

Factors that are important in determining the results include the portion of project spending that goes towards purchasing products locally, and a variety of project-specific factors. Experts at the National Renewable Energy Laboratory "performed extensive interviews with power generation project developers, state tax representatives, and others in the electric power industry to determine appropriate default values contained within the models. However, actual project spending on goods and services can vary significantly by project and location."

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