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North Carolina Solar and Agriculture

NC SUSTAINABLE
ENERGY ASSOCIATION

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The NC Sustainable Energy Association (NCSEA) is a 501(c)(3) nonprofit membership organization of individuals, businesses, government, and nonprofits interested in North Carolina's sustainable energy future. Our mission is to drive policy and market development to create clean energy jobs, economic opportunities and affordable energy that benefits all of North Carolina.

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1. Executive Summary

Generating electricity from solar photovoltaic (PV) technology is growing rapidly in North Carolina. Much of this growth is due to utility-scale solar PV installations that occupy large amounts of land, in many cases formerly used for agricultural purposes. Since agriculture plays such a significant part in the state's economy, any loss of agricultural land raises concerns from stakeholders in the industry. The purpose of this publication is to inform and to dispel myths about the effects of utility-scale solar on agricultural lands in North Carolina. This report highlights many areas of the ongoing conversation about solar and agriculture with the goal of providing the most up-to-date and accurate information regarding the total amount of land used, economic impacts, environmental impacts, decommissioning, and the future of the industry.

According to a study conducted by the NC Department of Agriculture and Consumer Services and the NC Sustainable Energy Association (NCSEA), as of December 2016, only 0.19% of cropland or 9,000 acres in North Carolina has been repurposed from agriculture to utility-scale solar installations. Putting these numbers in perspective, within the last decade, there has been a 1,000,000 acre loss of cropland in North Carolina from development and housing, and solar is only about 1% of that total.

Allowing solar to generate electricity on a farm represents a stable revenue source that, in most cases, is more than typical rent payments for the land. Furthermore, the solar developer usually pays the related taxes that can arise from land use changes, which strengthens the profitability for land owners.

The environmental effects of utility-scale solar installations are minimal, especially if decommissioning responsibilities and plans are clearly defined in the contracts between land owners and solar developers.

Finally, using data from the US Energy Information Administration (EIA) and the investor-owned utilities (IOUs) that serve the state, NCSEA projected the amount of electricity that solar would generate as well as the amount of agricultural land that the new solar installations would occupy from 2017-2030. These projections show that even with solar providing more than 5% of North Carolina's electricity needs, the utility-scale solar installations that generate this electricity occupy less than 0.6% of the state's agricultural land. In other words, even as utility-scale solar PV continues to develop, it is still not a significant cause of the loss of agricultural land in North Carolina.

2. Introduction

North Carolina is an emerging leader in solar photovoltaic (PV) capacity, ranking second in the nation for cumulative solar installations as of 2016.[1] Solar-friendly policies have brought significant economic benefits to the state as the number of solar installations has increased. In fact, North Carolina's solar industry has spurred over $1.4 billion in revenues and supports over 5,400 jobs (full time equivalent jobs).[2, 3] Many of the economic development opportunities that solar has brought to North Carolina have occurred in rural areas of the state, which have historically struggled to secure tax revenues.[4] Through 2015, Tier 1 counties received over $1.6 billion and Tier 2 counties received over $2.0 billion in major solar investment projects (greater than $1 million) for a combined 87% of total solar investments in the state.[5] North Carolina's utilization of solar PV has propelled the state as a leader in policy adoption, economic success, and environmental progress in the Southeast and the nation as a whole.

Solar energy comprises 23% of all clean energy revenue in North Carolina and is a critical resource in reaching the state's Renewable Energy and Energy Efficiency Portfolio Standard (REPS) by 2021.[6,7] By increasing solar electricity generation, North Carolina has realized diverse benefits such as employment and tax revenue increases, greenhouse gas mitigation, improvements to air and water quality, and greater diversification and resilience of energy sources. To that end, developers are increasingly looking to agricultural land as a potential space to host utility-scale solar installations. Questions about solar land use, however, have arisen with this increased adoption. In response, agricultural stakeholders have expressed concerns over this trend by asking questions about potential effects on the state's agricultural industry, economy, and environment.

The purpose of this publication is to inform and to dispel myths about the effects of utility-scale solar on agricultural lands in North Carolina. Section 2 provides an overview of agriculture and its importance in North Carolina, a description of solar photovoltaic (PV) technology in the state, and how agriculture and solar technology work together. Section 3 discusses the economic implications of leasing agricultural land to solar developers from the perspective of landowners, state and local governments, and the economy. Section 4 examines the environmental impacts of utility-scale solar in North Carolina. Section 5 describes the decommissioning of solar PV installations, and Section 6 explores the future of solar and agriculture in North Carolina. In summary, this report provides a thorough understanding of the agricultural, economic, and environmental systems at play and is intended to empower agricultural stakeholders to make better informed decisions about the impacts of solar PV on agricultural land.

3. Solar and North Carolina Agriculture

Farming has been a way of life for North Carolinians for hundreds of years and agriculture is deeply ingrained in the state's heritage. Today, the agricultural economy, including food, fiber, and forestry continues to flourish and remains a staple in the state's overall economy. This section will provide an overview of agriculture in North Carolina (Section 3.1), solar PV in North Carolina (Section 3.2), and solar electricity generation on North Carolina farmland (Section 3.3).

3.1 North Carolina Agriculture

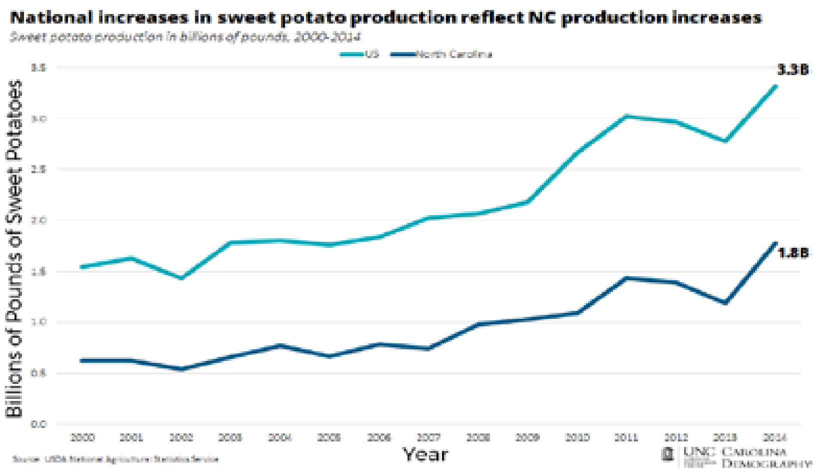
Agriculture is a significant contributor to the state's economy, adding $84 billion annually, or more than 17% of the state's income.[8] Agriculture employs over 820,000 people, which accounts for 17% of the state's workforce.[9, 10] North Carolina's 52,200 farms average about 168 acres in size and grow more than 80 distinct commodities, making the state's agricultural industry one of the most varied in the country.[11, 12] All of this is accomplished using 27% of the state's total land area, or 8.4 million of North Carolina's 31 million acres.[13]

Table 1. North Carolina's Top Agricultural Commodities

Source: NC DA&CS[14] and USDA (2016)[15]

Commodity	U.S. Rank
Sweet Potatoes	1
Tobacco	1
Poultry & Eggs	1
Hogs & Pigs	2
Turkey	2
Cut Christmas Trees	2

Figure 1. National Sweet Potato Production Reflects North Carolina Production



In addition to its significant impact on the state's economy, North Carolina's tobacco and sweet potato industries lead the nation in production (see Table 1 above). In fact, national sweet potato production is highly dependent on North Carolina's individual production (see Figure 1 above).

North Carolina also competes well against the rest of the United States in terms of farm income. The state has a net farm income of over $2.8 billion, which is seventh in the country, and an average per farm net income of over $57,000, which is tenth in the country.[16, 17] It is clear that farming is a vital component of North Carolina's economy for individuals and the state as a whole, as well as for the United States' overall agricultural production.

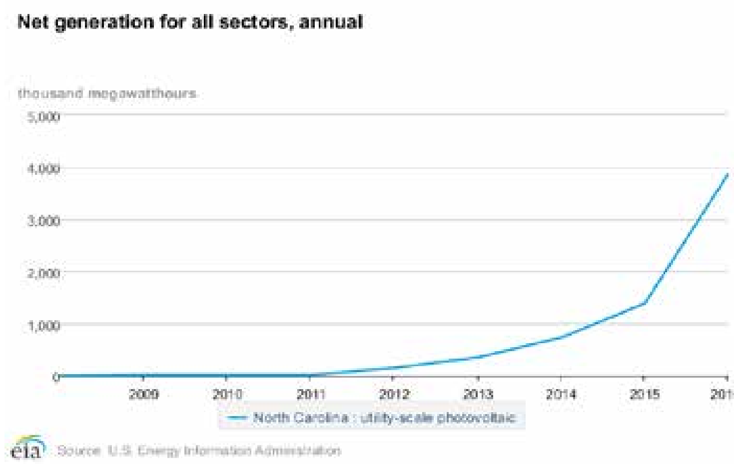
3.2 Solar PV in North Carolina

Solar electricity generation is a major contributor to North Carolina's $6.4 billion clean energy economy, adding $1.4 billion annually, or more than 23% of the state's clean energy sector income. Currently, there are more than 330 solar companies at work throughout the value chain in North Carolina which employ over 5,400 people, or 16% of the state's clean energy sector workforce.[18] These companies provide a wide variety of solar products and services that can be broken down into categories such as manufacturers, contractors, project developers, and financers.[19] Solar installations produce almost 2.5 GW of electricity while only occupying little more than 11,600 acres of North Carolina land.[20, 21]

Table 2. States with most PV Installations
Source: SEIA (2016)[22]

State	U.S. Rank
California	1
North Carolina	2
Utah	3
New Jersey	4
Nevada	5

Figure 2. Trend in Utility-Scale PV Electricity Generation in North Carolina from 2008-2015



In addition to significantly contributing to North Carolina's clean energy industry, North Carolina is also a national leader in solar PV installation as well, coming in second only to California (see Table 2 above).

Particularly since 2011, the amount of electricity generated from utility-scale PV systems in the state has greatly increased from about 1.8 GWh in 2008 to 13.7 GWh in 2015, as shown in Figure 2 above.[23]

3.3 Farmland and Solar

3.3.1 Effects on Land

Some agricultural stakeholders believe that once farmland is used for solar installations, it can no longer be used for farming and claim that efforts required to maintain the solar infrastructure can have lasting impacts on future farming potential.[24] Evidence, however, suggests that the long-term effects of solar panels on farmland are minor and manageable, especially because decommissioning plans and budgets are standard in the initial project development phase and lease agreements. For example, although solar installations can slightly affect the permeability of the surface, if solar panels are elevated during installation without significantly affecting the surface vegetation, the permeability of the surface can be preserved.[25] This adjustment can be accomplished by both allowing vegetation to grow under and between the arrays and by spacing the arrays so that storm water can enter the soil without creating additional runoff.

3.2.2 Total Amount of Land Used by Solar Installations

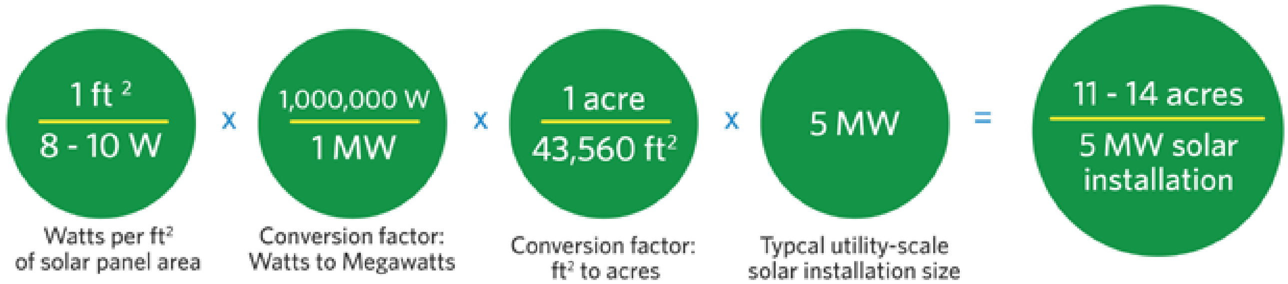
Figure 3. Waco (6.4 MW) Installation in Cleveland County, NC
Source: Strata Solar (2016)[26]

There is a total of 4,745,014 acres of agricultural land in North Carolina.[27] NCSEA and the NC Department of Agriculture & Consumer Services (NCDA&CS) conducted a joint study to determine the exact impact of North Carolina's utility-scale solar facilities on the land. The study used aerial photography and GIS mapping of all the ground-mounted solar PV installations in the state, and this nine-month analysis found that, as of December 2016, the total area of land occupied by solar PV installations in North Carolina is estimated to cover 11,559 acres.[28] Of these 11,559 acres, 9,074 were formerly used as farmland, which means 0.2% of farmland has been converted from farmland to solar installations.[29]

3.3.3 Solar Installation Footprint

In general, a utility-scale solar installation requires between 3 and 6 acres of land for every megawatt (MW) of generating capacity. Exact figures, however, vary depending on the specific technology used as well as the design of the solar installation.[30] In North Carolina, many utility-scale solar installations are approximately 5 MW and occupy between 20 and 35 acres of land. Smaller installations of around 2 MW require about 6-12 acres of land. These acreage values are the total area of the solar installation and represent the land enclosed by the site boundary. The direct area of the solar installation, or the land occupied by solar arrays, access roads, substations, service buildings, and other infrastructure for PV installations, ranges from 2.2 acres/MW for small installations to 12.2 acres/MW for large installations.[31] In general, according to NCSEA and NCDA&CS' aerial photography and GIS study, solar installations occupy about 5.78 acres/MW.[32] This figure, however, should decrease as technology continues to improve.

Figure 4. PV Panel Area Requirements for Utility-Scale Solar Installation



A typical solar panel will produce 8 - 10 watts per square foot of solar panel surface area, which translates to 11 to 14 acres of panels for a 5 MW installations, as calculated in Figure 3 above.[33]

3.3.4 Dual Land Use

It is possible to successfully combine solar electricity generation and agriculture on the same piece of land. For example, one solar developer, 02 emc, has integrated solar PV with sheep grazing at 6 of their 10 solar installations in North Carolina. [34] This partnership between 02 emc and Sun-Raised Farms is a great example of the mutually beneficial relationship between these two industries. Electricity is successfully generated on the same land on which sheep are raised. This affiliation between these two businesses demonstrates the viable business of a technology use and a traditional use.

A number of ongoing research projects conducted through top institutions in the state, including NC State University's Clean Energy Technology Center and the University of North Carolina at Chapel Hill's School of Government, are studying the short-term and long-term effects of solar PV on agricultural land as well as providing guidelines for decommissioning solar installations. [35] In addition, researchers at Appalachian State University have integrated small-scale farming operations with solar PV power and other sustainable practices in order to combine crop production and energy generation on the Sustainable Development Teaching and Research Farm. [36] North Carolina's agricultural industry leaders have direct access to a variety of research projects conducted by these premier universities in order to seamlessly and safely combine solar power generation and agriculture.

4. Economic Impacts

Investment in solar PV has the potential to benefit not only solar developers, but also agricultural landowners, state and local governments, and North Carolina as a whole. The following sections will explore how solar PV development on agricultural lands affects individual property owners (Section 4.1), state and local tax revenues (Section 4.2), and the statewide economy (Section 4.3).

4.1 Revenue and Costs for Property Owners

4.1.1 Potential Revenues

Agricultural landowners earn greater income from leasing land to a solar developer than from traditional agriculture operations. Solar companies typically make annual rent payments of $500 or more per acre, whereas the average 2015 rent in North Carolina for crop and pasture land is much lower, only ranging from $27 to $102 per acre. [37, 38, 39] While the average revenue generated from traditional agricultural production is slightly higher than solar rents, the costs landowners incur from leasing out land are likely considerably lower than operational costs of farms, as the primary costs of leasing land to solar developers are income and property taxes (see Section 4.1.2).[40, 41]

Furthermore, solar energy systems provide opportunities for farmers to diversify their income as well as provide a reliable revenue stream for the landowner over the lease term. More importantly, this is a revenue stream that is not tied to weather patterns or fluctuations of commodity markets.[42] In fact, according to the National Agricultural Statistics Service of the U.S. Department of Agriculture, solar rent payments can be more lucrative per acre than the sales per acre of nine commodities in North Carolina including soybeans, wheat, and barley.[43, 44]

As previously stated, the average ground mounted utility-scale solar installation in North Carolina is 33.9 acres while the average farm in the state is 168 acres.[45] Assuming an annual rent payment of $500 per acre, this means a typical solar installation will generate $16,950 per year for its land owner.[46] According to the 2012 U.S. Department of Agriculture Census of Agriculture, the average net cash farm income per farm is $57,042.[47] This means that solar installations generate about 30 percent of the income of a whole farm while occupying about 20 percent of the land.

Project developers typically lease land from private landowners for a 20 to 30-year period. In some cases, however, the project developer will also be the landowner.[48] Even though solar lease terms and payment options can vary greatly, developers own the solar equipment and are responsible for the design, permits, and installation of the PV system. Payments to landowners can take the form of lump-sum payments at the beginning of the lease, annual fixed payments per solar panel, or payments based on a percentage of electricity returns.[49] If a landowner sells the property during the lease term, the terms of the lease agreement may transfer to the new owner.[50]

4.1.2 Potential Costs

Property owners who lease land to solar developers must pay regular state and federal income taxes on the lease payments.[51] In addition, landowners may also need to pay property taxes, deferred taxes, and decommissioning costs. In most cases, the project developer will assume responsibility for these additional costs incurred.

Solar PV installations are considered property improvements and thus are subject to property taxes.

These taxes are typically 20 percent of the market value of the PV system.[52] The party responsible for paying the property tax will vary from lease to lease, but is typically the developer. [53] Regardless, taxes are levied for the lifetime of the photovoltaic solar electric system, typically 20 years. [54] A North Carolina property tax abatement, however, exempts 80% of the appraised value of a solar PV system from property taxes.[55]

Installation of solar PV systems may also trigger deferred taxes. The party responsible for these taxes is defined in the lease and usually the system owner. Taxes on agricultural land in North Carolina are based on the land's Present Use Value (PUV), which is its ability to produce income. Property taxes, on the other hand, are typically based on a land's market value.[56] Agricultural landowners generally owe fewer property taxes because PUV of a tract of land is significantly less than the market value for the same piece of land.[57] If land is no longer used for agriculture, the landowner owes the difference between the market value and the PUV as "deferred taxes for the current year and the three previous years with accrued interest."[58] Minimum requirements in income and production must be met for a tract of land to qualify for agricultural PUV and these may not occur once solar panels are installed.[59, 60] Lease agreements include language specifying the landowner's fiscal responsibility in the case of deferred tax liability.[61] Nonetheless, if solar PV and a form of agricultural production, such as livestock grazing, occur simultaneously on the same piece of land, that land may still qualify for agricultural PUV and deferred taxes would not be owed.[62]

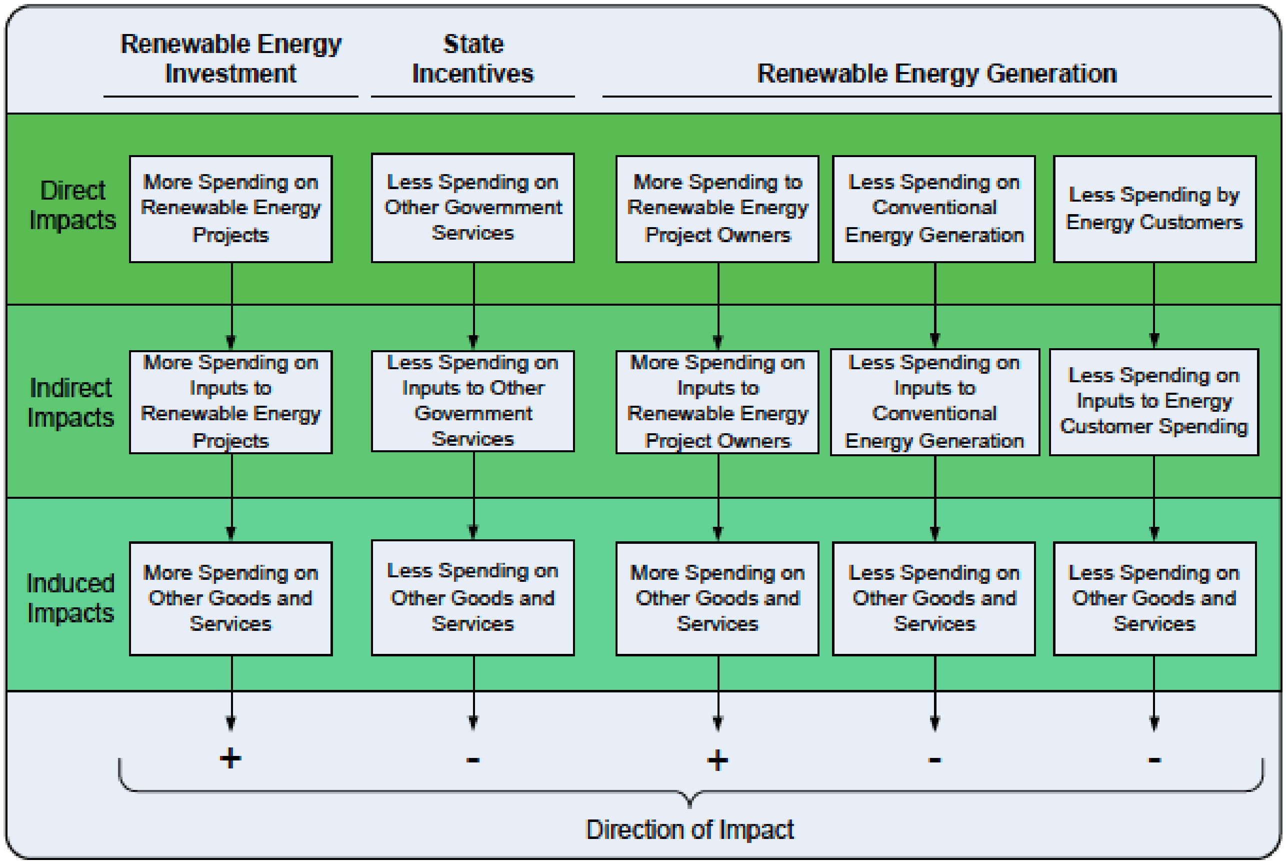
4.2 Tax Revenues

Exact figures for the total revenue generated from solar PV installations in North Carolina are unknown. Determining the portion of revenue generated from solar installations on agricultural land is also difficult. But between 2007 and 2015, over $2 billion was invested in utility-scale solar PV projects in North Carolina.[63] In 2015 alone, over $351 million business-related renewable energy tax credits were claimed for solar electric projects, representing over $1 billion property costs for North Carolina. Furthermore, solar electric projects comprised 78% of the projects claimed and 87% of the credits generated.[64] Most importantly, each dollar of renewable energy tax credit claimed translates to $1.64 in tax revenues for state and local government.[65]

4.3 Additional Economic Impacts

Investments in solar PV systems have direct impacts on employment, both state and local tax revenues, and gross state product (GSP). Investments may also induce indirect impacts through supply chain spending, income changes, and consumer spending changes. The direction of these indirect impacts is ambiguous since positive influences on supply chain spending and employment for the solar PV industry are counteracted by negative influences for the conventional energy industry. Figure 5 summarizes the direct and indirect impacts from renewable energy investments.

Figure 5. Renewable Energy Direct and Indirect Economic Impacts
Source: RTI International (2016)



Although the magnitude of direct and indirect effects on North Carolina's economy from solar PV investments on agricultural land is unknown, RTI International's *Economic and Rate Impact Analysis of Clean Energy Development in North Carolina - 2016 Update* estimates a cumulative net positive impact on GSP, employment, and tax revenue across all renewable energy technologies. Another potential source of avoided cost to solar owners is through the Modified Accelerated Cost-Recovery System (MACRS). This program allows solar system owners to depreciate their solar system over a five-year period, which reduces the overall tax burden.

5. Environmental Impacts

Installing more solar PV has both advantages and some slight disadvantages in terms of environmental impact. Despite relatively small potential negative environmental effects, solar PV still mitigates environmental degradation caused by electricity generation from fossil fuels such as coal and natural gas. The following sections will discuss PV's environmental impacts such as toxic chemicals (Section 5.1), greenhouse gases (Section 5.2), air quality (Section 5.3) and water (Section 5.4).

5.1 Toxic Chemicals

Although solar panels contain some caustic chemicals, they are sealed and the chemicals enclosed such that they cannot mix with water or vaporize into the air.[68, 69] Furthermore, most panels are made with tempered glass and are manufactured to endure all weather conditions, even weather events such as hail. Solar PV panels are even regularly installed in Arctic and Antarctic climates. Finally, in cases of fire, solar panels must reach a temperature of 1000° C before they emit toxic substances. These temperatures would be rare at solar installations, due to the lack of fuel for fires to burn. For example, grass fires do not typically burn hotter than 200° C. [71]

5.2 Greenhouse gases (GHG)

North Carolina's Renewable Energy and Energy Efficiency Portfolio Standard (REPS) mandates that all investor-owned utilities (IOUs) in North Carolina supply 12.5% of their in-state electricity sales from renewable energy resources by 2021.[72] While the REPS does not mandate Energy Efficiency measures be used to meet its requirement, it does allow Energy Efficiency to make up 25 percent of the general REPS requirements and then up to 40 percent for 2021 and beyond.[73] One of the greatest advantages of incorporating renewable energy into the energy mix is reduction of greenhouse gas (GHG) emissions, since solar systems do not emit them during operation.

For example, the Strata Solar installation in Chapel Hill has a 1 MW generating capacity. The electricity generated from the installation is enough to supply 116 homes with energy, and the carbon dioxide emission avoided by generating this electricity with solar instead of burning fossil fuels is approximately 660 tons per year.[74] This is significant because carbon dioxide is the most common greenhouse gas. Currently, North Carolina has 2,531MW of installed PV capacity and is likely to install an additional 3,479 MW of PV systems within the next five years.[75] The state's current PV capacity reduces carbon dioxide emissions by 752,400 tons per year and is on track to reduce carbon dioxide emissions by 3 million tons per year within five years.

5.3 Air Quality

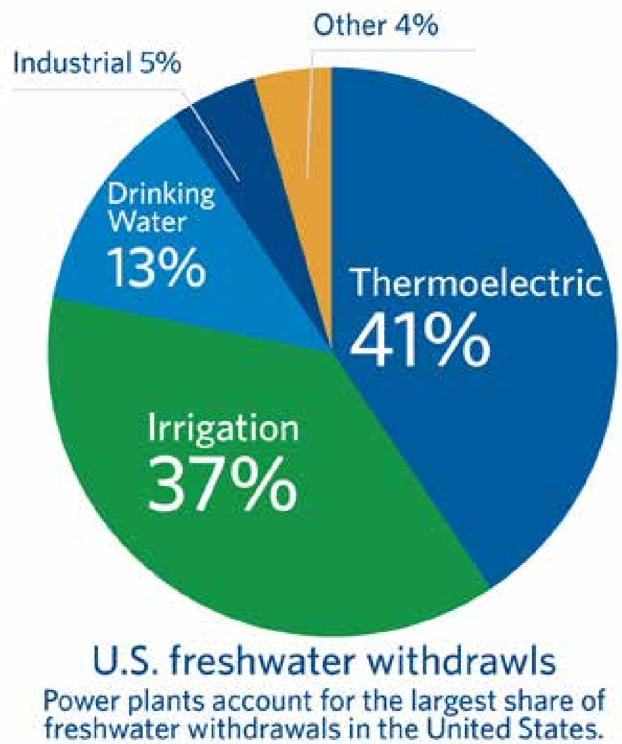
Solar electricity generation reduces harmful air pollutants by replacing fossil fuels such as coal and natural gas. It is important to understand the effects of conventional energy sources to grasp the importance of switching to solar PV. Coal is currently one of the largest fuel sources for electricity generation in the United States.[76] In addition to being a major contributor of greenhouse gas emissions, generating power from burning coal also emits sulfur dioxide, nitrogen oxide, particulate matter, and mercury. Other harmful pollutants emitted from coal plants include lead, cadmium, carbon monoxide, hydrocarbons and arsenic.[77] Each of these substances detrimentally affects the health of both plants and animals when it is released into the atmosphere. Although these emissions can be controlled by technology, most U.S. coal plants have not installed these technologies because of their cost.[78]

5.4 Water

As shown in Figure 6, water used by power plants for thermoelectric energy production is the largest cause of freshwater withdrawal in the United States. This means that while an average American family of four people may directly consume 400 gallons of water per day, the family also indirectly consumes about 600-1800 gallons more water per day when accounting for water utilized in the generation of electricity that they use.[79]

Figure 6. U.S. freshwater withdrawals

Source: Union of Concerned Scientists (2010)[80]



If the United States could reach 80% renewable electricity by 2050, the annual water use of the power sector would be reduced by roughly 50%.[81] This means that conversion from fossil fuel-fired power plants to solar PV systems would also save water consumption by up to 300 gallons per day for a four-person family.

Reducing the use of water insulates North Carolina from the risk of a water supply shock. For example, in 2016, seven Western North Carolina counties experienced "severe drought conditions" as declared by the North Carolina Drought Management Advisory.[82] These types of severe droughts affect power generation as well as agriculture. Reducing the water used in electricity generation, therefore, would provide water security for farmers and protect North Carolina's agricultural industry.

6. Decommissioning

Decommissioning is an important step in the life of a solar facility. Although solar PV systems have minimal environmental impact, deconstructing the equipment requires proper care to ensure the land returns to its original use, whether that is agriculture or some other purpose.

6.1 Decommissioning Responsibility

Generally, decommissioning responsibilities are lease-specific and may be regulated under a county ordinance.[83] Developers assume responsibility for solar equipment removal from the leased property at the end of the contract but not all leases contain a decommissioning provision.[84, 85] Though decommissioning costs can be high, it is possible to receive a positive net profit through salvaging the remaining components.[86, 87] To address concerns about the decommissioning process, stakeholders, including solar developers, government officials, non-profits, planners, and citizens, convened in a series of forums and working group meetings in 2012 and 2013 to build a template solar development ordinance as a guide for local jurisdictions.[88] The template ordinance requires a decommissioning plan specifying the party responsible for the decommissioning, the terms of removal and restoration of the land, and a timeline for the decommissioning project.[89] To protect the party not originally deemed responsible for decommissioning costs, these stakeholders intentionally did not include a financial surety requirement in the template ordinance.

6.2 Waste Management

According to the Solar Energy Industries Association (SEIA), a PV panel has a life cycle of 20-30 years. [90] Throughout its lifetime, the panel capacity does not diminish, meaning panels installed in the early 1980s still perform at its original capacity.[91] And, even at the end of its life cycle, 90-95% of a PV panel is recyclable.[92]

Despite the rapid growth of North Carolina's solar power, the waste from retiring a PV panel is substantially less than what may be expected. While both silicon and cadmium telluride solar panels contain chemicals, both pass the Toxic Leaching Characteristics Procedure Test, a method designed by the EPA to "determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes." This means that the panels can be sent to regular landfills when they reach the end of their lifetimes.[93, 94]

7. Projections for 2017 - 2030

NCSEA collected historical data on utility-scale solar installations and future installations projected by the IOUs in the state. Based on this work, NCSEA calculated solar's share of total electricity generated in the state as well as the percentage of agricultural land that solar PV installations would occupy in the near future.

7.1 Contribution of Solar to Total Electrical Generation

In order to predict the amount of land that utility-scale solar installations will occupy in the future, NCSEA downloaded data from the U.S. Energy Information Administration's Electricity (EIA) Data Browser for North Carolina. This website has data for total electrical generation as well as the amount of electricity generated exclusively from utility-scale solar.[95] NCSEA also retrieved the projected amount of solar energy added to the grid by Dominion North Carolina Power, Duke Energy Progress, and Duke Energy Carolinas from 2017-2030 based on their Integrated Resources Plans (IRPs).[96, 97, 98]

None of the three utilities operate exclusively in North Carolina. Duke Energy Progress and Duke Energy Carolinas cover both North Carolina and South Carolina and Dominion operates in North Carolina and Virginia. Therefore, the projected solar generating capacity published in the IRPs had to be separated into what would be located in North Carolina and what would be located elsewhere. For the Duke Energy Carolinas and Progress additions, NCSEA calculated the percentage of North Carolina generating capacity using the summer and winter electricity generating totals provided in the IRPs. NCSEA then averaged the respective percentages and multiplied the result by the total solar generation each firm projected. The combination of these values is the total amount of projected solar electrical generation capacity that would be added by Duke Energy in North Carolina from 2017-2030.

For Dominion, NCSEA used electricity sales data from 2005-2014 to calculate the percentage of electricity sold by Dominion to North Carolina customers. Then, NCSEA multiplied that percentage by the projected amount of utility-scale solar electricity generated. Finally, NCSEA added the estimates for the new utility-scale solar for Duke Energy and Dominion to arrive at the total amount of solar electrical generating capacity from 2017-2030.

Using linear regression and the data from EIA, NCSEA estimated the total electrical generation in the state from 2017-2030. NCSEA then divided the projected amount of new solar in the state by the estimated total electrical generation to predict the percentage of total electricity generated in North Carolina by utility-scale solar from 2017-2030. Figure 7 on page 16 shows this in tabular form.

Figure 7. Projected percentage of electricity generation contributed by utility-scale solar

Year	Total Electrical Generation (GWh)	Total Projection of New Solar (GWh)	Percentage of Electrical Generation from Solar
2017	126,728	2,961	2.34%
2018	126,914	3,495	2.75%
2019	127,101	4,079	3.21%
2020	127,287	4,570	3.59%
2021	127,473	5,064	3.97%
2022	127,660	5,416	4.24%
2023	127,846	5,594	4.38%
2024	128,032	5,744	4.49%
2025	128,219	5,882	4.59%
2026	128,405	6,014	4.68%
2027	128,591	6,146	4.78%
2028	128,778	6,273	4.87%
2029	128,964	6,395	4.96%
2030	129,151	6,491	5.03%

7.2 Agricultural Land used by Solar from 2017-2030

After determining the electricity generated from utility-scale solar in the next 15 years, NCSEA calculated the amount of farmland occupied by the new installations. NCSEA assumed agricultural land as cropland. Cropland totals for North Carolina were extracted from USDA Censuses of Agriculture conducted from 1925-2012.[99, 100, 101]

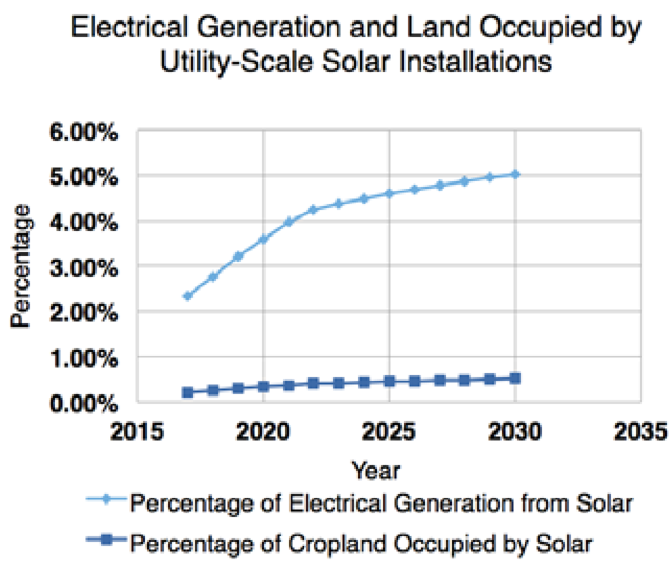
Figure 8. Projected percentage of cropland occupied by utility-scale solar

Year	Total Cropland (Acres)	Projected New Land Occupied by Solar (Acres)	Percentage of Cropland Occupied by Solar
2017	4,833,141	11,494	0.24%
2018	4,803,821	13,566	0.28%
2019	4,774,502	15,832	0.33%
2020	4,745,183	17,738	0.37%
2021	4,715,864	19,653	0.42%
2022	4,686,545	21,020	0.45%
2023	4,657,226	21,714	0.47%
2024	4,627,907	22,294	0.48%
2025	4,598,588	22,828	0.50%
2026	4,569,269	23,343	0.51%
2027	4,539,950	23,853	0.53%
2028	4,510,630	24,347	0.54%
2029	4,481,311	24,822	0.55%
2030	4,451,992	25,192	0.57%

To project the North Carolina land occupied by utility-scale solar from 2017-2030, NCSEA multiplied the projected additional solar generation capacity by the 5.78 MW/acre value used in the NC Department of Agriculture/NCSEA land analysis (recall this is the number for the average amount of land covered per MW of generation).

Finally, after assuming that all the new utility-scale solar would be installed on agricultural land, NCSEA divided the land occupied by solar facilities by the total agricultural land to calculate a percentage of agricultural land used by solar for every year from 2017-2030. Figure 8 shows this in tabular form.

Figure 9. Projected percentage of electricity and agricultural land occupied by utility-scale solar installations from 2017-2030



8. The Future of Solar and Agriculture in NC

In recent years, North Carolina created a supportive environment for solar energy's growth. Rooftop solar is an important contributor to North Carolina's clean energy industry, but the state will not be able to meet its renewable energy goals without the continued development of utility-scale solar. As demand for solar electricity in North Carolina increases and prices fall due to improvements in solar PV technology and energy storage becomes deployed, investments in solar electricity generation will continue its upward trend. Despite the recent boom in the industry, though, the retirement of the state renewable energy investment tax credit will likely signal a slower rate of growth over the next few years until developers adjust to a new regulatory environment.

Agriculture in North Carolina affects the livelihood of the state's residents and the nation as a whole. Furthermore, North Carolina's agricultural industry is a crucial cultural and economic cornerstone. For these reasons, it is important that the expansion of solar energy generation onto agricultural lands does not undermine it.

As farmers look to diversify income sources, solar leasing provides an opportunity to incorporate energy generation into their financial portfolio without seriously limiting production. Solar installations do not and will not compromise agricultural production in the state as around 0.18% of all farmland in the state is currently occupied by PV systems. This directly disputes concerns about solar seriously threatening agricultural land. In fact, agrivoltaic systems offer the opportunity to minimize the perceived trade-offs between solar electricity generation and agricultural production by combining the two activities. In addition to crop-based agrivoltaic systems, livestock can be raised in conjunction with solar PV and result in minimal impact on productivity.[102] Furthermore, the sweet potato, a staple of North Carolina agriculture, is an experimentally-verified shade-tolerant crop which makes it a promising candidate for agrivoltaic production.[103]

The combination of solar PV and agricultural lands stands to benefit landowners, solar developers, and the North Carolina economy. Policy makers, however, must continue to make adjustments to support all parties as the utility-scale solar industry matures and the number of agricultural participants in the budding energy sector expands. The support and participation of landowners, solar developers, and policy makers will sow the seeds not only for a mutually beneficial relationship between the energy and agricultural sectors, but also for North Carolina's continued economic growth.

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