12E. PUBLIC HEARING ZONING MAP AMENDMENT GEENEX

This public hearing is held pursuant to Section(s) 15.2-1427 and 15.2-2204 of the Code of Virginia, 1950, as amended to consider a request by GEENEX c/o Jürgen Fehr, applicant, on behalf of Richard W. Vaughn, owner, for a Zoning Map Amendment from A-1, Agriculture, which permits general agriculture, farming and forestry, and certain residential, institutional, commercial, and industrial uses to CM-2, Conditional General Industrial with conditions to construct a solar power generating facility and general agriculture, farming and forestry and single family dwelling ancillary to general agriculture on a portion of each of the properties referenced in item 12D above (CPA 2016:02). The properties are located in the general area of 31118 Meherrin Road, Boykins, are generally located on both side of Meherrin Road (SR 35) between General Thomas Highway (SR 671) and Lassiters Drive, a private road, and total approximately 422.72 acres. The properties identified as Tax Parcels 100-14, 100-14C, 100-14D, 100-31, 100-31A, 100-31B, 100-31C and 100-31D are all designated "Agriculture, Forestry, Open Space, Rural Residential" in the 2015-2025 Southampton County Comprehensive Plan, and the density range in that classification provides "limited low-density residential development and accessory units may be permitted subject to the current options outlined in the Rural Residential section of the Zoning Ordinance." The properties are all listed above in item number 12D (CPA 2016:02) and are located in the Boykins Voting and Magisterial Districts.

The notice of public hearing was published in the Tidewater News on September 11 and September 18, 2016 and all adjacent property owners were notified as required by law. Following its public hearing on August 11, 2016, the Southampton County Planning Commission deferred action until its next meeting on September 8, at which time they resolved to recommend denial of the application on a 5-1 vote.

After conclusion of tonight's public hearing, the Board of Supervisors will consider the comments offered this evening and will proceed to approve, deny or defer action on the request.

Mrs. Beth Lewis, Secretary to the Planning Commission, will provide introductory remarks after which all interested parties are invited to come forward and express their views.

MOTION REQUIRED: **If the Board is so inclined, a motion is required to accept the Planning Commission recommendation and deny the Zoning Map Amendment.**

RZA 2016:05

Owner:	Richard Vaughan
Applicant:	GEENEX c/o Jürgen Fehr
Application Request:	Zoning Map Amendment

IDENTIFICATION AND LOCATION INFORMATION

Current Comprehensive Plan designation:	Agriculture/Forestry/Open Space/Rural Residential The requested Plan amendment would change the designation to Institutional.
Requested Zoning Designation:	CM-2, Conditional General Industrial with conditions
Current Zoning:	A-1, Agricultural
Acreage:	422.72 acres +/- total 396.0 acres within the Limit of Development
Proposed Use:	Solar photovoltaic electric power generating facility, 24 MW
Tax Map No.:	100-14, 100-14C, 100-14D, 100-31, 100-31A, 100-31B, 100-31C, 100-31D
Location:	The properties are located in the general area of 31118 Meherrin Road, Boykins, are generally located on both sides of Meherrin Road (SR 35) between General Thomas Highway (SR 671) and Lassiters Drive, a private road.
Magisterial District:	Boykins
Voting District:	Boykins
Adjacent Plan designations:	North: Agriculture/Forest/Open Space/Rural Residential South: Institutional, Agriculture/Forest/Open Space/Rural Residential East: Agriculture/Forest/Open Space/Rural Residential West: Agriculture/Forest/Open Space/Rural Residential
Adjacent Land Use:	North: Agriculture/forestry South: Agriculture/forestry, Boykins cemetery East: Agriculture/forestry West: Agriculture/forestry

LAND USE ANALYSIS

Overview

This request is for a zoning map amendment for eight (8) parcels near the Boykins-Newsoms area to allow the development of a solar photovoltaic electric power generating facility. The following conditions are provided:

The Property may only be used for one of the following uses:

- Solar power generation facilities, together with the accessory structures and infrastructure required for their operation and maintenance;
- General agriculture, farming and forestry activities as specifically defined in Section 18-1 of the Southampton County Code of Ordinances;
- A single family residential dwelling ancillary to the general agriculture, farming and forestry activities as specifically defined in Section 18-1 of the Southampton County Code of Ordinances; and
- Uses and structures that are customarily ancillary to the above-listed uses.

A draft decommissioning plan is provided with a minimum amount of surety set at $60,000. Such plan shall be reviewed every five (5) years and the surety amended if necessary.

Following are some unanswered questions regarding the proposal:

- No landscape plan for ground cover within the project or buffering around the project along the abutting roadways is provided.
- Little topography information as required in a preliminary site plan is provided.
- No wetland or floodplain information is provided, although both are shown on this property in the areas it abuts the Southampton Solar project as shown on Southampton Solar's plans.
- No driveway locations or types are provided so review by VDOT is limited.
- No fencing information is provided, either as to location or type.
- No details of any invertor structures are provided.
- No information is provided as to when or if commercial delivery of power will commence.
- No proffers are provided regarding training for first responders, landscape or buffering plan, glare or view shed issues in the future, care of any landscaping or fencing, single point of contact, how to resolve maintenance issues.

Projects such as this require a number of layers of review and approval. The County review considers land use and zoning issues. The PJM Interconnection Grid performs a review to analyze the project in the context of the 13-state electric power transmission grid. This project has not undergone such review so no interconnection rights have been established. The Virginia Department of Environmental Quality also reviews the plans and coordinates review through various state agencies to evaluate impacts on the natural and cultural resources. These agencies include the Department of Game and Inland Fisheries, the Department of Conservation and Recreation, the Department of

Historic Resources, and Department of Mines, Minerals, and Energy, and the State Corporation Commission.

Economics

The local extension office was asked for information regarding the change of property use from agriculture to solar energy generation. Following is the information received:

> I have not been able to locate an economist who can calculate that cumulative impact (i.e. the dollars that get recirculated locally - output/employment multipliers) of say an average cotton acre. I have attached a cotton budget and you can see that even though the landowner doesn't receive $700/ac/yr that there is about $700/ac/yr that gets spent on that acre in the way of seed/fertilizers/insurance/labor/hauling/tractors/etc. Some of that $700 is likely to get spent several times before leaving Southampton county. But on short notice, I can only circumstantially determine how many times.
>
> Likewise peanuts at about $650/ac/yr variable expenses are attached.

Site Topography and Characteristics

Reference the summary provided with the staff report for CPA 2016:02 for discussion of the soil survey report. No information was provided in the application regarding topography, wetlands, floodplains, any topographical features.

Transportation

The properties are all served by existing public rights-of-way. VDOT is unable to review driveways because no information was provided in the application.

Environmental

The properties are in agricultural or forest use now. Erosion and sedimentation control measures will be required during construction, and the properties will be required to follow the County stormwater management ordinance as well. Existing wetlands within the properties are not provided but will need to be delineated and avoided.

From the local extension office:

> The soil/property will likely be in quite poor condition after the 30 years. This may be better determined contractually on how the decommissioning is performed. Significant preparation (i.e. tillage/foreign material removal) would need to be done and nutrients replenished (i.e., lime / potash / etc.) and if they dig too deep then sometimes soil structure becomes disturbed. Case in point, the farms to our west where the titanium was mined are much less productive than they were prior to mining.

Utilities
The properties will require no well or septic service. Overhead power lines are available in the area.

Community Comments
Comments were provided at the August 11, 2016 Planning Commission meeting. Proponents and opponents spoke, with comments fairly evenly split. Prior to the September 8 Planning Commission meeting, a number of written comments were provided to the Planning Commission for review as well. The proponents both in person and in writing spoke of economic development, financial security of the families whose property in included, property rights, and the need to be forward-looking. The opponents spoke and wrote of the loss of productive farmland, the loss of the jobs and the money circulated in the community through the work of agriculture, the concern that solar panels will proliferate throughout the county, and the loss of the agrarian heritage of the community.

CONCLUSION

Strengths of application:

- While the industrial uses permitted in the M-2 zoning designation are varied and some may have a negative impact on surrounding agricultural uses, the conditions limit the property to only solar energy generation and agricultural uses, providing protection for the surrounding properties. Any uses besides those outlined in the proffers would require a subsequent zoning map amendment, and those uses would be limited by the Institutional Plan designation if approved.
- Providing a means for families engaged in agriculture to have a steady stream of income not affected by the volatility of the agricultural markets through land leases for solar energy generation may provide those families a way to continue to participate in agriculture on the remaining portions of their properties.
- Once construction is complete, solar energy generation is relatively quiet. Little traffic is generated. No odors, smoke, or vibrations are emitted. No outside storage of fuel occurs. Once construction is complete, the site will remain as it is except for maintenance and repairs for the lease period.
- Property in use for activity besides agriculture and forestry typically makes a larger contribution to the County's tax base than property in agriculture and forestry use. In the instance of solar energy generation, few demands on County infrastructure will be required.

Weaknesses of application:

- In a community with strong agricultural ties, removing land from agricultural use may be seen as a threat to the future of agricultural uses in the area.
- While the conditions limit the M-2 uses to solar energy generation and agricultural uses, introducing any industrial designation in an agricultural area, limited or not, may be seen as a step to further industrialization in the area.

- Little is known about the viability of the land for agriculture after decommissioning. It is seen by the Extension Service that the land will likely be in poor condition at the end of the lease period.
- The economic impacts on the businesses that serve the agricultural industry are unclear.
- No landscape or buffering plans are provided, and no provisions for screening future residential properties are provided.
- While under construction, the sites are industrial in nature. The staging area accommodates a large number of vehicles and a great deal of material storage takes place.

PLANNING COMMISSION ACTION

The Planning Commission held a well-attended public hearing on August 11, 2016. A number of speakers provided comments, both in favor and in opposition to the request. Due to the lateness of the hour, the Planning Commission, at the conclusion of the public hearing, voted to close the public hearing and deliberate at the September 8, 2016 meeting.

The Planning Commission discussion that took place for the Southampton Solar LLC project was in effect the same discussion that took place for the GEENEX project. The loss of agricultural land, the effect on the agricultural community, the fear that these two requests are the first of a number of such requests that would have a negative effect on the County were all topics of discussion.

Discussion continued as to the proposed decommissioning plan and whether sufficient funds would be proposed as the minimum to clean up the site when the installation is no longer in use.

A motion was made to deny the requested zoning map amendment. Five voted in favor of the motion, while one voted in opposition to the motion to deny the request, and a recommendation of denial of the request is forwarded to the Board.

SUPPORT INFORMATION AND ATTACHMENTS

1) Staff Analysis
2) Application
3) Notification of adjacent landowners
4) Site map

Signs posted
Letters mailed
Legal ad Tidewater News

To:	Southampton County Board of Supervisors
From:	Geenex Solar
Date:	**September 20, 2016**
Re:	**REVISED** Beetle Solar, LLC CUP Application For 26 MW Solar Facility

Geenex Solar is pleased to submit an updated Conditional Use Permit / Rezoning application for the Southampton County Board of Supervisors' public hearing on October 24, 2016. There have been a few minor updates in these materials from the version the Planning Commission reviewed, most notable being a change in the system size from a 24 MW to a 26 MW solar photovoltaic facility. All additional changes are in relation to this slight increase in the system's energy production capabilities.

Southampton County
Mail to: Franklin Southampton Community Development
207 W 2nd Avenue, Franklin, VA 23851
757-562-1003

APPLICATION FOR:

REZONING	COMPREHENSIVE PLAN AMENDMENT	CONDITIONAL USE PERMIT
X	X	X

CONTACT INFORMATION

Applicant or Representative Name: Beetle Solar LLC c/o Jürgen Fehr

Address: 5960 Fairview Rd, Suite 400

City, State, Zip: Charlotte, NC 28210

Phone: Day 704.907.7163___ Evening ____________________ Mobile ____________________

Owner Name: Richard W. Vaughan

Address: 136 S Garris St.

City, State, Zip: Lasker, NC 27845

Phone: Day _________________ Evening ____________________ Mobile ____________________

PROPERTY INFORMATION

Address or Location: Vicinity of 31118 Meherrin Rd_

Tax Parcel Number: 100-14 (partial), 100-14C, 100-14D, 100-31, 100-31A, 100-31B (partial), 100-31C (partial), 100-31D

Total Acreage of Parcel: _422.72 ac________

Amount of above acreage to be considered: _396.0 ac_____

Current Use of property: _Agricultural____________________________________

Rezoning request from __A-1________________ to ____CM-2______________________

Comprehensive Plan request from _Agricultural______ to ___Institutional________

Conditional Use request: Section ___18-313 (38)_________ of the Southampton County Code

Give a brief description of the application request (attach additional sheets if necessary):

____To develop and maintain the property as an industrial facility capable of producing __

______solar generated power. The facility will not produce any hazardous waste. The___

______facility will not require operating personnel therefore no potable water or________

_______wastewater infrastructure will be required. _________________

Required Items to be submitted with application:

__X___ Application Form

__X___ Application Fee of $1,000 payable to City of Franklin

__X___ Cover Letter

__X___ Site Plan / Exhibit

__X__ Proffer Statement (if applicable)

__X___ Other (To be determined by agent)
(Special Limited Power of Attorney form)

Note: If applicant is anyone other than the fee simple owner, written authorization of the fee simple owner designating the applicant as the authorized agent for all matters concerning this application shall be filed with the agent. A Special Limited Power of Attorney form is available upon request.

The undersigned ____ Owner _X__ Applicant authorizes the entry of Southampton County personnel onto the property in order to perform their duties with regard to this request.

7/15/2016	[signature]	
Date	Signature	Signature

OFFICE USE ONLY

Received By: _________________

Date: _______________________

Post Sign By: _________________

PC Agenda Date: ______________

BOS Agenda Date: ______________

PROFFERS FOR CONDITIONAL REZONING

__X___ Original   _______ Amended

Pursuant to Section 18-546 (b) of the Southampton County Code, the owner or duly authorized agent hereby voluntarily proffers the following conditions which shall be applicable to the property, if rezoned:

I (we) hereby proffer that the development of the subject property of this application shall be in strict accordance with the conditions set forth in this submission:

The Property may be utilized only for the following uses:

1. Solar power generation facilities, together with the accessory structures and infrastructure required for their operation and maintenance;

2. General agriculture, farming and forestry activities as specifically defined in Section 18-1 of the Southampton County Code of Ordinances;

3. A single-family residential dwelling ancillary to the general agriculture, farming and forestry activities as specifically defined in Section 18-1 of the Southampton County Code of Ordinances; and

4. Uses and structures that are customarily ancillary to the above-listed uses.

______________________________   7/15/2016

Signature of Owner/Applicant *   Date

* If applicant is someone other than the owner, a Special Limited Power of Attorney Form must be submitted with this application.

City of Franklin VIRGINIA
Growth • Community • Spirit

SOUTHAMPTON COUNTY, VIRGINIA 1749

DEPARTMENT OF COMMUNITY DEVELOPMENT
PLANNING - BUILDING INSPECTIONS – ZONING
SPECIAL LIMITED POWER OF ATTORNEY

Know All Men By These Presents: That I (We)
(Name) Richard W. Vaughan (Phone) ____________________
(Address) 136 S Garris St, Lasker, NC 27845
the owner(s) of all those tracts or parcels of land ("Property") conveyed to me (us), by deed recorded in the Clerk's Office of the Circuit Court of the County of Southampton, Virginia, by
Instrument No: ____________________, on Page ______________, and is described as
SEE ATTACHED PROPERTY CARDS
Parcel: ________ Lot: ________ Block: _______ Section: ________ Subdivision: ___________
do hereby make, constitute and appoint:
(Name) Jürgen Fehr (Phone) 704.907.7163
(Address) 5960 Fairview Rd, Suite 400, Charlotte, NC 28210
To act as my true and lawful attorney-in-fact for and in my (our) name, place and stead with full power and authority I (we) would have if acting personally to file planning applications for my (our) above described Property, including:

__	Rezoning (including proffers)	__	Conditional Use Permit
__	Conditional Use Permit	__	Variance
__	Special Use Exception	__	Administrative Site Plan
__	Subdivision	__	Building Permit(s)

My attorney-in-fact shall have the authority to offer proffered conditions and to make amendments to previously approved proffer conditions except as follows:

____

This authorization shall expire one year from the day it is signed, or until it is otherwise rescinded or modified.
In witness thereof, I (we) have hereto set my (our) hand and seal this 28th day of June, 2016.
Signature(s) [signature]
State of Virginia, City/County of Southampton, To-wit:
I, Laurel E. Livingston, a Notary Public in and for the jurisdiction aforesaid, certify that the person(s) who signed to the foregoing instrument and who is (are) known to me, personally appeared before me and has acknowledged the same before me in the jurisdiction aforesaid this 28th day of June, 2016.
[signature] My commission expires: 03-31-2020
Notary Public

LAUREL E. LIVINGSTON NOTARY PUBLIC REG. #7220579 MY COMMISSION EXPIRES 3/31/2020 COMMONWEALTH OF VIRGINIA

Southampton County

Search Locality

VamaNet
Virginia Mass Appraisal Network

Property Information - Tax Map# 100 14 - Account# 704935202

Property Owner:
Vaughan Richard W

Owners Address:
136 S Garris St
Lasker, Nc 27845

Total Land Area:
70.25Acres
Land Use
$ 107600

Physical Location:
31118 Meherrin Rd

Magisterial District:
Boykins

Legal Description:
Parcel A, Bernice Powell
Estate

View Sketch
(Building 1)

Zoned:
A-1

Prior Assessment:	273,300
Assessment Values:	
Building 1	208,638
Building 2	5,000
Other Improvements:	89,720
Land Value:	217,900
Calculated Value:	521,258
Rounded Taxable Value:	521,300

Southampton County

Search Locality

VamaNet
Virginia Mass Appraisal Network

Property Information - Tax Map# 100 14C - Account# 704935210

Property Owner:
Vaughan Richard W

Owners Address:
136 S Garris St
Lasker, Nc 27845

Total Land Area:
73.95Acres
Land Use
$ 49500

Physical Location:
Not On File

Magisterial District:
Boykins

Legal Description:
Parcel A-1, Pt. Powell
Estate

Zoned:
A-1

Prior Assessment:	150,900
Assessment Values:	
Building 1	0
Other Improvements:	0
Land Value:	161,400
Calculated Value:	161,400
Rounded Taxable Value:	161,400

-Property Information- -Sales Information-

If you encounter any difficulties with this site, please e-mail the Webmaster.

Southampton County

Search Locality

VamaNet
Virginia Mass Appraisal Network

Property Information - Tax Map# 100 14D - Account# 704935211

Property Owner:
Vaughan Richard W

Owners Address:
136 S Garris St
Lasker, Nc 27845

Total Land Area:
55.42Acres
Land Use
$ 36400

Physical Location:
Not On File

Magisterial District:
Boykins

Legal Description:
Parcel A-2, Prt. Powell Estate

Zoned:
A-1

Prior Assessment:	110,300
Assessment Values:	
Building 1	0
Other Improvements:	0
Land Value:	117,900
Calculated Value:	117,900
Rounded Taxable Value:	117,900

If you encounter any difficulties with this site, please e-mail the Webmaster.

Southampton County

Search Locality

VamaNet
Virginia Mass Appraisal Network

Property Information - Tax Map# 100 31 - Account# 704935203

Property Owner:
Vaughan Richard W

Owners Address:
136 S Garris St
Lasker, Nc 27845

Total Land Area:
150.66Acres
Land Use
$ 113900

Physical Location:
31073 Meherrin Rd
Boykins, Va 23827

Magisterial District:
Boykins

Legal Description:
Parcel 2, Bernice Powell Estate

View Sketch (Building 1)

Zoned:
A-1

Prior Assessment:	346,900
Assessment Values:	
Building 1	8,023
Other Improvements:	0
Land Value:	343,400
Calculated Value:	351,423
Rounded Taxable Value:	351,400

-Property Information- -Sales Information-

Southampton County

Search Locality

VamaNet
Virginia Mass Appraisal Network

Property Information - Tax Map# 100 31A - Account# 704935205

Property Owner:
Vaughan Richard W

Owners Address:
136 S Garris St
Lasker, Nc 27845

Total Land Area:
38.08Acres
Land Use
$ 26100

Physical Location:
Not On File

Magisterial District:
Boykins

Legal Description:
Parcel 1, Bernice Powell
Estate

Zoned:
A-1

Prior Assessment:	79,600
Assessment Values:	
Building 1	0
Other Improvements:	0
Land Value:	93,300
Calculated Value:	93,300
Rounded Taxable Value:	93,300

-Property Information- -Sales Information-

If you encounter any difficulties with this site, please e-mail the Webmaster.

Southampton County

Search Locality

VamaNet
Virginia Mass Appraisal Network

Property Information - Tax Map# 100 31B - Account# 704935212

Property Owner:
Vaughan Richard W

Owners Address:
136 S Garris St
Lasker, Nc 27845

Total Land Area:
26.62Acres
Land Use
$ 16600

Physical Location:
Not On File

Magisterial District:
Boykins

Legal Description:
Parcel B, Prt. Powell
Estate

Zoned:
A-1

Prior Assessment:	58,600
Assessment Values:	
Building 1	0
Other Improvements:	0
Land Value:	109,700
Calculated Value:	109,700
Rounded Taxable Value:	109,700

-Property Information- -Sales Information-

Southampton County

Search Locality

VamaNet
Virginia Mass Appraisal Network

Property Information - Tax Map# 100 31C - Account# 704935213

Property Owner:
Vaughan Richard W

Owners Address:
136 S Garris St
Lasker, Nc 27845

Total Land Area:
5.71Acres
Land Use
$ 3600

Physical Location:
Not On File

Magisterial District:
Boykins

Legal Description:
Parcel A, Pt. Powell
Estate

Zoned:
A-1

Prior Assessment:	30,400
Assessment Values:	
Building 1	0
Other Improvements:	0
Land Value:	17,100
Calculated Value:	17,100
Rounded Taxable Value:	17,100

Southampton County

Search Locality

VamaNet
Virginia Mass Appraisal Network

-Home- -Legal- -Contact VamaNet- -Commissioners- -Localities- -FAQs- -About this Site-

Property Information - Tax Map# 100 31D - Account# 704935214

Property Owner:
Vaughan Richard W

Owners Address:
136 S Garris St
Lasker, Nc 27845

Total Land Area:
2.03Acres
Land Use
$ 1300

Physical Location:
Not On File

Magisterial District:
Boykins

Legal Description:
Lot 1, Pt. Parcel 1,
Powell Estate

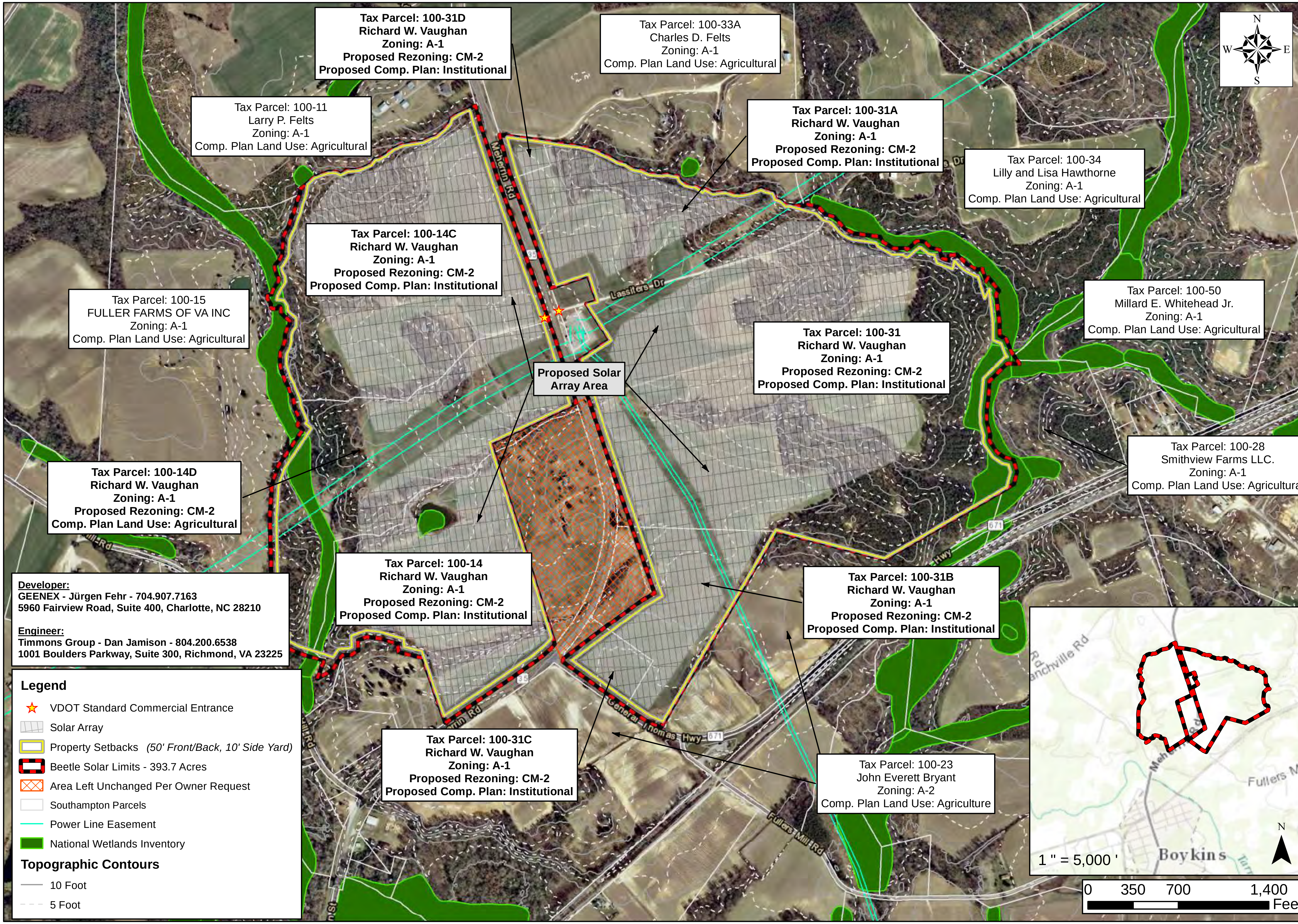
Zoned:
A-1

Assessment Values:

Building 1	0
Other Improvements:	0
Land Value:	23,100
Calculated Value:	23,100
Rounded Taxable Value:	23,100

-Property Information- -Sales Information-

If you encounter any difficulties with this site, please e-mail the Webmaster.



Path: Y:\804\99999-GEENEX_Solar\37996-Beetle\GIS\Zoning Map\Vaughan Zoning Map.mxd

THIS DRAWING PREPARED AT THE CORPORATE OFFICE
1001 Boulders Parkway, Suite 300 | Richmond, VA 23225
TEL 804.200.6500 FAX 804.560.1648 www.timmons.com

Site Development | Residential | Infrastructure | Technology | Environmental

YOUR VISION ACHIEVED THROUGH OURS

TIMMONS GROUP

REVISION DESCRIPTION

DATE

DATE 07/14/2016

DRAWN BY C. CHAPPELL

DESIGNED BY C. CHAPPELL

CHECKED BY C. SESSOMS

SCALE 1" = 700'

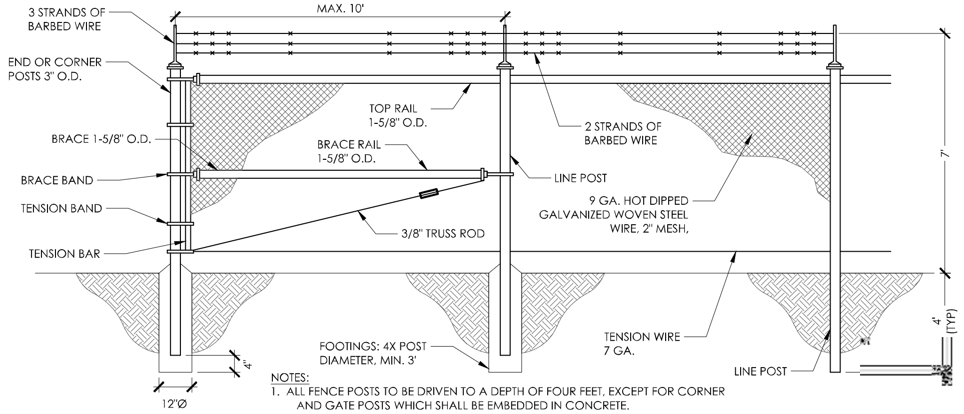
BEETLE SOLAR PROPERTIES

SOUTHAMPTON COUNTY, VIRGINIA

PRELIMINARY SITE PLAN

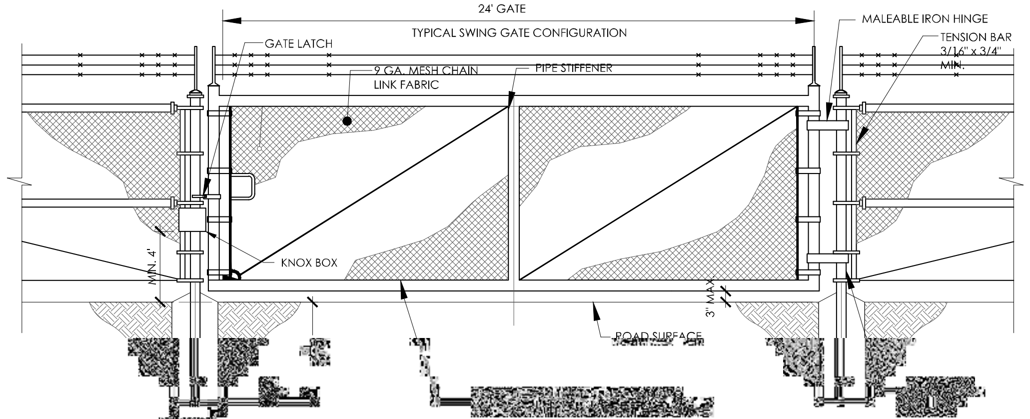
JOB NUMBER 99999

SHEET NO. 1 OF 1

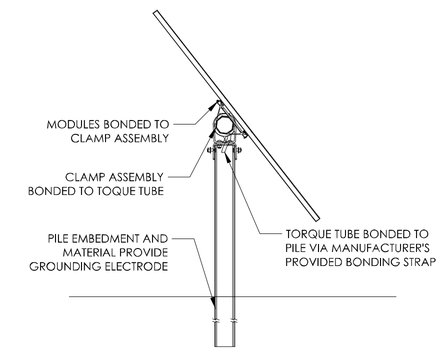


NOTES:
1. ALL FENCE POSTS TO BE DRIVEN TO A DEPTH OF FOUR FEET, EXCEPT FOR CORNER AND GATE POSTS WHICH SHALL BE EMBEDDED IN CONCRETE.
2. PROVIDE CONCRETE FOR POSTS ADJACENT TO CORNER AND GATE POSTS.

1 FENCE ELEVATION [redacted]



[redacted]



[redacted]NDING NOTE: ATI DURATRACK ASSEMBLY IS UL 1703 LISTED [redacted] GROUNDING. DRIVEN STEEL PILES MEET THE [redacted]3 OF NEC 250.52 AND ASTM A123, AND ARE USED AS [redacted]ELECTRODES FOR EACH ROW.

[redacted]CKER ELEVATION

SCALE: 3/8"=1'-0"

[redacted]

4 [redacted]

PAD GROUNDING SYMBOLS

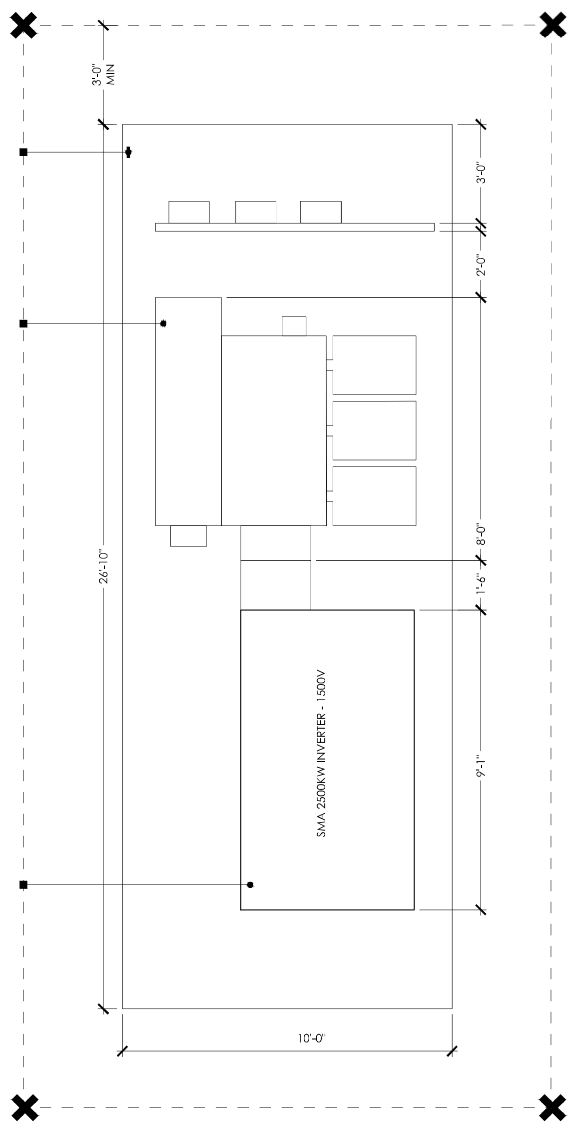
- CAD WELD TO REBAR IN CONCRETE PAD
- CAD WELD OR IRREVERSIBLE SPLICE
- EQUIPMENT GROUND CONNECTION TO SWBD
- 3/4" X 10' GROUND ROD
- #4/0 AWG BARE COPPER BONDING JUMPERS AND GROUND RING CONDUCTOR

PAD GROUNDING NOTES

1. ROUTE GROUNDING CONDUCTOR 36' BELOW FINISHED GRADE.
2. REFER TO EQUIPMENT INSTALLATION MANUALS FOR MANUFACTURER'S RECOMMENDED GROUNDING LOCATIONS.
3. GROUNDING RESISTANCE SHALL NOT EXCEED 5 OHM.

GENERAL NOTES

1. QUANTITY ON PROJECT: 16



3 TYP SWBD PAD PLAN VIEW AND GROUNDING

SCALE: 3/8"=1'-0"

BayWa r.e. renewable energy

BayWa r.e. Solar Projects LLC

17901 Von Karman Ave Suite 1050
Irvine, CA 92614
Phone: 949.398.3915 | Fax: 949.398.3914
www.baywa-re.us

SITE INFORMATION
BEETLE SOLAR,
BOYKINS, VA, USA

PROJECT MANAGER
MACSUN FREDERICK
CONTACT

PROJECT ENGINEER
NAME
CONTACT

NO.	ISSUE	DATE
1	PRELIMINARY	06.10.16

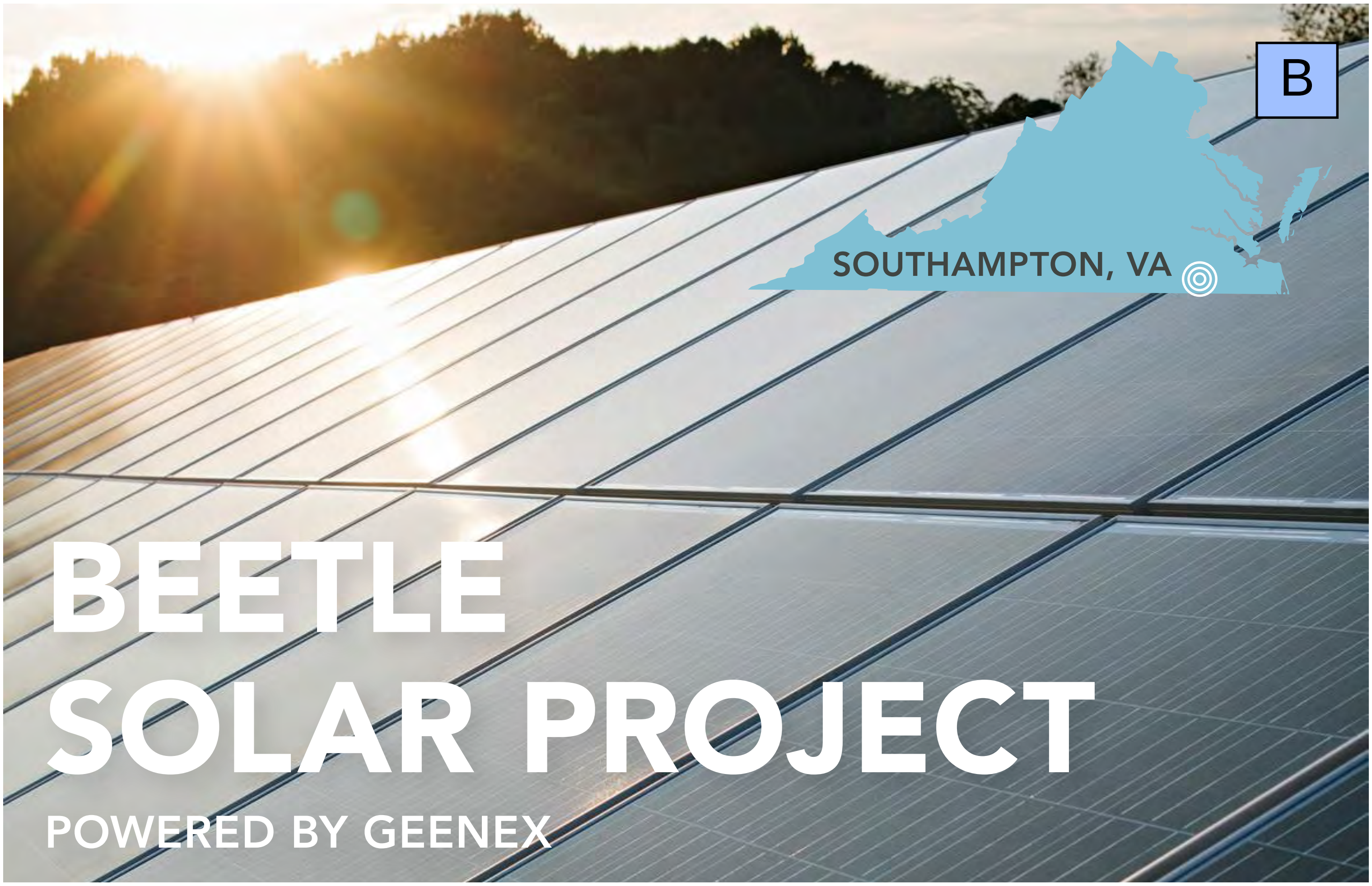
PROJECT NUMBER USA.DEV.0166
DRAWN BY LR
REVIEWED BY DC
APPROVED BY

CLIENT SIGNATURE

MISC. DETAILS

DRAWING NUMBER **E3.00**

SHEET SIZE: ARCH D - 24" x 36"



BEETLE SOLAR PROJECT

POWERED BY GEENEX

GEORG VEIT, CEO:

Geenex is very happy to come to Southampton.
We aim to not only deliver reliable assets to our investors, but also strive to have a long term positive impact to the community.

We choose our sites first by feasibility for interconnection, then by limiting impacts on the community. During the final design and permitting process, we further limit impacts on the neighborhood in close discussion with the community and government agencies.

Working on a project that will deliver power through a technology that is not harmful to us or the environment is exciting. The resource, the sun, is right here and will be here for a long, long time. That is what gives us our drive and dedication, and that is what we want to share with you.

The cost of solar has dropped dramatically over the last years, and we are now starting to compete with traditional sources of energy. Virginia will see a tremendous growth in the solar industry with both large investments and job creation. Through training and education, we invite Southampton to take part in this growth.

PROJECT FACTS

1. BOYKINS SUBSTATION ON SITE –NO NEW SUBSTATION NEEDED
2. PJM PROCESS ALLOWS FOR SIMULTANEOUS INTERCONNECTION. CAPACITY FOR BEETLE CONFIRMED IN FEASIBILITY STUDY
3. PROJECT DESIGNED AS 26 MW AC
4. PLANNED WITH POLY CRYSTALLINE SOLAR PANELS
5. PROJECT WILL BE REVIEWED AND NEEDS APPROVAL FROM VARIOUS STATE AND FEDERAL AGENCIES INCLUDING:

   – Army Corps of Engineers
   – Virginia Department of Environmental Quality
   – Virginia Stormwater Management Program

BENEFITS

The Beetle Solar project will provide a number of benefits to the county and surrounding community. The project will bring jobs to the community during construction and long term.

The spending on development and permitting of such a project provides a number of opportunities. Construction not only provides construction jobs, but provides opportunities for local contractors and businesses (installation, fencing, landscaping, machine rentals etc.) as well as increased economic activity in the area with hotels and restaurants being among the businesses benefiting.

Finally the project will be producing clean renewable energy, increasing the USA's energy independence and decreasing negative effects on the environment.

CLEAN, SAFE, AND NO HEALTH IMPACTS

TREMENDOUS INDUSTRY GROWTH EXPECTED IN VIRGINIA

40 YEARS LIFETIME OF FACILITY

6.5 BILLION YEARS SUNLIGHT LEFT

20% INCREASE IN JOBS IN THE SOLAR INDUSTRY IN 2015

GEENEX HAS BEEN BRINGING SOLAR INTO THE COMMUNITIES SINCE 2012. SEE OUR WORK ON YOUTUBE:

PROJECT TIMELINE

August 2015	March 2016	March 2017	June 2017	March 2018
Land control and interconnection application	Start permitting, continue interconnection study	Completion of development, start of procurement and mobilization	Start of construction	System completed and start of delivery of power

CONTACT US

GEENEX SOLAR
INFO@GEENEXSOLAR.COM

CALL US ON
704 817 0397

7804–C FAIRVIEW RD. 257
CHARLOTTE, NC 28226

C

GEENEX german engineering experience

DECOMMISSIONING PLAN

Outlined below is the Decommissioning Plan for the 26 MW Beetle Solar, LLC solar facility (the "Project") proposed by Geenex Solar and to be constructed and operated in Southampton County, Virginia. This Decommissioning Plan outlines how the decommissioning activities will be funded and provides specific details as to what those decommissioning activities entail. This plan will ensure the landowner, the County, and its citizens will not be financially liable for the future return of the proposed site to its pre-existing condition and use. This Decommissioning Plan will be binding upon each successor and assignee of Beetle Solar, LLC (the "Project Owner"):

DECOMMISSIONING FUNDING:

Geenex shall provide a Decommissioning Cost Estimate, prepared by a Virginia Licensed Engineer, prior to the issuance of building permits, which shall include the following:

(a) the gross estimated cost to perform Decommissioning as set forth in Section II above ("Gross Cost");

(b) an administrative and inflation factor D of the Gross Cost ("Admin Factor");

(c) the estimated resale and salvage values associated with the Project equipment ("Salvage Value")

(d) a reduction from the Salvage Value by 20% such that only 80% of the Salvage Value can be used as a credit against the Gross Cost and Admin Factor. The Salvage Value multiplied by 80% is the "Salvage Credit".

Thus the Decommissioning Cost Estimate formula is:

Gross Cost + Admin Factor - Salvage Credit = the "Decommissioning Cost Estimate".

Geenex shall provide a revised and updated Decommissioning Cost Estimate on every fifth anniversary of the date when the Project first began to continuously deliver electric energy to the electric grid for commercial sales ("Commercial Operation Date") for the Project Life, which shall account for inflation, cost and value changes, and advances in decommissioning technologies and approaches.

The Decommissioning Cost Estimate shall include a table allocating the net cost estimate across the Project area, based on the percentage of generating capacity in megawatts (MW) on each property ("Allocation Areas"). The Allocation Areas will be divided based upon the lease areas, however Allocation Areas will reference the underlying land, in case ownership of the underlying land changes control during the life of the Project.

The County may elect to have the Decommissioning Cost Estimates reviewed by a Virginia Licensed Engineer on behalf of the County, in which case reasonable engineering review fees shall be reimbursed by Geenex.

Financial Security:

Geenex will provide an amount equal to the Decommissioning Cost Estimate (as determined by a Virginia Licensed Engineer, per section lll), provided, however, that the amount of security shall never be less than Sixty Thousand Dollars ($60,000), ("Decommissioning Security"). Decommissioning Security shall be provided by Geenex prior to the Commercial Operation Date.

A Virginia licensed engineer shall provide an Updated Decommissioning Cost Estimate on or before the fifth anniversary of the Commercial Operation Date and every five years thereafter during the Project Life. Geenex shall replenish and fully fund the Decommissioning Security based on each Updated Decommissioning Cost Estimate, if applicable.

The Decommissioning Security may be in one of the following forms: (i) cash to be held in escrow by the County Treasurer at a Bank, or (ii) a letter of credit from a financial institution reasonably acceptable to the County which shall be irrevocable unless replaced with cash or other form of security reasonably acceptable to County (each a form of "Acceptable Credit Support").

Geenex shall post Acceptable Credit Support in the amount of the Decommissioning Security prior to the Commercial Operation Date.

Upon the receipt of the first Updated Decommissioning Cost Estimate (following the fifth anniversary of the Commercial Operation), any increase or decrease in the Decommissioning Security shall be funded by GEENEX, or refunded to GEENEX (if permissible by the form of Credit Support and such that Decommissioning Security is not Geenex than $60,000), within ninety (90) days and will be similarly trued up for every subsequent five year updated Decommissioning Cost Estimate.

DECOMMISSIONING PROCEDURES:

1. General Environmental Protection

During decommissioning and restoration activities, general environmental protection and mitigation measures would be implemented. Many activities during decommissioning would be comparable to the construction phase, including the use of heavy equipment on site, preparing staging areas, and restoring constructible areas around all Project infrastructure.

2. Pre-Dismantling Activities

Prior to engaging in decommissioning activities, the Proponent will provide an updated decommissioning/dismantling plan in accordance with County requirements at the time of decommissioning. Decommissioning and restoration activities will be performed in accordance with all relevant statutes in place at the time of decommissioning. At the end of the Project's useful life, it will first be de-energized and isolated from all external electrical lines.

Prior to any dismantling or removal of equipment, staging areas would be delineated at each the solar arrays, along collector line, and along transmission line, the substation property, as appropriate. All decommissioning activities would be conducted within designated areas; this includes ensuring that vehicles and personnel stay within the demarcated areas. Work to decommission the collector lines and transmission lines would be conducted within the boundaries of the municipal road allowance and appropriate private lands.

3. Equipment Dismantling and Removal

The basic components of the Project are photovoltaic (PV) modules, steel tracker system, electrical cabling, inverter skids, and substation.

3.1.1 PV Module Collection and Recycling

All modules will be disconnected, removed from the trackers, packaged and transported to a designated location for resale, recycling or disposal. Any disposal or recycling will be done in accordance with applicable laws and requirements. The connecting underground cables and the junction boxes will be de- energized, disconnected, and removed. The steel tracking system supporting the PV modules will be unbolted and disassembled by laborers using standard hand tools, possibly assisted by small portable crane. All steel support structures will be completely removed by mechanical equipment and transported off site for salvage or reuse. Any demolition debris that is not salvageable will be transported by truck to an approved disposal area. Other salvageable equipment and/or material will be removed for the site for resale, scrap value or disposal.

3.1.2 Electrical Equipment and String Inverters

All decommissioning of electrical devices, equipment, and wiring/cabling will be in accordance with local, state and federal laws. Any electrical decommissioning will include obtaining required permits, and following applicable safety procedures before de-energizing, isolating, and disconnecting electrical devices, equipment and cabling.

Decommissioning will require dismantling and removal of the electrical equipment, including inverters, transformers, underground/aboveground cables and overhead lines, and substation electrical building. The equipment will be disconnected and transported off site by truck. The concrete foundations and support pads will be broken up by mechanical equipment (backhoe-hydraulic hammer/shovel, jackhammer), loaded onto dump trucks and removed from the site. Smaller pre-cast concrete support pads will be removed intact by cranes and loaded onto trucks for reuse, or will be broken up and hauled away by dump trucks. Prior to removal of the inverter transformers, the oil will be pumped out into a separate industry approved disposal container and sealed to prevent any spill during storage and/or transportation. Equipment and material may be salvaged for resale or scrap value depending on the market conditions.

3.1.3 Roads, Parking Area

Unless retained for other purposes, all access roads, the parking area (if required) and the substation yard will be removed to allow for the complete rehabilitation of these areas. Typically, the granular base covering these areas would be removed using a wheel loader to strip off the material and dump trucks to haul the aggregate to a recycling facility or approved disposal facility. The underlying subsoil, if exhibiting significant compaction (more likely for the site entrance road than the interior access roads), will then be diced using a tractor and disc attachment to restore the soil structure and to aerate the soil. Clean topsoil would be imported on site by dump truck, replaced over the area and levelled to match the existing grade.

3.1.4 Other Components

Unless retained for other purposes, removal of all other facility components from the site will be completed, including but not limited to surface drains, access road cross-culverts, and fencing. Anything deemed usable shall be recovered and reused elsewhere. All other remaining components will be considered as waste and managed according to local, state, and federal laws.

For safety and security, the security fence will be dismantled and removed from the site after all major components, PV modules, tracker system and foundations have been removed.

3.3.5 Site Restoration

Following decommissioning, the Project site will be stabilized to ensure that there are no ongoing adverse environmental effects. The site will be restored to ensure it is clean, safe and environmentally stable. The following activities will be undertaken:

- Site cleanup, re-grading to original contours and, if necessary, restoration of surface drainage swales and ditches.
- Any trenches/drains excavated by the Project will be filled with suitable materials and levelled.
- Any road, parking area and substation yard will be removed completely, filled with suitable subgrade material and levelled.
- Any compacted ground will be tilled, mixed with suitable subgrade materials and levelled.
- Topsoil will be spread as necessary to ensure suitable conditions for vegetation regrowth.

3.3.6 Management of Wastes and Excess Materials

All waste and excess materials will be disposed of in accordance with local, state and federal laws. Soil removed for construction purposes will be relocated on the site or used for landscaping after the Project completion. Waste that can be recycled under municipal programs will be done accordingly. Waste that requires disposal will be disposed of in a state licensed facility by a state licensed hauler. Although hazardous waste is not anticipated on the site, any hazardous waste would be removed and disposed of in accordance with local, state, and federal laws.

3.3.7 Emergency Response and Communications Plans

During decommissioning, the Proponent will coordinate with local authorities, the public, and others as required to provide them with information about the ongoing activities. Besides regular direct/indirect communication, signs will be posted at the Project facility to give information to the local public and visitors. The Proponent's contact information (telephone number, email and mailing address) will be made public for those seeking more information about the decommissioning activities and/or reporting emergencies and complaints. All inquiries will be directed to the Proponent's Project Representative who will respond to any inquiry. In the event of an emergency, the Proponent will mobilize its resources to the site to respond to the event. Personnel involved in decommissioning will be trained in the emergency response and communications procedures. Emergency response procedures will be prepared prior to decommissioning.

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LET'S TALK IMPACT …

Beetle Solar Project – Southampton County, VA
26 MW Solar Facility

COMMUNITY IMPACT:

In addition to the many benefits of clean energy already discussed within our application, the Beetle Solar project is also uniquely sited within Southampton County. There is no additional utility-scale infrastructure needed for its interconnection since it is being built around and directly connected to an existing substation within the County. In addition, Beetle Solar's compact design allows us to make more efficient use of the land being developed and to easily mitigate the visual impact of the site from neighboring residences and roadways. As solar developers, Geenex always strives to be good neighbors to the surrounding community and its citizens.

FINANCIAL IMPACT:

Beetle Solar is a proposed 26 MW solar facility that will cost approximately $50,700,000 to construct. The value of this project will bring an increase to the tax base to Southampton County through increased property tax valuations, including a five-year roll back tax payment generated from the removal of the land from the agricultural tax discount program. Outlined below is a revised estimate of taxes to be paid to Southampton County:

Property Tax

Year 1 Revenue – Approximately $73,561

Total Revenue (35 years) - Approximately $1,234,720

Real Property Tax

Acres converted to solar use - 350 acres
Value Farming - $2,250/acre
Annual tax payment (farming use) - Approximately $6,500
Value Solar - $8,500/acre
Annual tax payment (solar use) – Approximately $24,300

Annual tax increase - Approximately $18,000
Total tax increase (over 35 years) - Approximately $630,000

Sales and Use Tax

Tax basis (cost of racking, conduit and meters) - Approximately $5,616,000
Total tax Rate - 6%
Total tax revenue - Approximately $561,600
Tax retained by County - 1%
County Tax revenue - Approximately $5,616

These tax benefits are in addition to the other financial impacts already stated within our application including job creation, construction spending, and future economic development implications.

ENVIRONMENTAL IMPACT:

Solar facilities are specifically designed for minimal environmental impact. There are no emissions, and no environmental hazards from the materials used in their operation; a statement which certainly cannot be said for most energy-generation facilities. However, in light of the agricultural-based economy in Southampton County, there were concerns expressed about future soil impacts when the site is decommissioned as a solar facility and returned to its former use. From various studies and years of research, Thomas Cleveland, PE with the NC Clean Energy Technology Center at N.C. State University, has provided the information below to address aluminum and zinc in the soil that may arise from materials used in a solar facility.

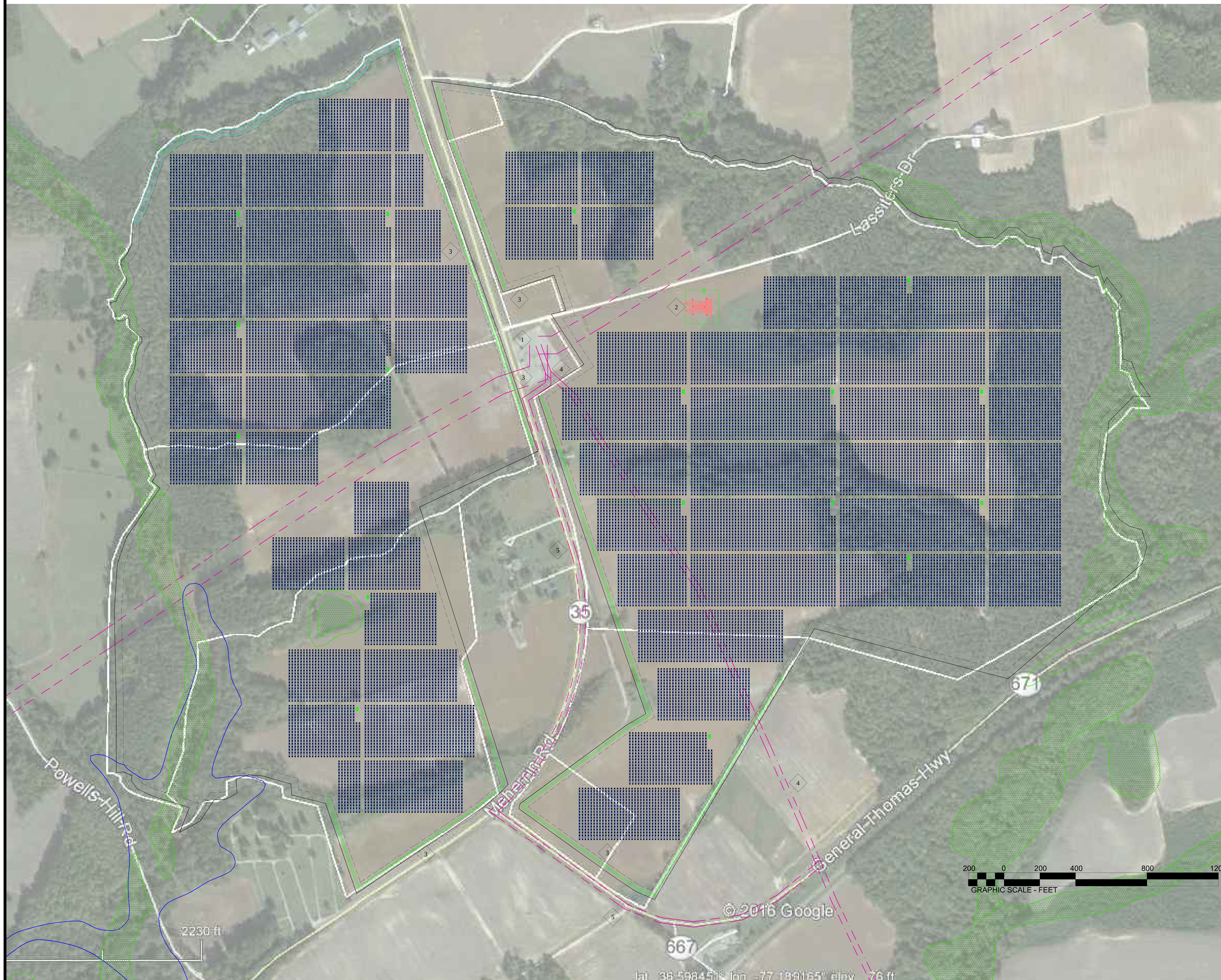
Aluminum:

Aluminum is very common in soils around the world, including those common in North Carolina and Virginia. In fact, the earth's crust is about 7% aluminum, and most soils are over 1% aluminum! The aluminum is generally unavailable to plants as long as the soil pH is above about 5.5. In acidic soils many forms of aluminum become more bio-available to plants which is toxic to many plant species. This effect is one of the major reason many plants do not tolerate very acidic soils. The use of aluminum building materials releases negligible amounts of aluminum during their useful life because the material is so corrosion resistant. Aluminum is very corrosion resistant in its natural state, meaning very very small amounts of the aluminum are lost to the local environment due to corrosion. The aluminum frames of PV modules are anodized which adds a very thin hard coating to the exterior of the aluminum that greatly improves the aluminum's resistance to corrosion even more than when untreated. Therefore, any minute amount of aluminum that could be released by corrosion from aluminum construction materials during the life of a solar project will not materially add to the thousands or millions of pounds of aluminum naturally present in the soil of a typical solar facility.

Zinc:

The hundreds to thousands of small galvanized steel posts that support thousands of PV panels in a typical multi-megawatt solar energy facility will slowly release relatively small amounts of zinc in the immediate vicinity of each post over its decades of operation. While plants need some zinc, high levels of zinc in the soil is known to stunt plant growth, which most commonly occurs due to heavy application of swine waste or sludge, and peanuts are more sensitive than most other crops. Based on research on soil impacts of galvanized electric transmission line support towers, local experience with galvanized roofs, and input from N.C. State University soil scientists, it is expected that the zinc released from a solar installation over its operable lifetime would have an insignificant impact on future agricultural use of the site, with a possible exception for a potential for minor impact on peanut production.

Another impact on soil condition may be the method of **Weed and Grass Management** utilized on the site of a solar facility. Ground cover around the panels will include specific low-growth vegetation or grasses, native to the region, that will be kept to a height of less than approximately 18 inches. Beetle Solar, LLC will work with the Virginia Department of Environmental Quality in determining the best resources for grass and ground cover on the site. The management of this ground cover can include a combination of methods including sheep farming and/or occasional mowing (please note that mowing is easier within solar facilities utilizing tracking systems because the space if often greater between the rows of panels). Chemical control is not a favored choice of solar facility owners so no herbicides or pesticides will be used on the site.



1 SITE IMPROVEMENTS PLAN

KEYNOTES

1. DOMINION SWITCHYARD
*FINAL POSITION ALONG TRANSMISSION LINE PENDING DOMINION DESIGN
2. PLANT INTERCONNECTION FACILITIES
3. SITE ACCESS POINT
4. CURRENT ELECTRICAL EASEMENT ROUTING
5. PROPOSED NEW ELECTRICAL EASEMENT ROUTING

PROPERTY LINE SETBACK AND BUFFER NOTES:

1. SETBACKS HAVE BEEN OBSERVED AT 50' FROM ALL PROPERTY LINES USING THE SETBACK STANDARD FOR HIGHWAY OR OTHER STREET OR ROAD.
2. SETBACKS ARE MEASURED TO THE SOLAR ARRAY STRUCTURES AND OTHER ELECTRICAL EQUIPMENT. FENCING, ACCESS ROADS, AND LANDSCAPING MAY BE LOCATED WITHIN THE SETBACK AREAS.
3. LANDSCAPE BUFFERS WILL BE PROVIDED WHERE SHOWN ON THE SITE PLAN TO PROVIDE SCREENING OF THE SOLAR ARRAY FROM THE COMMUNITY. WHERE EXISTING VEGETATION WITHIN THE PROPERTY BOUNDARIES CAN BE LEFT IN PLACE AND PROVIDE EQUIVALENT VISUAL SCREENING.

LEGEND

- PROPERTY LINES (AMENDED CPCN PARCELS)
- TRACKING PV ARRAY
- PROPERTY LINE SETBACKS
- UTILITY EASEMENT
- KNOWN WETLANDS
- LANDSCAPE BUFFER ALONG ROADS
- 30FT SETBACK FOR EXISTING VEGETATION

NOTES

1. THIS PLAN IS PROVIDED FOR CUP PERMIT APPROVALS AND IS NOT FOR CONSTRUCTION.
2. THIS PRELIMINARY PLAN IS BASED ON GIS DATA.

BayWa r.e. renewable energy

BayWa r.e.
Solar Projects LLC

17901 Von Karman Ave Suite 1050
Irvine, CA 92614
Phone: 949.398.3915 | Fax: 949.398.3914
www.baywa-re.us

SITE INFORMATION
BEETLE SOLAR,
BOYKINS, VA, USA

PROJECT MANAGER
MACSUN FREDERICK
CONTACT

PROJECT ENGINEER
NAME
CONTACT

NO.	ISSUE	DATE
1	PRELIMINARY	06.10.16

PROJECT NUMBER	USA.DEV.0166
DRAWN BY	LR
REVIEWED BY	DC
APPROVED BY	

CLIENT SIGNATURE

CPU-SITE IMPROVEMENTS PLAN

DRAWING NUMBER PV-C1.10

SHEET SIZE: ARCH D - 24" x 36"

BayWa r.e.
renewable energy

F

July 15, 2016

Baywa r.e. Solar Projects
17901 Von Karman Ave. Suite
1050
Irvina, CA 92644

Re: Letter of Intent, Beetle Solar Project

BayWa r.e. Solar Projects, LLC ("BayWa") hereby expresses its intent to partner with Geenex and support its efforts on the Beetle Solar project in Southampton, VA. Baywa and Geenex have a partnership agreement and are currently working together on numerous projects in North Carolina and Virginia. Geenex' scope includes in land acquisition and permitting and Baywa provides engineering services, development funding, and ensures the projects' financing and construction.

BayWa is well positioned to finance the project and intends to rely on the $18 billion balance sheet of its parent company, Baywa AG, to facilitate the project's financing.

BayWa intends to fund this project through the development cycle and construction currently scheduled for 2017.

Sincerely,

Noah Eckert
Chief Commercial Officer

BayWa r.e. Solar Projects, LLC | 17901 Von Karman Avenue, Suite 1050 | Irvine, CA 92614
Phone +1 949 398 3915 | Fax +1 949 398 3914 | www.baywa-re.us

BayWa r.e.
renewable energy

August 10, 2016

SOUTHAMPTON COUNTY
Planning Commission

Re: Module Technology – Beetle Solar Project - CPA 2016:02 - RZA 2016:05 - CUP 2016:06

As demonstrated by the majority of the company's PV installations worldwide, BayWa r.e. Solar Projects, LLC ("BayWa") has a strong preference to design around crystalline module technology including Poly and Mono products.

This letter confirms BayWa's intent to utilize poly-crystalline or mono-crystalline solar module technology for the Beetle Solar project.

Please feel free to contact Patrick Brown at 714-904-5881, if you have any questions.

Sincerely,

Macsun Frederick
Senior Project Developer

BayWa r.e.
renewable energy

August 10, 2016

SOUTHAMPTON COUNTY
Planning Commission

Re: Decommissioning Pan for the Beetle Solar Project - CPA 2016:02 - RZA 2016:05 - CUP 2016:06

BayWa r.e. Solar Projects, LLC ("BayWa") has successfully implemented several decommissioning plans for solar PV projects throughout the US including utility scale single-axis tracker systems similar to the proposed Beetle Solar project.

This letter confirms BayWa's commitment to complete a detailed decommissioning plan for the Beetle Solar project prior to issuance of a building permit. Furthermore, we are pleased to offer our support and intent to work closely with Geenex Solar ("Geenex") and the County of Southampton to develop a responsible and effective decommissioning plan.

Please feel free to contact Macsun Frederick at 714-904-5881, if you have any questions.

Sincerely,

Macsun Frederick
Senior Project Developer

BayWa r.e. Solar Projects, LLC | 17901 Von Karman Avenue, Suite 1050 | Irvine, CA 92614
Phone +1 949 398 3915 | Fax +1 949 398 3914 | www.baywa-re.us

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GEENEX

german engineering experience

Corporate Overview

GEENEX and its partners have a long history in the well developed and highly competitive German solar market. Our expertise in the solar industry entails years of hands on experience, back to the beginning of the German solar success story. Building on excellent partnerships on both sides of the Atlantic, and with a strong team in North Carolina, GEENEX is combining German solar expertise with the American spirit and can-do attitude.

GEENEX was formed in 2012 and is active as a developer throughout the east coast. GEENEX is proud to have completed its first US system in 2014, only two years after entering the US market. This 30 MW_{DC} solar array on a 220 acre site in Halifax County NC was delivered turnkey to Duke Energy Renewables last December. Following up on its first project, GEENEX has a strong pipeline of projects on the east coast, ready for construction start in 2015 and 2016.

With a cemented presence on the east coast, a great network within the industry, both nationally and internationally, and the required financial know-how, GEENEX is ideally positioned as a utility scale developer.

Geenex passionately believes in the benefits of solar. The advantage of clean renewable energy expands beyond emission-free power and health benefits, to significantly bolster local economies and communities. Not only do our systems create meaningful tax revenues for local communities, but they are a part of a renewable energy industry driving job creation. GEENEX is constructing the Center for Energy Education in Roanoke Rapids which aims to deliver education, jobs and tangible benefits to the surrounding communities.



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Local leaders sign collaboration agreement

SPECIAL TO
THE DAILY HERALD

The Center for Energy Education and Halifax Community College announced Tuesday the execution of a partnership agreement in support of renewable energy education and workforce training.

While the Center for Energy Education is in final stages of construction, the partnership agreement will help solidify the Center's mission in renewable energy education with Halifax Community College as a major education partner.

The Center for Energy Education was founded by the solar development company Geenex. HCC has been a strong supporter of Geenex and partner in the efforts of the Center for Energy Education since its inception. Ervin Griffin, president/CEO of HCC, welcomed Geenex and its CEO, Georg Veit, and pledged support for workforce training for solar farm construction and operation, spearheading the development of a special curriculum in renewable energy technologies. The collaboration has resulted in some unique opportunities, including internships for students of solar PV courses to specialized training for linemen in operation and maintenance of utility-grade solar for Roanoke Electric Cooperative.

SUBMITTED

Ervin Griffin Sr., left, president/CEO of Halifax Community College, shakes hands with Geenex CEO Georg Veit after they both sign a partnership agreement.

"We are very proud and appreciative of the relationship the Center and Geenex have with the community college," Veit said. "The solar industry continues to grow in North Carolina bringing jobs, investment and new companies to Halifax and the surrounding communities. Geenex plans to build addition al solar projects in the area, and continue to develop ways to involve the community in our efforts."

Added Veit: "Through education everyone can participate in this industry, as jobs range from installation to operations to accountants specializing in solar. Our collective goal is to create a well trained, highly qualified, and diversified solar energy workforce of to meet the projected needs of the region."

The agreement outlines how the entities will work together in training and education and in the pursuit of grant opportunities to enhance renewable energy education. Halifax Community College has a representative on the Center's board of directors, and the college president will serve the board in an ex-officio capacity.

"We are very excited about the partnership between HCC and the Center for Energy Education," Griffin said. "The fact that we are signing this collaborative agreement today only solidifies our work with the Center for Energy Education in the area of renewable energy education and workforce development training ... I am excited about the many opportunities our collaboration will provide for the citizens of the Roanoke Valley. I believe that the best is yet to come for renewable education and training in Halifax and Northampton counties."

J

From the desk of
Thomas H. Cleveland III, P.E.
Raleigh, NC

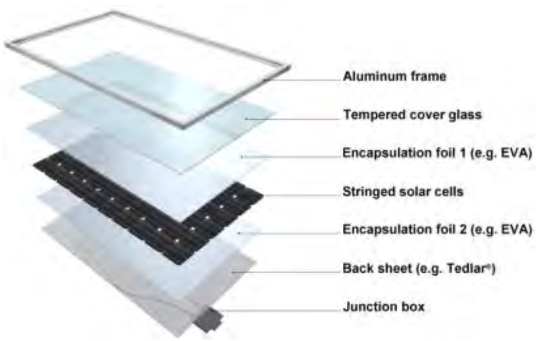
June 2015
On behalf of Geenex

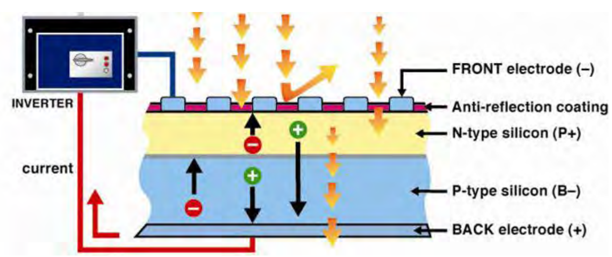
Site Impacts of Solar Photovoltaic (PV) Systems

PV systems are simple, consisting of

- PV panels (aka modules)
- Inverters (convert DC to AC)
- Wiring
- Steel and aluminum racks for panels
- Transformers (w/ non-toxic mineral or vegetable oil)
- Access roads

- The electricity they produce is immediately used by loads near the system. There are *no* batteries on or off-site to support the solar system.





PV panels…

- Have 25-year power warranties
- Do not contain toxic materials other than minute amounts of lead in solder[i]
- Are over 80% (by weight) glass and aluminum
- Encapsulate PV cells and internal wiring from air and water for life of panel

- PV cells in this project are crystalline silicon, which are nearly 100% silicon with tiny additions of non-toxic phosphorus and boron
- Silicon is non-toxic and is the second most common element in the earth's crust.

Solar is Healthy, Safe, & Environmentally Friendly

- No site emissions (air, water, or soil)
- Offsets power production from existing air- and water- polluting generators, reducing pollution
- Inverters create some sound while operating, but are generally not audible from 100-150 ft away
- Like anything with voltage and current, PV systems generate electric and magnetic fields (EMF). However, due to their relatively low voltages, low currents, and the locations of inverters, EMF at the system's fenced perimeter is generally at or below typical background environmental levels
- There is over 50 years of field experience with crystalline silicon PV technology
- Simple to decommission system and return site to original condition
- The systems have no material impact on the health or safety of its neighbors.

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[i] While lead is a toxic heavy metal, it is commonly used in large quantities in industrial and even consumer products. Less than 1% of industrial lead use is for use in solder, which is used in nearly all electrical products. PV panels use tiny amounts of solder.

K

Kirkland Appraisals, LLC

Richard C. Kirkland, Jr., MAI
9408 Northfield Court
Raleigh, North Carolina 27603
Phone (919) 414-8142
rkirkland2@gmail.com
www.kirklandappraisals.com

Impact Study Analysis Summary

Property Identification:

Real Estate ID (REID):	100-14C, 100-14D, 100-14, 100-31C, 100-31B, 100-31, 100-31A, 100-31E
Address:	Meherin Road, Boykins, Southampton County, VA
Ownership:	Richard Vaughan

Assignment Summary:

Effective Date of Analysis:	August 10, 2016
Client for this Assignment:	Geenex
Analysis Type:	Matched pair analysis for impact study
Indicated Use:	Permitting

Conclusion:

The matched pair analysis shows no impact in home values due to the adjacency to the solar farm as well as no impact to adjacent vacant residential or agricultural land. Matched pairs in Goldsboro, Chapel Hill, Roxboro and Semper show no impact on adjoining property value. The criteria for making downward adjustments on property values such as appearance, noise, odor, and traffic all indicate that a solar farm is a compatible use for a rural/residential transition area. Residential property values tend to be more sensitive to adjoining uses than industrial uses and therefore I conclude that the lack of impact on adjoining residential uses supports the assertion that there would be no impact on adjoining industrial uses.

Similar solar farms have been approved adjoining agricultural uses, industrial and residential developments. The adjoining residential uses have included single family homes up to $260,000 on lots as small as 0.74 acres. Homes are typically 100 feet or more from the solar panels in most solar farms in North Carolina and generally there is a landscaping screen between the solar farm and adjoining homes.

Where solar farms adjoin industrial land, it is often used as a buffer use between industrial uses and adjoining residential uses.

Based on the data and analysis in this report, it is my professional opinion that the solar farm proposed at the subject property will not substantially injure the value of adjoining or abutting property and that the proposed use is in harmony with the surrounding area.

Kirkland Appraisals, LLC

Richard C. Kirkland, Jr., MAI
9408 Northfield Court
Raleigh, North Carolina 27603
Phone (919) 414-8142
rkirkland2@gmail.com
www.kirklandappraisals.com

August 10, 2016

Mr. Walter Putnam
Geenex
5960 Fairview Road, Suite 400
Charlotte, North Carolina 28210

Re: Beetle Solar Farm Impact Study

Dear Mr. Putnam:

At your request, I have considered the likely impact of solar farms proposed to be constructed on a portion of a 422.19-acre assemblage of land located on Meherin Road, Boykins, Virginia. Specifically, I have been asked to give my professional opinion on whether the proposed solar farm will "maintain or enhance adjoining or contiguous property values" and whether "the location and character of the use, if developed according to the plan as submitted and approved, will be in harmony with the area in which it is to be located."

To form an opinion on these issues, I have researched and visited existing and proposed solar farms in North Carolina as well as proposed solar farms in Virginia, researched articles through the Appraisal Institute and other studies, and discussed the likely impact with other real estate professionals. I have not been asked to assign any value to any specific property.

This letter is a limited report of a real property appraisal consulting assignment and subject to the limiting conditions attached to this letter. My client is Geenex, represented to me by Mr. Walter Putnam. My findings support the Conditional Use Permit application. The effective date of this consultation is August 10, 2016.

Proposed Use Description

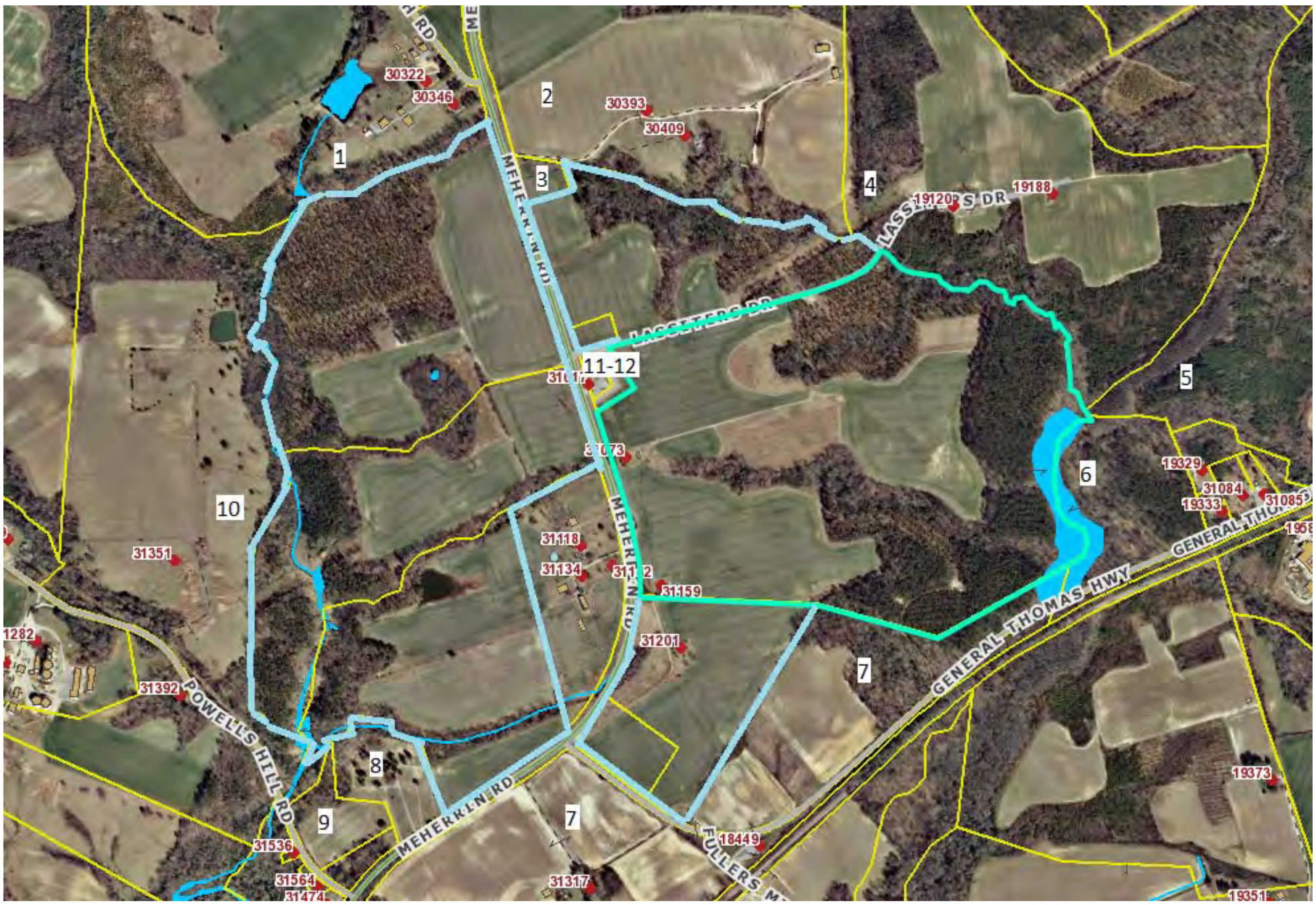
The proposed solar farm will be constructed on a portion of a 422.19-acre assemblage of land located on Meherin Road, Boykins, Virginia.

Adjoining land is primarily agricultural and residential uses, which is common for solar farms as detailed later in this report. The solar farm will consist of fixed solar panels that will generate no noise, no odor, and less traffic than a residential subdivision. The panels will be less than 15 feet in height and located behind a chain link fence.

I have considered adjoining uses and included a map to identify each parcel's location. The breakdown of those uses by acreage and number of parcels is summarized below.

Adjoining Use Breakdown

	Acreage	Parcels
Residential	0.27%	16.67%
Agricultural	9.94%	16.67%
Agri/Res	89.79%	50.00%
Substation	0.00%	16.67%
Total	**100.00%**	**100.00%**

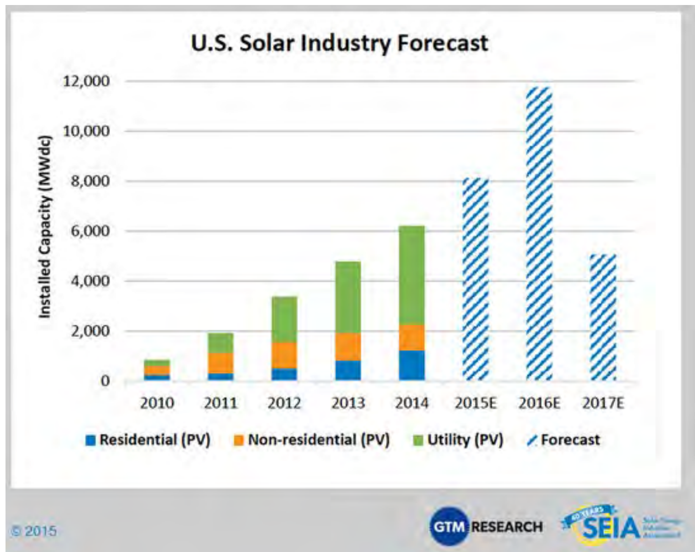


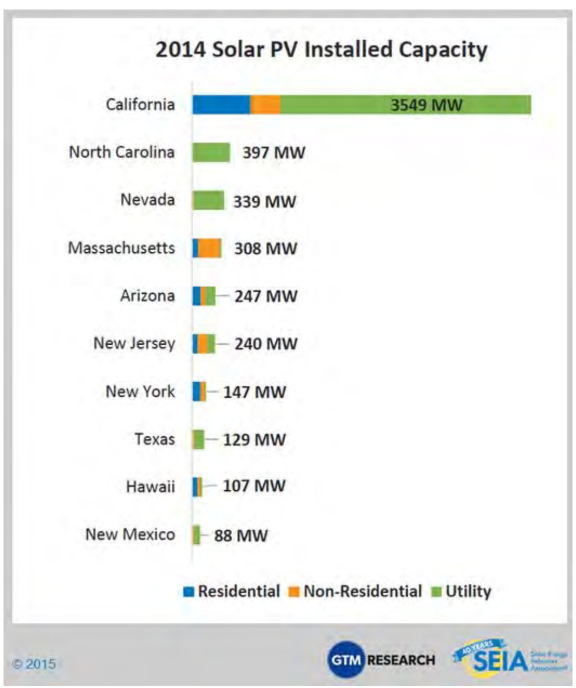
Surrounding Uses

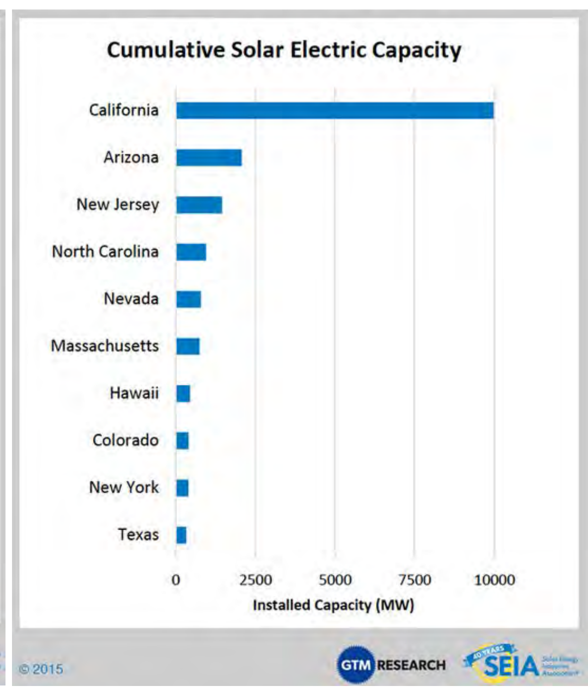
#	MAP ID	Owner	GIS Data Acres	Present Use	% Adjoining Acres	% Adjoining Parcels	Distance in Feet: Home to Panels
1	100-11	Felts	103.8	Agri/Res	13.95%	8.33%	310
2	100-33A	Felts	96.25	Agri/Res	12.93%	8.33%	475
3	100-31D	Vaughan	2.03	Residential	0.27%	8.33%	N/A
4	100-34	Hawthorne	107	Agri/Res	14.38%	8.33%	600
5	100-50	Whitehead	99	Agri/Res	13.30%	8.33%	3350
6	100-28	Smithview	73.96	Agricultural	9.94%	8.33%	N/A
7	100-23	Bryant	202.23	Agri/Res	27.17%	8.33%	780
8	100-16	N/A	0	Cemetary	0.00%	8.33%	N/A
9	100-14A	N/A	0	Agricultural	0.00%	8.33%	N/A
10	100-15	Fuller Farms	60	Agri/Res	8.06%	8.33%	1500
11	100-32	N/A	0	Substation	0.00%	8.33%	N/A
12	100-32A	N/A	0	Substation	0.00%	8.33%	N/A
		Total	**744.270**		**100.00%**	**100.00%**	1,169

I. Overview of Solar Farms Development in North Carolina

Across the nation the number of solar installations has dramatically increased over the last few years as changes in technology and the economy made these solar farms more feasible. The charts below show how this market has grown and is expected to continue to grow from 2010 to 2017, the drop off in 2017 is expected due to the expiration of tax credits for solar installations. The U.S. Solar Market Insight Reports for 2010 and 2011 which is put out by the Solar Energy Industries Association note that 2010 was a "breakout" year for solar energy. The continued boom of solar power is shown in the steady growth. North Carolina was ranked as having the second most active photovoltaic installed capacity in 2014.







As shown in the charts above, North Carolina ranked second in installed solar energy in 2014. North Carolina ranked fifth in cumulative installed solar energy in the United States.

II. Market Analysis of the Impact on Value from Solar Farms

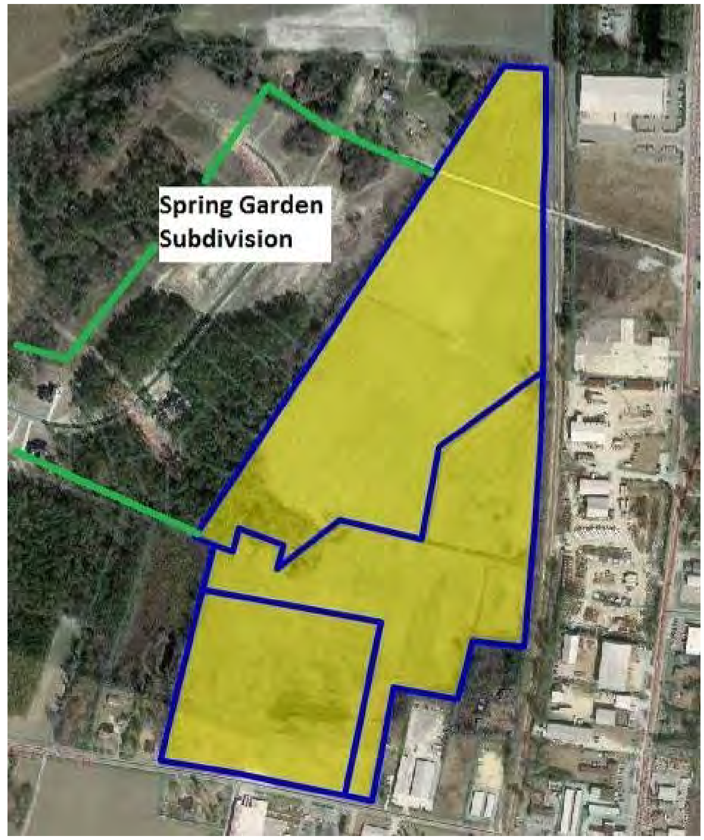
I have researched a number of solar farms in North Carolina to determine the impact of these facilities on the value of adjoining property. I have provided a breakdown of the adjoining uses to show what adjoining uses are typical for solar farms and what uses would likely be considered consistent with a solar farm use. This breakdown is included in the Harmony of Use section of this report.

I also conducted a series of matched pair analyses. A matched pair analysis considers two similar properties with only one difference of note to determine whether or not that difference has any impact on value. Within the appraisal profession, matched pair analysis is a well-recognized method of measuring impact on value. In this case, I have considered residential properties adjoining a solar farm versus similar residential properties that do not adjoin a solar farm. I have also considered matched pairs of vacant residential and agricultural land.

As outlined in the discussion of each matched pair, I concluded from the data and my analysis that there has been no impact on sale price for residential, agricultural, or vacant residential land that adjoins the existing solar farms included in my study.

1. Matched Pair – AM Best Solar Farm, Goldsboro, NC

This solar farm adjoins Spring Garden Subdivision which had new homes and lots available for new construction during the approval and construction of the solar farm. The recent home sales have ranged from $200,000 to $250,000. This subdivision sold out the last homes in late 2014. The solar farm is clearly visible particularly along the north end of this street where there is only a thin line of trees separating the solar farm from the single-family homes.

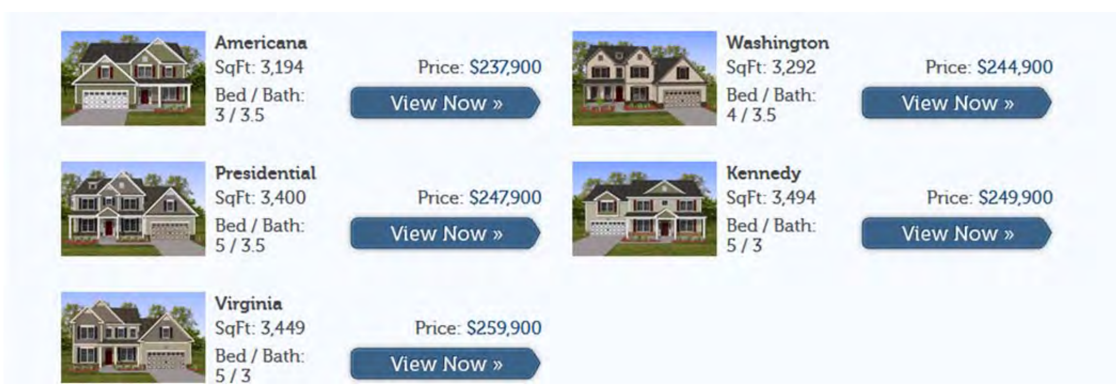


Homes backing up to the solar farm are selling at the same price for the same floor plan as the homes that do not back up to the solar farm in this subdivision. According to the builder, the solar farm has been a complete non-factor. Not only do the sales show no difference in the price paid for the various homes adjoining the solar farm versus not adjoining the solar farm, but there are actually more recent sales along the solar farm than not. There is no impact on the sellout rate, or time to sell for the homes adjoining the solar farm.

I spoke with a number of owners who adjoin the solar farm and none of them expressed any concern over the solar farm impacting their property value.

The data presented on the following page shows multiple homes that have sold in 2013 and 2014 adjoining the solar farm at prices similar to those not along the solar farm. These series of sales indicate that the solar farm has no impact on the adjoining residential use.

The homes that were marketed at Spring Garden are shown below.



AM Best Solar Farm, Goldsboro, NC

Matched Pairs
As of Date: 9/3/2014

Adjoining Sales After Solar Farm Completed

TAX ID	Owner	Acres	Date Sold	Sales Price	Built	GBA	$/GBA	Style
3600195570	Helm	0.76	Sep-13	$250,000	2013	3,292	$75.94	2 Story
3600195361	Leak	1.49	Sep-13	$260,000	2013	3,652	$71.19	2 Story
3600199891	McBrayer	2.24	Jul-14	$250,000	2014	3,292	$75.94	2 Story
3600198632	Foresman	1.13	Aug-14	$253,000	2014	3,400	$74.41	2 Story
3600196656	Hinson	0.75	Dec-13	$255,000	2013	3,453	$73.85	2 Story
	Average	1.27		$253,600	2013.4	3,418	$74.27	
	Median	1.13		$253,000	2013	3,400	$74.41	

Adjoining Sales After Solar Farm Announced

TAX ID	Owner	Acres	Date Sold	Sales Price	Built	GBA	$/GBA	Style
0	Feddersen	1.56	Feb-13	$247,000	2012	3,427	$72.07	Ranch
0	Gentry	1.42	Apr-13	$245,000	2013	3,400	$72.06	2 Story
	Average	1.49		$246,000	2012.5	3,414	$72.07	
	Median	1.49		$246,000	2012.5	3,414	$72.07	

Adjoining Sales Before Solar Farm Announced

TAX ID	Owner	Acres	Date Sold	Sales Price	Built	GBA	$/GBA	Style
3600183905	Carter	1.57	Dec-12	$240,000	2012	3,347	$71.71	1.5 Story
3600193097	Kelly	1.61	Sep-12	$198,000	2012	2,532	$78.20	2 Story
3600194189	Hadwan	1.55	Nov-12	$240,000	2012	3,433	$69.91	1.5 Story
	Average	1.59		$219,000	2012	2,940	$74.95	
	Median	1.59		$219,000	2012	2,940	$74.95	

Nearby Sales After Solar Farm Completed

TAX ID	Owner	Acres	Date Sold	Sales Price	Built	GBA	$/GBA	Style
3600193710	Barnes	1.12	Oct-13	$248,000	2013	3,400	$72.94	2 Story
3601105180	Nackley	0.95	Dec-13	$253,000	2013	3,400	$74.41	2 Story
3600192528	Mattheis	1.12	Oct-13	$238,000	2013	3,194	$74.51	2 Story
3600198928	Beckman	0.93	Mar-14	$250,000	2014	3,292	$75.94	2 Story
3600196965	Hough	0.81	Jun-14	$224,000	2014	2,434	$92.03	2 Story
3600193914	Preskitt	0.67	Jun-14	$242,000	2014	2,825	$85.66	2 Story
3600194813	Bordner	0.91	Apr-14	$258,000	2014	3,511	$73.48	2 Story
3601104147	Shaffer	0.73	Apr-14	$255,000	2014	3,453	$73.85	2 Story
	Average	0.91		$246,000	2013.625	3,189	$77.85	
	Median	0.92		$249,000	2014	3,346	$74.46	

Nearby Sales Before Solar Farm Announced

TAX ID	Owner	Acres	Date Sold	Sales Price	Built	GBA	$/GBA	Style
3600191437	Thomas	1.12	Sep-12	$225,000	2012	3,276	$68.68	2 Story
3600087968	Lilley	1.15	Jan-13	$238,000	2012	3,421	$69.57	1.5 Story
3600087654	Burke	1.26	Sep-12	$240,000	2012	3,543	$67.74	2 Story
3600088796	Hobbs	0.73	Sep-12	$228,000	2012	3,254	$70.07	2 Story
	Average	1.07		$232,750	2012	3,374	$69.01	
	Median	1.14		$233,000	2012	3,349	$69.13	

Matched Pair Summary

	Adjoins Solar Farm		Nearby Solar Farm	
	Average	**Median**	**Average**	**Median**
Sales Price	$253,600	$253,000	$246,000	$249,000
Year Built	2013	2013	2014	2014
Size	3,418	3,400	3,189	3,346
Price/SF	$74.27	$74.41	$77.85	$74.46

Percentage Differences

Median Price	-2%
Median Size	-2%
Median Price/SF	0%

I note that 2308 Granville Drive sold again in November 2015 for $267,500, or $7,500 more than when it was purchased new from the builder two years earlier (Tax ID 3600195361, Owner: Leak). The neighborhood is clearly showing appreciation for homes adjoining the solar farm.

The Median Price is the best indicator to follow in any analysis as it avoids outlying samples that would otherwise skew the results. The median sizes and median prices are all consistent throughout the sales both before and after the solar farm whether you look at sites adjoining or nearby to the solar farm. The average for the homes nearby the solar farm shows a smaller building size and a higher price per square foot. This reflects a common occurrence in real estate where the price per square foot goes up as the size goes down. This is similar to the discount you see in any market where there is a discount for buying larger volumes. So when you buy a 2 liter coke you pay less per ounce than if you buy a 16 oz. coke. So even comparing averages the indication is for no impact, but I rely on the median rates as the most reliable indication for any such analysis.

AM Best Solar Farm, Goldsboro, NC

View of home in Spring Garden with solar farm located through the trees and panels – photo taken on 9/23/15.

View from vacant lot at Spring Garden with solar farm panels visible through trees taken in the winter of 2014 prior to home construction. This is the same lot as the photo above.

2. Matched Pair – White Cross Solar Farm, Chapel Hill, NC

A new solar farm was built at 2159 White Cross Road in Chapel Hill, Orange County in 2013. After construction, the owner of the underlying land sold the balance of the tract not encumbered by the solar farm in July 2013 for $265,000 for 47.20 acres, or $5,606 per acre. This land adjoins the solar farm to the south and was clear cut of timber around 10 years ago. I compared this purchase to a nearby transfer of 59.09 acres of timber land just south along White Cross Road that sold in November 2010 for $361,000, or $6,109 per acre. After purchase, this land was divided into three mini farm tracts of 12 to 20 acres each. These rates are very similar and the difference in price per acre is attributed to the timber value and not any impact of the solar farm.

Type	TAX ID	Owner	Acres	Date	Price	$/Acre	Notes	Conf By
Adjoins Solar	9748336770	Haggerty	47.20	Jul-13	$265,000	$5,614	Clear cut	Betty Cross, broker
Not Near Solar	9747184527	Purcell	59.09	Nov-10	$361,000	$6,109	Wooded	Dickie Andrews, broker

The difference in price is attributed to the trees on the older sale.
No impact noted for the adjacency to a solar farm according to the broker.
I looked at a number of other nearby land sales without proximity to a solar farm for this matched pair, but this land sale required the least allowance for differences in size, utility and location.

Matched Pair Summary

	Adjoins Solar Farm		Nearby Solar Farm	
	Average	**Median**	**Average**	**Median**
Sales Price	$5,614	$5,614	$6,109	$6,109
Adjustment for Timber	$500	$500		
Adjusted	$6,114	$6,114	$6,109	$6,109
Tract Size	47.20	47.20	59.09	59.09

Percentage Differences

Median Price Per Acre	0%

This matched pair again supports the conclusion that adjacency to a solar farm has no impact on adjoining residential/agricultural land.

3. Matched Pair – Wagstaff Farm, Roxboro, NC

This solar farm is located at the northeast corner of a 594-acre farm with approximately 30 acres of solar farm area. This solar farm was approved and constructed in 2013.

After approval, 18.82 acres were sold out of the parent tract to an adjoining owner to the south. This sale was at a similar price to nearby land to the east that sold in the same time from for the same price per acre as shown below.

Type	TAX ID	Owner	Acres	Present Use	Date Sold	Price	$/AC
Adjoins Solar	0918-17-11-7960	Piedmont	18.82	Agriculatural	8/19/2013	$164,000	$8,714
Not Near Solar	0918-00-75-9812 et al	Blackwell	14.88	Agriculatural	12/27/2013	$130,000	$8,739

Matched Pair Summary

	Adjoins Solar Farm		Nearby Solar Farm	
	Average	**Median**	**Average**	**Median**
Sales Price	$8,714	$8,714	$8,739	$8,739
Tract Size	18.82	18.82	14.88	14.88

Percentage Differences

Median Price Per Acre	0%

This matched pair again supports the conclusion that adjacency to a solar farm has no impact on adjoining residential/agricultural land.

4. Matched Pair – Mulberry, Selmer, TN

This solar farm adjoins two subdivisions with Central Hills having a mix of existing and new construction homes. Lots in this development have been marketed for $15,000 each with discounts offered for multiple lots being used for a single home site. I spoke with the agent with Rhonda Wheeler and Becky Hearnsberger with United County Farm & Home Realty who noted that they have seen no impact on lot or home sales due to the solar farm in this community.

I have included a map below as well as data on recent sales activity on lots that adjoin the solar farm or are near the solar farm in this subdivision both before and after the announced plan for this solar farm facility. I note that using the same method I used to breakdown the adjoining uses at the subject property I show that the predominant adjoining uses are residential and agricultural, which is consistent with the location of most solar farms.

Adjoining Use Breakdown

	Acreage	Parcels
Commercial	3.40%	0.034
Residential	12.84%	79.31%
Agri/Res	10.39%	3.45%
Agricultural	73.37%	13.79%
Total	**100.00%**	**100.00%**

From the above map, I identified four recent sales of homes that occurred adjoining the solar farm both before and after the announcement of the solar farm. I have adjusted each of these for differences in size and age in order to compare these sales among themselves. As shown below after adjustment, the median value is $130,776 and the sales prices are consistent with one outlier which is also the least comparable home consisered. The close grouping and the similar price per point overall as well as the similar price per square foot both before and after the solar farm.

Matched Pairs

#	TAX ID	Owner	Date Sold	Sales Price	Acres	Built	GBA	$/GBA	Style	Parking
6&7	0900 A 011.00	Henson	Jul-14	$130,000	2.65	2007	1,511	$86.04	1 Story	2 Garage
12	0900 A 003.00	Amerson	Aug-12	$130,000	1.20	2011	1,586	$81.97	1 Story	2 Garage
15	099C A 003.00	Smallwood	May-12	$149,900	1.00	2002	1,596	$93.92	1 Story	4 Garage
16	099C A 002.00	Hessing	Jun-15	$130,000	1.00	1999	1,782	$72.95	1 Story	2 Garage
		Average		$134,975	1.46	2005	1,619	$83.72		
		Median		$130,000	1.10	2005	1,591	$84.00		

					Adjustments*					
#	TAX ID	Owner	Date Sold	Sales Price	Acres	Built	GBA	Style	Parking	Total
6&7	0900 A 011.00	Henson	Jul-14	$130,000	-$7,500	$2,600	$6,453	$0	$0	$131,553
12	0900 A 003.00	Amerson	Aug-12	$130,000	$0	$0	$0	$0	$0	$130,000
15	099C A 003.00	Smallwood	May-12	$149,900	$0	$6,746	-$939	$0	-$15,000	$140,706
16	099C A 002.00	Hessing	Jun-15	$130,000	$0	$7,800	-$14,299	$0	$0	$123,501
		Average		$134,975	-$1,875	$4,286	-$2,196	$0	-$3,750	$131,440
		Median		$130,000	$0	$4,673	-$470	$0	$0	$130,776

* I adjusted all of the comparables to a base line 2011 Year Built and 1,586 s.f. based on Lot 12

I also considered a number of similar home sales nearby that were both before and after the solar farm was announced as shown below. These homes are generally newer in construction and include a number of larger homes but show a very similar price point per square foot.

Nearby Sales Before Solar Farm Announced

TAX ID	Owner	Date Sold	Sales Price	Acres	Built	GBA	$/GBA	Style	Parking
099B A 019	Durrance	Sep-12	$165,000	1.00	2012	2,079	$79.37	1 Story	2 Garage
099B A 021	Berryman	Apr-12	$212,000	2.73	2007	2,045	$103.67	1 Story	2 Garage
090O A 060	Nichols	Feb-13	$165,000	1.03	2012	1,966	$83.93	1 Story	2 Garage
	Average		$180,667	1.59	2010	2,030	$88.99		
	Median		$165,000	1.03	2012	2,045	$83.93		

Nearby Sales After Solar Farm Announced

TAX ID	Owner	Date Sold	Sales Price	Acres	Built	GBA	$/GBA	Style	Parking
090N A 040	Carrithers	Mar-15	$120,000	1.00	2010	1,626	$73.80	1 Story	2 Garage
099C A 043	Cherry	Feb-15	$148,900	2.34	2008	1,585	$93.94	1 Story	2 Garage
	Average		$134,450	1.67	2009	1,606	$83.87		
	Median		$134,450	1.67	2009	1,606	$83.87		

I then adjusted these nearby sales using the same criteria as the adjoining sales to derive the following breakdown of adjusted values based on a 2011 year built 1,586 square foot home. The adjusted values are consistent with a median rate of $128,665, which is actually lower than the values for the homes that back up to the solar farm.

Nearby Sales Adjusted				Adjustments*					
TAX ID	Owner	Date Sold	Sales Price	Acres	Built	GBA	Style	Parking	Total
099B A 019	Durrance	Sep-12	$165,000	$0	-$825	-$39,127	$0	$0	$125,048
099B A 021	Berryman	Apr-12	$212,000	-$7,500	$4,240	-$47,583	$0	$0	$161,157
090O A 060	Nichols	Feb-13	$165,000	$0	-$825	-$31,892	$0	$0	$132,283
090N A 040	Carrithers	Mar-15	$120,000	$0	$600	-$2,952	$0	$0	$117,648
099C A 043	Cherry	Feb-15	$148,900	-$7,500	$2,234	$94	$0	$0	$143,727
	Average		$165,500	-$1,875	$798	-$30,389	$0	$0	$134,034
	Median		$165,000	$0	-$113	-$35,510	$0	$0	$128,665

* I adjusted all of the comparables to a base line 2011 Year Built and 1,586 s.f. based on Lot 12

If you consider just the 2015 nearby sales, the range is $117,648 to $143,727 with a median of $130,688. If you consider the recent adjoining sales the range is $123,501 to $131,553 with a median of $127,527.

This difference is less than 3% in the median and well below the standard deviation in the sales. The entire range of the adjoining sales prices is overlapped by the range from the nearby sales. These are consistent data sets and summarized below.

Matched Pair Summary

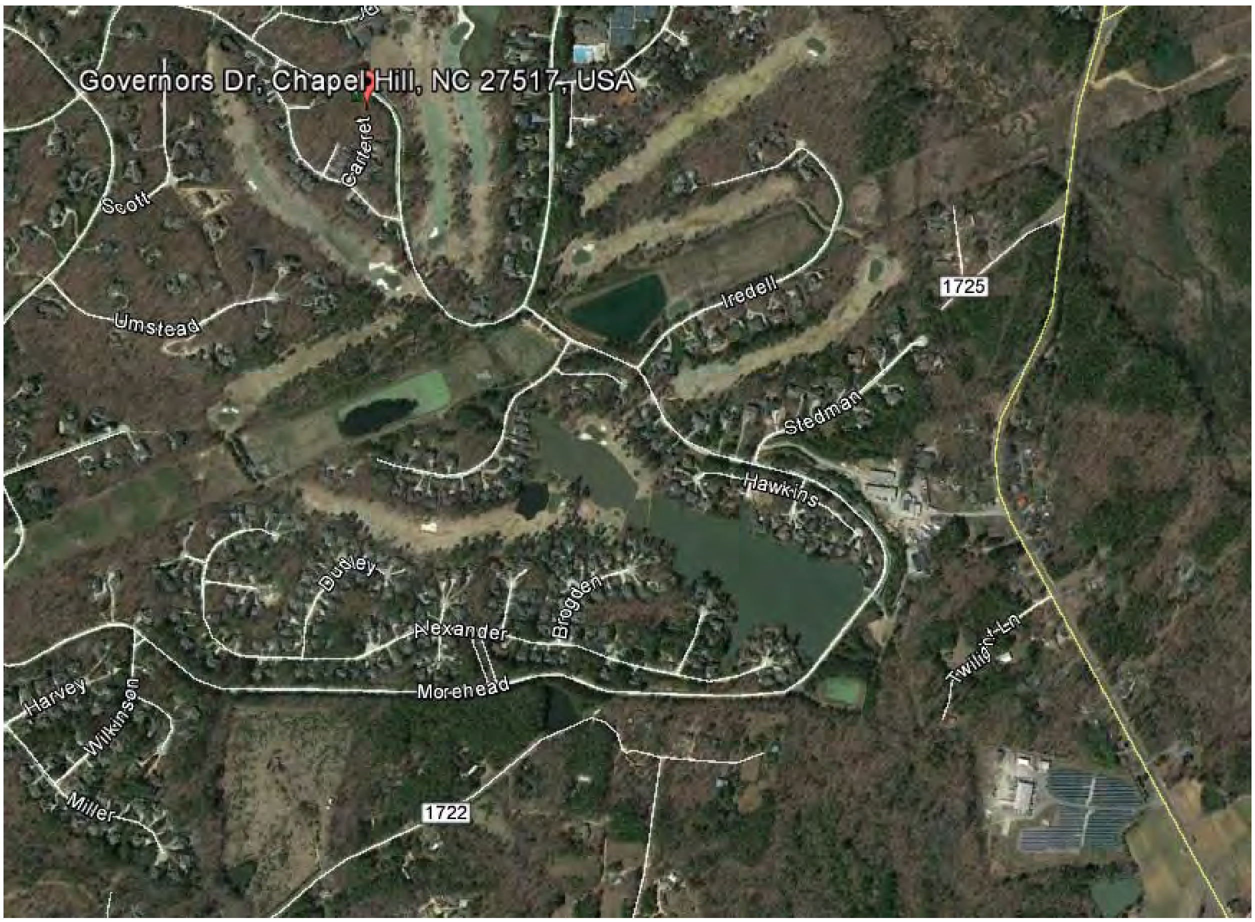
	Adjoins Solar Farm		Nearby After Solar Farm	
	Average	**Median**	**Average**	**Median**
Sales Price	$134,975	$130,000	$134,450	$134,450
Year Built	2005	2005	2009	2009
Size	1,619	1,591	1,606	1,606
Price/SF	$83.72	$84.00	$83.87	$83.87

Percentage Differences	
Median Price	3%
Median Size	1%
Median Price/SF	0%

Based on the data presented above, I find that the price per square foot for finished homes are not being impacted negatively by the presence of the solar farm. The difference in pricing in homes in the neighborhood is accounted for by differences in size, building age, and lot size. The median price for a home after those factors are adjusted for are consistent throughout this subdivision and show no impact due to the proximity of the solar farm. This is consistent with the comments from the broker I spoke with for this subdivision as well.

III. Harmony of Use/Compatability

I have visited over 200 solar farms and sites on which solar farms are constructed and proposed in multiple states, but mostly in North Carolina to determine what uses are compatible with a solar farm. The data I have collected and provide in this report strongly supports the compatibility of solar farms with adjoining agricultural and residential uses. While I have focused on adjoining uses, I note that there are many examples of solar farms being located within a quarter mile of residential developments, including such notable developments as Governor's Club in Chapel Hill, which has a solar farm within a quarter mile as you can see on the following aerial map. Governor's Club is a gated golf community with homes selling for $300,000 to over $2 million.



The subdivisions included in the matched pair analysis also show an acceptance of residential uses adjoining solar farms as a harmonious use.

Beyond these anecdotal references, I have quantified the adjoining uses for a number of solar farm comparables to derive a breakdown of the adjoining uses for each solar farm. The chart below shows the breakdown of adjoining or abutting uses by total acreage. While most of these solar farms were located in North Carolina, the breakdown of adjoining uses is very similar to that shown for Oregon as shown earlier in this report.

Percentage By Adjoining Acreage										
Total Solar Farms Reviewed	173									
	Res	Ag	Res/AG	Park	Sub	Comm	Ind	All Res Uses	All Comm Uses
Average	13%	57%	22%	1%	0%	0%	5%	94%	5%
Median	6%	63%	7%	0%	0%	0%	0%	100%	0%

Res = Residential, Ag = Agriculture, Sub = Substation, Com = Commercial, Ind = Industrial.

I have also included a breakdown of each solar farm by number of adjoining parcels rather than acreage. Using both factors provides a more complete picture of the neighboring properties.

Percentage By Total Number of Adjoining Parcels									
Total Solar Farms Reviewed	173								
	Res	Ag	Res/AG	Park	Sub	Comm	Ind	All Res Uses	All Comm Uses
Average	58%	27%	9%	0%	0%	2%	4%	94%	5%
Median	63%	25%	4%	0%	0%	0%	0%	100%	0%

Res = Residential, Ag = Agriculture, Sub = Substation, Com = Commercial, Ind = Industrial.

Both of the above charts show a marked residential and agricultural adjoining use for most solar farms. Every single solar farm considered included an adjoining residential use except for one, which included an adjoining residential/agricultural use. These comparable solar farms clearly support a compatibility with adjoining residential uses along with agricultural uses.

IV. Summary of Local Solar Farm Projects

Parcel #	State	County	City	Name	Acres	Avg. Dist to home	Closest Home	Adjoining Use by Acreage Residential %	Agricultural %	Comm/Ind %
115	VA	Buckingham	Cumberland	Firestone	481.18	N/A	N/A	8%	92%	0%
121	VA	Powhatan	Amelia	Scott	898.4	1421	730	29%	71%	0%
204	VA	New Kent	Walker-Correctional	Barhamsville	484.65	516	103	13%	87%	0%
205	VA	Sussex	Sapony	Stony Creek	371.38	571	185	N/A	N/A	N/A
216	VA	Southampton	Boykins	Beetle	422.19	1169	310	0%	100%	0%

Summary of Findings

Total Number of Solar Farms

	Acres	Avg. Dist to home	Closest Home	Residential %	Agricultural %	Comm/Ind %
Average	531.56	919.25	332.00	12%	88%	0%
Median	481.18	870.00	247.50	10%	90%	0%
High	898.40	1421.00	730.00	29%	100%	0%
Low	371.38	516.00	103.00	0%	71%	0%

V. Specific Factors on Harmony of Use

I have completed a number of Impact Studies related to a variety of uses and I have found that the most common areas for impact on adjoining values typically follow the following hierarchy with descending levels of potential impact. I will discuss each of these categories and how they relate to a solar farm.

1. Hazardous material
2. Odor
3. Noise
4. Traffic
5. Stigma
6. Appearance

1. Hazardous material

The solar farm presents no potential hazardous waste byproduct as part of normal operation. Any fertilizer, weed control, vehicular traffic, or construction will be significantly less than typically applied in a residential development or even most agricultural uses.

The various solar farms that I have inspected and identified in the addenda have no known pending environmental impacts associated with the development and operation.

2. Odor

The various solar farms that I have inspected produced no noticeable odor.

3. Noise

These are passive solar panels with no associated noise beyond a barely audible sound during daylight hours. The transformer reportedly has a hum similar to a fluorescent light in an office building that can only be heard in close proximity to this transformer and the buffers on the property are sufficient to make emitted sounds inaudible from the adjoining properties. No sound is emitted from the facility at night.

The various solar farms that I have inspected were inaudible from the roadways. I heard nothing on any of these sites associated with the solar farm.

4. Traffic

The solar farm will have no onsite employee's or staff. The site requires only minimal maintenance. Relative to other potential uses of the site (such as a residential subdivision), the additional traffic generated by a solar farm use on this site is insignificant.

5. Stigma

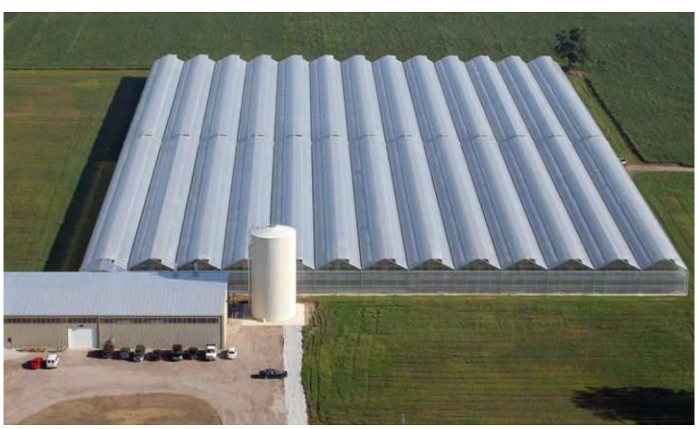
There is no stigma associated with solar farms and solar farms and people generally respond favorably towards such a use. While an individual may express concerns about proximity to a solar farm, there is no specific stigma associated with a solar farm. Stigma generally refers to things such as adult establishments, prisons, rehabilitation facilities, and so forth.

Solar panels have no associated stigma and in smaller collections are found in yards and roofs in many residential communities. Solar panels on a roof are often cited as an enhancement to the property in marketing brochures.

I see no basis for an impact from stigma due to a solar farm.

6. Appearance

Larger solar farms using fixed panels are a passive use of the land that is considered in keeping with a rural/residential area. As shown below, solar farms are comparable to larger greenhouses. This is not surprising given that a greenhouse is essentially another method for collecting passive solar energy. The greenhouse use is well received in residential/rural areas and has a similar visual impact as a solar farm.




The fixed solar panels are all less than 15 feet high, which means that the visual impact of the solar panels will be similar in height to a typical greenhouse and lower than a single story residential dwelling. Were the subject property developed with single family housing, it would have a much greater visual impact on the surrounding area given that a two-story home with attic could be three to four times as high as these proposed panels. The panels will be located behind a chain link fence.

7. Conclusion

On the basis of the factors described above, it is my professional opinion that the proposed solar farm will be in harmony with the area in which it is to be developed. The breakdown of adjoining uses is similar to the other solar farms tracked.

VI. Market Commentary

I have surveyed a number of builders, developers and investors regarding solar farms over the last year. I have received favorable feedback from a variety of sources; below are excerpts from my conversations with different clients or other real estate professionals.

I spoke with Betty Cross with Keller Williams Realty in Chapel Hill, who sold the tract of land adjoining the White Cross Road solar farm. She indicated that the solar farm was not considered a negative factor in marketing the property and that it had no impact on the final price paid for the land.

I spoke with Lynn Hayes a broker with Berkshire Hathaway who sold a home at the entrance to Pickards Mountain where the home exits onto the Pickard Mountain Eco Institute's small solar farm. This property is located in rural Orange County west of Chapel Hill. This home closed in January 2014 for $735,000. According to Ms. Hayes the buyer was excited to be living near the Eco Institute and considered the solar farm to be a positive sign for the area. There are currently a number of 10 acre plus lots in Pickards Meadow behind this house with lots on the market for $200,000 to $250,000.

A new solar farm was built on Zion Church Road, Hickory at the Two Lines Solar Farm on the Punch property. After construction of the solar farm in 2013, an adjoining tract of land with 88.18 acres sold for $250,000, or $2,835 per acre. This was a highly irregular tract of land with significant tree cover between it and the solar farm. I have compared this to a current listing of 20.39 acres of land that is located southeast just a little ways from this solar farm. This land is on the market for $69,000, or $3,428 per acre. Generally, a smaller tract of land would be listed for more per acre. Considering a size adjustment of 5% per doubling in size, and a 10% discount for the likely drop in the closed price off of the asking price, I derive an indicated value per acre of the smaller tract of $2,777 per acre. This is very similar to the recently closed sale adjoining the solar farm, which further supports the matched pair analysis earlier in this report.

Rex Vick with Windjam Developers has a subdivision in Chatham County off Mt. Gilead Church Road known as The Hamptons. Home prices in The Hamptons start at $600,000 with homes over $1,000,000. Mr. Vick expressed interest in the possibility of including a solar farm section to the development as a possible additional marketing tool for the project.

Mr. Eddie Bacon, out of Apex North Carolina, has inherited a sizeable amount of family and agricultural land, and he has expressed interest in using a solar farm as a method of preserving the land for his children and grandchildren while still deriving a useful income from the property. He believes that solar panels would not in any way diminish the value for this adjoining land.

I spoke with Carolyn Craig, a Realtor in Kinston, North Carolina who is familiar with the Strata Solar Farms in the area. She noted that a solar farm in the area would be positive: "A solar farm is color coordinated and looks nice." "A solar farm is better than a turkey farm," which is allowed in that area. She would not expect a solar farm will have any impact on adjoining home prices in the area.

Mr. Michael Edwards, a broker and developer in Raleigh, indicated that a passive solar farm would be a great enhancement to adjoining property: "You never know what might be put on that land next door. There is no noise with a solar farm like there is with a new subdivision."

These are just excerpts I've noted in my conversations with different clients or other real estate participants that provided other thoughts on the subject that seemed applicable.

VII. <u>Conclusion</u>

The matched pair analysis shows no impact in home values due to the adjacency to the solar farm as well as no impact to adjacent vacant residential or agricultural land. The criteria for making downward adjustments on property values such as appearance, noise, odor, and traffic all indicate that a solar farm is a compatible use for rural/residential transition areas.

Similar solar farms have been approved adjoining agricultural uses, schools and residential developments. Industrial uses rarely absorb negative impacts from adjoining uses. The adjoining residential uses to other solar farms have included single family homes up to $260,000 on lots as small as 0.74 acres. The solar farm at the Pickards Mountain Eco Institute adjoins a home that sold in January 2014 for $735,000 and in proximity to lots being sold for $200,000 to $250,000 for homes over a million dollars.

Based on the data and analysis in this report, it is my professional opinion that the solar farm proposed at the subject property will maintain or enhance the value of adjoining or abutting property and that the proposed use is in harmony with the area in which it is located.

If you have any further questions please call me any time.

Sincerely,

Richard C. Kirkland, Jr., MAI
State Certified General Appraiser

Limiting Conditions and Assumptions

Acceptance of and/or use of this report constitutes acceptance of the following limiting conditions and assumptions; these can only be modified by written documents executed by both parties.

- The basic limitation of this and any appraisal is that the appraisal is an opinion of value, and is, therefore, not a guarantee that the property would sell at exactly the appraised value. The market price may differ from the market value, depending upon the motivation and knowledge of the buyer and/or seller, and may, therefore, be higher or lower than the market value. The market value, as defined herein, is an opinion of the probable price that is obtainable in a market free of abnormal influences.

- I do not assume any responsibility for the legal description provided or for matters pertaining to legal or title considerations. I assume that the title to the property is good and marketable unless otherwise stated.

- I am appraising the property as though free and clear of any and all liens or encumbrances unless otherwise stated.

- I assume that the property is under responsible ownership and competent property management.

- I believe the information furnished by others is reliable, but I give no warranty for its accuracy.

- I have made no survey or engineering study of the property and assume no responsibility for such matters. All engineering studies prepared by others are assumed to be correct. The plot plans, surveys, sketches and any other illustrative material in this report are included only to help the reader visualize the property. The illustrative material should not be considered to be scaled accurately for size.

- I assume that there are no hidden or unapparent conditions of the property, subsoil, or structures that render it more or less valuable. I take no responsibility for such conditions or for obtaining the engineering studies that may be required to discover them.

- I assume that the property is in full compliance with all applicable federal, state, and local laws, including environmental regulations, unless the lack of compliance is stated, described, and considered in this appraisal report.

- I assume that the property conforms to all applicable zoning and use regulations and restrictions unless nonconformity has been identified, described and considered in this appraisal report.

- I assume that all required licenses, certificates of occupancy, consents, and other legislative or administrative authority from any local, state, or national government or private entity or organization have been or can be obtained or renewed for any use on which the value estimate contained in this report is based.

- I assume that the use of the land and improvements is confined within the boundaries or property lines of the property described and that there is no encroachment or trespass unless noted in this report.

- I am not qualified to detect the presence of floodplain or wetlands. Any information presented in this report related to these characteristics is for this analysis only. The presence of floodplain or wetlands may affect the value of the property. If the presence of floodplain or wetlands is suspected the property owner would be advised to seek professional engineering assistance.

- For this appraisal, I assume that no hazardous substances or conditions are present in or on the property. Such substances or conditions could include but are not limited to asbestos, urea-formaldehyde foam insulation, polychlorinated biphenyls (PCBs), petroleum leakage or underground storage tanks, electromagnetic fields, or agricultural chemicals. I have no knowledge of any such materials or conditions unless otherwise stated. I make no claim of technical knowledge with regard to testing for or identifying such hazardous materials or conditions. The presence of such materials, substances or conditions could affect the value of the property. However, the values estimated in this report are predicated on the assumption that there are no such materials or conditions in, on or in close enough proximity to the property to cause a loss in value. The client is urged to retain an expert in this field, if desired.

- Unless otherwise stated in this report the subject property is appraised without a specific compliance survey having been conducted to determine if the property is or is not in conformance with the requirements of the

Americans with Disabilities Act (effective 1/26/92). The presence of architectural and/or communications barriers that are structural in nature that would restrict access by disabled individuals may adversely affect the property's value, marketability, or utility.

- Any allocation of the total value estimated in this report between the land and the improvements applies only under the stated program of utilization. The separate values allocated to the land and buildings must not be used in conjunction with any other appraisal and are invalid if so used.
- Possession of this report, or a copy thereof, does not carry with it the right of publication.
- I have no obligation, by reason of this appraisal, to give further consultation or testimony or to be in attendance in court with reference to the property in question unless further arrangements have been made regarding compensation to Kirkland Appraisals, LLC.
- Neither all nor any part of the contents of this report (especially any conclusions as to value, the identity of the appraiser, or the firm with which the appraiser is connected) shall be disseminated to the public through advertising, public relations, news, sales, or other media without the prior written consent and approval of Kirkland Appraisals, LLC, and then only with proper qualifications.
- Any value estimates provided in this report apply to the entire property, and any proration or division of the total into fractional interests will invalidate the value estimate, unless such proration or division of interests has been set forth in the report.
- Any income and expenses estimated in this report are for the purposes of this analysis only and should not be considered predictions of future operating results.
- This report is not intended to include an estimate of any personal property contained in or on the property, unless otherwise state.
- This report is subject to the Code of Professional Ethics of the Appraisal Institute and complies with the requirements of the State of North Carolina for State Certified General Appraisers. This report is subject to the certification, definitions, and assumptions and limiting conditions set forth herein.
- The analyses, opinions and conclusions were developed based on, and this report has been prepared in conformance with, our interpretation of the guidelines and recommendations set forth in the Financial Institutions Reform, Recovery, and Enforcement Act of 1989 (FIRREA).
- This is a Real Property Appraisal Consulting Assignment.

Certification – Richard C. Kirkland, Jr., MAI

I certify that, to the best of my knowledge and belief:

1. The statements of fact contained in this report are true and correct;

2. The reported analyses, opinions, and conclusions are limited only by the reported assumptions and limiting conditions, and are my personal, unbiased professional analyses, opinions, and conclusions;

3. I have no present or prospective interest in the property that is the subject of this report and no personal interest with respect to the parties involved;

4. I have no bias with respect to the property that is the subject of this report or to the parties involved with this assignment;

5. My engagement in this assignment was not contingent upon developing or reporting predetermined results;

6. My compensation for completing this assignment is not contingent upon the development or reporting of a predetermined value or direction in value that favors the cause of the client, the amount of the value opinion, the attainment of a stipulated result, or the occurrence of a subsequent event directly related to the intended use of the appraisal;

7. The reported analyses, opinions, and conclusions were developed, and this report has been prepared, in conformity with the requirements of the Code of Professional Ethics and Standards of Professional Appraisal Practice of the Appraisal Institute;

8. The reported analyses, opinions and conclusions were developed, and this report has been prepared, in conformity with the Uniform Standards of Professional Appraisal Practice.

9. The use of this report is subject to the requirements of the Appraisal Institute relating to review by its duly authorized representatives;

10. I have not made a personal inspection of the property that is the subject of this report, and;

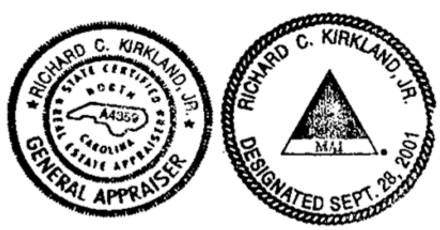
11. No one provided significant real property appraisal assistance to the person signing this certification.

12. As of the date of this report I have completed the requirements of the continuing education program of the Appraisal Institute;

13. I have not appraised this property within the last three years.

Disclosure of the contents of this appraisal report is governed by the bylaws and regulations of the Appraisal Institute and the National Association of Realtors.

Neither all nor any part of the contents of this appraisal report shall be disseminated to the public through advertising media, public relations media, news media, or any other public means of communications without the prior written consent and approval of the undersigned.



Richard C. Kirkland, Jr., MAI
State Certified General Appraiser

Kirkland Appraisals, LLC

Richard C. Kirkland, Jr., MAI
9408 Northfield Court
Raleigh, North Carolina 27603
Mobile (919) 414-8142
rkirkland2@gmail.com
www.kirklandappraisals.com

PROFESSIONAL EXPERIENCE

Kirkland Appraisals, LLC, Raleigh, N.C. — 2003 – Present
Commercial appraiser

Hester & Company, Raleigh, N.C.
Commercial appraiser — 1996 – 2003

PROFESSIONAL AFFILIATIONS

MAI (Member, Appraisal Institute) designation #11796	2001
NC State Certified General Appraiser # A4359	1999
VA State Certified General Appraiser # 4001017291	
OR State Certified General Appraiser # C001204	
SC State Certified General Appraiser # 6209	

EDUCATION

Bachelor of Arts in English, University of North Carolina, Chapel Hill	1993

CONTINUING EDUCATION

Uniform Standards of Professional Appraisal Practice Update	2016
Forecasting Revenue	2015
Wind Turbine Effect on Value	2015
Supervisor/Trainee Class	2015
Business Practices and Ethics	2014
Subdivision Valuation	2014
Uniform Standards of Professional Appraisal Practice Update	2014
Introduction to Vineyard and Winery Valuation	2013
Appraising Rural Residential Properties	2012
Uniform Standards of Professional Appraisal Practice Update	2012
Supervisors/Trainees	2011
Rates and Ratios: Making sense of GIMs, OARs, and DCFs	2011
Advanced Internet Search Strategies	2011
Analyzing Distressed Real Estate	2011
Uniform Standards of Professional Appraisal Practice Update	2011
Business Practices and Ethics	2011
Appraisal Curriculum Overview (2 Days – General)	2009
Appraisal Review - General	2009
Uniform Standards of Professional Appraisal Practice Update	2008
Subdivision Valuation: A Comprehensive Guide	2008
Office Building Valuation: A Contemporary Perspective	2008
Valuation of Detrimental Conditions in Real Estate	2007
The Appraisal of Small Subdivisions	2007
Uniform Standards of Professional Appraisal Practice Update	2006
Evaluating Commercial Construction	2005

Conservation Easements	2005
Uniform Standards of Professional Appraisal Practice Update	2004
Condemnation Appraising	2004
Land Valuation Adjustment Procedures	2004
Supporting Capitalization Rates	2004
Uniform Standards of Professional Appraisal Practice, C	2002
Wells and Septic Systems and Wastewater Irrigation Systems	2002
Appraisals 2002	2002
Analyzing Commercial Lease Clauses	2002
Conservation Easements	2000
Preparation for Litigation	2000
Appraisal of Nonconforming Uses	2000
Advanced Applications	2000
Highest and Best Use and Market Analysis	1999
Advanced Sales Comparison and Cost Approaches	1999
Advanced Income Capitalization	1998
Valuation of Detrimental Conditions in Real Estate	1999
Report Writing and Valuation Analysis	1999
Property Tax Values and Appeals	1997
Uniform Standards of Professional Appraisal Practice, A & B	1997
Basic Income Capitalization	1996

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February 2015

Economic and Rate Impact Analysis of Clean Energy Development in North Carolina—2015 Update

Prepared for

North Carolina Sustainable Energy Association
4800 Six Forks Rd Suite 300
Raleigh, NC 27609

Prepared by

RTI International
3040 E. Cornwallis Road
Research Triangle Park, NC 27709

RTI Project Number 0214485

RTI INTERNATIONAL

Contents

Appendices

Figures

Tables

Executive Summary

This report presents an update to the retrospective economic impact analysis of renewable energy and energy efficiency investment included in the 2014 report *Economic Impact Analysis of Clean Energy Development in North Carolina—2014 Update*, prepared by RTI International (2014). This report also includes a rate impact analysis of clean energy development to date and expected in the future to meet the Renewable Energy and Energy Efficiency Portfolio Standard set for the State of North Carolina, prepared by ScottMadden Management Consultants.

In this supplement to the 2014 report, the direct and secondary effects associated with major energy efficiency initiatives and the construction, operation, and maintenance of renewable energy projects (collectively, "clean energy development") are analyzed to measure the magnitude of clean energy development's contribution to North Carolina's economy.

Changes in consumer, utility, and government spending patterns are analyzed, including

- investment in clean energy projects in North Carolina and their ongoing operation and maintenance,
- how renewable energy generation and energy savings from energy efficiency projects have changed spending on conventional energy generation,
- reductions in spending due to the Renewable Energy and Energy Efficiency Portfolio Standard (REPS)[1] rider requirement.
- government funds that would have been spent on other government services in the absence of state support for clean energy investment.

[1] Under this law investor-owned utilities in North Carolina will be required to meet up to 12.5% of their energy needs through renewable energy resources or energy efficiency measures. Rural electric cooperatives and municipal electric suppliers are subject to a 10% REPS requirement.

Our research findings are as follows:

- Approximately $3,472.8 million was invested in clean energy development in North Carolina between 2007 and 2014, which was supported, in part, by the state government at an estimated cost of $195.6 million. Clean energy investments were nearly 18 times larger than the state incentives for them.
- Renewable energy project investment in 2014 was $651.9 million, or nearly 38 times the $17.3 million investment observed in 2007.
- Total contribution to gross state product (GSP) was $4,197.9 million between 2007 and 2014 (see **Table ES-1**).
- Clean energy development supported 44,549 annual full-time equivalents (FTEs), equivalent to one person working full time for a year, from 2007 to 2014.
- Catawba, Davidson, Duplin, Person, Robeson, and Wayne Counties experienced the greatest amount of investment—more than $100 million each between 2007 and 2014.
- Beaufort, Cabarrus, Columbus, Cleveland, Wake, Nash, Chatham, Harnett, Montgomery, Lenoir, and Davie Counties each experienced between $50 million and $100 million in investment between 2007 and 2014.
- The net present value of the Renewable Energy and Energy Efficiency Portfolio Standard savings compared to a conventional portfolio equals $651 million. The analysis finds the greatest annual savings occur in 2029, when the portfolio provides $287 million in savings.
- Over the 21-year period since the start of the clean energy policies in North Carolina, rates are expected to be lower than they would have been had the state continued to only use existing, conventional generation sources.

Table ES-1. Total Economic Impacts, 2007–2014

	Total Output[a] (Million, 2013$)	Gross State Product[b] (Million, 2013$)	Employment (Full-Time Equivalents)	Fiscal Impacts[c] (Million, 2013$)
Direct economic impact from clean energy development	3,472.8	2,086.6	19,671	213.4
Direct economic impact from change in government spending[d]	−165.7	−83.5	−1,219	−3.3
Secondary economic impact[e]	3,001.2	2,194.8	26,096	59.1
Total economic impact	6,308.3	4,197.9	44,549	269.1

[a] Total output refers to revenue received by North Carolina individuals and businesses. [b] GSP represents the total value added. [c] State support for clean energy projects is included in the analysis as an offset to output and is not reflected in the fiscal impact results. Note: Sums may not add to totals because of rounding. See Appendix A for details. [d] Direct economic impact from change in government spending refers to the in-state impact of $135.2 million in state clean energy incentives, less $25.7 million that, based on historical spending patterns, would have otherwise procured goods and services from out of state. [e] Secondary impacts represent spending changes resulting from renewable energy generation and energy savings and indirect and induced impacts associated with supply chain effects and increased labor income spending.

1 Introduction and Analysis Approach

Between 2007 and 2014, annual investment in clean energy development in North Carolina increased nearly 20-fold from $47.7 million to $900.7 million, of which $651.9 million (72%) was for renewable energy projects and $248.7 million (28%) was for major energy efficiency initiatives.

The total amount of energy generated or saved through renewable energy and energy efficiency programs amounted to 16.1 million MWh, which is sufficient to power nearly 1.2 million homes for 1 year.[2]

Although the growth in energy generation from renewable sources has been documented in annual energy reports,[3] the economic impact of clean energy development—economic activity from construction, operation, maintenance, changes in energy use, and consequent changes in spending—on North Carolina's economy had not been comprehensively measured until the 2013 report *The Economic, Utility Portfolio, and Rate Impact of Clean Energy Development in North Carolina*, prepared by RTI International and LaCapra Associates (2013).

This report updates the economic impact results to include clean energy investments made in 2014. Otherwise, the data and analysis methodology are unchanged.

This report also includes a rate impact analysis.

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[2] The Energy Information Administration (EIA) estimates that in 2012 a North Carolina residential utility customer consumed 12,924 kWh (or 12.924 MWh) per year. See EIA (2012): http://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3.

[3] For more information on renewable energy generation in the United States, see EIA (2014): http://www.eia.gov/electricity/annual/?src=Electricity-f4.

This work was commissioned by the North Carolina Sustainable Energy Association, a professional and membership association, which had no role in the preparation of the analysis or report apart from posing research questions, suggesting data sources, and reviewing drafts.

Similar to previous reports, this analysis answered two principal research questions:

- *What are the comprehensive retrospective statewide economic and fiscal impacts of clean energy development?*
- *What is the expected electric utility rate impact of the renewable energy and energy efficiency portfolio standard?*

1.1 ANALYSIS APPROACH

The economic impact analysis contained herein uses methods that provide results about the portion of North Carolina's economic activity directly and indirectly associated with clean energy development. Clean energy development is defined to include the construction, operation, and maintenance of renewable energy facilities and energy efficiency initiatives.

This retrospective analysis of clean energy development

- analyzed the most current data available from the North Carolina Utilities Commission (NCUC), North Carolina Renewable Energy Tracking System (NC-RETS), the North Carolina Department of Revenue, the North Carolina Department of Environment and Natural Resources, and the U.S. Energy Information Administration (EIA);
- measured spending for clean energy investments made in North Carolina over the 8-year period from 2007 through 2014 along multiple dimensions, including project value and megawatt capacity or equivalent;
- used a regional input-output (I-O) analysis to estimate the gross indirect (supply chain) and induced (consumer spending from increased labor income) impacts throughout the state economy resulting from those investments, including the impacts of reduced conventional energy generation and of government incentives over the study period; and

- presented the gross employment, fiscal, economic output, and valued added (gross state product [GSP]) impacts of clean energy development on North Carolina's economy.

Two categories of economic effects were considered.

1. Direct effects: Information was gathered to quantify the direct investment (expenditures) related to clean energy development over the period 2007 through 2014. The following impact categories were in scope: investment in renewable energy and energy efficiency projects and reduction in government spending on other services to account for the foregone tax revenue (e.g., the costs of state policies).
2. Secondary effects: These direct economic impact estimates were combined with spending changes resulting from renewable energy generation and energy savings and modeled using a regional I-O model to measure the indirect (supply chain) and induced (consumer spending) impacts resulting from clean energy development.

The total economy-wide impacts represent the combination of the two categories. Analysis results are presented as the cumulative impact from 2007 through 2014; therefore, results should not be interpreted as annual totals.

Unlike other studies, the analysis accounts for selected displacement effects such as

- reduced spending on conventional energy production,
- how households and businesses would have otherwise spent the REPS rider for the renewable energy and energy efficiency performance standard, and
- how state government funding would have been spent in the absence of state incentives for clean energy development.

However, the analysis does not consider the alternative uses for the investment dollars devoted to clean energy projects. As a result, the economic impact measures used in this report are best interpreted as gross versus net changes in state-level economic activity.[4]

It is also important to note that the selected methodology does not evaluate how North Carolina's clean energy incentives and

[4] See also http://www.nrel.gov/analysis/jedi/limitations.html.

policies influence investment or how state incentives and policy interact with other federal policy. Thus, for example, the methodology does not estimate the portion of investment that occurred as a result of state incentives; instead, it estimates gross changes in economic activity associated with all clean energy investment that took place over the study period.

1.2 ABOUT RTI INTERNATIONAL

RTI International is one of the world's leading independent nonprofit research institutes. Based in Research Triangle Park, North Carolina, RTI has a mission to improve the human condition by turning knowledge into practice. Founded in 1958 with the guidance of government, education, and business leaders in North Carolina, RTI was the first tenant of Research Triangle Park. Today we have nine offices in the United States and nine in international locations. We employ over 2,200 staff in North Carolina, 500 across the United States, and over 900 worldwide. RTI performs independent and objective analysis for governments and businesses in more than 75 countries in the areas of energy and the environment, health and pharmaceuticals, education and training, surveys and statistics, advanced technology, international development, economic and social policy, and laboratory testing and chemical analysis. In 2013, RTI's revenue was $783 million.

2 Economic Impacts, 2007–2014

From 2007 through 2014, $2,613.5 million was invested in the construction and installation of renewable energy projects in North Carolina. An additional $859.3 million was spent on implementing energy efficiency projects.[5] Total clean energy development was valued at $3,472.8 million.

Although investment was distributed across the state, Catawba, Davidson, Duplin, Person, Robeson, and Wayne Counties each experienced the greatest amount, with more than $100 million in renewable energy project investment each.

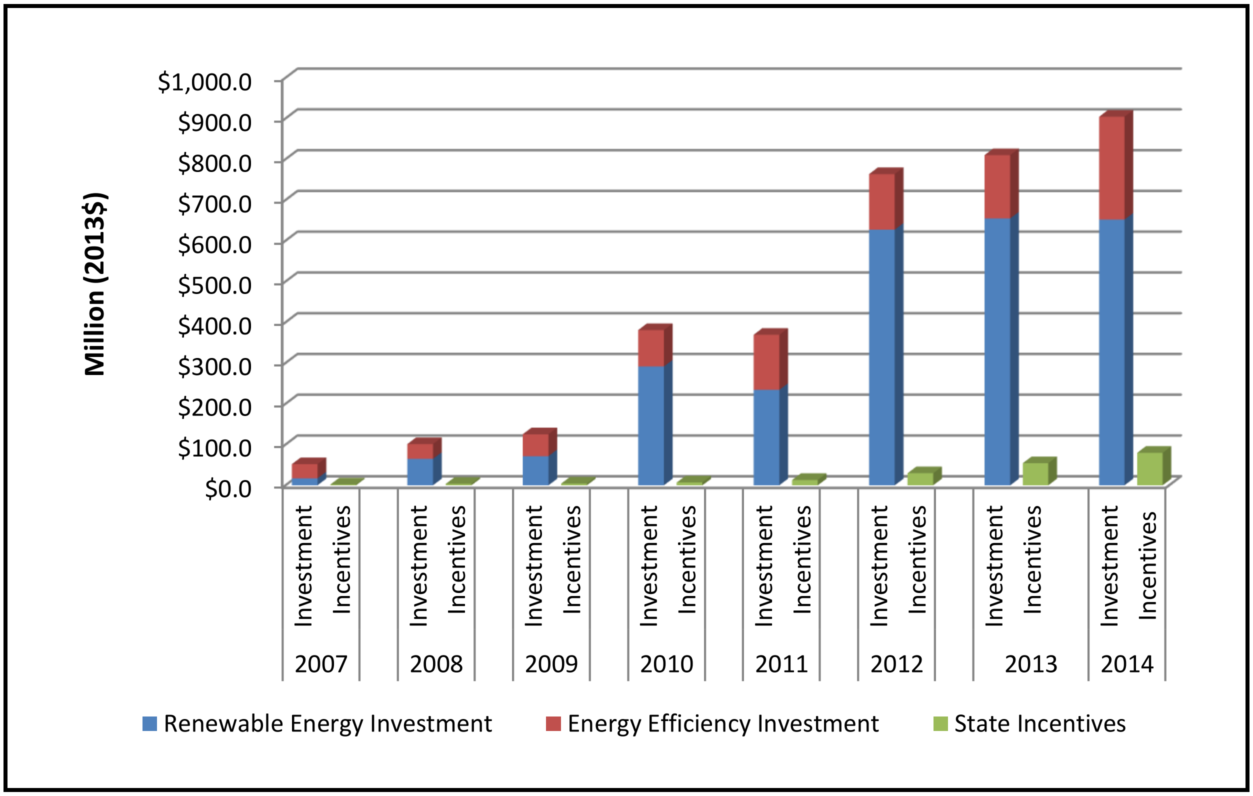
Clean energy development contributed $4,197.9 million in GSP and supported 44,549 annual FTEs statewide. As a result of changes in economic activity from the development of clean energy in North Carolina, state and local governments realized tax revenue of $269.1 million.

2.1 ESTIMATED DIRECT IMPACTS OF CLEAN ENERGY DEVELOPMENT

As depicted in **Figure 2-1** and **Table 2-1**, investment in clean energy development increased substantially over the 8-year analysis period. For example, renewable energy project investment in 2014 was $651.9 million, which was about 38 times the size of 2007's $17.3 million. In 2013 and 2014 combined, clean energy investment was 49% of the total investment from 2007 to 2014.

[5] All dollar values are presented in real 2013 terms. Nominal values were adjusted using the U.S. city average annual consumer price index on all items, developed by the Bureau of Labor Statistics.

Figure 2-1. Clean Energy Investment in North Carolina, 2007–2014



See Appendix A for data sources.

Table 2-1. Clean Energy Investment in North Carolina, 2007–2014

	Renewable Energy		Energy Efficiency		Clean Energy Investment		State Incentives
Year	**(Million, 2013$)**	**% of Total**	**(Million, 2013$)**	**% of Total**	**(Million, 2013$)**	**% of Total**	**(Million, 2013$)**
2007	$17.3	1%	$30.4	4%	$47.7	1%	$2.1
2008	$64.8	2%	$32.0	4%	$96.8	3%	$3.9
2009	$71.5	3%	$49.3	6%	$120.9	3%	$4.5
2010	$291.6	11%	$84.9	10%	$376.5	11%	$7.2
2011	$234.3	9%	$130.8	15%	$365.1	11%	$13.3
2012	$627.4	24%	$131.9	15%	$759.3	22%	$29.9
2013	$654.6	25%	$151.2	18%	$805.8	23%	$54.5
2014	$651.9	25%	$248.7	29%	$900.7	26%	$80.0
Total	$2,613.5	100%	$859.3	100%	$3,472.8	100%	$195.6

See Appendix A for data sources. Sums may not add to totals because of independent rounding.

In addition to demonstrating growth in investment value over time, Figure 2-1 and Table 2-1 illustrate that clean energy projects were nearly 18 times as large as the state incentives for them. Although we do not attempt to statistically estimate the share of these investments that was motivated by these incentive programs, it is likely that there is a strong positive relationship.

The remainder of Section 2.1 reviews in-depth

- investment value of clean energy projects,
- energy generated or saved by clean energy projects, and
- state incentives for clean energy development.

2.1.1 Investment Value of Clean Energy Projects

Renewable energy investment was estimated primarily from facilities registered with NC-RETS, supplemented with data from EIA databases—EIA-860 and EIA-923; North Carolina's Department of Environment and Natural Resources; North Carolina Utility Commission (NCUC) dockets for individual projects; North Carolina GreenPower; and personal communication with industry experts to adjust reported data or address areas where information was incomplete. Investments in energy efficiency were taken from program reports submitted by utilities to the NCUC and annual reports of the Utility Savings Initiative. See **Appendix A** for more information.

Table 2-2 summarizes the cumulative direct spending in renewable energy by category between 2007 and 2014. Investment in renewable energy projects totaled $2,613.5 million. Investment in energy efficiency totaled $859.3 million. Thus, total clean energy investment was $3,472.8 million during the study period.

Of the $2,613.5 million investment in renewable energy projects,

- solar photovoltaics made up $2,143.1 million (82%),
- landfill gas made up $234.4 million (9%), and
- biomass made up $136.0 million (5%).

Table 2-2. Direct Spending in Clean Energy Development by Technology, 2007–2014

Category	Technology	Value (Million, 2013$)	%
Renewable energy direct investment	Biogas fuel cell	$70.5	3%
	Biomass	$136.0	5%
	Geothermal	$24.5	1%
	Hydroelectric (<10 MW capacity)[a]	$25.0	1%
	Landfill gas	$169.9	7%
	Passive solar	$3.6	0%
	Solar photovoltaic	$2,143.1	82%
	Solar thermal	$40.2	2%
	Wind	$0.7	0%
	Total	$2,613.5	100%
Energy efficiency direct investment	Utility energy efficiency and demand-side management programs	$617.4	72%
	Utility Savings Initiative	$241.8	28%
	Total	$859.3	100%
Total		$3,472.8	

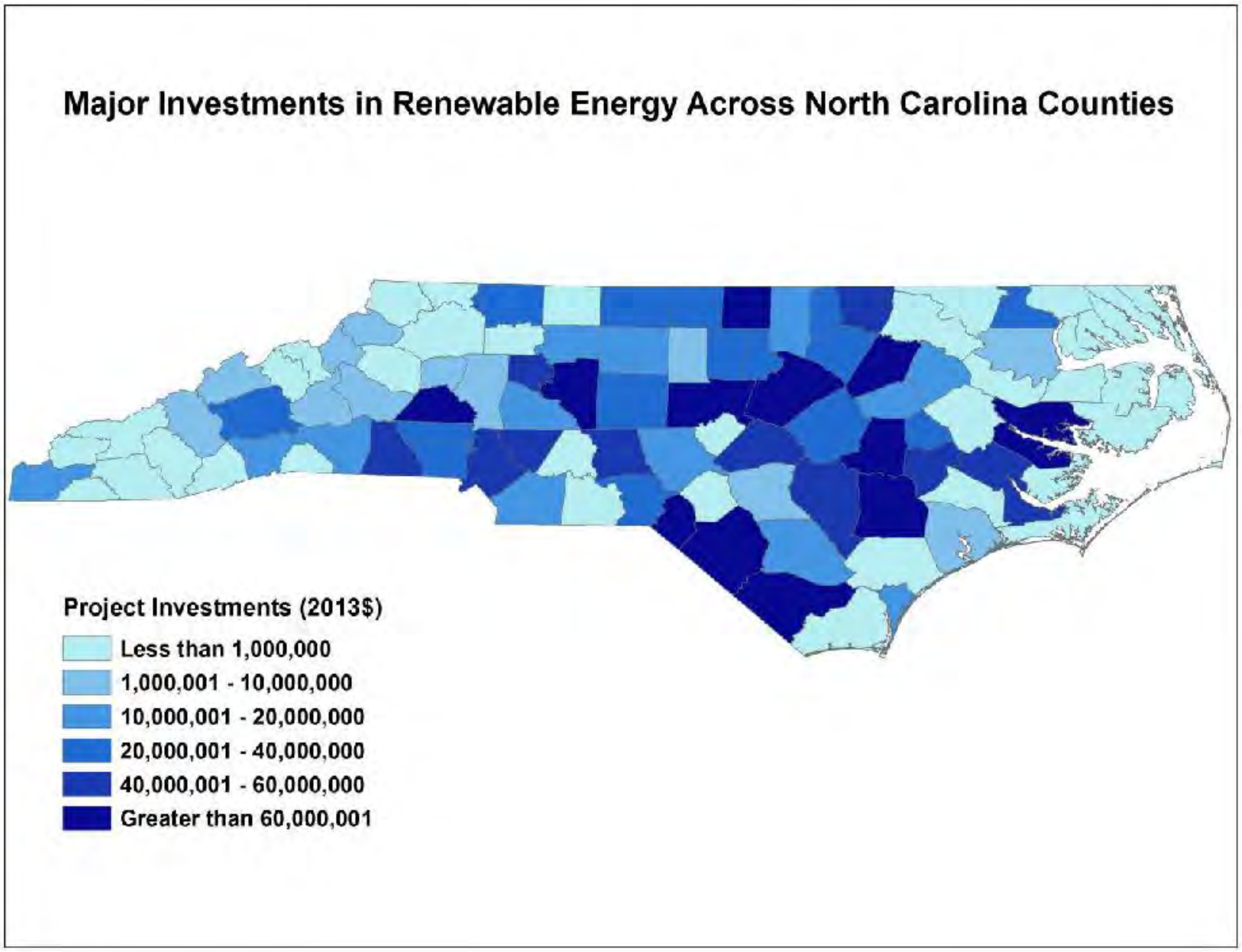
[a] Hydroelectric projects were found using NC-RETS. RTI worked in collaboration with ScottMadden to verify capacity added within the study period. Only projects under 10 MW are tracked in NC-RETS, so these results may be an underestimate of hydroelectric capacity and investment.

See also Appendix A. Sums may not add to totals because of independent rounding.

Renewable energy projects are widely distributed across North Carolina, bringing investment to both urban and rural counties. **Figure 2-2** illustrates the geographic distribution of renewable energy projects individually valued at $1 million or greater. The figure including all eligible wind, landfill gas, biomass, hydroelectric, solar photovoltaics, and solar thermal projects valued over $1 million. These projects account for renewable energy investment of approximately $2,383.8 million (91% of the total $2,613.5 million in renewable investment over the period).

Catawba, Davidson, Duplin, Person, Robeson, and Wayne Counties each experienced more than $100 million in renewable energy project investment, and Beaufort, Cabarrus, Cleveland, Columbus, Nash, Scotland, and Wake Counties each experienced between $50 million and $100 million in renewable project investment from 2007 through 2014.

Figure 2-2. Distribution of Renewable Energy Projects Valued at $1 Million or Greater across North Carolina Counties



See also Appendix B.

2.1.2 Energy Generated or Saved from Clean Energy Projects

Tables 2-3 and **2-4** summarize the energy generated by renewable projects and the energy saved by energy efficiency projects between 2007 and 2014.

Table 2-3. Renewable Energy Generation, 2007–2014

Technology	Facilities		Energy Equivalent Generated	
	Number	%	Thousand MWh	%
Biogas fuel cell[a]	1	0%	51	1%
Biomass (including combined heat and power)	18	1%	6,291	65%
Geothermal	831	40%	66	1%
Hydroelectric (<10 MW capacity)	10	0%	208	2%
Landfill gas	20	1%	1,569	16%
Passive solar	N/A	N/A	3	0%
Solar photovoltaic	1,108	53%	1,437	15%
Solar thermal	83	4%	53	1%
Wind	9	0%	2	0%
Total	2,080	100%	9,679	100%

a. Biogas Fuel Cell generation has doubled due to a doubling of capacity at this facility over the past two years.

See also Appendix A. Sums may not add to totals because of independent rounding.

Table 2-4. Energy Efficiency Energy Savings, 2007–2014

Program	Energy Saved[a] (Thousand MWh)	Energy Costs Saved (Million, 2013$)
Utility Programs	6,424	$385.5
Utility Savings Initiative	N/A[b]	$732.2
Total	6,424	$1,117.6

[a] Energy savings were estimated using an estimate of $0.06/kWh for years 2007 through 2014.[6]

[b] Data on the energy savings from the Utility Savings Initiative were not provided. We were unable to calculate the energy savings from standard EIA estimates because of uncertainties regarding the costs of energy for Utility Savings Initiative projects.

[6] Avoided costs received by qualified facilities vary by utility and length of contract. These values represents a central value among those reported in avoided cost schedules to NCUC.

Renewable energy facilities generated 9.7 million MWh of energy, of which

- 65% was biomass,
- 16% was landfill gas, and
- 15% was solar photovoltaics.

Efficiency initiatives also produced large savings in North Carolina. Energy efficiency programs run by utility companies saved 6.4 million MWh of energy during the study period. The Utility Savings Initiative, a government-run energy efficiency program, lacked data on specific MWh saved, but the program documents note savings of $732.2 million on energy expenses.[7]

Thus, the total energy generated or saved from clean energy projects is estimated to amount to at least 16.1 million MWh.

2.1.3 State Incentives for Clean Energy Investment

State incentives for clean energy investment, including the renewable energy investment tax credit and state appropriations for the Utility Savings Initiative, are modeled as a reduction in spending on other government services.

Investment spending was funded, in part, through state incentives. Through direct state government appropriations, renewable energy projects received $182.6 million in tax credits and energy efficiency projects received $13.0 million. Total government expenditures were $195.6 million between 2007 and 2014 (**Table 2-5**).

For the purpose of this study, it was assumed that the money the government spent on renewable energy and energy efficiency programs was not spent on other government services. Thus, the government programs contributed to the positive investment in renewable energy and energy efficiency of $3,472.8 million.

[7] The cost of energy avoided from the Utility Savings Initiative was calculated using data from the "Annual Report for the Utility Savings Initiative for Fiscal Year July 1, 2012–June 30, 2014." First, sums of avoided energy costs per calendar year were calculated from the fiscal year sums, assuming that energy savings were equally split between the calendar years in each fiscal year. Without full data for 2014, RTI assumed energy costs were avoided at the same rate in the second half of 2014 as they were during the fiscal year from 2013 to 2014. To convert sums to 2013 U.S. dollars, we applied inflation multipliers calculated from the CPI-U (see Table A-3).

However, the $195.6 million spent on renewable energy and energy efficiency programs was shifted from what the government could have otherwise spent the money on, creating a minor offset that reduces gross impacts slightly. Section 2.3 includes discussion that illustrates these offsets.

Table 2-5. State Incentives for Clean Energy Development, 2007–2014

Year	Renewable Energy Investment Tax Credit[a,b] (Million, 2013$)	Energy Efficiency[c] (Utility Savings Initiative, Million, 2013$)	Total (Million, 2013$)
2007	$0.5	$1.6	$2.1
2008	$2.3	$1.6	$3.9
2009	$2.9	$1.6	$4.5
2010	$5.6	$1.6	$7.2
2011	$11.7	$1.6	$13.3
2012	$28.3	$1.6	$29.9
2013	$52.9	$1.6	$54.5
2014	$78.3	$1.6	$80.0
Total	$182.6	$13.0	$195.6

Note: For the Utility Savings Initiative, an appropriation of $13.0 million was taken, which we distributed evenly across the study period for the purposes of the analysis. The tax credit for 2013 was estimated, and this estimation is detailed in Appendix A.

[a] North Carolina Department of Revenue, Policy Analysis and Statistics Division. (2007-2011). Unaudited NC-478G. Raleigh, NC: North Carolina Department of Revenue, Policy Analysis and Statistics Division.

[b] North Carolina Department of Revenue, Revenue Research Division. (2012). "Credit for Investing in Renewable Energy Property Processed during Calendar Year 2012." Raleigh, NC: North Carolina Department of Revenue, Revenue Research Division.

[c] North Carolina Department of Commerce. (November 1, 2013). "Annual Report for the Utility Savings Initiative for Fiscal Year July 1, 2012–June 30, 2014." Raleigh, NC: North Carolina Department of Commerce.

2.2 SECONDARY IMPACTS OF CLEAN ENERGY DEVELOPMENT

To estimate the overall impact of clean energy development in North Carolina, the spending described in Section 2.1 was analyzed using an I-O model of the North Carolina economy. The I-O model was constructed using IMPLAN software, which is widely used to assess regional economic impacts at the local, state, and regional levels.

I-O models provide a detailed snapshot of the purchasing relationships between sectors in the regional economy. In response to these direct inputs, the I-O model estimates the increases in in-state output, employment, and spending within the supply chain for clean energy and the decreases in in-state output, employment, and spending within the supply chain for conventional energy.

Increased renewable energy production requires increased employment in that sector and in the sectors in its supply chain (indirect impacts). This increased employment, and associated increased income, will result in increased purchases of consumer goods and services within the state. The model estimates these increased household expenditures (induced impacts), including both the increased consumer spending derived from the increased direct and indirect employment associated with renewable energy production and the decreased consumer spending resulting from decreased direct and indirect employment associated with conventional energy production.

The total economic impact of clean energy development for North Carolina is the sum of the direct, indirect, and induced impacts. **Figures 2-3** and **2-4** describe direct, indirect, and induced impacts.

Two types of secondary economic impacts were modeled in this study:

- those resulting from the value of investment dollars spent on a clean energy project, representing indirect and induced supply chain effects, and
- those resulting from the reduction in spending on the production of conventional energy and that are reallocated to energy efficiency and renewable project owners.

Figure 2-3. Renewable Energy Direct, Indirect, and Induced Economic Impacts Related to Clean Energy Incentives

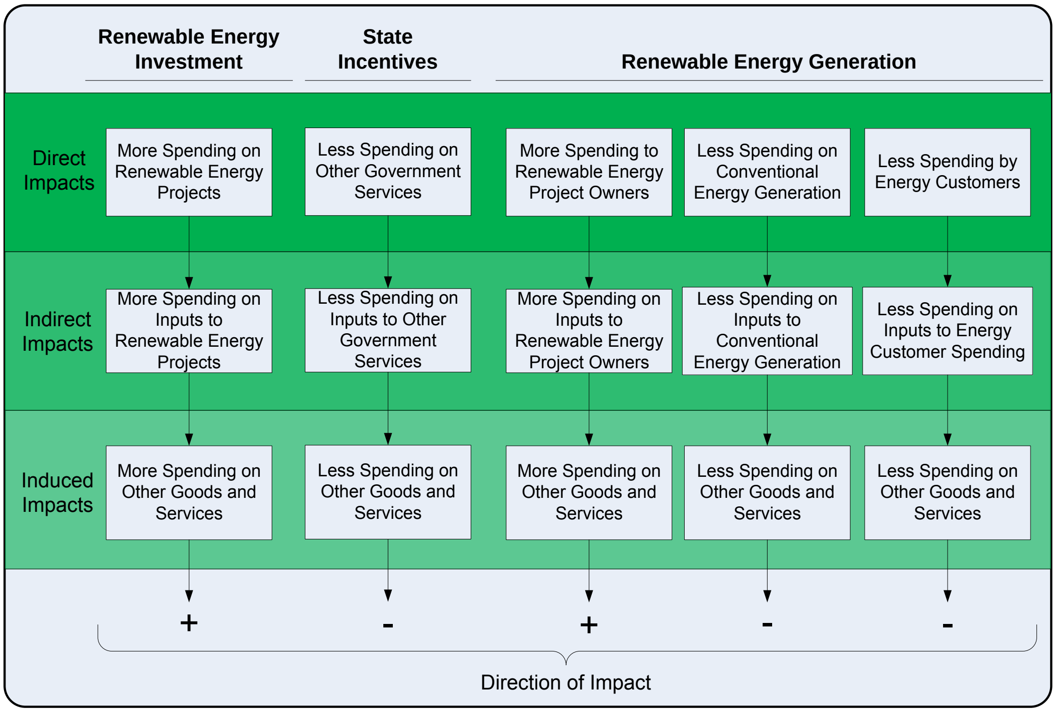
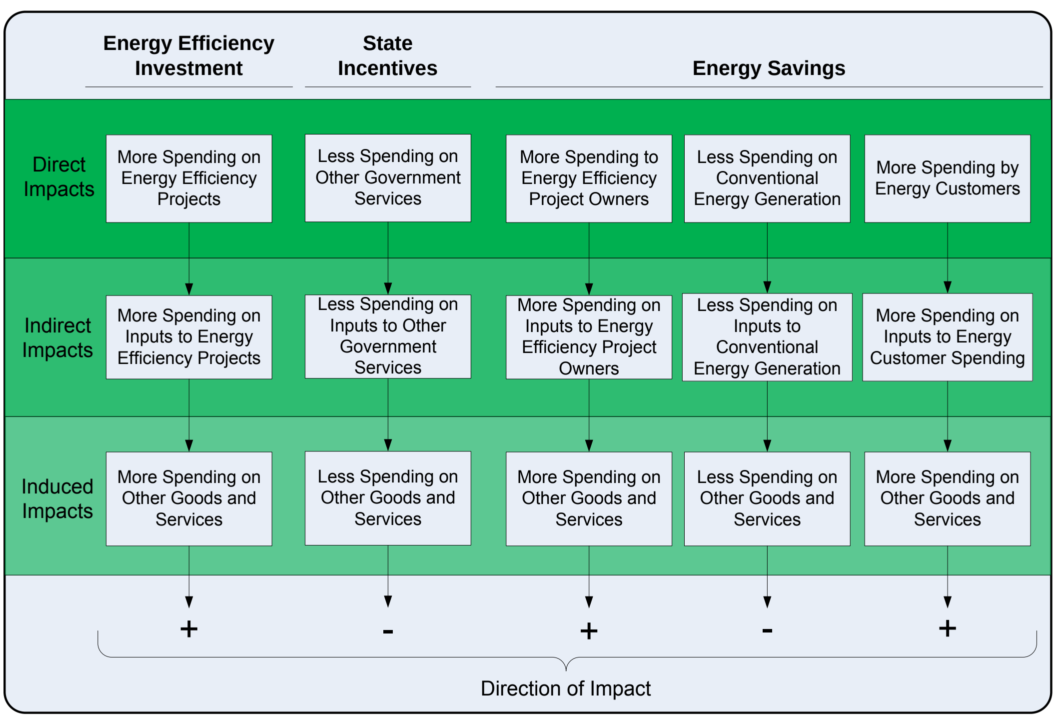


Figure 2-4. Energy Efficiency Direct, Indirect, and Induced Economic Impacts Related to Clean Energy Incentives



2.2.1 Changes in North Carolina Spending Patterns from Renewable Energy Generation

To estimate the changes in spending resulting from renewable energy *generation*, renewable energy produced by facilities was estimated by applying capacity factors, either at the facility level based on 2011 generation (EIA-923) or the technology level (see Table 2-1). Electricity generated by these facilities was assumed to receive $0.06/kWh[8] in avoided costs for the years 2007 through 2014, which was modeled as a transfer to renewable generation from inputs to conventional generation. Renewable thermal energy produced by these facilities was modeled as a transfer of the retail electricity rate between utilities and utility customers ($0.0682/kWh for industrial and $0.099/kWh for commercial and residential customers [EIA, 2013]). Finally, the full Renewable Energy Portfolio Standard (REPS) rider over these years was modeled as a transfer from utility customers to renewable project owners.

As Table 2-3 stated, renewable energy facilities have generated an estimated 9.7 million MWh of energy over the study period. This generation is estimated to have resulted in a total of $606.6 million[9] in avoided cost and retail energy savings no longer spent on conventional energy. The total REPS rider over the study period is estimated to be $220.8 million.[10]

2.2.2 Changes in North Carolina Spending Patterns from Energy Efficiency Initiatives

To estimate changes in spending resulting from *energy savings* from energy efficiency, the avoided cost of energy saved by utility energy efficiency and demand-side management programs. These avoided costs were modeled as a transfer

[8] Avoided costs received by qualified facilities vary by utility and length of contract. This value represents a central value among those reported in avoided cost schedules to NCUC.

[9] This $606.6 million was calculated by multiplying 6,950,034 MWh generated by nonthermal renewable projects by $60/MWh avoided cost to yield $417,002,048. The 2,607,319 industrial thermal MWh generated was multiplied by industrial retail savings of $68.20/MWh (EIA, 2012) to yield $177,819,124. Lastly, the 119,152 commercial and residential thermal MWh generated was multiplied by the average retail savings of $99/MWh (EIA, 2012) to yield $11,796,018. Summing the three totals together yields $606,617,190.

[10] This total was estimated using the most recent REPS cost data available at the time of the analysis. Documents issued after this analysis was performed include some minor adjustments, as well as providing costs for Dominion North Carolina Power, which did not file for REPS cost recovery prior to 2013.

from the inputs of conventional energy generation to utility customers, in line with Duke Energy's Save-A-Watt program.[11] Energy savings from the Utility Savings Initiative were a transfer from utilities to government spending. A full description of how these assumptions were implemented is provided in Appendix A.

As Table 2-4 indicated, utility programs yielded 6.4 million MWh in energy savings. The avoided cost for these programs, assuming $0.06/kWh and $0.05/kWh stated previously, was $370.1 million.[12] Combining this with the $732.2 million saved by the Utility Savings Initiative yields a total energy efficiency savings of $1,102.3 million.

2.3 NORTH CAROLINA ECONOMY-WIDE IMPACTS

In summary, total output (gross revenue) in North Carolina associated with clean energy development, after accounting for secondary effects, is estimated at $6,308.3 million over the 8-year period from 2007 to 2014. Clean energy development accounted for $4,197.9 million in GSP over the study period. Total employment effects were estimated to be 44,549 FTEs over the study period.

2.3.1 Impacts Associated with Renewable Energy Projects

As shown in the first data row of **Table 2-6**, $2,613.5 million in in-state spending on renewable energy projects has a direct impact on GSP ($1,614.6 million), employment (14,636 FTEs), and state and local tax revenue ($186.1 million).

These renewable projects received an estimated $182.6 million in state tax credits between 2007 and 2014. Because in the absence of the incentive program, the state government would have spent the money on other government services, there is an offsetting direct economic impact that must be considered.

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[11] Duke Energy's Save-A-Watt program was chosen as a model for simulating the transfer of avoided energy costs for both its size and the simplicity of its avoided cost allocation method. The "Shared Savings Mechanism" replaced the Save-A-Watt program effective January 1, 2014. As such the impact of this change is was not reflected in the current study.

[12] The avoided cost was calculated by multiplying 4,888,502 MWh by $60/MWh ($0.06/kWh) and 1,535,964 MWh by $50/MWh ($0.05/kWh) avoided cost to yield $370.1 million.

According to IMPLAN's assumptions out of $182.6 million, the state government would have spent $154.7 million in state and spent $27.9 million out of state for goods and services Therefore, the direct economic impact from the change in government spending patterns is −$154.7 million. GSP, employment, and fiscal impacts are reduced as well. Note that the second data row of Table 2-6 shows an offsetting direct economic impact using negative values.

Table 2-6. Renewable Energy Projects Economic Impacts, 2007–2014

	Total Output[a] (Million, $2013)	Gross State Product[b] (Million, $2013)	Employment (Full-Time Employee Equivalents)	Fiscal Impacts (Million, $2013)
Direct economic impact from renewable energy	2,613.5	1,614.6	14,636	186.1
Direct economic impact from change in government spending[c]	−154.7	−74.3	−1,076	−3.0
Secondary economic impact	2,259.9	1,627.2	13,107	97.6
Total economic impact	4,718.8	3,167.5	26,667	280.7

[a] Total output refers to revenue received by North Carolina individuals and businesses. [b] Gross state product represents the total value added. [c] Direct economic impact from change in government spending refers to the in-state impact of $182.6 million in renewable tax credits, less $27.9 million that would have otherwise procured goods and services from out of state. Note: Sums may not add to totals because of rounding. See also Appendix A.

The two direct impacts—the increase in renewable energy project spending and the reduction in state government spending on other things—are combined and analyzed to estimate the changes in spending resulting from renewable energy generation and the indirect and induced impacts resulting from supply chain effects and changes in income.

Ultimately, the total economic impact amounts to a contribution to GSP of $3,167.5 million, 26,667 FTEs, and $280.7 million in state and local tax revenue.[13]

2.3.2 Impacts Associated with Major Energy Efficiency Initiatives

Table 2-7 provides the same impact information as Table 2-6 for the energy efficiency initiatives. It was estimated that there

[13] Although not broken out in Table 2-6, the substitution of renewable energy for conventional energy, including reduced household spending due to the REPS rider, resulted in a small positive impact to employment, economic output, and state and local tax revenue.

was $859.3 million in energy efficiency investment, and the resulting energy savings and changes in spending over the study period contributed $1,030.4 million to total GSP and supported 17,881 FTEs.

Table 2-7. Energy Efficiency Initiatives Economic Impacts, 2007–2014

	Total Output[a] (Million, 2013$)	Gross State Product[b] (Million, 2013$)	Employment (Full-Time Employee Equivalents)	Fiscal Impacts (Million, 2013$)
Direct economic impact from energy efficiency	859.3	472.0	5,035	27.3
Direct economic impact from change in government spending[c]	−11.0	−9.1	−143	−0.3
Secondary economic impact	741.2	567.6	12,989	−38.6
Total economic impact	1,589.5	1,030.4	17,881	−11.6

[a] Total output refers to revenue received by North Carolina individuals and businesses. [b] Gross state product represents the total value added. [c] Direct economic impact from change in government spending refers to the in-state impact of $13.0 million in state government procurement to the Utility Savings Initiative, less $2.0 million that would have otherwise procured goods and services from out of state. Note: Sums may not add to totals because of rounding. See also Appendix A.

As with state incentives for renewable energy projects, there is an offsetting negative direct impact associated with government spending on the Utility Savings Initiative and not on other activities. If the state government were to spend $13.0 million on other government services, $2.0 million would have been spent out of state. See the second data row in Table 2-7.

A net negative fiscal impact of $11.6 million was estimated for energy efficiency projects due primarily to negative fiscal impacts from their resulting energy savings. This is primarily because more state and local taxes are estimated to be recovered from a dollar of spending on utilities than on other government services now purchased from Utility Savings Initiative savings.

2.3.3 Total Impact Associated with Clean Energy Projects

For 2007 through 2014, the total economic activity associated with renewable energy projects and energy efficiency initiatives was (**Table 2-8**):

- $6,308.3 million in gross output (revenue),
- $4,197.9 million in GSP (value-added),

- 44,549 FTEs, and
- $269.1 million in state and local tax revenues.

Table 2-8. Total Economic Impacts, 2007–2014

	Total Output[a] (Million, 2013$)	Gross State Product[b] (Million, 2013$)	Employment (Full-Time Employee Equivalents)	Fiscal Impacts (Million, 2013$)
Direct economic impact	3,472.8	2,086.6	19,671	213.4
Direct economic impact from change in government spending[c]	−165.7	−83.5	−1,219	−3.3
Secondary economic impact	3,001.2	2,194.8	26,096	59.1
Total economic impact	6,308.3	4,197.9	44,549	269.1

[a] Total output refers to revenue received by North Carolina individuals and businesses. [b] Gross state product represents the total value added. [c] Direct economic impact from change in government spending refers to the in-state impact of $195.6 million in state clean energy incentives, less $29.9 million that would have otherwise procured goods and services from out of state. Note: Sums may not add to totals because of rounding. See also Appendix A.

These results account for a comparatively small offset associated with government spending changes because the tax credit and appropriations for the Utility Savings Initiative caused an estimated loss in output of $165.7 million. It should be noted that these losses are due to a reduction in government spending and not from any assumed issues with governmental involvement in the energy sector.

In Table 2-8, the fiscal impact analysis shows that state and local governments realized revenue of $269.1 million as a result of gross changes in economic activity.

3 Prospective Rate Impacts of Clean Energy Policies

In this section, we discuss the rate impacts of North Carolina's Renewable Energy and Energy Efficiency Portfolio Standard (REPS). The analysis compares the cost of two alternative energy policy scenarios– one where existing clean energy policies are in place throughout the study period (Compliance Portfolio) and one where only the energy policies prior to 2007 are in place (Conventional Portfolio). The rate impacts are analyzed for years 2008 to 2029.

The Compliance Portfolio assumed renewable energy certificates (RECs) from actual renewable energy and energy efficiency measures in place through 2014. In future years, the analysis used the least-cost resources to meet remaining REPS requirements. The Conventional Portfolio considers a scenario where the North Carolina REPS does not exist. In this portfolio, new conventional combined cycle natural gas capacity is used to replace incremental electricity needs met by post-REPS portions of the Compliance Portfolio. The methodology is described in detail below.

3.1 METHODOLOGY

The North Carolina REPS requires electric utilities to acquire RECs to meet a total requirement and within that total meet "set-aside" requirements for poultry litter, swine waste, and solar resources. Having satisfied the set-aside requirements, utilities are free to use any qualifying REC to meet the remaining, or general, requirement. A REC is produced when an eligible renewable energy technology generates one megawatt hour (MMh) of electricity or approved energy efficiency measures supplies one MWh of energy savings. RECs from poultry, swine and solar in excess of the set-aside requirement may be used to satisfy the overall general requirement.

North Carolina REPS requirements are based on a set percentage of retail MWh sales from the previous year. The analysis calculated North Carolina retail sales for each utility using REPS compliance reports and REPS compliance plans filed with the North Carolina Utilities Commission.[14] Total retail sales for North Carolina are shown in **Table 3-1**.

Table 3-1. North Carolina Retail Sales (MWh), 2008–2029[a]

Year	NC Retail Sales	Year	NC Retail Sales
2008	130,069,257	2019	140,626,289
2009	126,419,351	2020	142,032,552
2010	135,618,702	2021	143,452,878
2011	131,371,429	2022	144,887,407
2012	127,718,921	2023	146,336,281
2013	128,612,020	2024	147,799,643
2014	133,486,566	2025	149,277,640
2015	135,125,993	2026	150,770,416
2016	136,498,098	2027	152,278,120
2017	137,858,750	2028	153,800,902
2018	139,233,950	2029	155,338,911

[a] Data from 2008 to 2013 represent historical retail sales. Data from 2014 to 2029 are forecasted retail sales.

The analysis calculated general and set-aside requirements for each utility based on the required percentage of retail sales. With the exception of poultry litter, RPS requirements are calculated independently for each utility. The North Carolina REPS only mandates a statewide MWh energy requirement for poultry litter. For this analysis, the poultry requirement was allocated to each utility based on their percentage of North Carolina retail sales. Individual utility requirements were then aggregated to determine the total North Carolina requirements shown in **Table 3-2**.

[14] Duke Energy Carolinas and Duke Energy Progress forecast 1.0% net load growth in 2014 integrated resource plans filed with the North Carolina Utilities Commission. The analysis assumes retail sales grew 1.0% when forecasts were unavailable.

Table 3-2. North Carolina REPS REC Requirements, 2008–2029[a]

Year	Solar	Poultry	Swine	General	Total
2008	—	—	—	—	—
2009	—	—	—	—	—
2010	25,290	—	—	—	25,290
2011	27,131	—	—	—	27,131
2012	91,967	—	—	3,849,185	3,941,152
2013	89,413	—	—	3,742,164	3,831,575
2014	90,037	170,007	—	3,598,325	3,858,369
2015	186,889	700,010	93,450	7,028,851	8,009,200
2016	189,184	900,009	189,184	6,829,191	8,107,568
2017	191,106	900,010	191,106	6,907,670	8,189,892
2018	275,727	900,008	193,011	12,417,137	13,785,883
2019	278,476	900,008	278,476	12,466,443	13,923,403
2020	281,261	900,008	281,261	12,600,108	14,062,638
2021	284,074	900,008	284,074	15,364,740	16,832,896
2022	286,914	900,008	286,914	15,527,388	17,001,224
2023	289,785	900,008	289,785	15,691,656	17,171,234
2024	292,683	900,008	292,683	15,857,575	17,342,949
2025	295,609	900,008	295,609	16,025,150	17,516,376
2026	298,563	900,008	298,563	16,194,406	17,691,540
2027	301,549	900,008	301,549	16,365,352	17,868,458
2028	304,564	900,008	304,564	16,538,007	18,047,143
2029	307,610	900,008	307,610	16,712,384	18,227,612

[a] Following existing regulatory orders and requests, the analysis assumed delayed starts for poultry and swine requirements. See: North Carolina Utilities Commission. (2014a). "Annual Report Regarding Renewable Energy and Energy Efficiency Portfolio Standard in North Carolina."

The Compliance Portfolio was designed to meet the required number of RECS each year allowing for the use of extra RECS produced in early years of production in excess of RPS requirements. The Compliance Portfolio assumed RECs from actual renewable energy and energy efficiency measures in place through 2014 as the baseline.[15] Based on compliance plans, Duke Energy Carolinas and Duke Energy Progress meet 25% of their general requirement with out-of-state RECs through 2014. The analysis assumes Dominion North Carolina

[15] Data for existing renewable energy generation and capacity were collected from the North Carolina Renewable Energy Tracking System (NC-RETS). Energy efficiency savings data were collected from NC-RETS and 2014 integrated resource plans.

Power (DNCP) meets 100% of their general requirement with out-of-state RECs through 2014.[16]

Going forward, the Compliance Portfolio assumes additions of set aside capacity sufficient to meet specific requirements (net of banked RECs). Energy efficiency, as the least cost option, is used to the maximum extent possible to meet the remaining general requirement.[17] Out of state RECS are included in two instances: (1) DNCP's ability to meet 100% of general REPS requirements and (2) as the next best alternative to energy efficiency where percentage limitations do not allow individual utilities to meet the full requirement with energy efficiency.[18] The portfolio was also designed to maintain a reasonable long-term reserve of excess energy efficiency RECS in order to mitigate the risk associated with an unexpected shortfall in REC generation. The use of each resource is discussed in more detail below:

- **Existing Renewable Energy and Energy Efficiency**—The analysis uses existing renewable energy capacity and energy efficiency savings to meet set-aside and general REPS requirements.[19] The analysis retired excess RECs from previous years and then retired newly generated RECs. Solar resources produce RECs in excess of the solar set-aside requirement. These RECs are used to meet the general requirement.
- **New Set-Aside Capacity**—Existing poultry litter and swine waste capacity are not sufficient to meet the final set-aside requirements. The analysis added poultry litter and swine waste capacity to ensure that the combination of generation and excess RECs from the prior years meet the minimum REPS requirements in each year.
- **New Energy Efficiency Measures**—Energy efficiency is added before out-of-state RECs because the resource offsets the need for alternative generation and is more

[16] North Carolina general statute § 62-133.8.(1)(2)(e) authorizes DNCP to meet 100% of general requirement with out-of-state RECs.
[17] The North Carolina REPS allows utilities to meet 25% of requirement with energy efficiency. In 2021, Duke Energy Carolinas and Duke Energy Progress are allowed to meet 40% of requirement with energy efficiency.
[18] With the exception of DNCP, the North Carolina REPS allows utilities to meet up to 25% of annual requirements with out-of-state RECs.
[19] The analysis assumes Duke Energy Progress, Duke Energy Carolinas, municipal utilities, and electric cooperatives meet 25% of the total requirements with energy efficiency RECs through 2020 and 40% of the total requirement through 2029.

cost effective than out-of-state RECs when these costs are considered.

- **Purchase Out-of-State RECs**—The remaining REPS requirements are met through the purchase of-out-state RECs. The exception is DNCP is assumed to meet 100% of general requirements with out-of-state RECs.

Table 3-3 shows the resources used in the Compliance Portfolio. The table distinguishes pre-REPS renewable capacity as resources operational before 2008. Post-REPS renewable capacity represents resources operational in 2008 and later. The analysis assumes post-REPS renewable capacity was built to support compliance with the North Carolina REPS. These resources are included in the cost analysis while pre-REPS renewable capacity is excluded.

Figure 3-1 shows the RECs generated from the Compliance Portfolio over the study period. The majority of compliance is met with post-REPS generation and energy efficiency savings. **Figure 3-2** shows the RECs generated from the Compliance Portfolio compared to the overall REPS requirement. It should be noted that the resources in the Compliance Portfolio does not reflect the resources forecasted in integrated resource plans submitted to the North Carolina Utilities Commission. The integrated resource plans forecast renewable energy and energy efficiency beyond the resources used in the Compliance Portfolio. The analysis excluded the majority of these resources as they were not needed for REPS compliance during the study period and therefore outside the scope of the analysis.

The analysis used the levelized cost of energy to determine the generation costs associated with the Compliance Portfolio and Conventional Portfolios. The levelized cost of energy reflects the lifetime expenses required to construct and operate a generation facility. The analysis calculated the levelized cost of energy for each generation technology for each year of the analysis. All calculations were in nominal dollars and assumed

Table 3-3. Compliance Portfolio Resources by Year

Resource	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Pre-REPS Renewable Capacity (Operational before 2008) (MWh)											
Dedicated biomass	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301
Hydropower	536,219	645,468	683,804	556,686	502,613	677,140	677,140	677,140	677,140	677,140	677,140
Solar PV	17	17	17	17	17	17	17	17	17	17	17
Post-REPS Renewable Capacity (Operational 2008 or Later) (MWh)											
Dedicated biomass	85,048	239,271	292,181	1,029,763	1,327,355	1,376,525	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738
Biomass co-firing	0	0	118,976	251,243	304,144	312,969	312,969	312,969	312,969	312,969	312,969
Landfill gas	0	96,463	138,175	232,735	324,000	425,475	496,957	496,957	496,957	496,957	496,957
Hydropower	2,387	137,751	119,766	103,341	126,425	327,772	327,772	327,772	327,772	327,772	327,772
Onshore wind	0	0	87	105	93	110	110	110	110	110	110
Biomass thermal savings	0	0	0	405,986	916,772	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438
Set-Aside Requirements (MWh)											
Poultry litter	2,046	0	0	1,401	14,220	24,884	127,456	886,675	886,675	886,675	886,675
Swine waste	68,957	2,063	2,143	1,574	2,438	1,864	1,864	253,796	253,796	253,796	253,796
Solar PV	283	5,407	23,309	53,999	134,665	382,817	568,935	568,935	568,935	568,935	568,935
Solar thermal savings	236	1,541	2,928	5,524	9,362	8,857	8,857	8,857	8,857	8,857	8,857
Energy Efficiency (MWh)											
Energy savings	19,837	74,488	492,357	1,119,925	1,269,063	2,091,317	3,258,564	3,258,564	3,258,564	3,258,564	3,258,564
Out-of-State RECs											
RECs	0	0	0	0	822,338	804,147	805,619	217,741	212,474	215,498	387,391
Results											
Total REC Production	1,082,331	1,569,770	2,241,044	4,129,600	6,120,806	7,914,633	9,454,737	9,878,009	9,872,742	9,875,766	10,047,659
REPS Requirement	—	—	25,290	27,131	3,941,152	3,831,575	3,858,369	8,009,200	8,107,568	8,189,892	13,785,883
REC Surplus/Deficit	1,082,331	1,569,770	2,215,754	4,102,469	2,179,654	4,083,058	5,596,368	1,868,809	1,765,174	1,685,874	−3,738,224
NET Excess RECs	1,082,331	2,652,101	4,867,854	8,970,323	11,149,977	15,233,035	20,829,403	22,698,212	24,463,387	26,149,261	22,411,038

(continued)

Table 3-3. Compliance Portfolio Resources by Year (continued)

Resource	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Pre-REPS Renewable Capacity (Before 2008) (MWh)											
Dedicated biomass	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301
Hydropower	677,140	677,140	677,140	677,140	677,140	677,140	677,140	677,140	677,140	677,140	677,140
Solar PV	17	17	17	17	17	17	17	17	17	17	17
Post-REPS Renewable Capacity (2008 or Later) (MWh)											
Dedicated biomass	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738
Biomass co-firing	312,969	312,969	312,969	312,969	312,969	312,969	312,969	312,969	312,969	312,969	312,969
Landfill gas	496,957	496,957	496,957	496,957	496,957	496,957	496,957	496,957	496,957	496,957	496,957
Hydropower	327,772	327,772	327,772	327,772	327,772	327,772	327,772	327,772	327,772	327,772	327,772
Onshore wind	110	110	110	110	110	110	110	110	110	110	110
Biomass thermal savings	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438
Set-Aside Requirements (MWh)											
Poultry litter	886,675	886,675	886,675	886,675	886,675	886,675	886,675	886,675	886,675	886,675	886,675
Swine waste	253,796	253,796	253,796	253,796	253,796	253,796	253,796	253,796	253,796	253,796	253,796
Solar PV	568,935	568,935	568,935	568,935	568,935	568,935	568,935	568,935	568,935	568,935	568,935
Solar thermal savings	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857
Energy Efficiency (MWh)											
Energy savings	3,258,564	3,258,564	3,258,564	5,026,835	6,708,244	6,775,329	6,843,079	6,911,511	6,980,628	7,050,434	7,120,936
Out-of-State RECs											
RECs	388,940	393,110	1,225,203	3,976,357	4,077,730	4,180,121	4,283,534	4,387,984	4,493,478	4,600,026	4,704,971
Results											
Total REC Production	10,049,208	10,053,378	10,885,472	15,404,897	17,187,678	17,357,155	17,528,318	17,701,200	17,875,810	18,052,164	18,227,612
REPS Requirement	13,923,403	14,062,638	16,832,896	17,001,224	17,171,234	17,342,949	17,516,376	17,691,540	17,868,458	18,047,143	18,227,612
REC Surplus/ Deficit	−3,874,195	−4,009,260	−5,947,424	−1,596,327	16,444	14,206	11,942	9,660	7,352	5,021	0
Net Excess RECs	18,536,843	14,527,584	8,580,159	6,983,832	7,000,276	7,014,482	7,026,423	7,036,083	7,043,435	7,048,455	7,048,455

Figure 3-1. Renewable Energy Certificates Generated from Compliance Portfolio

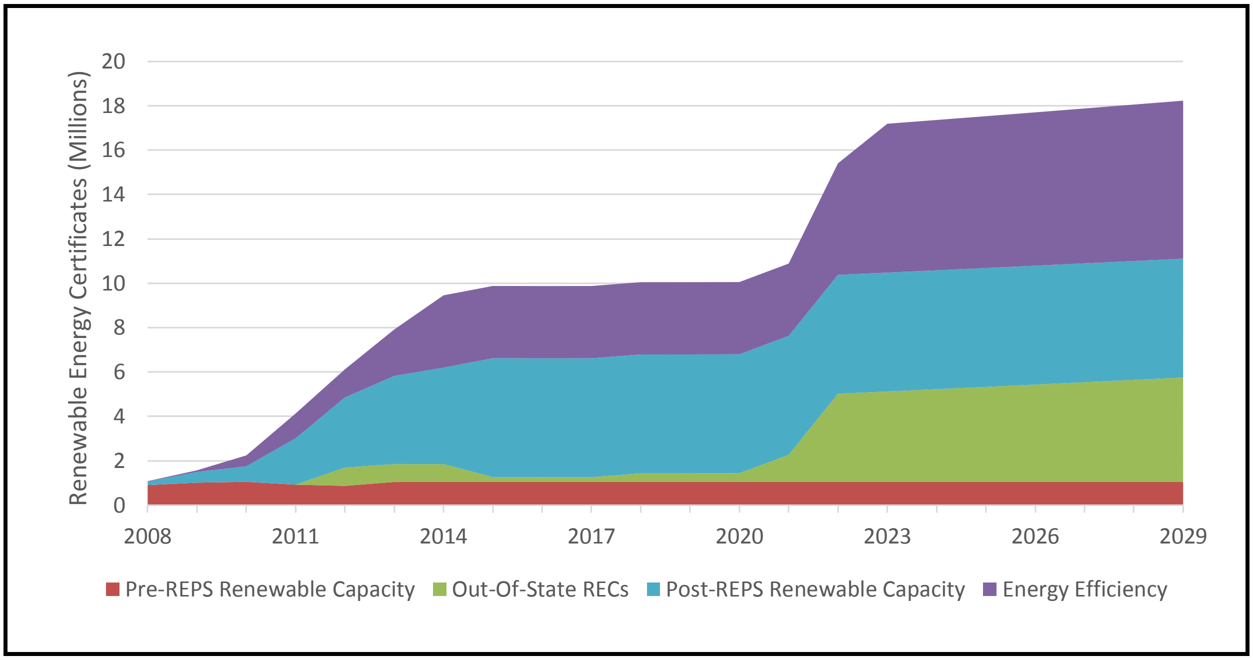
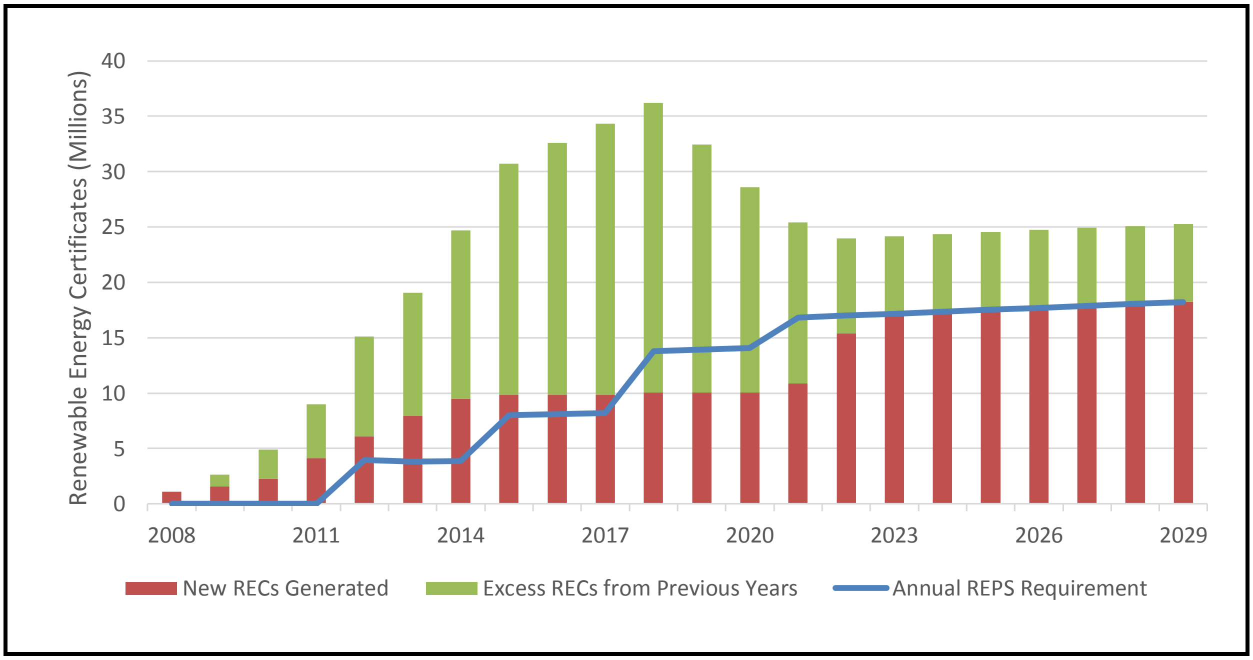


Figure 3-2. Compliance Portfolio Renewable Energy Certificates Compared to REPS Requirement



an annual rate of inflation of 2.4%.[20] In addition, the analysis included project financing,[21] state and federal tax credits,[22] and modified depreciation.[23]

Table 3-4 shows the key assumptions for each technology. The assumptions are based on a similar analysis conducted in February 2013.[24] Updates to assumptions are noted with footnotes in the table. The technology decline rate reflects the annual decrease in installed cost of a technology. The analysis assumed historical natural gas fuel prices through 2013. Additional years used a forecast from the U.S. Energy Information Administration.[25] Other fuel prices were benchmarked to inflation.

The cost of the Compliance Portfolio included the costs of post-REPS generation, energy efficiency, and out-of-state RECs. As noted earlier, pre-REPS generation was not included because the capacity was constructed in the absence of REPS requirements and therefore outside the scope of the rate impact analysis.

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[20] Inflation assumption reflects the compound annual growth rate of the consumer price index from 2004 to 2013.

[21] The analysis assumed 50% debt financing at an 8% interest rate for 20 years. Equity investment required a 12% return on investment.

[22] A 30% federal investment tax credit was assumed for solar technologies operational between 2008 and 2016; the tax credit decreased to 10% beginning in 2017. A federal production tax credit was assumed for eligible technologies operational between 2008 and 2014; the tax credit expired at the beginning of 2015. A 35% North Carolina investment tax credit was assumed for renewable facilities becoming operational between 2008 and 2015.

[23] Depreciation was assumed for all generation technologies. Renewable energy technologies were permitted accelerated depreciation. Further, the analysis assumed 50% bonus depreciation for all technologies from 2008 through 2013. The one exception was 2011, when all technologies were eligible for 100% bonus depreciation.

[24] RTI International and La Capra Associates. (2013). The Economic, Utility Portfolio, and Rate Impact of Clean Energy Development in North Carolina. Prepared for the North Carolina Sustainable Energy Association.

[25] U.S. Energy Information Administration. (2014a). Annual Energy Outlook 2014.

Table 3-4. Levelized Cost Assumptions for 2013 (Nominal Dollars)

Resource	Capacity Factor[a]	Installed Cost ($/MW)	Technol-ogy Decline Rate	Fixed O&M ($/kW-yr)	Variable O&M ($/MWh)	Fuel Heat Rate (Btu/kWh)[b]	Fuel Costs ($/mmBtu)
Biomass Co-firing	70%	$461	0%	$0.00	$0.00	12,000	$2.38
Dedicated Biomass[c]	80%	$3,799	0%	$108.17	$5.39	13,500	$2.38
Hydropower[c]	45%	$3,027	0%	$14.47	$0.00	—	$0.00
Landfill Gas[d]	85%	$2,053	0%	$148.48	$0.00	11,428[e]	$0.00
Natural Gas (Conventional Combined Cycle)[c]	70%	$862	0%	$13.49	$3.69	7,050	$3.73
Poultry Litter	90%	$3,880	0%	$104.86	$10.49	13,000	$5.24
Solar PV (<10 kW)[c]	16%	$6,235 [f]	5%	$25.28	$0.00	—	$0.00
Solar PV (10-100 kW)[c]	16%	$4,705 [f]	5%	$25.28	$0.00	—	$0.00
Solar PV (>100 kW)[c]	16%	$2,941 [f]	5%	$25.28	$0.00	—	$0.00
Solar Thermal[c]	42%	$4,457	3%	$68.87	$0.00	—	$0.00
Swine Waste	75%	$5,243	0%	$238.12	$0.00	—	$0.00
Onshore Wind[c]	30%	$2,152	0%	$40.50	$0.00	—	$0.00

[a] Solar PV capacity factor was updated to better reflect the sola resource available in North Carolina. See: National Renewable Energy Laboratory. (2014). "PVWatts. Version 1." Available at http://rredc.nrel.gov/solar/calculators/pvwatts/version1/.

[b] Biomass fuel costs were updated with more recent data. See: U.S. Energy Information Administration. (2014d). State Energy Data 2012: Prices and Expenditures.

[c] Analysis updated installed cost, fixed O&M variable O&M and fuel heat data. Installed costs reflect data for generation being installed in North Carolina. See: U.S. Energy Information Administration. (2014d). Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants.

[d] Analysis updated installed cost, fixed O&M, and variable O&M data. See: "World Energy Council. (2013). World Energy Perspective: Cost of Energy Technologies.

[e] The fuel heat rate for landfill gas represents the capacity weighted average among existing landfill gas facilities in North Carolina. Weighted average fuel heat was calculated from SNL Financial data.

[f] The installed cost for solar PV represents North Carolina data reported by Lawrence Berkley National Laboratory. Figures have been adjusted from DC to AC using an 85% conversion factor. See: Lawrence Berkeley National Laboratory. (2014). Tracking the Sun VII: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2013.

Within each year of the study, the cost of the Compliance Portfolio was determined by:

- Calculating the levelized cost of energy for incremental new renewable generation
- Calculating the levelized cost of saved energy for incremental new energy efficiency savings[26]
- Summing the levelized cost of energy and saved energy from current and previous years
- Adding the cost to purchase out-of-state RECs[27]

The cost of the Conventional Portfolio was determined in a similar manner. The analysis replaced generation from post-REPS renewable capacity and energy efficiency with generation from new conventional combined cycle natural gas facilities. The Conventional Portfolio did not include offsetting costs of RECs produced by thermal resources or out-of-state RECs because these resources did not generate electricity that needed to be replaced by the Conventional Portfolio. The levelized cost of energy was calculated for new incremental generation within each year. The cumulative cost of the Conventional Portfolio was determined by adding the annual costs of new generation from current and previous years.

The analysis acknowledges several limitations of the methodology. An important consideration is the Conventional Portfolio may not reflect operational changes or capacity additions that would have occurred in the absence of the North Carolina REPS. In addition, investor-owned utilities are unable to recover costs associated with the REPS until a REC is retired for compliance. However, this analysis assumes costs are recovered from ratepayers in the year the generation becomes operational. Finally, the analysis does not consider research and development or administrative expense associated with REPS compliance.

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[26] The analysis used $28/MWh in 2011 as the cost of energy savings. This figure represents the average cost of energy savings for 20 jurisdictions delivering energy efficiency to electric customers from 2009 to 2013 See: American Council for an Energy-Efficient Economy, (2014).

[27] The price of an out-of-state REC was assumed to be the average price of wind REC from Texas.

3.2 RATE IMPACT ANALYSIS

Figure 3-3 compares the costs incurred by electric ratepayers in the Compliance Portfolio to the Conventional Portfolio. The Compliance Portfolio shows small cost savings until 2022 when the addition of new energy efficiency results increases the savings. Considering the length of the study period, it is necessary to calculate the net present value of the Compliance Portfolio. The net present value of the Compliance Portfolio savings compared to the Conventional Portfolio equals $651 million. The analysis finds the greatest annual savings occur in 2029, when the Compliance Portfolio provides $287 million in savings compared to the Conventional Portfolio.

Figure 3-3. Cost of Compliance Portfolio Compared with Conventional Portfolio

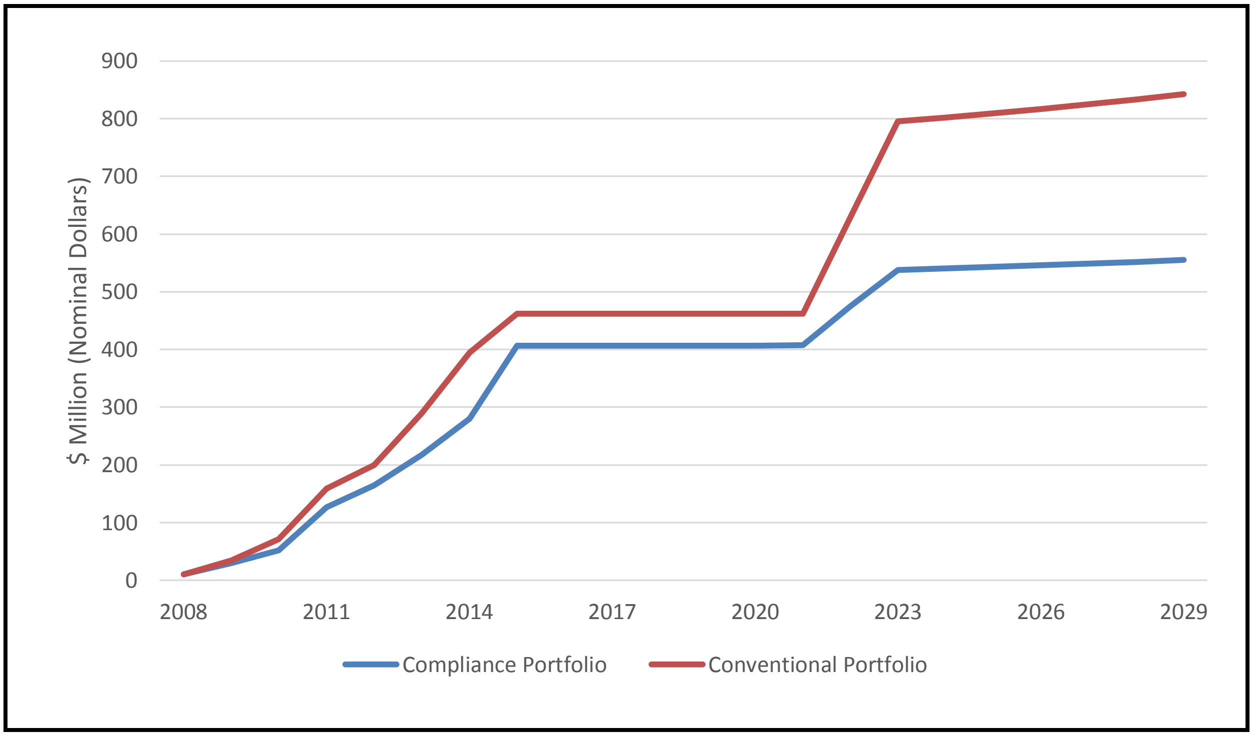
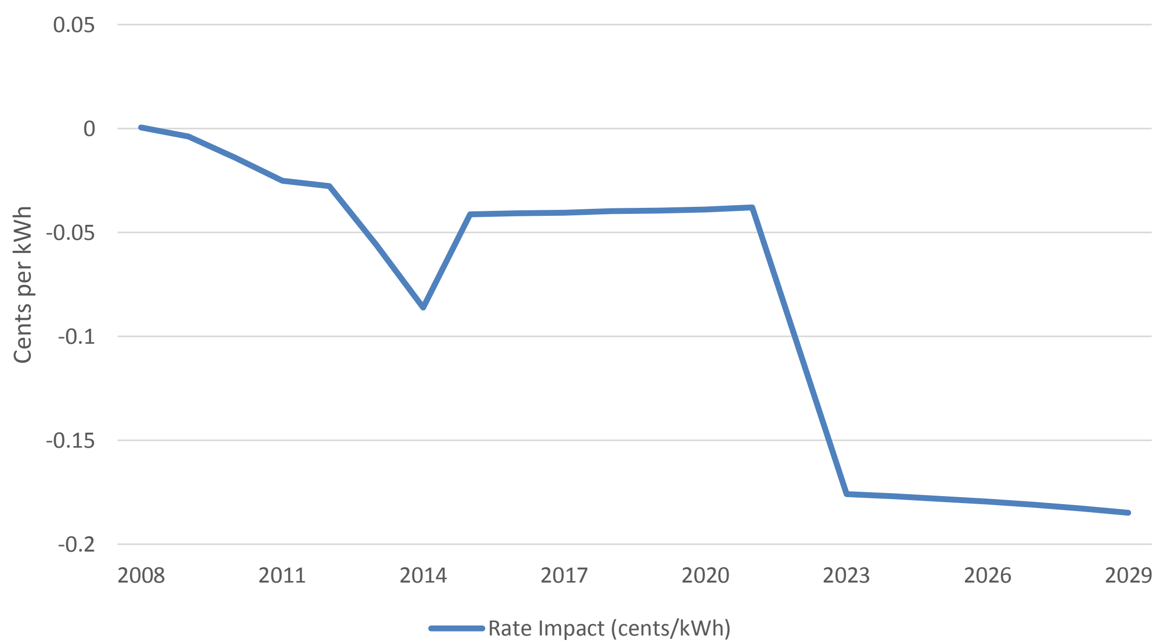


Figure 3-4 divides North Carolina retail sales by the savings of the Compliance Portfolio in order to determine the impact in cents per kilowatt-hour (kWh). The results show savings from the Compliance Portfolio grow steadily through 2014. The savings are reduced in 2015 with the addition of new poultry litter and swine waste capacity to meet set-aside requirements. The savings grow significantly in 2022 with the addition of new energy efficiency measures. Overall, the net present value of

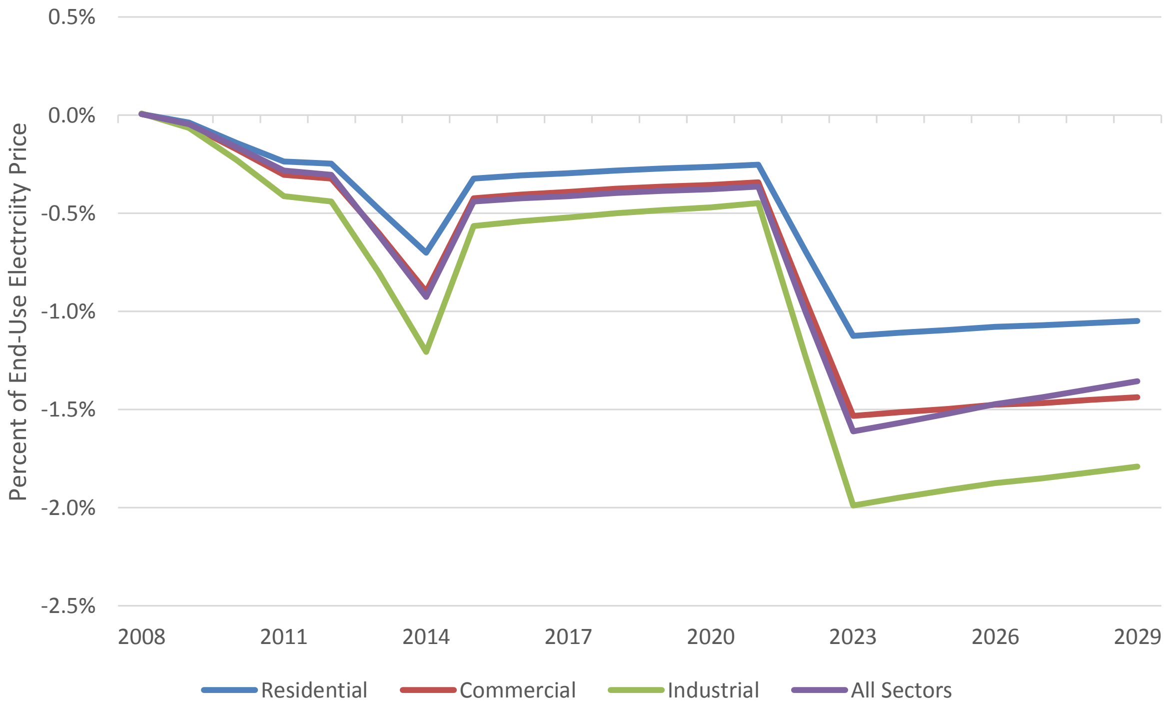
the Compliance Portfolio savings compared to the Conventional Portfolio is 0.46 cents per kWh.

Figure 3-4. Rate Impact of Compliance Portfolio in Cents per kWh Compared with Conventional Portfolio



The analysis also calculated the rate impact as a percentage of the end-use electricity price for different customer classes. The analysis divided the Compliance cost savings (in cents per kWh) by the electricity price of each customer class. **Figure 3-5** shows residential customers receive the smallest savings as a percentage of end-use electricity prices. The residential customer class receives the smallest rate impact because it has the highest electricity prices among the three customer classes. Industrial customers receive the largest savings as a percentage of end-use electricity prices because of lower end-use electricity prices. The decrease in savings from 2021 to 2029 reflects an increase in end-use electricity prices while the annual rate impact remains relatively unchanged.

Figure 3-5. Rate Impact of Compliance Portfolio as a Percentage of End-Use Electricity Price Compared with Conventional Portfolio



Overall, the analysis shows considerable renewable energy and energy efficiency resources are available as a result of the North Carolina REPS. Despite the robust development in recent years, additional resources will be required to meet REPS compliance through 2029. The analysis finds the use of existing resources and the addition of least-cost resources in a Compliance Portfolio results in a savings over time when compared to the Conventional Portfolio. While significant in absolute dollars, the savings result in a small reduction in the electricity rates. Even though the savings are small, the North Carolina REPS has a positive impact on electric ratepayers under the assumptions outlined in this analysis.

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Appendix A: Technical Appendix

A.1 RENEWABLE TECHNOLOGY DATA SOURCES AND ASSUMPTIONS

A.1.1 Solar Photovoltaic

Installed solar photovoltaic capacity between 2007 and 2014 was estimated based on data from North Carolina Renewable Energy Tracking System (NC-RETS, 2014), North Carolina GreenPower (North Carolina GreenPower, personal communication, February 20, 2014), and three additional systems totaling 16.48 MW not in these data sets verified via a press release (Duke Energy, 2013) and personal communication with project developers. Energy generated was estimated by applying a capacity factor of 19%, based on RTI's review of 2011 photovoltaic generation in North Carolina (U.S. Energy Information Administration [EIA], 2011) and PVWattv2 (National Renewable Energy Laboratory [NREL], 2012b).

Because of the magnitude of solar photovoltaic relative to other clean energy projects and the rapid decline in the cost of photovoltaic installations over the time period (NREL, 2012a), we developed cost estimates for installations by size of system and year of installation. These estimates rely on projected photovoltaic project costs from developers through December 31, 2014, that the North Carolina Sustainable Energy Association (NCSEA) compiled from NCUC.[28] For systems in the database with capacity not specified as AC, RTI converted from DC to AC by applying a derate factor of 0.79. As a data quality check, RTI independently reviewed several registrations to verify values within the database against North Carolina Utilities Commission (NCUC) dockets. RTI further cleaned the data by removing outliers (removing values 1.5x the interquartile range below the first and above the third quartile for each year). Costs for each year were then adjusted to 2013$ using the consumer price index (CPI) (Bureau of Labor Statistics [BLS], 2013). **Table A-1** shows RTI's estimates of the average costs per kW (AC), which are consistent with other available photovoltaic cost data sources over the study period. Annual

[28] It is worth noting that projected costs reported by developers frequently are much higher than the actual project costs incurred once installation is complete. Unfortunately, the more accurate post-installation cost data is not publicly reported. Using the projected costs rather than the actual installed costs may obscure the economies of scale for the installed cost of larger solar PV projects.

fixed operating and maintenance (O&M) costs were assumed to be $26/kW.[29]

Table A-1. Average Cost for Solar Photovoltaic Installations by Year and Size (AC kW, 2013$)

Expected Year Online	<10 kW	10 kW–100 kW	100 kW–1 MW	1 MW–2 MW	>2 MW
2006	15,791				
2007	10,298	9,114			
2008	10,622	10,672	12,025		
2009	9,942	9,407	7,017		
2010	8,850	7,644	5,889	5,355	
2011	8,195	6,652	5,952	5,417	3,781
2012	7,841	6,320	5,126	4,676	4,087
2013	6,799	4,850	3,271	3,185	3,365
2014	6,260	4,798	3,137	2,433	2,956

A.1.2 Landfill Gas

Capacity for landfill gas (LFG) facilities was estimated using data from NC-RETS (2014) and modified based on personal communication for one facility. We estimated generation by LFG facilities based on EIA 2011 and 2012 generation data (EIA, 2011; EIA, 2012) where available and otherwise applied a uniform capacity factor. Installation and O&M costs were also based on uniform estimates with the exception of personal communication regarding installation costs for one facility.

In addition to standard LFG facilities, the NC-RETS (2014) database indicated the addition of an LFG fuel cell project in 2012. Project capacity was provided by NC-RETS but was modified based on EIA generation data (EIA, 2012). Installation costs were assumed to be $7,000 per kW of rated output, with variable O&M costs of $43 per MWh (EIA, 2013a; EIA, 2013c).

A.1.3 Hydroelectric

NC-RETS (2014) represents the universe from which we pulled specific hydroelectric projects. Because NC-RETS tracks only hydroelectric projects under 10 MW, our analysis may underestimate total hydroelectric investment over the study

[29] Installment costs, O&M costs, capacity factor, and fuel cost assumptions for all renewable technologies included in our analysis are reported in Table 3-4 of this report.

period. RTI estimated new or incremental capacity at hydroelectric facilities between 2007 and 2014 from NC-RETS, EIA data (EIA, 2011), and NCUC registrations (Duke Energy, 2012; Kleinschmidt, N/A; Brooks Energy, 2008; Advantage Investment Group LLC, 2004; Cliffside Mills LLC, 2008; Madison Hydro Partners, 2010).

A.1.4 Biomass

Capacity for biomass facilities installed between 2007 and 2014 was estimated using data from NC-RETS (2014) and adjusted to reflect data in NCUC registrations for two facilities (EPCOR USA, 2009). Capacity for co-fired facilities was adjusted to reflect the 2011 fraction of renewable fuel consumed (EIA, 2011). We estimated generation by biomass facilities based on EIA 2011 generation data (EIA, 2011) where available and otherwise applied a uniform capacity factor. Installation, O&M, and fuel costs were based on uniform estimates or reported costs in NCUC dockets or press releases where available (Capital Power, 2011; Coastal Carolina Clean Power LLC, 2008; Prestage Farms Incorporated, 2011).

A.1.5 Biomass Combined Heat and Power

Thermal output capacity at biomass combined heat and power (CHP) facilities was developed from NC-RETS (2014) and NCUC registrations for eight facilities (EPCOR USA, 2009). Capacity for co-fired facilities was adjusted to reflect the fraction of renewable fuel consumed (EIA, 2011). For CHP facilities in the EIA-923 database, capacity was further adjusted to reflect the fraction of heat generated used for electricity. We estimated generation by biomass facilities based on EIA generation data (EIA, 2011) where available and otherwise applied a uniform capacity factor. Costs of these facilities are incorporated in the biomass cost estimates discussed above.

A.1.6 Wind

Wind power installations were developed from NC-RETS (2014) and North Carolina GreenPower (personal communication, February 20, 2014). Capacity factor and installation and O&M costs were based on uniform estimates or reported costs in NCUC dockets or press releases where available (ASU News, 2009; Madison County School System, 2009).

A.1.7 Solar Thermal Heating

Estimates of solar thermal heating capacity installed between 2007 and 2013 are based on data reported in NC-RETS (2014). RTI reviewed publicly available sources of project installation costs, annual energy generation, and system O&M (North Carolina Department of Commerce, 2010; NREL, 2011a) to develop the assumptions that solar thermal systems cost $3,500/kW to install and $60/kW for annual O&M. Installation costs for one project were taken from a news report (*News and Observer*, 2012). We assumed that solar thermal heating systems have the same capacity factor as photovoltaic systems.

A.1.8 Geothermal Heat Pumps

Geothermal heat pump capacity is not reported in NC-RETS. The North Carolina Department of Environment and Natural Resources (NCDENR) provided permit data for geothermal wells (NCDENR, personal communication, September 9, 2014). Although the number of wells per system varies based on system type and local conditions, given the available data, we assumed that a typical 3 ton system in North Carolina required five wells to convert wells to system size based on a project case study (Bosch Group, 2007). Based on personal communication with geothermal system contractors in North Carolina, we assumed the cost of an average 3 ton system to be $20,000. Because of a lack of suitable publicly available data in North Carolina, conversion of system tons to kW and annual energy savings per ton were estimated from available project data for a large installation in Louisiana (NREL, 2011b). O&M cost per year are assumed to be $35/kW (International Energy Agency [IEA], 2010).

A.1.9 Passive Solar

Passive solar tax credit spending data from the North Carolina Department of Revenue (2007−2013) are the only available data for passive solar projects over the study period. Energy savings were estimated based on the number of passive solar projects from North Carolina Department of Revenue data, as well as information on typical kWh savings provided by the Oregon Department of Energy (2012) and a study by RETScreen International (2004).

A.1.10 State Incentives for Renewable Energy

Tax credits taken for 2007 through 2013 were developed from figures provided by the North Carolina Department of Revenue (2011b; 2012a). We estimated the 2014 tax credits by looking at the trend in increasing tax credits from the previous 7 years and forecasting that trend out to 2014. This is a change in the methodology from the previous analysis to correct for overestimation of tax credits taken.

A.1.11 Spending Changes from Renewable Energy Generation

We applied the following assumptions to estimate spending changes resulting from energy generated at renewable energy facilities. For electricity produced by renewable facilities, we assumed that renewable project owners receive the avoided cost of electricity net of O&M and fuel costs that would be otherwise spent on conventional energy generation. Based on a review of avoided cost schedules for qualifying facilities from Duke Energy Carolinas (2012b) and Progress (2012a), we applied the simplifying assumption that the avoided cost paid to all renewable facilities is $60/MWh. For the most recent years we assumed this avoided cost decreased to $50/MWh. This value was concluded using the same methodology that was used to assume $60/MWh.

For nonelectric renewable energy, we assumed that the energy saved results in a reduction in retail energy spending. For biomass thermal generation at CHP facilities, we assumed the cost of energy saved is the industrial retail price for electricity, $68.20/MWh (EIA, 2013b). For geothermal, solar thermal, and passive solar, we assumed that the cost of energy saved is the average retail price for electricity, $99/MWh (EIA, 2013b).

The total Renewable Energy Portfolio Standard (REPS) rider charged to customers over the study period was taken from NCUC dockets (Duke Energy Carolinas, 2009b, 2010, 2011, 2012a, 2013b, 2014 Progress, 2009b, 2010a, 2011b, 2012a, 2013a, 2014, GreenCo, 2010a, 2010c, 2012a, 2012b, 2013, 2014, ElectriCities, 2009, 2010, 2011a, 2012a, 2013a, 2014) and included in the analysis as a change in spending to project owners from utility customers.

A.1.12 Universe of Included Projects

Table A-2 summarizes the sources used to compile our list of renewable energy and energy efficiency projects. Although additional resources were used to characterize these projects, the universe of projects in this analysis was limited to the sources below.

Table A-2. Sources Used in Compiling the Universe of Included Projects

	NC-RETS	NC Green-Power	Press Releases	Personal Communi-cation	NCDENR	NC DOR	NCUC Dockets
Solar photovoltaic	x	x	x	x			
Landfill gas	x						
Hydroelectric	x						
Biomass	x						
Wind	x	x					
Solar thermal heating	x						
Geothermal heat pumps					x		
Passive solar						x	
Utility energy efficiency							x

A.1.13 Inflation Adjustments

To accurately compare expenditures over time, it was necessary to convert all dollars to the same year. **Table A-3** presents the CPI data from the BLS that we used to adjust for inflation.

Table A-3. Inflation Adjustment Factors

Year	Consumer Price Index for All Urban Consumers	Multiplier for Conversion to 2013 USD
2006	201.60	1.16
2007	207.34	1.12
2008	215.30	1.08
2009	214.54	1.09
2010	218.06	1.07
2011	224.94	1.04
2012	229.59	1.01
2013	232.96	1.00
2014	236.38	0.99

Source: BLS, 2014.

A.2 ENERGY EFFICIENCY DATA SOURCES AND ASSUMPTIONS

A.2.1 Utility Programs

Energy efficiency program costs were taken from the start of the program until 2014 (Dominion North Carolina Power, 2010, 2011, 2012, 2013, 2014), Duke Energy Carolinas (2013a), NC GreenCo (2010b), NCMPA1 and NCEMPA (ElectriCities, 2011b; 2011c; 2011d; 2011e; 2011f; 2011g; 2012b; 2012c; 2013b; 2013c), and Progress (Progress, 2008, 2009a, 2010b, 2011a, 2012b, 2013b). Demand-side management program costs were only included for 2011 through 2014 because these programs could not pass along costs to consumers until 2011 (General Assembly, 2011).

Energy savings associated with utility programs between 2007 and 2011 were estimated based on NC-RETS data (2014). Energy savings from utility programs in 2014 were estimated from expected 2014 savings from NCUC dockets. We assumed that the change in spending associated with these energy savings is equal to the avoided cost of electricity, $60/MWh for the previous analysis and $50/MWh for 2014 values, and is distributed evenly between the utilities and utility customers, consistent with cost savings under Duke's Save-A-Watt program (Duke Energy Carolinas, 2009a).

A list of the utility programs considered in our analysis is included in **Table A-4**.

Table A-4. Utility Energy Efficiency Programs

Program	Utility
Commercial Distributed Generation Program	Dominion
Commercial Energy Audit	Dominion
Commercial Duct Testing & Sealing	Dominion
Commercial HVAC Upgrade Program	Dominion
Commercial Lighting Program	Dominion
Low Income Program	Dominion
Residential Air Conditioning Cycling	Dominion
Residential Audit	Dominion
Residential Duct Testing & Sealing	Dominion
Residential Heat Pump Tune-up	Dominion
Residential Heat Pump Upgrade	Dominion

(continued)

Table A-4. Utility Energy Efficiency Programs (continued)

Program	Utility
Residential Lighting Program	Dominion
Appliance Recycling Program	Duke
Energy Efficiency in Schools	Duke
Home Retrofit	Duke
Low Income Weatherization	Duke
Non Residential Smart Saver Lighting	Duke
Non-Residential Energy Assessments	Duke
Non-Residential Smart Saver	Duke
Power Manager	Duke
Power Share	Duke
Residential Energy Assessments	Duke
Residential Energy Comparison Report	Duke
Residential Neighborhood Program	Duke
Residential Smart Saver	Duke
Smart Energy Now	Duke
Agricultural Energy Efficiency	GreenCo
Commercial Energy Efficiency	GreenCo
Commercial New Construction	GreenCo
Community Efficiency Campaign	GreenCo
Energy Cost Monitor	GreenCo
Energy Star Appliances	GreenCo
Energy Star Lighting	GreenCo
Low Income Efficiency Campaign	GreenCo
Refrigerator/Freezer Turn-In	GreenCo
Residential New Home Construction	GreenCo
Water Heating Efficiency	GreenCo
C&I Energy Efficiency Program	NCMPA
Commercial Prescriptive Lighting Program	NCMPA
High Efficiency Heat Pump Rebate	NCMPA
Home Energy Efficiency Kit	NCMPA
LED and ECM Pilot for Refrigeration Cases	NCMPA
Municipal Energy Efficiency Program	NCMPA
Commercial, Industrial, and Government Demand Response	Progress
Commercial, Industrial, and Government Energy Efficiency	Progress
Compact Fluorescent Light Pilot	Progress
Distribution System Demand Response	Progress
EnergyWise	Progress
Lighting—General Service	Progress
Residential Energy Efficiency Benchmarking	Progress

(continued)

Table A-4. Utility Energy Efficiency Programs (continued)

Program	Utility
Residential Appliance Recycling	Progress
Residential Home Advantage	Progress
Residential Home Energy Improvement	Progress
Residential Lighting	Progress
Residential Low Income Program	Progress
Residential New Construction	Progress
Small Business Energy Saver	Progress
Solar Hot Water Heating Pilot	Progress

A.2.1 Utility Savings Initiative

Data on the cost, savings, and incentives for the Utility Savings Initiative were taken from the project's 2014 annual report (North Carolina Department of Commerce, 2014).

A.3 IMPLAN ANALYSIS

We distributed spending for each renewable facility, efficiency program, government incentive, and change in spending resulting from renewable energy generation and energy savings across IMPLAN sectors based on distributions in other comparable reports and models where appropriate (NREL, 2012c; NREL, 2012d; Regulatory Assistance Project, 2005; Bipartisan Policy Center, 2009), 2011 IMPLAN default data for North Carolina (MIG Inc., 2012), and original assumptions where necessary (**Table A-5**).

Three breakouts were developed using IMPLAN default data to model additional spending or savings to utility customers. First, post-tax consumer income was created using the proportion of money spent by consumers. Second, corporate net income was created using the proportion of money spent, saved, and taxed from corporations. Third, state spending was developed using the three categories that IMPLAN has for state spending: investment, education, and noneducation. Dollars not spent by the state were deducted based on the proportion of state spending in these three categories.

Table A-5. IMPLAN Breakout for Renewable Energy, Energy Efficiency, and State Spending

Type	Direct Spending	Secondary Effects
Renewable Energy		
Solar Photovoltaic	Investment spending was allocated across IMPLAN sectors using the default breakout in the JEDI Photovoltaic model (NREL, 2012c) according to the installation size.	The avoided cost of energy produced was transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution.
Hydroelectric	Investment spending was allocated to IMPLAN Sector 36, Construction of Other New Nonresidential Structures.	Avoided cost net of fixed and variable O&M costs was transferred to Sector 366, Lessors of Non-financial intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed and variable O&M costs were allocated to IMPLAN Sector 39, Maintenance and Repair Construction of Non-residential Structures.
Wood Biomass	Investment spending was allocated based on the Wood Biomass IMPLAN distribution in the 2009 Bipartisan Policy Center report.	Avoided cost of energy produced net of fuel, fixed O&M, and variable O&M costs were transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed and variable O&M costs were allocated based on the Wood Biomass IMPLAN distribution in the 2009 Bipartisan Policy Center. Fuel costs were allocated to Sector 15, Forestry, Forest Products, and Timber Tract Production.
Biomass Co-fire	Investment spending was allocated based on the Biomass Co-Fire IMPLAN distribution in the 2009 Bipartisan Policy Center report.	Avoided cost net of fuel, fixed O&M, and variable O&M costs were transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed and variable O&M costs were allocated based on the Biomass Co-Fire IMPLAN distribution in the 2009 Bipartisan Policy Center report. Fuel costs were allocated to Sector 15, Forestry, Forest Products, and Timber Tract Production.

(continued)

Table A-5. IMPLAN Breakout for Renewable Energy, Energy Efficiency, and State Spending (continued)

Type	Direct Spending	Secondary Effects
Renewable Energy (cont.)		
Swine Biomass	Investment spending was allocated based on the Swine Biomass IMPLAN distribution in the 2009 Bipartisan Policy Center report.	Avoided cost net of fixed O&M and variable O&M costs were transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed and variable O&M costs were allocated based on the Swine Biomass IMPLAN distribution in the 2009 Bipartisan Policy Center report.
Wind	Investment spending was allocated across IMPLAN sectors using the default breakout in JEDI Wind model (NREL, 2012d).	The avoided cost of energy net of fixed O&M produced was transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed O&M costs were allocated across IMPLAN sectors using the default breakout in JEDI Wind model (NREL, 2012d).
Landfill Gas	Investment spending was allocated based on the Landfill Gas IMPLAN distribution in the 2009 Bipartisan Policy Center report.	The avoided cost of energy produced net of fixed O&M costs was transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed O&M costs were allocated based on the Landfill Gas IMPLAN distribution in the 2009 Bipartisan Policy Center report.
Geothermal Heat Pumps	Investment spending was allocated 50% to Sector 216, Air Conditioning, Refrigeration, and Warm Air Heating Equipment Manufacturing, 25% to Sector 36, Construction of Other New Non-residential Structures, and 25% to Sector 319, Wholesale Trade.	The retail cost of energy saved net of O&M costs was transferred 70% to corporate net income and 30% to post-tax consumer spending (assuming systems with 10 or fewer wells were for residential customers, and those with more were commercial customers) from Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed O&M costs were allocated to IMPLAN Sector 39, Maintenance and Repair Construction of Non-residential Structures.
Passive Solar	Investment spending was allocated to Sector 37, Construction of New Residential Permanent Site Single and Multi-family Structures.	The retail cost of energy saved was transferred to Post-Tax Consumer Spending from Sector 31, Electricity, Generation, Transmission, and Distribution.

(continued)

Table A-5. IMPLAN Breakout for Renewable Energy, Energy Efficiency, and State Spending (continued)

Type	Direct Spending	Secondary Effects
Renewable Energy (cont.)		
Solar Thermal	Investment spending was allocated across IMPLAN sectors using the photovoltaic breakout for 100 kW–1 MW systems from JEDI Photovoltaic model (NREL, 2012c).	The retail cost of energy saved net of O&M costs was transferred to Corporate Net Income from Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed O&M costs were allocated to IMPLAN Sector 39, Maintenance and repair construction of non-residential structures.
REPS Rider		REPS rider was transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from a split of 50% from corporate net income for commercial and industrial customers and 50% from post-tax consumer spending for residential customers.
Efficiency Programs		
Utility Programs	Efficiency program investments were allocated to IMPLAN sectors according to the 2005 Regulatory Assistance Project report breakouts for the following categories: residential retrofit, residential new construction, commercial retrofit and commercial new construction. In addition, for residential appliance recycling program, we distributed investment spending 10% to Sector 390, Waste Management and Remediation Services, and 90% to Sector 319, Wholesale Trade Businesses. For school education programs, we distributed spending across 100% to Sector 380, All Other Miscellaneous Professional, Scientific and Technical Services.	The avoided cost of energy saved was transferred 50% to Sector 366, Lessors of Non-financial Intangible Assets for Utility Recovery of Avoided Costs, 25% to corporate net income for industrial and commercial customer savings and 25% to post-tax consumer spending for residential customer savings from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution.
Utility Savings Initiative	Utility Savings Initiative program investments were allocated to IMPLAN sectors according to the Commercial Retrofit category in the 2005 Regulatory Assistance Project report.	Utility Savings Initiative savings transferred to State Spending and taken from Sector 31, Electricity, Generation, Transmission, and Distribution.
Government Initiatives		
Tax Credit		Tax credit deducted from IMPLAN State Spending breakout.
Utility Savings Initiative		Utility Savings Initiative appropriations deducted from IMPLAN State Spending breakout.

A.4 DIFFERENCES FROM LAST YEAR'S REPORT

The results of this analysis differ from last year's *Economic Impact Analysis of Clean Energy Development in North Carolina—2014 Update* (RTI, 2014). The list below outlines several changes to the underlying data, study scope, and reporting conventions that may lead to differences between the reports.

- The study frame was expanded to include 2014, whereas the last report's study frame was 2007 to 2013.
- Differences in yearly renewable energy investment can be explained by the availability of new data on the timing of photovoltaic investments from North Carolina GreenPower, the addition of new renewable energy projects in the NC-RETS database that were not present at the time of the 2014 report, updated geothermal data from NC DENR, updated data for estimating passive solar investments, and increased data on photovoltaic costs per kW.
- Utility Savings Initiative spending data are not available annually; lengthening the study frame requires a new allocation of total investment to prior years.
- Differences in yearly state incentives can be explained by several factors. For one, because Utility Savings Initiative state appropriation data are not available annually, lengthening the study frame requires a new allocation of total appropriation to prior years. Also, whereas the 2014 report estimated 2013 tax credits taken, this study used retrospective data provided by the North Carolina Department of Revenue for this year's tax credits.
- To account for the entire year of renewable energy investment, RTI estimated renewable energy investment for the months of November and December based on average investment trends in the final 2 months of the previous 2 years.

A.5 REFERENCES

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Appendix B: Renewable Energy Projects Valued at $1 Million or Greater by County

Table B-1. Major Investments in Renewable Energy Across North Carolina Counties ($)

County Name	Solar	Landfill Gas	Hydro	Biomass	Solar Thermal	Total
Alamance	3,421,086	—	—	—	—	3,421,086
Alexander	6,584,279	—	—	—	—	6,584,279
Alleghany	—	—	—	—	—	—
Anson	—	—	—	—	—	—
Ashe	—	—	—	—	—	—
Avery	4,931,295	—	—	—	—	4,931,295
Beaufort	66,230,319	—	—	—	—	66,230,319
Bertie	—	—	—	1,696,437	—	1,696,437
Bladen	19,825,375	—	—	—	—	19,825,375
Brunswick	—	—	—	—	—	—
Buncombe	18,045,187	3,590,323	—	—	—	21,635,510
Burke	1,232,824	—	4,585,831	—	—	5,818,654
Cabarrus	23,319,011	28,339,107	—	—	1,446,279	53,104,396
Caldwell	—	—	—	—	—	—
Camden	—	—	—	—	—	—
Carteret	—	—	—	—	—	—
Caswell	39,650,750	—	—	—	—	39,650,750
Catawba	143,510,545	70,492,159	—	—	—	214,002,704
Chatham	24,031,236	—	14,243,051	—	—	38,274,287
Cherokee	14,793,884	—	—	—	—	14,793,884
Chowan	—	—	—	—	—	—
Clay	—	—	—	—	—	—
Cleveland	58,265,081	—	—	—	—	58,265,081
Columbus	69,898,323	—	—	—	—	69,898,323
Craven	21,900,098	11,010,691	—	—	—	32,910,788
Cumberland	6,306,114	—	2,589,646	—	—	8,895,759
Currituck	—	—	—	—	—	—
Dare	—	—	—	—	—	—
Davidson	130,792,574	4,187,876	—	—	—	134,980,450
Davie	35,053,949	—	—	—	—	35,053,949
Duplin	102,632,853	—	—	20,440,023	—	123,072,875
Durham	18,805,353	8,459,930	—	—	—	27,265,283
Edgecombe	12,126,574	—	—	—	—	12,126,574
Forsyth	1,785,084	6,089,594	—	—	2,182,104	10,056,783
Franklin	26,894,835	—	—	—	—	26,894,835
Gaston	30,526,654	7,180,646	—	—	—	37,707,300
Gates	—	—	—	—	—	—
Graham	—	—	—	—	—	—
Granville	12,400,088	—	—	—	—	12,400,088
Greene	9,541,091	—	—	—	—	9,541,091

(continued)

Table B-1. Major Investments in Renewable Energy Across North Carolina Counties ($) (continued)

County Name	Solar	Landfill Gas	Hydro	Biomass	Solar Thermal	Total
Guilford	14,869,301	—	—	—	1,178,046	16,047,348
Halifax	—	—	—	—	—	—
Harnett	41,444,391	—	—	—	—	41,444,391
Haywood	5,814,317	—	—	—	—	5,814,317
Henderson	7,074,259	—	—	—	2,537,331	9,611,590
Hertford	19,576,648	—	—	1,339,292	—	20,915,940
Hoke	—	—	—	—	—	—
Hyde	—	—	—	—	—	—
Iredell	—	8,482,849	—	—	—	8,482,849
Jackson	—	—	—	—	—	—
Johnston	17,963,763	3,920,000	—	—	—	21,883,763
Jones	—	—	—	—	—	—
Lee	—	—	—	—	—	—
Lenoir	44,421,296	—	—	—	—	44,421,296
Lincoln	19,825,375	—	—	—	—	19,825,375
Macon	—	—	—	—	—	—
Madison	—	—	—	—	—	—
Martin	—	—	—	—	—	—
McDowell	—	—	4,585,831	—	—	4,585,831
Mecklenburg	24,366,077	4,587,514	—	11,530,871	—	40,484,462
Mitchell	—	—	—	—	—	—
Montgomery	14,563,287	23,179,017	—	—	—	37,742,303
Moore	13,543,857	—	—	—	—	13,543,857
Nash	66,067,096	—	—	—	—	66,067,096
New Hanover	13,988,368	—	—	—	1,051,180	15,039,547
Northampton	—	—	—	—	—	—
Onslow	—	4,784,850	—	—	—	4,784,850
Orange	21,913,289	—	—	—	1,424,530	23,337,819
Pamlico	—	—	—	—	—	—
Pasquotank	—	—	—	—	—	—
Pender	—	—	—	—	—	—
Perquimans	—	—	—	—	—	—
Person	54,929,281	—	—	92,945,202	—	147,874,483
Pitt	—	—	—	—	—	—
Polk	—	—	—	—	—	—
Randolph	18,070,343	—	—	—	—	18,070,343
Richmond	26,163,338	—	—	—	—	26,163,338
Robeson	170,585,373	2,485,887	—	—	15,534,678	188,605,938
Rockingham	20,867,111	1,960,000	—	2,306,174	—	25,133,285

(continued)

Table B-1. Major Investments in Renewable Energy Across North Carolina Counties ($) (continued)

County Name	Solar	Landfill Gas	Hydro	Biomass	Solar Thermal	Total
Rowan	9,559,759	—	—	1,286,120	—	10,845,879
Rutherford	4,065,751	—	—	—	—	4,065,751
Sampson	28,762,492	15,435,000	—	1,724,901	—	45,922,392
Scotland	71,011,766	—	—	—	—	71,011,766
Stanly	—	—	—	—	—	—
Stokes	—	—	—	—	—	—
Surry	20,301,121	11,515,000	—	—	—	31,816,121
Swain	—	—	—	—	—	—
Transylvania	—	—	—	—	—	—
Tyrrell	—	—	—	—	—	—
Union	19,825,375	—	—	—	—	19,825,375
Vance	28,563,347	—	—	—	—	28,563,347
Wake	81,563,307	15,534,678	—	—	—	97,097,985
Warren	40,388,854	—	—	—	—	40,388,854
Washington	—	—	—	—	—	—
Watauga	9,228,048	—	—	—	—	9,228,048
Wayne	107,936,531	8,323,403	—	—	—	116,259,934
Wilkes	—	—	—	—	—	—
Wilson	19,825,375	—	—	—	—	19,825,375
Yadkin	—	—	—	—	—	—
Yancey	—	—	—	—	—	—
Total	**1,959,582,956**	**239,558,523**	**26,004,358**	**133,269,020**	**25,354,148**	**2,383,769,006**

Note: This table only includes renewable projects with installment costs greater than $1,000,000 (in 2013 dollars). Total renewable investment was $2.61 billion across North Carolina.

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FEBRUARY 2015

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The Center on Globalization, Governance & Competitiveness (**CGGC**), an affiliate of the Social Science Research Institute at Duke University, is built around the use of the Global Value Chain (GVC) methodology, developed by the Center's Director, Gary Gereffi. The Center uses GVC analysis to study the effects of globalization on various topics of interest, including industrial upgrading, international competitiveness, the environment, global health, engineering and entrepreneurship, and innovation in the global knowledge economy. More information about CGGC is available at http://www.cggc.duke.edu.

About the Authors

Lukas Brun is a Senior Research Analyst at Duke CGGC and lead author of the study. His research at CGGC uses global value chain analysis to understand the competitiveness of firms, industries and regions. Lukas has more than 10 years of experience in the energy and environment research field, including as a senior economist for a Los Angeles-based energy advisory services firm. Lukas holds master's degrees with concentrations in economic development and international political economy from the University of North Carolina at Chapel Hill, and bachelor's degrees in economics and political science from Texas Christian University.

Danny Hamrick and **Jack Daly** provided research assistance for the study. Danny holds a master's degree in international studies from North Carolina State University and a bachelor's degree in Spanish language and literature from Wake Forest University. Jack holds a master's degree in international studies and bachelor's degrees in economics and history from North Carolina State University.

The Environmental Defense Fund sponsored the research for this report. Errors of fact or interpretation remain the exclusive responsibility of the author(s). The opinions expressed or conclusions made in this study are not endorsed by the project sponsor. We welcome comments and suggestions. The lead author may be contacted at lukas.brun@duke.edu.

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Report design & layout by Winking Fish

Contents

TABLES & FIGURES

ACRONYMS

AC	Alternating Current
BOS	Balance of System
CGGC	Center on Globalization, Governance & Competiveness (Duke)
CPV	Concentrated Photovoltaics
DC	Direct Current
EIA	Energy Information Administration
EPC	Engineering, Procurement and Construction
GVC	Global Value Chain
GW	Gigawatt (1 billion watts)
IREC	Interstate Renewable Energy Council
ITC	Investment Tax Credit
kW	Kilowatt (1,000 watts)
MACRS	Modified Accelerated Cost Recovery System
MLP	Master Limited Partnership
MW	Megawatt (1 million watts)
NCDOR	North Carolina Department of Revenue
NC-RETS	North Carolina Renewable Energy Tracking System
NCUC	North Carolina Utilities Commission
NREL	National Renewable Energy Laboratory
O&M	Operations and Maintenance
PPA	Power Purchase Agreement
PV	Photovoltaic
QF	Qualifying Facility
REIT	Real Estate Investment Trust
REPS	Renewable Energy and Energy Efficiency Portfolio Standard
RETC	Renewable Energy Tax Credit
RPS	Renewable Energy Portfolio Standard
VC/PE	Venture Capital/Private Equity
WTO	World Trade Organization

Executive Summary

North Carolina is the South's leader, and fourth among U.S. states, in using solar power to diversify its portfolio of electric power generation fuels. A sunny climate, investor and business-friendly policies, and capable companies across the solar power value chain have made North Carolina's leadership position possible.

The benefits of being the South's leader in solar power have accrued to North Carolinians across the state. All regions – West, Central and East – and both rural and urban areas have profited from solar power investments. North Carolinians also receive gains from the economic, environmental and social benefits of less-polluting electric power generation. To paraphrase one company executive we interviewed, North Carolina is good for solar, but solar has also been very good for North Carolina.

While the present is bright, uncertainty exists in North Carolina's solar future. Three policy issues affect the future of North Carolina's continued development of large-scale solar: (1) the expiration on December 31, 2015 of the state-level renewable energy tax credit, which has been in place at some level since 1977; (2) the reduction of the federal investment tax credit from 30% to 10% on December 31, 2016; and (3) the backlog of interconnection agreement assessments acting as a block to the timely completion of solar power projects.

Report Objectives

The purpose of this report is to assess three issues related to North Carolina's utility-scale photovoltaic solar investments, which we define as a solar facility equal to or greater than 1 MW_{ac}, (1 megawatt, alternating current) or, in non-technical terms, large-scale solar used to generate electricity for business use or to be placed on the bulk power grid. The first issue investigated is the condition of the solar market: the industry, market and technology trends affecting the cost and feasibility of additional investments in utility-scale solar in the world generally and in the United States and North Carolina in particular.

The second issue investigated in this report is the amount of utility-scale solar resources in North Carolina relative to other places in the United States and the world. We find that solar resources, or *insolation*, in North Carolina are quite significant when compared to other states and countries. Clearly North Carolina has the necessary sunny climate needed to be a leader in solar electric power generation. We then turn toward better understanding the existing and planned solar power plant installations in North Carolina. From 2008 through mid-December 2014, 150 solar facilities with 573 MW in total solar capacity have been installed, and another 377 solar facilities with 3,034 MW of solar capacity are in various stages of planning and development.

The third issue examined in this report is the economic footprint of utility-scale solar in North Carolina. Our assessment of the North Carolina utility-scale solar value chain finds that the direct investments in solar affect thousands of jobs across the state.

North Carolina:

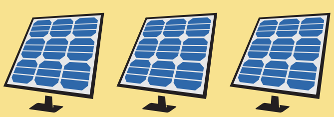
#1

in the South

#4

in the country

for installed solar capacity.



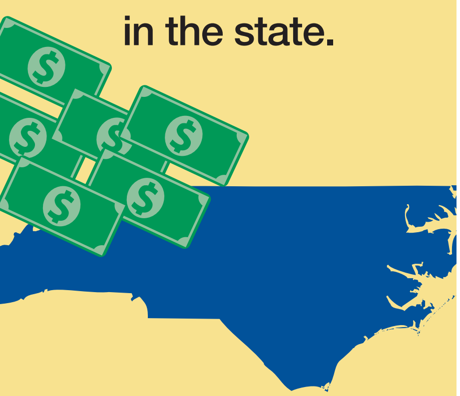
North Carolina is home to over

450 companies

involved in the solar industry— they represent at least

$2 billion

of direct investment in the state.



KEY FINDINGS

Finding #1

Solar-friendly policies have made **North Carolina No. 1 in the South and No. 4 in the country** for installed solar investment. **All parts of the solar value chain – investors, solar developers, construction contractors, solar panel and component manufacturers – are creating jobs and providing landowners, workers and towns across North Carolina with income and tax revenue.**

- Despite having the same amount of sun exposure as other states in the South, North Carolina has attracted a disproportionate share of solar industry investment – as evidenced by its No. 1 ranking in the South and No. 4 ranking nationally – due to its solar business-friendly policies.
- North Carolina is well-positioned in all parts of the solar value chain, including investors (e.g., Bank of America of Charlotte and Blue Cross & Blue Shield of Durham), developers (e.g., O2 Energies of Cornelius), construction contractors (e.g., Horne Brothers of Fayetteville), solar panel manufacturers (e.g., DuPont of Fayetteville), and component manufacturers (e.g., Schletter of Shelby for racking, ABB of Raleigh for inverters, and Torpedo Specialty Wire of Rocky Mount for electrical wiring).
- North Carolina is home to over 450 companies involved in the solar industry, and they support approximately 4,307 jobs and represent at least $2 billion of direct investment in the state.

Finding #2

The solar industry's growth in North Carolina is **providing jobs and economic development opportunities to all parts of the state, including rural areas** that have struggled historically to create jobs and businesses.

- Utility-scale solar installations are growing from North Carolina's mountains to the coast.
- Some of the highest levels of investment are occurring in North Carolina's rural counties. Catawba, Robeson and Wayne are the leading counties in the state for utility-scale solar investment.

Finding #3

North Carolina's ability to continue attracting companies in the solar industry, create jobs and promote economic development throughout the state is at risk unless policy makers act.

- Uncertainty surrounding the continuation of existing state policies has the potential to slow the growth of North Carolina's utility-scale solar industry. The challenges include:
    - Expiration of the North Carolina Renewable Energy Investment Tax Credit at the end of 2015.
    - Attempts to repeal the North Carolina Renewable Energy and Energy Efficiency Portfolio Standard (REPS).
    - Interconnection bottlenecks that are slowing the ability of solar projects to connect to the grid.

1. Introduction

1.1 Report Overview

The purpose of this report is to conduct an assessment of three major issues related to North Carolina's utility-scale photovoltaic (PV) solar investments.[1] The first issue is the state of the solar market: the industry, marketplace and technology trends affecting the cost and feasibility of additional investments in utility-scale solar in the world generally and in the United States and North Carolina in particular.

The second issue investigated in this report is the amount of utility-scale solar resources in North Carolina relative to other places in the United States and the world. We find that solar resources, or *insolation*, in North Carolina are quite significant when compared to those of other states and countries. Clearly, North Carolina has the sunny climate needed to be a leader in solar electric power generation. We then turn our attention to the existing and planned solar power plant installations in North Carolina. We find that North Carolina ranks fourth among U.S. states in terms of installed capacity and sixth in terms of electric power generation from solar resources.[2]

The third issue examined in this report is the economic footprint of utility-scale solar in North Carolina. As in many of CGGC's reports on environmental technologies, we use the value chain analytic framework to understand the industrial organization and development impacts of the solar power industry in North Carolina. Value chain studies provide insight into how goods and services are made, and they describe the many actors and economic forces present within the industry, from developers, manufacturers, installers and end purchasers to the supporting policies and organizations important to the success of an industry in a region.

Our assessment of the North Carolina utility-scale solar value chain finds that at least $2 billion in direct investment has been made in the state, affecting at least 4,307 direct jobs in 450 companies. Between 2008 and mid-December 2014 (the last date for which official statistics are available), 150 solar facilities with 573 MW in total solar capacity have been installed. Another 377 solar facilities with 3,034 MW of solar capacity are in various stages of planning and development, although it is uncertain how many of those projects will be completed.[3] Aside from these impressive impacts, a remarkable aspect about utility-scale solar in North Carolina is the degree to which its impacts are spread across all regions of the state: Western, Central, and Eastern and both rural and urban areas all receive the benefits of utility-scale solar. Overall, we agree with the perspective offered by John Morrison of Strata Solar, who said, "North Carolina is good for solar, but solar is also very good for North Carolina. This includes not only the environmental benefits of solar, but the economic benefits from what we're doing. It's the employment, the people we've trained, and the tax revenue that goes to local counties in very rural, poor parts of the state. And then there is

> *"One of the things that I want people to understand is that North Carolina is good for solar, but that solar is also very good for North Carolina."*
>
> *– John Morrison, Strata Solar*

what solar means to the landowners, the farmers, who are able to receive a long-term, fairly secure income for leasing a portion of their property for a solar farm."

1.2 Report Organization

The report is organized into four sections:

Solar Market Overview:
Analyzes the industry, market and technology trends affecting the level of adoption of photovoltaic solar power in North Carolina. The industry appears hopeful that technology and installation costs will continue to decline, making PV solar power ever more competitive within the portfolio of renewable resources for electric power generation.

Utility-scale solar in North Carolina:
Summarizes the photovoltaic resources and the amount of installed and proposed solar capacity in the state. The source for this capacity summary is filings with the North Carolina Utilities Commission (NCUC), which represent the most accurate assessment of solar capacity in the state available. Proposed solar capacity figures represent solar facilities at various stages of planning and development, but no certainty exists whether or when the facilities will be built.

The utility-scale PV solar value chain:
Describes the solar power value chain, the key segments and sub-segments in the chain, the companies that participate in each segment of the value chain, and the supporting policies and organizations in the chain.

The appendices and endnotes provide additional detail and supporting information to the narrative and analysis provided in the main text.

2. Solar Market Overview

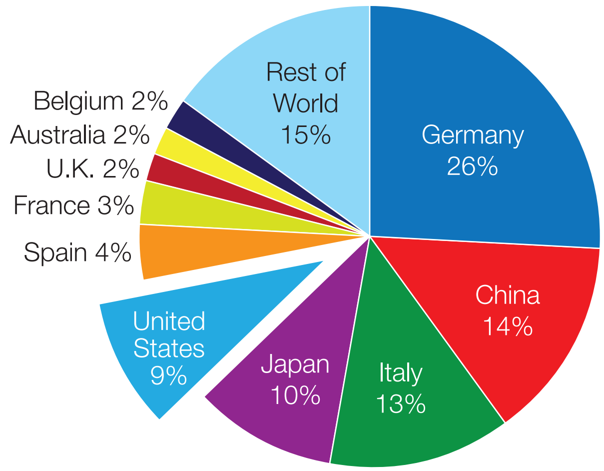
2.1 Industry Trends

The global solar PV industry has grown rapidly over the last 10 years. In 2004, global capacity was estimated at 3.7 GW, with a total annual investment of $4 billion. In 2013, global solar PV capacity was estimated at 139 GW, with a total annual investment of just under $100 billion, a 3,600% change in capacity and a 2,400% change in investment from 2004.[4] Almost half of all operating PV capacity in the world was added in the past two years.[5]

In 2013, the United States represented 9% (12.1 GW) of global PV solar capacity (see Figure 1). Approximately 4.8 GW of that was newly installed PV solar capacity and 2.8 GW was at the utility scale.[6] At the end of 2013, North Carolina had approximately 375 MW of installed capacity,[7] and by mid-December 2014 it had 573 MW of installed solar capacity.[8]

In 2013, newly installed capacity was largely the result of falling prices for PV panels and installation.[9] Large ground-mounted projects represented more than 80% of capacity additions, which are being made by commercial businesses as well as utilities. The primary motivation for commercial businesses to invest in their own solar plants is to reduce energy costs, with excess capacity being sold to utilities through long-term contracts.[10] Utility development of PV capacity, though sometimes based solely on the price of solar versus alternatives,[11] is largely affected by the Renewable Energy Portfolio Standard (RPS) and Renewable Energy and Energy Efficiency Portfolio Standard (REPS) targets in the state. The addition of new projects by utilities may slow as utilities approach their RPS and REPS targets, and industry observers have already noted that investment has slowed in some states for this reason.[12]

Figure 1: 2013 Solar PV Global Capacity, by Country



Source: Ren21 *Global Status Report,* 2014 (Table R7 and Table 12)

The size of projects also has grown, with the United States leading the world in projects of 50MW or greater. By early 2014, more than 1,430 MW of U.S. capacity existed in these large projects.[13] As mentioned by REN21's 2014 Global Status Report, it is emblematic of the rapid changes in the PV market that large-scale projects worthy of note were 200kW in 2011, 20 MW in 2012, 30 MW in 2013, and 50 MW in 2014. The increased scale of solar PV projects appears to be an unimpeded industry trend.[14] The Solar Foundation's *National Solar Jobs Census 2014* found that the U.S. solar industry employed 173,807 U.S. workers as of November 2014.[15] In 2014, an estimated 4,307 employees in North Carolina worked in companies associated with the solar industry, and these companies had an estimated $1.6 billion in revenues.[16]

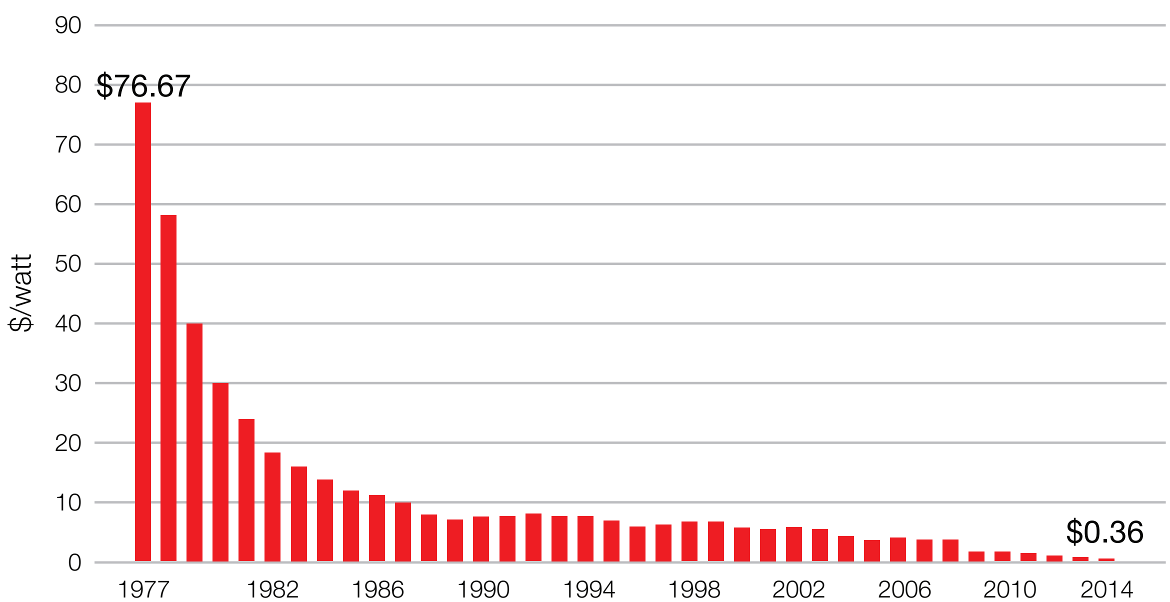
2.2 Market and Technology Trends

Manufacturing: Production costs for PV modules have declined significantly (see Figure 2). As of Q3 2014, polysilicon was $21.70/kg, wafers $0.22/W, cells $0.41/W, and modules $0.73/W.[17] Module cost reduction is largely due to lower material costs, especially for polysilicon, improved manufacturing processes and economies of scale.[18]

An estimated 43GW of crystalline silicon cells and 47GW of modules were produced globally in 2013, a 20% increase from 2012. Global production capacity of crystalline photovoltaics is estimated at 67.6 GW. Thin-film production has risen more than 20% since 2012 to 4.9 GW, but capacity and thin-film's share of global PV production has remained flat.

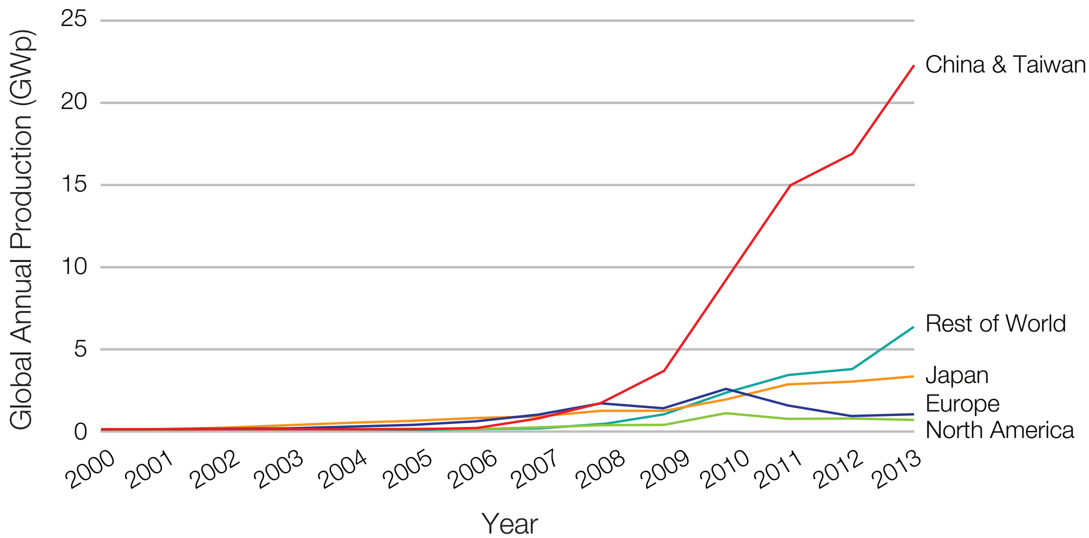
Since 2009 module production has been dominated by China, which accounts for 67% of global production (see Figure 3). Other Asian nations accounted for another 20% of production. CGGC interviews with solar companies noted an ongoing production shift away from China to other Southeast Asian countries as the industry seeks to further reduce production costs and overcome tariff barriers imposed on Chinese manufacturers by the United States. India, a promising manufacturer of solar PV, has idled most of its production due to lack of scale, the unavailability of low-cost financing, and anemic supply chains.[19] European production fell from 11% of global production in 2012 to 9% in 2013. The United

Figure 2: Price History of Silicon PV Cells, 1977-2014



Source: Bloomberg, *New Energy Finance*; pv.energytrend.com; Forbes.com

Figure 3: Global Annual PV Production, by Country, 2000-2013



Source: Fraunhofer ISE, *Global Photovoltaics Report*, 2014

States maintains 2.6% of global PV solar cell module production, of which 90% is crystalline silicon photovoltaics, 9% thin film, and 1% other, by value of shipments.[20] The U.S. industry comprises 122 companies employing 12,575 people. Ohio (thin-film), Tennessee (silicon) and California (silicon) are the leading U.S. states manufacturing PV modules. In 2012, North Carolina reported 94 peak kW in silicon PV module production, accounting for 0.01% of U.S. production.[21]

Solar inverters have rapidly developed to become one of the more sophisticated technologies supporting grid management.[22] The inverter is a crucial subsystem, converting DC to AC and holding the solar arrays close to their peak power point. ABB (Switzerland) acquired Power-One (U.S.) to become one of the world's largest manufacturers of solar power inverters. Competitive pressures have led to reduced prices for inverters as the focus for cost-cutting in the solar PV market.[23] In 2013, the average cost of inverters declined 15-18% from previous-year levels. Racking systems also declined 19-24% in 2013 due to increased competition among utility racking manufacturers.[24]

Imports and Exports: In 2012, the latest year for which data are available, U.S. imports of PV modules came primarily from China (35%) and Malaysia (33%). Imports from China largely consisted of silicon PV modules, accounting for 53% of silicon PV modules imported to the United States. Imports from Malaysia were primarily in thin-film PV modules, accounting for 88% of thin-film PV module imports. Mexico, the Philippines and South Korea each had more than a 5% share of imports, almost exclusively in silicon PV modules.[25] The sourcing of solar cells by North Carolina solar developers is significantly affected by price. Ongoing trade disputes between the United States and China (discussed in the policies section 4.2.4.1), have affected the purchasing decisions of North Carolina solar developers.

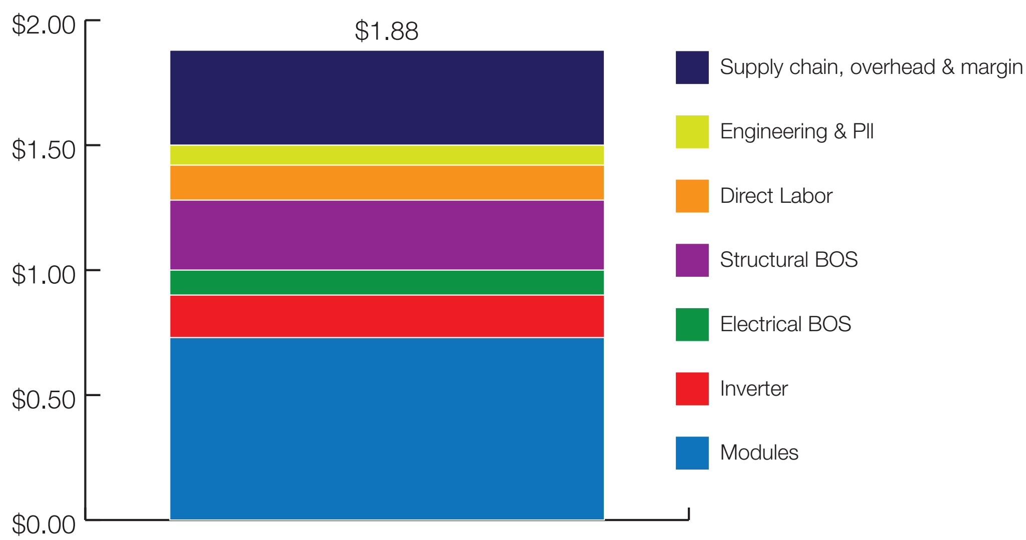
Exports of U.S.-manufactured PV modules in 2012 were directed to Japan (24.3%), India (18.5%), Germany (11.9%) and Italy (10.3%). The predominant type of export shipment was crystalline silicon modules, accounting for about 72% of total U.S. exports.[26]

Installation: Reductions in the costs of materials ("hard costs") and installation ("soft costs") reduced costs for utility-scale solar systems by 61% since the beginning of 2010.[27] Average installation costs for PV solar in Q3 2014 were $1.88/W, down from about $10/W in 2002. SEIA reports that installation costs during Q3 2014 were $1.88/W$_{dc}$ (Figure 4), with a range of $1.55/ W$_{dc}$ for new markets with lower component and EPC margins to $2.10/W$_{dc}$ for legacy power purchase agreements (PPAs) with higher component costs.[28]

Technology Changes: Solar cell efficiency continues to increase, with the National Renewable Energy Laboratory (NREL) recording significant new records in solar cell efficiency across a number of different solar cell technologies (see Figure 5). Crystalline silicon and thin-film technologies remain the two major cell technologies used in utility-scale solar projects. Other technologies, notably concentrated photovoltaics[29] (CPVs) and to a lesser degree perovskite cells,[30] offer significant potential for increased efficiency and reduced costs. Due to a number of ongoing technology changes, cell costs will likely continue to decline.

Mergers & Acquisitions: Market consolidation is a theme in PV solar, as large companies are purchasing smaller firms with promising technologies and building partnerships to expand into new markets. Examples include First Solar's acquisition of GE's cadmium telluride division and its announcement of a partnership with GE to further develop thin-film PVs.

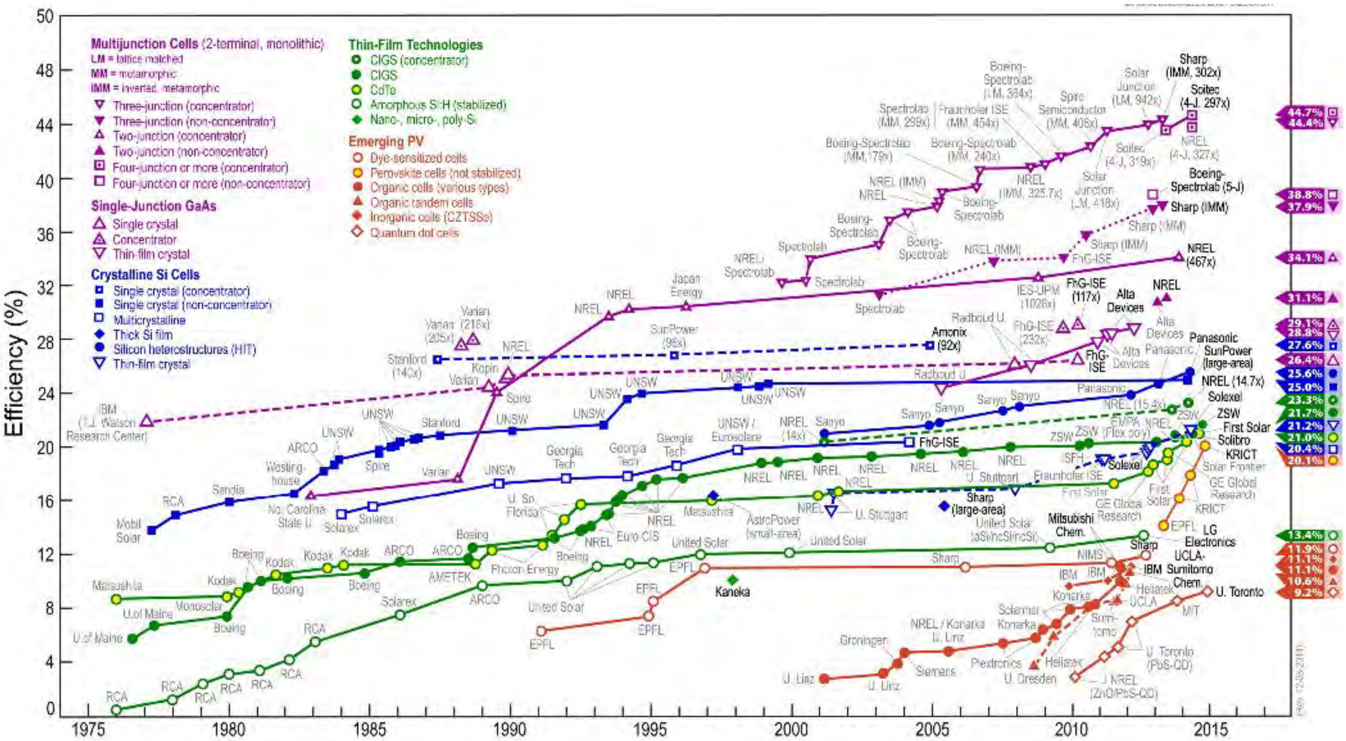
Figure 4: Utility PV System Pricing, Q3 2014, by Cost Category



Note: Assumes a 10MW horizontal fixed ground-mount system with standard crystalline silicon. BOS = balance of system.

Source: SEIA, 2014

Figure 5: Best Research-Cell Efficiencies, by Technology, 1975-2014



Source: U.S. National Renewable Energy Laboratory (NREL) 2014, "Best Research Cell Efficiencies"

Expansion across the value chain into project development, operations and development is also a theme in the industry. For example, panel manufacturer Kyocera (Japan) announced plans to develop solar farms for institutional clients in the United States, and Hanwha Q Cells USA began offering product and services across the PV value chain.[31]

Financing: Innovative financing models are emerging. Securitization, master limited partnerships, real estate investment trusts (REITs), yield companies (YieldCos) and crowd funding (whereby individuals make small investments via the Internet in specific projects) are existing or potential new entrants into the solar market. In 2013, NRG Energy developed a tradable, dividend-producing YieldCo that includes both utility-scale and rooftop solar projects.[32] In early 2014, Mosaic, an online company based in the United States, began financing more than $5 million of solar project investments through crowd funding.[33] Nine institutional projects in North Carolina are currently partially funded by Mosaic investors.[34]

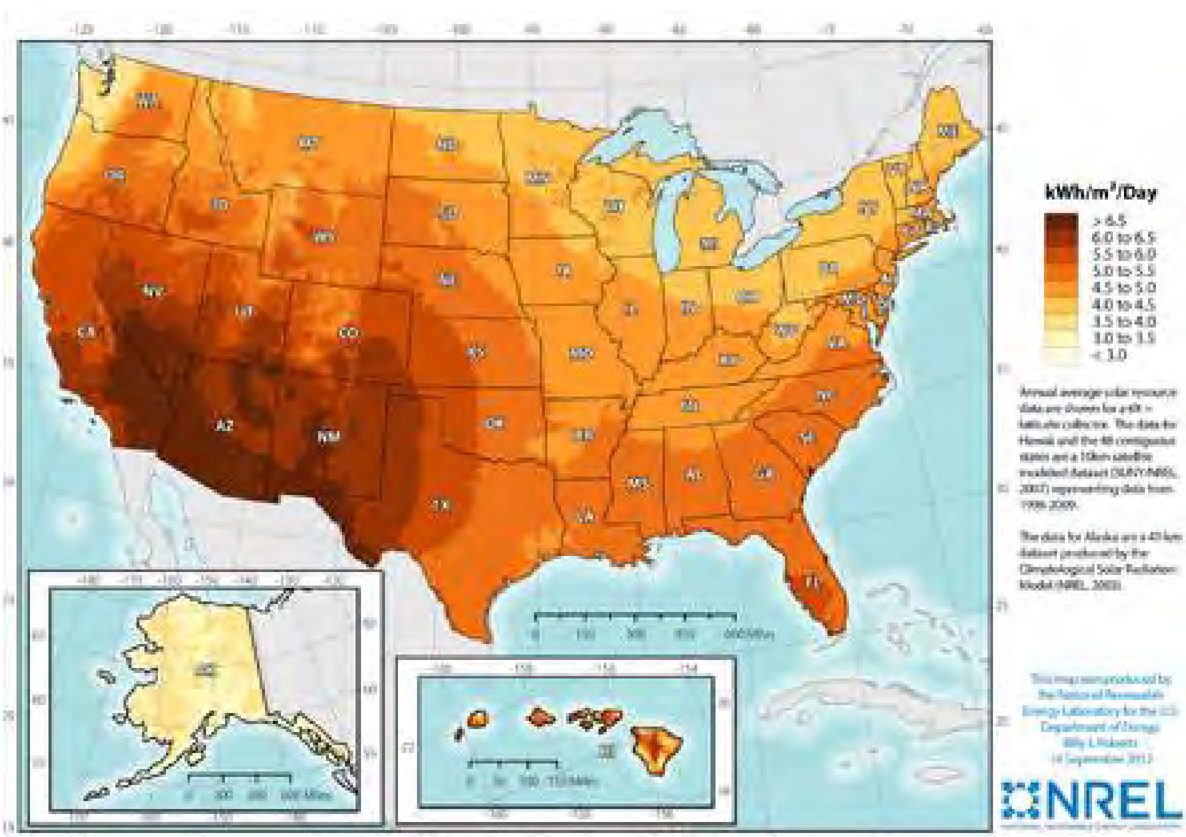
3. Utility-Scale Solar in North Carolina

3.1 Solar Photovoltaic Resources in North Carolina

North Carolina has significant PV solar resources – averaging 5-5.5 kWh/m^2/Day – compared to other U.S. states (Figure 6).[35] North Carolina has as much sun available for solar power generation than other states in the South, with the exception of portions in Florida.

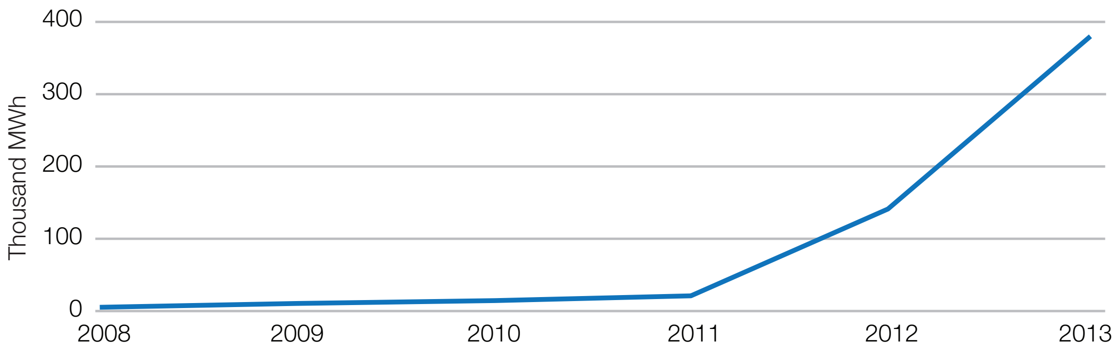
In 2013, the United States had approximately 12.1 GW of installed solar power generation and in that year added 4.8 GW of newly installed PV solar capacity, 2.8 GW at the utility scale.[36] According to the Interstate Renewable Energy Council (IREC), North Carolina had

Figure 6: Photovoltaic Solar Resources of the U.S.



Source: NREL

Figure 7: Net Solar Power Generation in North Carolina, 2008-2013



Source : EIA,2013 *Electricity Generation and Consumption* (EIA-906/920/923), table 1.6

Table 1: 2013 State Rankings of Solar Capacity and Solar Power Generation

Rank	State	Installed Solar Capacity (MW)
1	California	4,146
2	Arizona	1,250
3	New Jersey	948
4	North Carolina	375
5	Massachusetts	356
6	Nevada	339
7	Colorado	288
8	Hawaii	286
9	New Mexico	206
10	New York	193
11	Texas	173
12	Pennsylvania	144
13	Maryland	140
14	Florida	110
15	Georgia	88

Rank	State	Solar Power Generation (thousand MWh)
1	California	3,865
2	Arizona	2,041
3	Nevada	749
4	New Jersey	546
5	New Mexico	414
6	North Carolina	379
7	Florida	240
8	Colorado	199
9	Texas	176
10	Massachusetts	109
11	Pennsylvania	82
12	Maryland	80
13	Illinois	64
14	Ohio	64
15	Delaware	57

Note: Installed solar capacity is total grid-connected PV installations in MW at the end of calendar year 2013, as reported by IREC, "U.S. Solar Market Trends," July 2014. Reported DC converted to AC.

Source: Solar capacity, IREC, "U.S. Solar Market Trends 2013," 2014; power generation, EIA 2013, Electricity Generation and Consumption (EIA-906/920/923), Net Generation by State by Sector (table 1.6) approximately 375 MW of total grid-connected PV installations at the end of 2013.[37] It ranked fourth among U.S. states by installed capacity and sixth by power generation.[38] Our estimate of existing solar capacity in North Carolina, as of mid-December 2014, is 573 MW, suggesting the addition of roughly 200 MW of added capacity in 2014. We report in the next section details about existing and planned capacity in North Carolina.

3.2 Existing and Planned Solar Facilities in North Carolina

According to NCUC documents, the state had 150 operating solar facilities with 1 megawatt or more in nameplate capacity as of mid-December 2014. The facilities total 573 MW in nameplate capacity and $2 billion in total investment.[39] The facilities range from the many 1 MW plants throughout the state to the 12.4 MW Washington White Post Solar Farm in Beaufort County. The largest facilities operating in North Carolina are listed in Table 2.

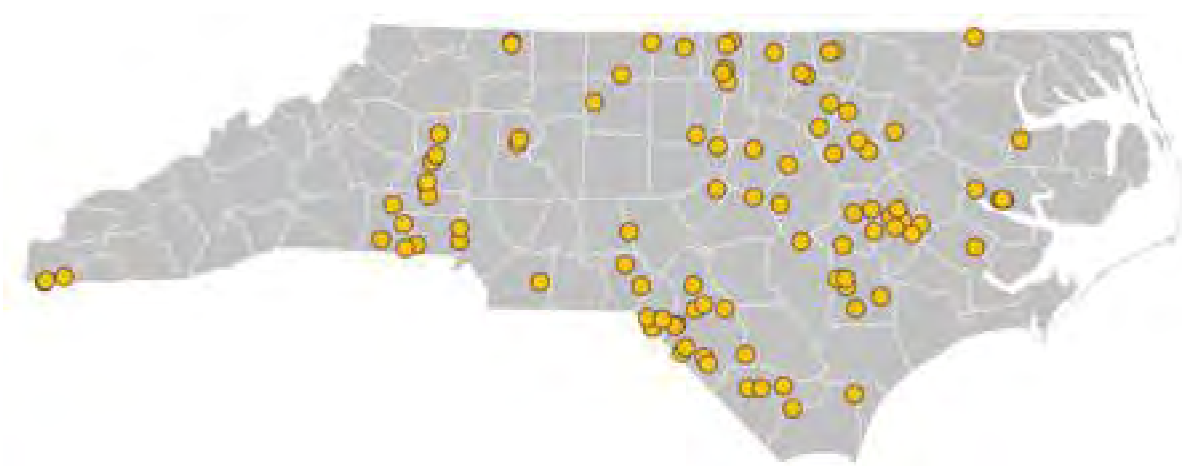
Table 2: Top Solar Facilities Operating in North Carolina, 2014

Facility	County	Capacity (MW)
Washington White Post Solar	Beaufort	12.40
Conover PV2 - DEL1	Catawba	9.73
Conover PV2 - DEL2	Catawba	9.73
Dixon Dairy Road	Cleveland	5.01

Source: Duke CGGC, based on NC-RETS

A number of utility-scale solar projects are proposed for the state. Currently, 377 facilities totaling 3,034 MW in nameplate capacity are in various stages of planning and development. It is uncertain how many of these projects will

Figure 8: Solar Facilities in North Carolina, 2014



Source : EIA, Electricity Generation and Consumption (EIA-906/920/923) be completed. The largest proposed plants are Innovative Solar's 80 MW facilities in Cumberland County and Anson County. Table 3 provides the largest proposed projects as of mid-December 2014.

3.2.1 Total Investment

The total investment in utility-scale solar projects across North Carolina is estimated at $2.0 billion.[40] The estimate includes all solar projects built from 2007 to mid-December 2014 and registered as operating with the North Carolina Renewable Energy Tracking System (NC-RETS). Table 4 lists the top-10 counties where solar investments have been made during that period. The full list is provided in Appendix C.

One of the remarkable aspects of the investment figures is the distribution across the Western, Central and Eastern regions and in both rural and urban areas of the state. Catawba, Robeson and Wayne counties, each rural, are the leading counties with utility-scale solar project investments. Western counties leading the list are Catawba and Cleveland. Central North Carolina counties hosting significant investments in solar power are Scotland, and Nash; Eastern counties are Robeson, Wayne, Beaufort, Duplin, Columbus, and Lenoir.

Table 3: Top Proposed Solar Plants, 2014

Facility	County	Capacity (MW)
Innovative Solar 46	Cumberland	80
Innovative Solar 37	Anson	80
Innovative Solar 42	Cumberland	75
Wiggins Mill Farm	Wilson	74

Note: Proposed plants are in various stages of planning and development. It is uncertain whether or when proposed plants will be completed or become operational.

Source: Duke CGGC, based on NCUC *Renewable Energy Facility Registrations*

Table 4: Solar investment by County, 2007-2014

County	Solar Investment ($)	Percent of NC Total Investment
Catawba	215,317,053	10.5%
Robeson	167,891,078	8.2%
Wayne	122,684,986	6.0%
Cleveland	99,437,456	4.9%
Beaufort	90,375,019	4.4%
Duplin	71,647,591	3.5%
Nash	69,741,783	3.4%
Columbus	66,344,689	3.2%
Scotland	60,311,599	2.9%
Lenoir	59,436,323	2.9%
Subtotal	**1,023,187,577**	**50.0%**
Other counties	1,021,322,217	50.0%
Total	**2,044,509,794**	**100.0%**

Source: Duke CGGC, based on NC-RETS

Solar Power on North Carolina's Military Bases

The U.S. military is moving to install and utilize renewable energy at domestic and international bases in an attempt to reduce expenditures on fuel and decrease reliance on foreign energy. In 2012, the military spent over $20 billion on energy and consumed 5 billion gallons of fuel. To address their mammoth energy needs, the Army, Navy and Air Force have announced planned installations of 3GW worth of renewable energy by 2025 (SEIA 2013). As of 2013, North Carolina bases have 3.51 MW of installed solar capacity. FLS Energy recently installed a large thermal solar facility at Camp Lejeune, a 246-square-mile Navy base located in Onslow County. The 2,000 panels installed on the base power nearly 75% of its hot water needs.

NC Solar Capacity, by Service Branch

Branch	Installed Capacity (MW)
Navy	2.780
Army	0.731
Air Force	0.002

Source: NC Sustainability Center. For additional information, see SEIA 2013 "Enlisting the Sun" and the National Resource Defense Council's Renewable Energy and Defense Database (READ-Database).

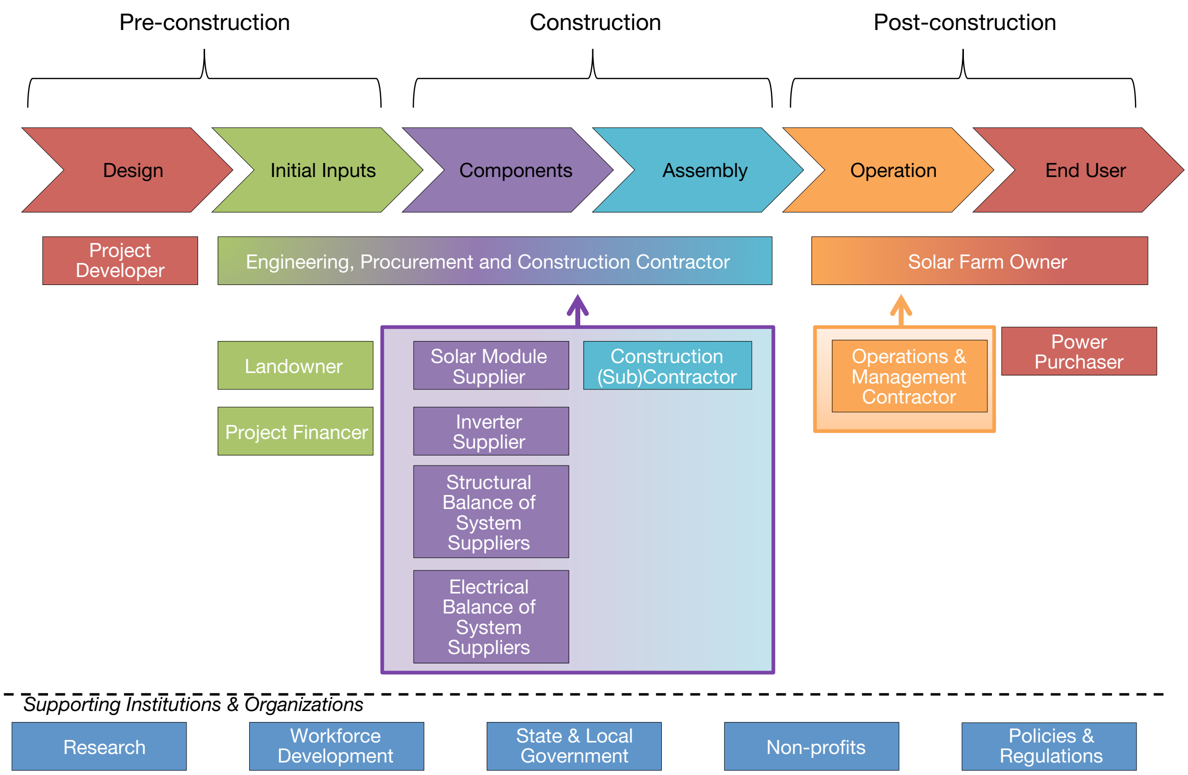
4. The Utility-Scale Solar PV Value Chain

4.1 Value Chain Overview

The utility-scale PV solar power value chain consists of key actors across pre-construction, construction, and post-construction phases. Figure 9 illustrates the utility-scale solar PV value chain.

North Carolina is home to over 450 companies that are involved in activities across the solar value chain and in supporting institutions such as research and advocacy. These companies support approximately 4,307 jobs across the utility-scale solar power value chain.[41] An overview of the actors in the value chain is provided in Table 5.

Figure 9: Utility-Scale Solar PV Value Chain



Source: Duke CGGC

Table 5: Value Chain Actors in the PV Solar Industry

Phase	Participant	Description
Pre-Construction	Project developer	The owner of the project when it is initiated. Usually responsible for initial design and permits.
	EPC contractor	The company primarily responsible for engineering, procurement and construction of the solar power plant.
	Landowner	The owner of the land on which the plant is located.
	Project finance	The financial partner providing any debt finance for the project (unless funded entirely through equity).
Construction	Construction (sub) contractor	The company responsible for plant construction. The construction firm may be the EPC contractor or a subcontractor of either the project developer or the EPC contractor.
	Component suppliers*	
	Solar module supplier	The manufacturer of the photovoltaic modules used in the power plant.
	Inverter supplier	The manufacturer of the power inverters used in the solar plant.
	Structural balance of system (BOS) suppliers	The manufacturers of the racking system, solar trackers and sensors (if installed) used in the plant.
	Electrical balance of system (BOS) suppliers	The manufacturers of cables, wires, switches, enclosures, fuses, meters and ground fault detectors used in the plant.
Post-Construction	Owner	The owner of the equity of the operating solar power plant. The owner is the beneficial recipient of the income generated by the solar power plant.
	O&M contractor	The organization primarily responsible for technical operation and maintenance (O&M) of the power plant after it is commissioned.
	Power purchaser	The utility, municipality or private commercial business purchasing the power output from the plant. Power interconnection agreements between the owner/project developer and the utility are a key bottleneck in the NC PV solar power value chain.
Supporting Organizations & Policies	Supporting organizations	The organizations facilitating information exchange, meetings and lobbying efforts on behalf of interested parties.
	Policies	The federal and state policies (e.g., tax credits, REPS, net metering rules) supporting the development of utility-scale solar.

* Component suppliers are selected by the EPC contractor, in consultation with the project developer.

Source: Compiled from various sources, including Rocky Mountain Institute (2010)[43] and WikiSolar[44]

Figure 10: Value Chain Actors Across Phases of Construction

Value Chain Actor	Pre-Construction	Construction	Post-Construction
Developer	✓	✓	
EPC Contractor	✓	✓	
Financing	✓	✓	✓
Component Suppliers		✓	✓
Owner			✓
O&M Contractor			✓
Power Purchaser	✓		✓

Source: Duke CGGC, based on company interviews

The value chain actors are active during different phases of the value chain. For example, project developers are primarily active during the pre-construction phase of the project, and they ensure that the design and permitting are in place for the EPC contractor to build the plant. The EPC contractor, in turn, is primarily active during the construction phase, and it ensures that the project is staffed with appropriate subcontractors and completed according to specifications. O&M contractors are active after the project is built, and they ensure the completion of the repair and maintenance required to operate the plant efficiently. Figure 10 illustrates the primary areas of activity for each value chain actor in the solar power value chain.

Many value chain actors have responsibilities across the project phases. For example, while the EPC contractor has the lead role during the construction phase, it also has an important role in the pre-construction phase in developing the site engineering and selecting subcontractors. Financing the project is not only a concern during the initial development phase but throughout the project as well, as financing partners cycle in and out and different types of financing are required (construction vs. equity investment). Similarly, the utility is primarily active in the post-construction phase as the power purchaser; however, the utility has an important role in the pre-construction negotiations with the project developer regarding interconnection and power purchasing agreements for the proposed plants. The timely processing of interconnection agreements was identified in our interviews as an important bottleneck in the further development of utility-scale solar power in North Carolina.

Having described the major phases and segments in the utility-scale solar PV value chain, we will now describe in more detail each segment and the actors active in North Carolina within each phase.

The Value Chain of a Project: The Ararat Rock Farm

The 4.4 MW Ararat Rock Solar Farm in Mount Airy spans across 25 acres of Surry County. Located next to the Ararat Rock Products quarry, the site generates approximately 6,288 MWh per year of electricity. The electricity is used at the quarry, with excess power sold to Duke Energy to place on the grid.

The developer and owner of the site is O2 Energies. National Renewable Energy Corporation (NARENCO), a Charlotte-based engineering, procurement and construction contractor (EPC), completed construction of the solar farm. The Ararat farm was built with more than 18,000 modules, purchased from REC Solar, that are manufactured with U.S.-produced silicon. In addition, Advanced Energy (AE), manufacturing in Colorado, supplied the inverters. Surrey Bank & Trust, a local financial institution, provided debt financing and insurance, making it one of the first local banks to participate in financing a large solar farm in its own community. O2 Energies worked with Surry Community College to provide workforce training for contractors, and NARENCO utilized local labor and vendors during the 16 weeks of construction. Sheep maintain the grass inside the fenced area and farmers work the land around the perimeter of the solar farm.

Source: NARENCO

4.2 Value Chain Segments and Actors

4.2.1 Pre-Construction Phase

The initial inputs necessary for utility-scale solar farms are land, permits and finance. The key actors securing these inputs in the pre-construction phase are the project developer, the finance partner and the EPC contractor.

4.2.1.1 Project Developer

The project developer, the owner of the project when it is initiated, is usually responsible for initial design and permits. The developer may or may not be the same entity as the EPC contractor, depending on whether it is a turnkey provider of utility-scale solar projects ("developer self-perform"). Table 6 lists the project developers in North Carolina with more than 5 MW of total capacity operating as of mid-December 2014.

4.2.1.2 EPC Contractor

The EPC contractor is the company primarily responsible for engineering, procurement and construction of the solar power plant. As mentioned above, the EPC contractor may also be the project developer, depending on whether the company is a turnkey provider of services. The largest EPC contractors active in North Carolina in the utility-scale solar sector are listed in Table 7.

Table 6: Top Project Developers Active in North Carolina, by Installed Capacity

Developer	Total MW	Headquarters	Employees	2013 Revenue ($M)
Strata Solar	271	Chapel Hill, NC	80	97.6
O2 Energies	32	Cornelius, NC	10	NA
Community Energy Inc. (CEI) (2)	28	Radnor, PA	40	4.6
SunPower Corporation	26	San Jose, CA	6,320	2507.2
Nationwide Renewable Energies Co (Narenco)	25	Charlotte, NC	15	NA
HelioSage	20	Charlottesville, VA	8	1.5
Apple, Inc.	19	Cupertino, CA	92,600	182,795
Sunlight Partners (2)	17	Mesa, AZ	2	.2
FLS Energy	11	Asheville, NC	150	150
Fresh Air Energy (Ecoplexus)	15	San Francisco, CA	4	5.4
SunEnergy1	14	Mooresville, NC	6	1.1
Duke Energy Renewables*	12	Charlotte, NC	27,948	24,598
Sustainable Energy Solutions	10	Northborough, MA	4	0.9
Argand Energy	9	Charlotte, NC	11	2.3
Carolina Solar Energy	5	Durham, NC	5	1.3

Note: Total MW based on NC-RETS.

*Data for Duke Energy Renewables and Duke Energy Carolina are for Duke Energy. *Duke Energy reports to the author that its operating installed capacity is 45 MW (see link).[45] The discrepancy is likely a reporting lag in the underlying source (NC-RETS). NA = not available.

Source: Duke CGGC; employees and revenue from OneSource, unless (2) Mergent Intellect

Table 7: Top EPC Contractors Active in North Carolina

Developer	Headquarters	Employees	2013 Revenue ($M)
Baker Renewable Energy	Raleigh, NC	15	NA
Carolina Solar Energy	Durham, NC	5	1.3
Entropy/Argand Energy	Charlotte, NC	11	2.3
ESA Renewables	Lake Mary, FL	9	NA
First Solar	Tempe, AZ	4,850	3,309.0
FLS Energy	Asheville, NC	78	39.1
Gerlicher-M&W	Springfield, NJ	20	3.0
Green State Power	Greensboro, NC	5	0.9
Innovative Solar	Fletcher, NC	3	0.6
National Renewable Energy Corporation (NARENCO)	Charlotte, NC	15	NA
O2 Energies	Cornelius, NC	4	0.3
PowerSecure/Southern Energy Management	Morrisville, NC	100	19.7
Strata Solar	Chapel Hill, NC	80	97.6
SunEdison	St. Peters, MO	300	25.2
SunEnergy1	Mooresville, NC	6	1.1

Note: NA = not available.

Source: CGGC; sales and employment from OneSource

4.2.1.3 Landowner

The landowner is the owner of the land on which the plant is located. Land selection criteria include access to a utility substation for interconnection, the price of the land, insolation, and general suitability for constructing a solar farm such as levelness of the land and soil quality. Land is normally leased to solar developers for periods of 20-30 years, but in some cases the owner of the solar farm will also own the land. Once a site is selected, permits are required from the local government for land use dedicated to solar farms.

4.2.1.4 Project Finance

Project finance refers to the financial partner providing debt or equity to complete a project. Financing is a crucial input for utility-scale solar projects. In this section, we review the major finance structures, sources of investment, and actors in North Carolina providing project finance for utility-scale solar.

4.2.1.4.1 Finance Structures

The finance structures for solar projects are based on the projected cash flow and other financial benefits (tax credits and depreciation) of the project. Utility-scale solar finance structures are typically of three types: (1) single owner (also known as "balance sheet finance"); (2) partnership flip (all-equity and leveraged types); and (3) leases (sale-leaseback and inverted lease). Different types of financing structures are not unheard of, as the selection of the structure can depend on many factors, including general investment conditions, the cost of capital, and the risk appetite of the developer and investor. Here we summarize the most common structures.[45]

Single-Owner Finance

Single-owner (balance sheet) finance occurs when the developer of the project invests directly into the project using its balance sheet, instead of relying project finance. Both utilities and private developers might use balance sheet finance.

Utility-owned solar projects allow the utility to diversify its electric power generation portfolio, to meet its renewable energy portfolio targets, and to exercise a high level of control over project siting and position in the electric grid. In addition, directly investing in solar projects has become more financially attractive due to the ability of utilities to access (until 2016) the 30% investment tax credit available through the Emergency Economic Stabilization Act in 2008.[46] Utilities can invest in a solar project through *direct finance, developer subsidiaries/ affiliates, ratepayer funding, shareholder funding, or utility prepay.*

- *Direct finance* occurs when the investor-owned utility (IOU) finances, owns and operates the solar plant. Utilities are particularly well positioned to access the capital needed to build solar projects because they are considered stable, creditworthy entities, and as a result they can attract capital at favorable interest rates even during tight credit markets. An example of direct finance is New Jersey's Public Service Electric and Gas Company (PSE&G), which in July 2009 received permission to use $515 million to install, own and operate 80MW of solar. The "Solar4All" program is anticipated to double the amount of solar in New Jersey.

- *Developer subsidiaries* are a second way utilities can invest in solar projects. Several major utilities, such as Duke Energy, San Diego Gas & Electric and NextEra, use development arms active in the market to install solar and renewable energy projects. For example, Duke Energy Generation Services, the unregulated developer subsidiary of Duke Energy, financed a 14.4 MW facility in Texas using balance sheet capital.[47]

- *Ratepayer funds* also can be used to support investment. For example, PG&E and SoCal Edison participate in California's Solar Power Initiative, in which solar power investments are recovered through the utility's base rate

Common Financial Structures in Utility-Scale Solar

Three finance structures are common in utility-scale solar: (1) single owner or "balance sheet finance" (2) partnership flips and (3) leases.

Single-owner (balance sheet) finance occurs when the developer invests directly into the project using its own funds, instead of relying on project finance. Advantages of balance sheet finance include access to 100% of the tax credits and the simplicity of outright ownership.

The **partnership flip** is designed to provide a fixed rate of return to the investor for a negotiated number of years, after which the cash flow and tax benefits revert (or flip) to the project developer. Partnership flips are a well understood financial structure in renewable energy. The tax equity investor realizes a reasonable return, and the developer accesses project financing at a reasonable cost.

Leases commonly used in the U.S. solar industry are the sale-leaseback and the inverted lease. In the sale-leaseback, the developer sells a completed system to a tax equity investor, who leases the system back to the developer while arranging a power purchase agreement with the power purchaser. In the inverted lease, the developer and tax equity investor fund a "master tenant" with a 1% investment by the developer and a 99% investment by the investor, in return for tax credits at the invested amount.

Details about the key advantages and disadvantages of each financial structure are discussed in the main body of the report.

and allowed to earn the company's weighted cost of capital.[48]

- *Shareholder funds* can be used to invest in private developers. For example, subsidiaries of PG&E invested tax equity in SolarCity and SunRun, enabling those companies to develop residential and commercial solar. The funds invested were shareholder funds that modified the dividends paid to shareholders but were not recoverable by ratepayers or incorporated into the rates charged by the utilities.[49]
- *Utility prepay (hybrid financing)* has been used by municipally owned utilities to take advantage of their low cost of capital and to receive the federal investment tax credit. In this structure, the utility will prepay for the energy delivered by a project under contract; the developer receives a lump sum payment, which it can use for a variety of purposes including construction financing. To finance the project, utilities can float bonds on their balance sheet. Although utility prepay is not currently used outside of municipal utilities, NREL considers it to be beneficial for solar projects, since the structure takes advantage of the low cost of debt for utilities and the federal tax credits associated with private project ownership.[50]

Private developer solar projects can be used to recapitalize the developer's balance sheet by selling an equity or debt position in projects, thus allowing the developer to commission more projects. The specific forms of partnership flips and leases discussed below are project financing mechanisms used by private project developers to increase the number and scale of projects beyond what they could afford using their balance sheet alone.

Partnership Flips

Partnership flips occur when a project developer partners with a tax equity investor to maximize the project's tax benefits.[51] Tax equity investors are investors who can use the tax benefits made available by state and federal investment tax credits (ITC) and accelerated depreciation schedules. The partnership flip financial structure is designed to provide a fixed rate of return for a negotiated number of years (typically 7-9%

after-tax internal rate of return (IRR) for 6-9 years), after which the cash flow and tax benefits revert (or "flip") to the project developer. The partnership agreement negotiated between the tax equity investor and the developer defines the terms of the initial investment by equity partners and the pre- and post-flip distribution of cash and tax benefits. The partnership has to be in place before the plant is placed into service.

Various forms of partnership flips exist, including the yield-based flip (based on the achievement of defined asset performance), the fixed flip (based on a fixed term regardless of performance), and the debt-based flip (in which the tax equity investor borrows part of the investment from a third party). The partnership flip is a well-understood financial structure in renewable energy markets, as it has been used for many years in wind energy. Advantages are that the tax equity investor realizes a reasonable return and the developer accesses project financing at a reasonable cost; project risk is reduced, as underperformance of the asset typically results only in a delay of the flip. Disadvantages are that the developer has to invest some of its own capital, which it may not have or want to use; less than 100% of the tax benefits are transferred to the equity investor, which may not be efficient if the developer is unable to participate in the ITC or accelerated depreciation; and tax benefits are based on the developer's cost, which may be less than the fair market value of the asset, thus reducing the benefits to both the tax equity investor and the developer.

Leases

Two types of leases are commonly used in the U.S. solar industry: the sale-leaseback and the inverted lease. In the *sale-leaseback,* the developer sells a completed system to a tax equity investor. At the same time, the tax equity investor leases the system back to the developer, who then arranges a power purchase agreement with the power purchaser. The PPA, in turn, is the primary revenue stream used to pay the lease payments to the tax equity investor. The advantages of the sale-leaseback are that it is a very simple financial structure; the tax equity investor receives 100% of the tax benefits; no financing capital is required from the developer; the financial structure can be put in place up to 90 days after the assets are in service; and the cost basis for tax benefits is the agreed price between the developer and the investor, which may be higher than the developer's cost. The disadvantages of the sale leaseback are that the cost of capital from tax equity investors may be higher than what the developer would incur using its own capital, even in part, to finance a project; the developer must make fixed rent payments, and these may be difficult to meet if the asset underperforms; and, if the developer wants to own the asset in the long term, it has to buy it back at the fair market value at the end of the lease, which must be 20% of the initial value.

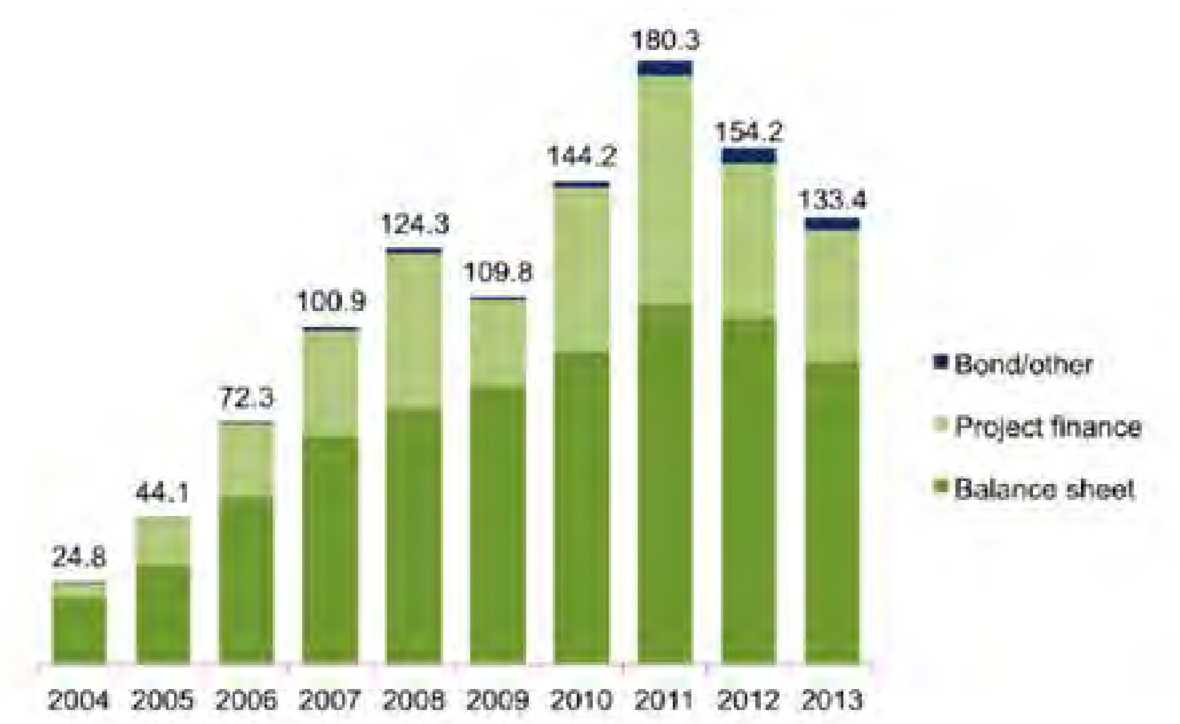
In the *inverted lease*, also known as a lease pass-through or master-tenant lease, the developer and tax equity investor fund a "master tenant" with a 1% investment by the developer and a 99% investment by the investor. In return, the developer receives 1% of the tax credit and the investor receives 99% of the tax credit. In addition, the developer and master tenant (99% owned by the investor) create an "owner/ lessor" - of which 51% is typically owned by the developer- to own and lease the system to the master tenant. This arrangement allows the developer and tax equity investor to claim depreciation benefits in proportion to their ownership. The master tenant sub-leases the asset to the power purchaser, who makes lease payments to the master tenant. The master tenant makes lease payments to the owner/ lessor. After the lease is completed, typically after 6-15 years, the developer takes back the project without any additional costs. The advantages of the inverted lease are that it allows an easy exit for the investor after the lease is completed; the tax credit is based on fair market value (appraised value) rather than the developer's cost, an arrangement that is good for the investor if the developer's cost is below industry averages; and depreciation is split from the tax credit, allowing the developer and investor to maximize benefits from these two tax streams. Disadvantages are that the investor/lessee has to make fixed payments to the developer/lessor regardless of the performance of the asset, and the Internal Revenue Service gives heightened scrutiny to inverted leases because the structure is susceptible to inflated fair market valuations.

4.2.1.4.2 Sources of Investment

Utility-scale solar projects are financed by a variety of actors. Globally, the largest proportion of asset financing of new investments in renewable energy comes from the balance sheet of the company (the shares were 81% in 2004 and 60% in 2011).[52] Project financing makes up most of the remaining 19-40% (see Figure 11).

Finance partners for utility-scale solar in the United States have typically been tax equity investors, equity investors and debt providers (see Table 8 for a summary). *Tax equity investors* are commercial banks, institutional investors, utilities and large corporations that can use the investment tax credit to offset tax liabilities.[53] At the national level, commercial banks active in utility-scale solar project financing are Bank of America, Citibank and Credit Suisse for large projects, and US Bancorp/US Bank, Wells Fargo and Union Bank for midsize projects.[54] Goldman Sachs, Morgan Stanley, JPMorgan and Bank of America's Merrill Lynch are investment banks active in utility-scale solar projects. Institutional investors active in utility-scale solar

Figure 11: Assets Financing New Investment in Renewable Energy ($B), 2004-2013



Source: Bloomberg, *New Energy Finance*, 2013 are MetLife Private Capital Investors, CalPERS (the California state employees' pension plan), and Potomac Energy Fund (a private equity fund that manages pension fund investments of trade unions such as the International Brotherhood of Electrical Workers. Utilities include the development arms of large utilities, including Duke Energy, San Diego Gas & Electric, NextEra and Washington Gas Holdings. Google is the most active corporate actor in utility-scale finance. Appendix B provides additional information on renewable energy investors active in the United States.

Equity investors are hedge funds and other institutional actors that have a stake in the company developing projects. York Capital Management and New Energy Capital are companies owning part or all of major developers in North Carolina.[55] U.S.-based venture capital and private equity (VC/PE) have generally reduced their investments in solar. In 2013 VC/PE investments declined 62% from the previous year.[56] VantagePoint Capital Partners abandoned fundraising in 2013 for a $1.25 billion clean technology fund it had launched in 2010 due to lack of interest. Others have reduced their exposure, including Kleiner Perkins Caufield & Byers, Draper Fisher Jurvetson, Mohr Davidow, NEA and Silver Lake. Interestingly, the CalPERS clean energy fund created in 2007, an early leader in this space, reduced its investments because of 10% losses over consecutive years.[57] Our interviews with utility-scale solar power developers in North Carolina indicate that VC/PE generally is not a good match for utility-scale PV solar due to the high returns on investment expected by these finance partners, typically in the double digits per year rather than the 7-9% IRR of a typical utility-scale solar project.[58]

Lenders provide construction financing and/or permanent debt for projects. Commercial banks in North Carolina that have provided funding for utility-scale solar are Wells Fargo, Fifth Third Bank and NC Bank. In addition, Seminole Financial Services and MP2 Capital have provided construction financing for projects in North Carolina. Community banks and credit unions in North Carolina have not had a big presence in utility-scale solar, largely because the capital investment required generally is too large for smaller banks. An exception is Surry Bank & Trust, which helped develop the Ararat Solar Farm in Mt. Airy, North Carolina (see *The Value Chain of a Project: The Ararat Rock Farm*, page 18).

Table 8: Investor Categories and Representative Companies Investing in Utility-Scale Solar

Investor Categories	Sample Companies
Commercial Banks	Bank of America
	Citibank
	Credit Suisse
	U.S. Bancorp
	Wells Fargo
Investment Banks	Goldman Sachs
	JPMorgan
	Merrill Lynch (BofA)
	Morgan Stanley
Institutional investors	MetLife
	CalPERS
	MP2 Capital
	Potomac Energy
Utilities	Duke
	SDG&E
	NextEra
	Washington Gas
Corporations	Google
Venture Capital/Private Equity	HighStar Capital
REITs	Hannon Armstrong Sustainable Infrastructure Capital
YieldCos	NRG Yield
	SunEdison
Crowdfunding	Mosaic

Source: Duke CGGC, based on Lutton 2013.

New investment entities and funding models are entering the utility-scale solar market. Securitizations, master limited partnerships (MLPs), real estate investment trusts (REITs), yield companies (YieldCos) and crowd funding are existing or potential new entrants into the solar market. For example, SolarCity, a rooftop solar developer, has created securitization through solar asset-backed securities; it raised about$ 55 million in bonds in late 2013 with plans for $200 million more, depending on the response in the market.[59] The asset-backed securities are funded from purchase power agreements and solar leases from existing customers. This model, although currently only used by SolarCity, could be adopted by utility-scale solar developers and owners for project financing. However, given the sunset of the 30% federal investment tax credit in 2016 and issues with mortgage securitizations arising out of the subprime lending crises, securitization is not as likely to be a dominant funding model. Other forms of funding could provide greater impact. MLPs have great potential to raise money for the solar industry. Although currently only available to the oil and gas industry, which has used MLPs to raise $84 billion for shale gas investments at an average cost of capital between 5.5% to 6%, the financing structure could be used to attract financing for renewables in general and utility-scale solar in particular, with legal modifications. The MLP legal modifications that would be required to allow parity among energy sources would have to overcome objections from the Treasury, which perceives MLPs as a tax shelter. But advocates say that if MLPs are allowed to exist, they should be available to all fuel sources.[60]

REITs have entered the market for renewables. REITs help developers convert assets into cash, and they create a liquid secondary market for renewable power projects that offer tax advantages. Hannon Armstrong Sustainable Infrastructure Capital invested $35 million in MidAmerican's Solar Project as part of its distributed energy generation portfolio, planned at $2 billion and yielding about 7% to its investors. While Hannon Armstrong was successful in converting itself from a renewable energy financing company into a REIT in April 2013, the regulatory status of REITs entering the renewable industry remains uncertain. The IRS has not made an administrative ruling to allow inclusion of renewable power assets in REITs, and congressional approval may be required.[61]

Yield companies (YieldCos) are an innovative financing vehicle that passes on a high share of earnings to shareholders. YieldCos enable developers to shift renewable power generation to a pure-play dividend-oriented company and provide stable, long-term cash flows.[62] In 2013, NRG Energy developed a tradable, dividend-producing security (NRG Yield) that includes both utility-scale and rooftop solar projects.[63] NRG Yield, with 1.3GW of rated generation (including solar and wind), became the first pure-play power YieldCo to execute an initial public offering on a U.S. exchange; it raised $431 million in July 2013. SunEdison raised over $530 million in the initial public offering of its yieldco TerraForm Power in late July 2014.[64]

Crowdfunding allows small companies and startups to raise capital from many small investors in return for an equity stake, structured payments and/or products. In early 2014, Mosaic, an online company based in the United States, began financing more than $5 million of solar projects by allowing individuals to make small investments in specific projects.[65] Mosaic provides yields of 5.5-7%, and has raised $5.6 million for solar projects since it opened its online platform in January 2013.[66] Nine institutional projects in North Carolina are currently partially funded by Mosaic investors.[67]

4.2.1.4.3 North Carolina Investors

The North Carolina Department of Revenue (NCDOR) compiles annual lists of state incentive recipients by amount of spending and amount of credits taken. Table 9 lists the major tax entities (company and individual) receiving credits under Article 3B, Business and Energy Credits for Investing in Renewable Energy Property. Since the majority of renewable energy investment in North Carolina is solar related, the lists provide detailed insights into the most important investors for solar energy in the state. A recently completed economic impact assessment by RTI estimates that $1.93 has been returned to state and local governments for each dollar spent on the Renewable Energy Investment Tax Credit.[68]

4.2.2 Construction Phase

The components required for utility-scale solar farms are solar modules, inverters, and structural and electrical balance-of-system (BOS) components. Specialized construction firms, EPC contractors or turnkey developers may provide the installation of the solar farms. We provide an overview of the key components and companies supplying and installing components to North Carolina utility-scale solar farms in this section. Section 4.2.2.1 discusses component suppliers, and Section 4.2.2.2 discusses construction contractors and installers.

4.2.2.1 Component Suppliers

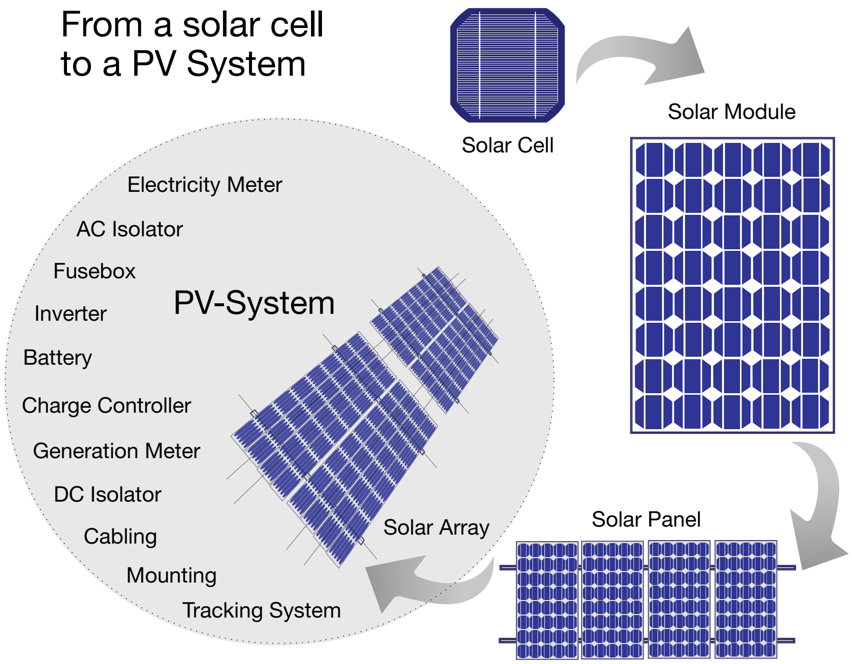
Solar Modules: The principal component necessary for solar farms are PV cells. These cells are grouped together into modules and panels, which are installed into the farm (see Figure 12).

Table 9: NC Renewable Energy Tax-Related Spending (<$10M) and Credits Taken, 2010-2013

Name	Spending	Credits Taken
Blue Cross and Blue Shield of NC	150,812,092	12,696,204
Metropolitan Life Insurance Co.	51,354,048	11,890,110
Bank of America Corp. and subs	43,379,764	7,969,794
Northwestern Mutual Life Ins. Co.	32,869,477	2,428,563
Wilhelm, Markus F. (Strata)	31,887,707	2,207,565
Tucker, Robert B.	27,339,369	1,880,220
United Services Automobile Association	26,909,244	4,895,039
BB&T Corporation	26,230,345	4,405,172
Habul, Kenny C. (SunEnergy1)	23,180,524	1,394,672
US Bank National Association	16,025,696	961,158
Duke Energy Corporation	15,242,000	2,491,129
Nationwide Mutual Fire Insurance Co.	15,226,287	1,065,839
FLS Solar	12,961,060	1,425,278
Waste Industries USA Inc.	12,021,185	105,586
Genworth Life Insurance Co.	10,565,186	780,609
Watts, Claudius E.	10,333,560	260,855
Others	*139,204,580*	*15,890,768*
Total	**645,542,124**	**72,748,561**

Source: NC Department of Revenue

Figure 12: A Solar PV System



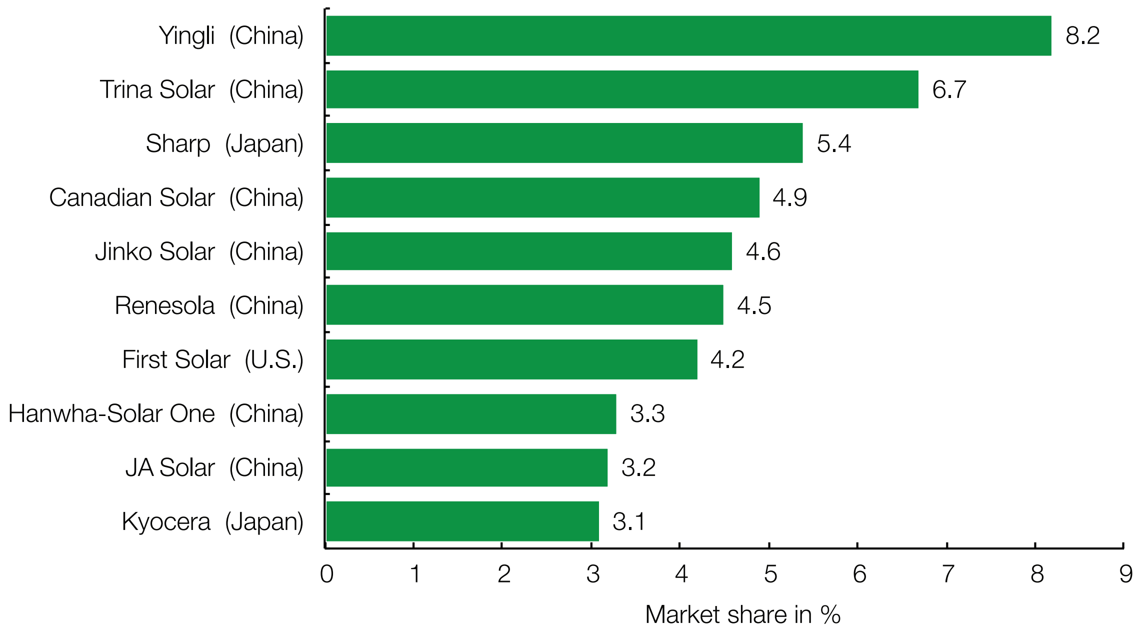
Source: Wikipedia Commons

The average number of panels and the capacity of utility-grade solar farms vary by location with the amount of sunlight, amount of electricity consumption, and temperature/climate all impacting the amount of PV panels needed. On average, each megawatt of solar energy in North Carolina is capable of powering 95 homes.

PV panels, mounted on racks made of steel or aluminum, are connected via copper wires into an inverter that converts the energy generated from DC into the AC energy required for the grid. The mounts are sourced from a variety of locations, with some firms, such as German-owned Schletter or Daetwyler Clean Energy, a subsidiary of Swiss-based Däetwyler, having manufacturing facilities in North Carolina. The AC electricity then flows to a transformer. Solar power generally produces electricity at tens to hundreds of thousands of volts, while solar inverters normally have an output of a few hundred volts. To prevent issues, currents pass through the transformer before being incorporated into the main electricity grid. A meter helps to track the amount of electricity transferred.

In some cases, utility-scale solar farms are used for large commercial purposes, such as shopping centers, factories or hospitals. The Apple Solar Farm near Maiden, N.C. is an example of such a plant. These plants may install batteries to store unused energy during peak times, and they may also incorporate bi-directional meters that credit an establishment when it transfers electricity to the main grid and records energy use during times the establishment draws from the grid.

Figure 13: Major PV Solar Cell Manufacturers & Market Share



Source: Bloomberg, *New Energy Finance,* April 2014

Major solar PV module manufacturers (see Figure 13) are Yingli (China), Trina Solar (China), Canadian Solar (Canada), Jinko Solar (China), RenaSolar (China), Sharp Solar (Japan), First Solar (U.S.), Hanwha SolarOne (China), Kyocera (Japan) and JA Solar (China).

Major Inverter Suppliers: The inverter is a crucial subsystem, not just for converting DC to AC but also for "power tracking" to hold the solar arrays close to their peak power point. Inverter suppliers are national companies with national markets. The major national inverter suppliers are listed in Table 10.

Racking Systems: Racking systems are sourced from a variety of providers like USAracking, UniRac, Schletter, RBISolar and SunLink. Schletter has manufacturing facilities in North Carolina.[69]

Table 10: Major Inverter Suppliers

Rank	Name	# of Projects	Total MW
1	SMA	26	648
2	Power-One	15	373
3	SunGrow	21	359
4	Schneider Electric	11	286
5	Emerson	10	212

*Number of projects and MW reported as of 2013

Source: SolarWiki

Developers and EPCs tend to have preferred vendors with whom they conduct business over time and across multiple projects (representative North Carolina component suppliers are listed in Table 11). The company-level supply chains for developers and EPCs appear to be an open secret in the industry. For example, Strata uses SMA for

Table 11: Representative NC Component Suppliers for PV Systems

Company	Component	Headquarters (U.S.)	Employees	2013 Revenue ($M)
ABB Inc.	Inverter	Raleigh, NC	11,250	3,800
Advanced Digital Cable Inc.	Cables	Hayesville, NC	60	73.9
Armacell LLC	Foam	Mebane, NC	300	15.7
Camstar Systems Inc.	Software	Charlotte, NC	15	100
Daetwyler Clean Energy	PV modules and racks	Huntersville, NC	NA	NA
DuPont Photovoltaic	PV panels	Fayetteville, NC	150	324.6
Hawe Hydraulics	Hydraulic tracking	Charlotte, NC	NA	NA
InnoLas Inc.	Semiconductors	Pittsboro, NC	NA	NA
Jetion Solar (US)	PV modules	Charlotte, NC	5	6.1
Muratec	Semiconductors	Charlotte, NC	110	190
Pilkington North America	Glass PV coating	Toledo, Ohio	400	159
Sapa Extrusions	Mounting systems	Burlington, NC	100	39.2
SBM Solar LLC	Panels	Concord, NC	6	1.9
Schletter Inc.	PV racks	Shelby, NC	150	4.9
Semprius Inc.	PV modules	Durham, NC	20	0.8
Smarttech International LP	Replacement parts	Charlotte, NC	NA	NA
Technical Coating Int'l	Coating	Leland, NC	30	4
Torpedo Specialty Wire Inc.	Wire	Rocky Mount, NC	126	142.8
Wieland Electric Inc.	Cables	Bungalow, NC	NA	NA

Source: Duke CGGC; employees and sales from OneSource

inverters and Schletter and FirstSolar for racking. FLS uses Schletter and SBI for racking and the Horne Brothers for construction. Entropy uses Solectria for inverters, RBI for racking and Canadian Solar for panels. Gerlicher uses Horne Construction and SunSolar for construction, SMA and AdvancedEnergy for inverters, and RBI and Schletter for racking. The panel market is less relational and more price sensitive. Panels used in North Carolina utility-scale solar are manufactured by Yingli, Catrina, Ginko and Canadian Solar, among others. Ongoing tariff disputes between the United States and China affect the selection by solar developers and EPCs of cell technology and manufacturers.

4.2.2.2 Construction Contractors/Installers

The installation of utility-scale solar farms is completed by either the developer (known as "developer self-perform" (DSP)) or a construction contractor, who may either be an EPC or a subcontractor of either the developer or the EPC. DSPs active in North Carolina are Strata Solar, FLS, Entropy and SunEnergy 1. Many construction contractors keep specialized project managers as salaried personnel, while construction workers are hired by the firm or by a temporary personnel agency on an as-needed basis. As a result, full-time-equivalent construction positions are difficult to accurately estimate for the state. As a general

Table 12: Major Construction Contractors Active in North Carolina's Utility-Scale Solar Power Value Chain

Company	Headquarters (US)	Employees	2013 Revenue ($M)
Advance Construction Enterprises (1)	Advance, NC	3	0.23
Bonville Construction DBA Sandhills Energy (2)	Pinehurst, NC	5	3.2
FirstSolar (2)	Tempe, AZ	4,850	3,309
Horne Brothers (2)	Fayetteville, NC	40	18.9
MB Haynes	Asheville, NC	145	40
Native Solar	Pembroke, NC	NA	NA
Phoenix Solar (2)	San Ramon, CA	187	114
Pike Energy Solutions (1)	Pittsburgh, PA	4,143	594
Pure Power Contractors Inc.	Waxhall, NC	4	1.0
Renewable Energy Contractors	Blowing Rock, NC	NA	NA
Solar Energy USA (1)	Alpharetta, GA	10	1.1
Solargenix (2)	Sanford, NC	14	3.7
Vaughn Industries	Carey, Ohio	525	130
Watson Electrical (1)	Wilson, NC	50	97.4
White Electrical Construction Company (1)	Atlanta, GA	300	37.4

Source: (1) Mergent Intellect; (2) ONESource; (others) company contact

rule of thumb, an average 5MW solar project takes about 12-16 weeks to complete and can involve 30-50 construction workers, electricians and installers. The major construction firms installing utility-scale solar in North Carolina are listed in Table 12.

4.2.3 Post-Construction

4.2.3.1 Power Purchasers

Utilities and large commercial/industrial organizations purchase and use the energy generated from utility-scale solar facilities. Utility companies such as Duke Energy have subsidiaries that invest and develop solar farms to add to their electric power generation mix. With legislation requiring that 12.5% of all energy come from renewable sources by 2021, the firm is increasing investments in solar farms. In September 2014 Duke Energy announced a $500 million investment in solar involving construction of three large solar farms, including one in Duplin County that will cover one square mile and have the capacity to generate 100 MW of power annually. If built, it will be the largest farm on the East Coast.

Table 13: North Carolina Solar Power Purchasers

Power Purchaser	Nameplate Capacity (MW)
Progress Energy	323
Duke Energy	158
North Carolina Eastern Municipal Power Agency	40
Duke Energy Carolinas	25
Duke Energy Progress	17
Dominion NC Power	5
Edgecombe EMC	5
Energy United Electric Membership Corporation	1
North Carolina Municipal Power Agency	1
Total	**573**

Note: Progress Energy, Duke Energy and Duke Energy Carolinas have merged to become Duke Energy Progress. Name in table reflects information reported to the NCUC.

Source: Duke CGGC, based on NCUC-RETS

Large organizations are also using utility-level solar farms to supply their energy needs. Businesses such as Apple have installed solar plants in the state; Apple's two operating farms contribute 20 MW to the state's energy grid, and in June 2014 the company announced plans to install a third solar farm in Claremont.[70] The National Gypsum plant in Mount Holly installed its solar farm on the building's 145,000 square-foot roof, taking advantage of the heavy sunlight to generate 1.2 MW annually that the company uses and also sells to Duke Energy.[71]

4.2.3.2 Operations and Facilities Maintenance (O&M Suppliers)

Turnkey developers like Strata Solar, which develop, finance and construct solar plants and hold the properties, often keep operations and facilities maintenance functions in house. Individual plants may subcontract with a local electrician for maintenance. Companies outside North Carolina providing O&M services are SunEdison and FirstSolar.

4.2.4 Supporting Policies and Organizations

This section highlights federal and state-level policies and organizations supporting the development of utility-scale solar power in North Carolina. The discussion on policies is divided into federal investment incentives and trade policy, and North Carolina policies in place to encourage investment in utility-scale solar. We close with a list of supporting organizations active in the utility-scale PV solar value chain.

4.2.4.1 Policies

Federal Tax and Energy Policies

The U.S. government has various mechanisms in place to encourage efforts that contribute to solar power investments.

- The **Energy Tax Act of 1978** established the federal Investment Tax Credit (ITC) to aid the financing and build-out of renewable energy projects. It allowed the cost of 10% of eligible solar properties to be deducted from taxable income. The **Energy Policy Act of 2005** increased the ITC from 10% to 30% for eligible solar properties. The **Emergency Economic Stabilization Act of 2008** extended the solar ITC at the 30% rate to 2016 and expanded eligibility to investor-owned public utilities; public utilities were not eligible for the ITC prior to the act. After 2016, unless renewed at the higher rate, the ITC will revert to 10% for eligible properties.
- The **Modified Accelerated Cost Recovery System** (MACRS) enables commercial and industrial owners to accelerate the depreciation of renewable energy equipment. Accelerated depreciation can be taken over five years of project life, or six tax years.

Depreciation is calculated on 85% of the cost of eligible solar property.

- The **Public Utilities Regulatory Policies Act (PURPA) of 1978** requires public utilities to purchase distributed generation below 80MW at the avoided cost rate, as determined by state regulators. PURPA requirements have been important in stimulating the development of distributed power generation in the United States.

Federal Trade Policies

U.S. trade policies have a major effect on solar panel manufacturers both domestically and abroad. The Commerce Department first implemented protective tariffs on Chinese crystalline silicon photovoltaic cells in a two-step process in 2012. In response to a 2011 complaint lodged by the American subsidiary of SolarWorld AG (based in Germany) and six U.S. companies, the agency ruled in May 2012 that Chinese companies were unfairly benefiting from government subsidies. The Commerce Department set initial punitive tariffs of 31% on 59 Chinese companies[72] including Yingli Green Energy, LDK Solar, Canadian Solar, Hanwha Solar One, JA Solar Holding and Jinko Solar.

In October 2012, the Commerce Department issued what it described as its "affirmative final decision" on the case.[73] The department determined that Chinese businesses had received subsidies of between 14.7% and 15.9% and had sold solar cells in the United States at dumping margins of 18-250%.[74] Dumping margins are the difference between the price (or cost) in the foreign market and the price in the U.S. market.[75] The specific products that Chinese firms were manufacturing were equipment crystalline silicon photovoltaic cells as well as modules, laminates and panels consisting of crystalline silicon photovoltaic cells. The final tariffs implemented against Chinese firms ranged from 24% to 36%, with Suntech, one of the largest panel makers, receiving the highest individual tariff.[76]

At the time, industry observers predicted that the Commerce Department's ruling would have only minimal repercussions for the market for solar panels.[77] That analysis proved to be accurate, although for reasons not completely anticipated at the time of the decision. After criticizing the United States as being overly protectionist, Chinese solar companies exploited a loophole through which they could assembly panels from cells produced abroad, especially Taiwan, and avoid the duties even if the cells were produced from smaller parts (ingots and wafers) made in China.[78]

In an effort to redress this apparent oversight, SolarWorld AG filed a grievance with the Commerce Department. In the summer of 2014, the agency offered two separate rulings that imposed new tariffs on Chinese companies. In June, the Commerce Department imposed duties of 19-35% on some Chinese firms; in July, it imposed additional tariffs of 10-55%. The immediate outcome was that panel prices increased in one month by roughly 10%, impairing the demand for products made by low-cost manufacturers such as Yingli and Suntech but boosting sales by companies that had previously been undercut by their Chinese competitors.[79]

Questions remain about the regulatory terrain for the industry. In July 2014, the World Trade Organization (WTO) ruled that the Commerce Department's 2012 judgment against China violated international trade rules. Chinese officials, presumably believing that the decision did not go far enough, filed an appeal in August 2014. Even without the appeal, industry stakeholders predicted that the WTO decision would not have a strong effect since it would not reduce anti-subsidy tariffs by a large amount; many have argued that the clearest path toward a stable regulatory environment is negotiating an agreement between SolarWorld AG and its competitors both in the United States and China and India that would eliminate or reduce duties.[80]

Blaming a "ministerial error," the Commerce Department reduced the tariffs being levied against solar products made in Taiwan in August 2014.[81] While the anti-dumping tariff on Taiwanese manufacturers such as Motech was reduced from 44.1% to 20.9%, industry analysts said they did not believe China would resume using Taiwanese suppliers. Chinese manufacturers of U.S.-bound modules had shifted to using Chinese companies almost exclusively, and paying the 2012 cell tariff, which was around 31%.[82] Conversations with solar developers in North Carolina indicate that the ongoing trade disputes and tariff levels affect their solar-panel purchasing decisions.

North Carolina Policies[83]

North Carolina has several policies in place supporting the development of solar power. Among these are:

- **Article 3B Renewable Energy Tax Credit (RETC):** The RETC legislation (G.S. 105-129.16A) allows the application of a 35% deduction of the cost of a renewable energy facility. The credit can be taken against the franchise tax, the income tax or, if the taxpayer is an insurance company, the gross premiums tax (G.S. 105-129.17(a)). It expires December 31, 2015.[84] North Carolina has had an RETC in place since 1977.[85] Past credits have ranged between 20% and 40%.[86]

- **Renewable Energy and Energy Efficiency Portfolio Standard (REPS):** REPS Legislation (G.S. 62-133.8) requires that investor-owned utilities derive 12.5% of all energy from renewable sources by 2021 (with annual interim targets, including 5% in 2015 and 10% in 2018). Municipally-owned utilities and cooperatives must achieve a 10% renewable target by 2018, with no additional requirement for 2021. Utilities can use energy efficiency gains to replace some renewable generation. Also known as Senate Bill 3, REPS received bipartisan support in 2013 in the face of repeal efforts because state legislators did not want to lose the economic development benefits of renewable energy.[87]

- **Interconnection Standards:** The NCUC adopted interconnection procedures in June 2008 that apply to the state's investor-owned utilities. These standards generally follow Federal Energy Regulatory Commission (FERC) standards.[88] North Carolina's standards include levels of interconnection review, with fast-track application available to generators smaller than 2 MW; systems larger than 2MW follow the "study process" in which the utility investigates and makes a determination about the adequacy of the proposed interconnection point for the qualifying facility.[89] North Carolina has adopted a standardized interconnection agreement that applies to all utilities. However, interconnection procedures are applicable only to public utilities, not municipally owned utilities and co-ops.[90] The timeliness of receiving approved interconnection agreements was repeatedly cited in our interviews as a key bottleneck in the pace of development in utility-scale solar.

- **Power Purchase Agreements (PPAs):** Solar projects at or below 5MW receive a standard power purchase agreement, which currently is at the avoided cost rate for 15 years. For solar projects above 5MW, PPAs are negotiated between the utility and the solar power project developer.

- **Net Metering:** The net metering policy allows the return of electricity generated from on-site distributed systems, such as solar panels, to the grid. Net metering energy credits are calculated at the retail rate. The statutory limit for net metering in North Carolina is 1MW, and thus does not apply to the overwhelming majority of the plants in the utility-scale solar segment investigated in this report.

> *"We don't want an environment where we have incentives forever. But we need a clear path to allow the industry to adjust so that we're not in a position where it starts and stops in fits."*
>
> *– Erik Lensch, Entropy Solar*

Policies at both the federal and state level have been successful in encouraging the growth of utility-scale solar in North Carolina. Most notable among these are the ITC at the federal level and the REPS and RETC at the state level. Whether the ITC and RETC policies will be extended beyond their expiration dates of December 31, 2016 and December 31, 2015, respectively, is a source of concern in the North Carolina utility-scale solar industry. While solar developers generally recognize the need to be cost competitive with other electric power generation fuel sources, the abrupt ending of the federal and state tax credits will have effects in the industry that to some are unnecessarily shortsighted and harmful to the future of the industry in the state. "We don't want an environment where we have incentives forever," stated Erik Lensch of Entropy Solar Integrators. "But we need a clear path to allow the industry to adjust so that we're not in a position where it starts and stops in fits.…[T]he visibility on our runway is pretty short, and I don't want people to lose work because of an incentive structure that has changed overnight."

The solar developers and EPC contractors we spoke to recommend a phased approach to the reduction or elimination of the state-level tax credit. Two policy proposals supported in the developer community were a "continuance of construction" policy, where investments made prior to the current state-level deadline would receive the tax credit if the projects were completed within a reasonable six- or 12-month window. A second proposal is the "safe harbor provision," which would allow the state credit to be taken within an 18-month period (by the middle of 2017) if a portion of the project expenses were taken by the end of 2015. These policies would remove the current incentive for developers to get projects in under the December 31, 2015 deadline and reduce the logjam of projects waiting for interconnection approval.

Developers noted that without these modifications the surge of projects in 2015 will make an already-clogged approval system for interconnection agreements worse. As noted by IREC in its annual report on grid-connected PV solar, it is typical to see a surge of applications before the incentives deadline and then a drop-off in installations after the deadline has passed.[91] The average length for design, permitting, finance and construction for a 5MW utility-scale solar project in North Carolina is around a year to 18 months, particularly with the current backlog of interconnection agreements approaching 400 facilities.[92] The interconnection study requirement for projects greater than 2MW has overwhelmed the utilities, and turned a "pro forma" 45-day process into a 365-day process. The result is that developers don't know when projects will get approved because a determination has not been made by the utility that an adequate interconnection point exists. This uncertainty acts as a limit on the number of projects that will get built in North Carolina.

Without the available tax credits, institutional and tax equity investors will reduce their investments in new renewable energy projects.[93] The reduced availability of tax credits will likely have two effects. The first is market consolidation among independent solar developers, which may occur because institutional investors prefer companies that can survive the subsidy's elimination and remain able to manage long-term investments.[94] The second is the expansion into new markets by developers with the financial ability to capture profits through their economies of scale. Among the developers identified as having aggressive national geographic diversification strategies are Strata, SunEdison, Recurrent Energy, SunPower, NextEra Energy, Hecate Energy, Juwi Solar, Innovative Solar Systems and FirstWind Solar.[95]

A decline in investment by independent solar developers may benefit electric utilities. A report by the Lawrence Berkeley National Lab found that utilities and shareholders could see revenue declines as solar PV increases unless utilities invest in or finance solar projects themselves.[96] The report found that solar affects utility revenues in two ways: one is the faster reduction of sales than costs leading to a "revenue erosion effect." The second is the reduced need of regulated utilities to invest in future capital, thereby reducing future earnings from returns on equity. Thus, policies that have the effect of reducing the pool of non-utility-owned facilities improve the long-term financial standing of utilities and their ability to benefit stockholders.

4.2.4.2 Organizations

A number of educational and non-profit organizations provide supporting roles in the North Carolina utility-scale PV solar power value chain. Among them are:

North Carolina State University Clean Technology Center: Formerly the N.C. Solar Center, the Clean Technology Center develops technology and policy initiatives in solar and other clean energies for businesses, policy makers and other organizations. The center is a clearinghouse for energy programs, information, applied research, technical assistance and training. It is home to the national Database of State Incentives for Renewable Energy (DSIREUSA.org), and it is a national reference site for energy policies across the United States (http://nccleantech.ncsu.edu/).

University of North Carolina at Chapel Hill Energy Frontier Research Center for Solar Fuels (UNC EFRC): Funded by the U.S. Department of Energy, Office of Basic Energy Sciences, and established in 2009, the UNC EFRC's efforts range from basic research on fundamental processes to integrating components into sub-systems and sub-systems into prototypical devices. The primary target is dye sensitized photoelectrosynthesis cells (DSPEC) for solar fuels production. The research center, headquartered in Chapel Hill, is partnered with the University of Florida, the Georgia Institute of Technology and the University of Colorado at Boulder (http://www.efrc.unc.edu/).

Duke University Nicholas Institute for Environmental Policy Solutions: The Nicholas Institute conducts policy research on renewable energy issues (http://nicholasinstitute.duke.edu/). In addition, the **Nicholas School for the Environment** (http://nicholas.duke.edu/) conducts basic research on energy issues and educates undergraduate and graduate students about renewable energy, among other issues.

Duke University Energy Initiative: The Energy Initiative is focused on educating future leaders, conducting research, and engaging with business and policy decision makers to address three major energy challenges: meeting growing energy demand to support a competitive and prosperous economy, reducing the environmental footprint of energy and addressing energy security concerns (http://energy.duke.edu/initiative).

Appalachian State University Appalachian Energy Center: The Appalachian Energy Center conducts energy research and applied program activities in the areas of energy efficiency, renewable energy technologies, forecasting and modeling, economic development, and policy analysis in a multidisciplinary environment that leverages the expertise of faculty, staff and students from across the university as a resource for private industry, local, state and federal governments, and non-profits. (http://energy.appstate.edu/).

North Carolina A&T State University Center for Energy Research and Technology: CERT is an interdisciplinary energy research center created to foster collaborative research and development of new energy-related technologies. Grounded in engineering and built-environment sciences, the center focuses on basic and applied research; outreach and extension activities; and education relating to renewable energy, energy efficiency, alternative fuels and vehicle technologies, sustainable green building, and the environment (http://www-dev.ncat.edu/research/cert/index.html).

North Carolina Sustainable Energy Association: NCSEA is a 501(c)(3) non-profit organization dedicated to driving public policy and market development that creates clean energy jobs, economic opportunities and affordable energy (http://www.energync.org/).

Appendix

A. Report Methodology, Data Sources and Limitations

Methodology

We conducted the research for this report in four phases. In the first phase, we reviewed secondary source materials – press releases, industry publications and online sources – for information on the global, U.S., and North Carolina utility-scale solar PV industry. The purpose of this phase was to better understand the solar power industry, the market and technology trends affecting the adoption of the technology, and the actors in the production network of goods or services in North Carolina. In the second phase, we interviewed developers, EPC contractors, and structural/electrical balance-of-system providers in the solar industry to develop a preliminary understanding of the value chain. As a result of these interviews, we developed the solar PV value chain to organize our understanding of the industry.

In the third phase of research, we conducted additional interviews with lead and local firms, experts in technology and finance, and regulatory agencies. The objective of this phase was to better understand specific technical or regulatory aspects not fully apparent at the second stage, to identify additional companies in the value chain nodes, and to better understand the role of these companies in the production system. During this phase, our questions became specific and covered the full range of issues discussed in this report.

In the fourth phase of research, CGGC contacted individuals who are well informed about the industry and asked them to review the value chain and accompanying report. We requested that they provide comments and corrections of either fact or interpretation. Revisions to the report as a result of the external review process were made. Conducting value chain studies in this manner is time intensive, but provides a level of detail and understanding of industries not replicable by a review of only secondary source materials or a quantitative analysis of economic impacts. A bottom-up, ground-level perspective offers insights into markets, technology trends, and the effective role for government action that would be difficult to achieve using other methods.

Data Sources

We relied on reports and data from international agencies, official U.S. statistics and reports, the North Carolina Utilities Commission, the North Carolina Department of Revenue, company interviews, and widely recognized and reputable third-party publications in the renewable energy field. The specific reports and data used in the report are cited in the endnotes. While existing reports were important for understanding general trends in the industry, we found that our interviews with North Carolina companies provided a level of detail and perspective about regional dynamics that other sources could not provide. We appreciate the cooperation of the many companies we contacted for their information and perspective.

Report Limitations

Although the direct impact of utility-scale solar reported here is impressive, we believe that the economic impact in North Carolina is broader in many ways. We do not measure employment and sales resulting from changes in personal spending due to increased employment income and lease payments to landowners (induced effects); infrastructure improvements to the electrical grid in rural areas of the state; the development of unproductive or underutilized land; or the economic, environmental and social benefits of less-polluting electric power generation. Value chain assessments are useful tools for conveying to the public and policy makers the importance of industries to economic development and jobs in direct economic terms. Our hope is that in combination with formal economic impact modeling, such as those recently completed with respect to the North Carolina renewable energy industry,[97] the true effects of utility-scale solar can be measured and used to inform the ongoing public policy debate about the role of photovoltaic solar power in North Carolina's energy future.

B. Examples of Renewable Energy Tax Equity Investors, Debt Providers and Project Finance Providers

Tax Equity Investors

2007	2008	2009	2010
Bank of America	Bank of America	Bank of America	Bank of America
GE EFS	GE EFS	Citibank	Citibank
HSH Norbank	HSH Norbank	Credit Suisse	Credit Suisse
JP Morgan	JP Morgan	GE EFS	GE EFS
Key Bank	Key Bank	JP Morgan	Google
Morgan Stanley	Morgan Stanley	Key Bank	JP Morgan
New York Life	New York Life	Morgan Stanley	Key Bank
Northern Trust	Northern Trust	Northern Trust	MetLife
Union Bank	Sempra Energy	U.S. Bank	Morgan Stanley
Wells Fargo	Sun Trust	Union Bank	Northern Trust
ABN Amro	U.S. Bank	Wells Fargo	PG&E
AIG	Union Bank		PNC Bank
Citibank	Wells Fargo		Sun Trust
Fortis			U.S. Bank
John Hancock			Union Bank
Lehman Brothers			Wells Fargo
Merrill Lynch			
Northwestern Mutual			
Prudential			
Wachovia			

Source: Mintz Levin

Debt Providers to US Renewable Energy

2007	2008	2009	2010
Banco Santander	Banco Espirito Santo	Banco Espirito Santo	Banco Santander
Bayern LB	Banco Sabadekk	Banco Santander	Bank of Montreal
BBVA	BBVA	BNP Paribas	Barclays
Dexia	BTMU	BTMU	BBVA
Fortis	Calyon (Credit Agricole)	Calyon (Credit Agricole)	BTMU
HSH Nordbank	Citibank	CoBank	Caja Madrid
JP Morgan Chase	Dexia	Credit Suisse	Citibanl
Mizuho	HSH Nordbank	Dexia	Credit Agricole
Natixis	ING	Helaba	Credit Suisse
Nord LB	Lloyds TSB	HSH Nordbank	Deutche Bank
Prudential	Morgan Stanley	John Hancock	Dexia
RBS	Nord LB	Key Bank	Heleba
Union	Prudential	LBBW	ING
	RBS	Lloyds TSB	John Hancock
	Scotia Bank	Nord LB	Key Bank
	UniCredit	Prudential	LBBW
	Union Bank	RBS	Morgan Stanley
		Scotia Bank	Natixix
		UniCredit	Prudential
		Union Bank	Rabobank
		Societe Generale	RBS
		West LB	Societe Generale
			UniCredit
			Union Bank
			West LB

Source: Mintz Levin

Solar Finance Providers (Sample)

Commercial/Industrial/Utilities		
Tioga Energy	MMA Renewable Ventures	Chevron Energy Solution
MEMC	Green Rock Enregy	Regenesis
First Solar	Green Energy Finder	Solatage
Photon Energy Services	PVOne	EI Solutions
Solar Power Partners	SunPower Corp	Helop Micro Utility
Clean Source Power	Envision Solar	MP2 Capital
Recurrent Energy		

Source: Mintz Levin

C. North Carolina Utility-Scale Operating Facilities, by County

County	Estimated Cost	Nameplate Capacity (MW_{ac})
Alamance	11,122,359	4
Alexander	6,500,000	1
Beaufort	90,375,019	27
Bladen	39,525,339	10
Buncombe	22,078,000	6
Cabarrus	14,997,000	5
Caswell	20,000,000	5
Catawba	215,317,053	59
Chatham	22,500,000	5
Cleveland	99,437,456	24
Columbus	66,344,689	19
Craven	25,354,856	6
Cumberland	13,902,949	5
Davidson	7,378,738	2
Davie	36,333,434	10
Duplin	71,647,591	22
Durham	22,500,000	5
Edgecombe	12,816,155	3
Franklin	27,533,374	7
Gaston	5,455,484	1
Gilford	26,462,654	10
Granville	11,774,074	3
Greene	12,000,000	4
Guilford	17,790,555	5
Harnett	35,912,456	11
Haywood	4,516,129	1
Henderson	5,466,640	2
Hertford	21,082,109	5
Hoke	19,525,339	5
Johnston	20,000,000	5
Lenoir	59,436,323	17
Lincoln	22,500,000	5
Mecklenburg	8,341,290	2
Montgomery	20,000,000	5
Moore	12,929,743	5
Nash	69,741,783	22
New Hanover	10,873,720	3
Orange	45,861,014	13
Pearson	53,263,855	13
Pitt	31,304,000	10
Randolph	13,950,000	5
Richmond	35,231,123	12
Robeson	167,891,078	44
Rockingham	56,333,434	15
Rowan	4,927,097	1
Rutherford	4,715,880	2
Sampson	26,000,000	7
Scotland	60,311,599	19
Surry	17,952,841	5
Union	17,128,174	5
Vance	25,469,944	8
Wake	56,942,299	13
Warren	39,628,174	10
Wayne	122,684,986	39
Wilson	55,441,986	16
Grand Total	**2,044,509,794**	**573**

Source: Duke CGGC, based on NC-RETS

D. Grid-Connected PV Installations (MW_{dc}) by U.S. State, 2008-2013

State	2008	2009	2010	2011	2012	2013
Alabama	-	0.2	0.4	0.5	1.1	1.9
Alaska	-	-	-	-	-	0.2
Arizona	25.3	46.2	109.8	397.6	1,106.4	1,563.1
Arkansas	-	0.2	1.0	1.1	1.5	1.8
California	528.3	768.0	1,021.7	1,563.6	2,559.3	5,183.4
Colorado	35.7	59.1	121.1	196.7	299.6	360.4
Connecticut	8.8	19.7	24.6	31.1	39.6	77.1
Delaware	1.8	3.2	5.6	26.5	46.1	62.8
District of Columbia	0.7	1.0	4.5	11.6	13.9	16.5
Florida	3.0	38.7	73.5	95.0	116.9	137.3
Georgia	-	0.2	1.8	6.9	21.4	109.9
Hawaii	13.5	26.2	44.7	85.2	199.5	358.2
Idaho	-	0.2	0.4	0.4	1.0	1.8
Illinois	2.8	4.5	15.5	16.2	42.9	43.4
Indiana	-	0.3	0.5	3.5	4.4	49.4
Iowa	-	-	-	0.1	1.2	4.6
Kansas	-	-	-	0.2	0.5	1.1
Kentucky	-	-	0.2	3.3	4.8	7.9
Louisiana	-	0.2	0.2	13.4	18.2	46.6
Maine	0.3	0.3	0.3	1.1	2.8	5.3
Maryland	3.1	5.6	10.9	37.1	116.8	175.4
Massachusetts	7.5	17.7	38.2	74.6	207.3	445.0
Michigan	0.4	0.7	2.6	8.8	19.9	22.2
Minnesota	1.0	1.9	3.6	4.8	11.3	15.1
Mississippi	-	0.1	0.3	0.6	0.7	1.0
Missouri	-	0.2	0.7	2.0	18.5	48.9
Montana	0.7	0.7	0.7	0.7	2.2	3.0
Nebraska	-	-	0.2	0.3	0.4	0.6
Nevada	34.2	36.4	104.7	124.1	349.7	424.0
New Hampshire	0.1	0.7	2.0	3.1	5.4	9.6
New Jersey	70.2	127.5	259.9	565.9	955.7	1,184.6
New Mexico	1.0	2.4	43.3	165.5	203.4	256.6
New York	21.9	33.9	55.5	123.8	179.4	240.5
North Carolina	4.7	12.5	40.0	85.5	207.9	469.0
North Dakota	-	-	-	-	0.1	0.2
Ohio	1.4	2.0	20.7	31.6	79.9	98.4

State	2008	2009	2010	2011	2012	2013
Oklahoma	-	-	-	0.2	0.3	0.7
Oregon	7.7	14.0	23.9	35.8	56.4	62.8
Pennsylvania	3.9	7.3	54.8	133.1	164.3	180.2
Rhode Island	0.6	0.6	0.6	1.2	1.9	7.6
South Carolina	-	0.1	0.2	4.1	4.6	8.0
South Dakota	-	-	-	-	-	-
Tennessee	0.4	0.9	4.7	22.0	45.0	64.8
Texas	4.4	8.6	34.5	85.6	140.3	215.9
Utah	0.2	0.6	2.1	4.4	10.0	16.0
Vermont	1.1	1.7	2.9	11.7	28.0	41.5
Virginia	0.2	0.8	2.8	4.5	10.5	12.6
Washington	3.7	5.2	8.0	12.3	19.5	27.4
West Virginia	-	-	-	0.6	1.7	2.2
Wisconsin	3.1	5.3	8.7	12.9	21.1	22.5
Wyoming	-	0.1	0.2	0.2	0.6	1.0
Total	**791.7**	**1,255.7**	**2,152.5**	**4,011.0**	**7,343.9**	**12,090.0**

Note: Cumulative installed capacity reported in MW_{dc}. AC is 20% less than DC.

Source: IREC, "U.S. Solar Market Trends," Appendix C, 2008-2013

Endnotes

1 For purposes of this report, we define utility-scale solar as photovoltaic solar energy projects exceeding 1MW(ac). The (ac) reflects that solar capacity is reported either in alternating current (AC) or direct current (DC) terms because solar panels generate DC energy, which must then be converted to AC power for use by the electrical grid. DC is 20% greater than AC.

2 Sources for rankings are Interstate Renewable Energy Council (IREC), *U.S. Solar Market Trends 2013,* and the U.S. Energy Information Agency (EIA), as cited in Table 1.

3 Sources for the summary statistics are: solar jobs and number of companies, 2014 NCSEA N.C. Clean Energy Census; number of existing facilities and capacity, solar facilities greater than 0.9MW, reported to the N.C. Utilities Commission NC-RETS system as of February 6, 2015. Direct investment, annual cost/MW of installed capacity for years 2008-2014 imputed from NCUC Dockets or, in cases where cost was reported, the actual cost. Facilities under development (number and total MW), facilities reported in "Renewable Energy Facility Registrations Accepted by the NC Utilities Commission," as of December 31, 2014 minus existing operating facilities in the NC-RETS system as of February 6, 2015.

4 Ren 21, *Global Status Report*, 2014, 49; UNEP (Frankfurt School-UNEP Centre/BNEF, 2014; *Global Trends in Renewable Energy Investment 2014* (henceforth cited as UNEP, 2014)) estimates worldwide investment in all solar technologies as $12.1 billion in 2004 and $113.7 billion in 2013. Ren21 figures represent global investment in PV only. Both UNEP and Ren21 note the reduction of investment in 2013 from 2012 levels at about 20%.

5 Ren21, 2014, 47.

6 Solar Energy Industries Association (SEIA),U.S. *Solar Market Insight: 2013 Year in Review* (Washington, DC: 2014). Executive summary: https://www.seia.org/research-resources/solar-market-insight-report-2013-year-review

7 IREC, *U.S. Solar Market Trends 2013*, 2014, Appendix C (p. 29). Reported DC is converted to AC.

8 NC-RETS as of February 6, 2015 reports facilities operating and receiving renewable energy tax credits in North Carolina. NC-RETS is the basis for all our capacity information for North Carolina. We recognize that not all solar facilities are listed in the NC-RETS because not all facilities are interested in tradable credits; however, RETS is the best available source of information for operating capacity in North Carolina. SEIA (http://www.seia.org/research-resources/major-solar-projects-list) and EIA (Form 860) provide other lists of solar facilities. However, we chose to report data from NC-RETS as the basis of our estimate because (1) we wanted to rely on official statistics, and (2) we found the EIA data reported in Form 860 to lag that of the NC-RETS. The NC-RETS is available at http://www.ncrets.org/public-reports/). Readers interested in the list of all renewable energy projects (including solar) registered with the NCUC, regardless of operational status, should visit http://www.ncuc.commerce.state.nc.us/reps/reps.htm (look for the *Renewable Energy Facility Registrations Accepted by the NC Utilities Commission* file).

9 Ren21, *Global Status Report,* 2014.

10 Ren21, *Global Status Report,* 2014.

11 Colorado's Xcel Energy decided in October 2013 that big solar (and wind) projects were the most economic choice based on price alone, regardless of state renewable portfolio standards (Dave Levitan, "For Utility Scale Solar, Key Questions About the Future," *Yale Environment*, 360, 21 November, 2013).

12 Both Ethan Howland ("Large Utility-Scale Solar Development Slows to a Crawl," *Utility Dive*, 14 Jan. 2014) and Levitan, 2013 note that utility procurement already has slowed in many states due to bumping up to state REPS targets.

13 Denis Lenardic, "Large-scale Photovoltaic Power Plants Ranking 1-50," updated 14 January 2015, http://www.pvresources.com/PVPowerPlants/Top50.aspx

14 The implication of this trend is not to be underestimated. Distributed "small scale" (below 1MW) solar projects are coming under increased resistance by utilities, as the utilities are concerned with customer base reduction and lost revenue resulting from small-scale solar projects (Ren21; UNEP). Both Ren21 (p. 48) and UNEP (ch. 6) discuss the trend occurring in Europe, the United States, and Australia. They note that in several U.S. states, increased debate is occurring about the future of existing net metering laws. However, it is also true that – despite a 25% global investment reduction in 2013 of small-scale solar (UNEP, p. 56) – the United States saw an 11% growth (to $7.9 billion) of investment in small-scale solar in 2013 (UNEP), due (at least partly) to falling prices, the federal investment tax credit (in place until at least 2016) and innovative financing options that enable installation with little or no upfront costs to the consumer by third-party funders like Sunrun, SolarCity and SunPower (Ren21, p. 47; UNEP, p. 57.) With the exception of Japan (76% year-over-year growth (UNEP), where homebuilders promote solar homes as a product differentiation strategy (Ren21), the United States was unique in its growth of small-scale solar. In the United States, California is a noted leader in this size project. In North Carolina, barriers to small-scale solar are the inability to use third-party power purchase agreements and lack of access to consumer loans for financing the projects.

15 http://www.thesolarfoundation.org/research/national-solar-jobs-census.

16 Employment & revenue: 2014 NCSEA N.C. Clean Energy Census.

17 SEIA, "U.S. Solar Market Insight," Q3 2014.

18 Source of statement: Ren21, *Global Status Report*, 2014. As a reference point the cost/W was $76.67 in 1977, $10.00 in 1987, $6.10 in 1997, and $4.00 in 2007 (Bloomberg, *New Energy Finance,* http://www.abb-conversations.com/2013/12/7-impressive-solar-energy-facts-charts/).

19 Ren21, *Global Status Report,* 2014.

20 Value of shipments (modules); EIA, 2012; "Annual PV Cell/Module Shipments Report," Table 2. By peak kW, the

breakout is 61% silicon and 38% thin film, per EIA, "Annual PV Cell/Module Shipments Report," 2012, Table 7.

21 EIA, "Annual PV Cell/Module Shipments Report," 2012, Table 7.

22 Solar inverters convert the DC output of a photovoltaic solar panel into AC that can be fed into a commercial electrical grid or used by a local, off-grid electrical network (en.wikipedia.org/wiki/Solar_inverter).

23 James Montgomery, "Price Pressures Squeeze Solar Inverter Shipment Outlook," *Renewable Energy World,* 16 Oct. 2013.

24 SEIA, *U.S. Solar Market Insight,* 2013.

25 EIA, "Annual PV Cell/Module Shipments Report," 2012, Table 8.

26 EIA, "Annual PV Cell/Module Shipments Report," 2012, Table 9.

27 SEIA, *U.S. Solar Market Insight,* 2014.

28 SEIA, *U.S. Solar Market Insight,* Q3 2014.

29 Concentrated photovoltaic (CPV) technology uses optics such as lenses or curved mirrors to concentrate a large amount of sunlight onto a small area of solar PV cells to generate electricity. China's CPV continues to consolidate and is expected to be the most used solar technology by 2016. Market consolidation in CPVs is a trend in this technology. U.S.-based Solar Junction and Amonix have partnered to improve CPV efficiencies. New cell and conversion records for CPV continue to occur. Concentrated photovoltaic (CPV), historically a niche market, has seen production consolidations in Europe, the United States and China. In Europe, CPV has moved from Germany to France, with Soitec (France) partnering with Alstom to produce CPV in France. Soitec also has moved production facilities out of Europe to California. See en.wikipedia.org/wiki/Concentrated_photovoltaic; REN21; and Frank Haugawitz, "CPV Developments: China's CPV Industry Too Is Facing Consolidation, May 2014 (http://www.frankhaugwitz.info/downloads.html).

30 A new technology promising efficient and inexpensive solar cells is based on perovskite materials, a rare earth mineral efficient at converting light into electrical energy. It can be manufactured using the same thin-film manufacturing techniques used for silicon solar cells. The promise of perovskite materials is an efficient and inexpensive solar cell. However, significant challenges remain to bring this solar technology to the commercial market, including the stability of the compounds outdoors and the toxicity of lead used in the perovskite solar cells. See http://www.cam.ac.uk/research/news/leds-made-from-wonder-material-perovskite#sthash.l6OxD3SQ.dpuf; http://en.wikipedia.org/wiki/Perovskite_%28structure%29#Material_properties; and http://www.nature.com/nmat/journal/v13/n9/full/nmat4065.html for additional information on perovskite cells.

31 Morgan Lee, "Kyocera to Develop Solar Projects in the U.S.," UTSanDiego.com, 10 Sep 2013; "Hanqwa Q Cells Expands Commercial Rooftop Solar Services," *PV News,* Dec. 2013.

32 SEIA, *U.S. Solar Market Insight,* 2013.

33 "Mosaic Awarded $1 Million, Plans International Expansion," *PV News,* Feb. 2014, p. 5.

34 https://joinmosaic.com/solar/north-carolina, last accessed Oct 8, 2014.

35 As a reference point, low = 2kWh/m2/day; medium = 4kWh/m2/day; high = 7.5kWh/m2/day; http://www.symtechsolar.com/pv-resources/return-of-investment/.

36 SEIA, *U.S. Solar Market Insight,* 2013.

37 IREC reports in MWdc. We converted the reported DC into AC for the figures provided in the table. See Appendix C for annual reporting by state in DC.

38 IREC 2014; EIA, Electricity Generation and Consumption (EIA-906/920/923), Net Generation by state by sector (Table 1.6). EIA data are available electronically at http://www.eia.gov/electricity/data/browser/

39 Total investment calculated based on the annual cost per MW of installed solar reported in NCUC documents. See note 3 for additional details.

40 RTI, "Economic Impact of Clean Energy Development in North Carolina," 2014 update (April 2014) places the investment of solar facilities in the state at $1.5 billion.

41 See note 3 for sources.

42 http://www.rmi.org/Content/Files/BOSReport.pdf.

43 http://wiki-solar.org/index.html.

44 See Duke Energy Renewables, "Solar Power Project Fact Sheet", available at http://www.duke-energy.com/pdfs/Solar-Power-Projects-Fact-Sheet.pdf

45 The discussion for this section is based on NREL, *Federal and State Structures to Support Financing Utility-Scale Solar Projects and the Business Models Designed to Utilize Them* (NREL/TP-6A20-48685), 2012.

46 See section 2.1.1 of NREL 2012 for additional information on this point.

47 Bloomberg *New Energy Finance*, 2010

48 NREL, 2012.

49 NREL, 2012.

50 NREL, 2012, pp. 30-32.

51 Coughlin J. and Cory, K. (March 2009) *Solar Photovoltaic Financing* NREL/TP-6A244853. Golden, CO: National Renewable Energy Laboratory.

52 Readers interested in global trends in renewable energy financing should consult UNEP, 2014 (*Global Trends in Renewable Energy Investment 2014).*

53 Institutional investors include pension funds, insurance companies and wealth managers (UNEP, 2014). Supporting the statement that equity investors are a core financing tool for renewable energy is from Carus, F. 2013 "Solar's ITC Equity Gap Taxes the Brightest Minds in Finance, PVTech, Dec 3.

54 Source is triangulation from Trabish, H. 2014 "Financing Utility-Scale Solar in the Years Ahead" The Energy Collective, May 8 and Lutton, J. 2013 "Tax Equity 101: Structures" Woodlawn Associates, March 8. Rabobank, a large Dutch bank known for its sustainability-oriented banking, is listed by Lutton, 2013; however, we do not name them here as they appear to be primarily focused on the California residential market.

55 The companies are Entropy Solar (York Capital Management) and FLS Energy (New Energy Capital). See http://www.newenergycapital.com/nec_investments.html

56 UNEP, 2014.

57 UNEP, 2014.

58 For typical returns on investment in North Carolina, see the 2014 testimony of Jonathan Gross in the Avoided Cost docket E-100 Sub 140 of the NCUC, p. 202.

59 Carus, 2013.

60 Carus, 2013.

61 UNEP, 2014; Carus, 2013.

62 UNEP, 2014.

63 SEIA, *U.S. Solar Market Insight,* 2013.

64 "SunEdison yield co nets extra cash from IPO," PV-Tech, July 24, 2014 http://www.pv-tech.org/news/sunedison_yield_co_nets_extra_cash_from_ipo.

65 "Mosaic Awarded $1 Million, Plans International Expansion," *PV News,* Feb. 2014, p. 5.

66 UNEP, 2014.

67 https://joinmosaic.com/solar/north-carolina, last accessed Oct. 8, 2014.

68 RTI International. Economic Impact Analysis of Clean Energy Development in North Carolina – 2014 Update. http://c.ymcdn.com/sites/www.energync.org/resource/resmgr/Resources_Page/NCSEA_econimpact2014.pdf

69 For additional information in racking, see SolarPro Magazine's excellent article, "Utility-Scale PV Ground-Mount Racking Solutions, available at http://solarprofessional.com/articles/design-installation/utility-scale-pv-ground-mount-racking-solutions. For specific rack manufacturers, see http://solarprofessional.com/sites/default/files/articles/ajax/docs/SP7_3_pg25_Table_1.pdf; http://solarprofessional.com/sites/default/files/articles/ajax/docs/SP7_3_pg26_Table_2.pdf.

70 http://www.ncuc.commerce.state.nc.us/reps/reps.htm.

71 http://www.bizjournals.com/charlotte/stories/2009/10/12/daily12.html?page=all.

72 The full list of companies and their tariff rates are available from the U.S. Department of Commerce International Trade Administration link at http://ia.ita.doc.gov/download/factsheets/factsheet_prc-solar-cells-ad-cvd-finals-20121010.pdf.

73 U.S. Department of Commerce, "Fact Sheet: Commerce Finds Dumping and Subsidization of Crystalline Silicon Photovoltaic Cells, Whether or Not Assembled Into Modules From the People's Republic of China," 2012, retrieved from http://enforcement.trade.gov/download/factsheets/factsheet_prc-solar-cells-ad-cvd-finals-20121010.pdf.

74 U.S. Department of Commerce, 2012.

75 U.S. Department of Commerce (undated) "Introduction to U.S. Trade Remedies" http://enforcement.trade.gov/intro/

76 Diane Cardwell, and Keith Bradsher, "U.S. Will Place Tariffs on Chinese Solar Panels," *New York Times,* 11 Oct. 2012. http://www.nytimes.com/2012/10/11/business/global/us-sets-tariffs-on-chinese-solar-panels.html?_r=0.

77 Cardwell and Bradsher, 2012.

78 Diane Cardwell, "U.S. Imposes Steep Tariffs on Importers of Chinese Solar Panels," *New York Times,* 4 June 2014, http://www.nytimes.com/2014/06/04/business/energy-environment/us-imposing-duties-on-some-chinese-solar-panels.html.

79 Diane Cardwell and Keith Bradsher, "Solar Industry Is Rebalanced by U.S. Pressure on China," *New York Times*, 26 July 2014, http://www.nytimes.com/2014/07/26/business/energy-environment/solar-industry-is-rebalanced-by-us-pressure-on-china.html.

80 Ari Phillips, "WTO Calls Out U.S. on Chinese Solar Tariffs But Real Issue Is Manufactured Back Home," *Think Progress,* 2014, http://thinkprogress.org/climate/2014/07/16/3460314/china-us-solar-wto/; Eric Wesoff, "SolarWorld Wins Trade Case, But Faces Sliding Stock, Faulty Lug Recall and More," *GreenTechMedia,* 2014, http://www.greentechmedia.com/articles/read/SolarWorld-Wins-Trade-Case-But-Stock-Slides-Panels-Are-Recalled-and-More.

81 Christian Roseland, "U.S. Lowers Anti-Dumping Tariffs on Taiwanese Solar Cells, Modules," 2014, http://www.pv-magazine.com/news/details/beitrag/us-lowers-anti-dumping-tariffs-on-taiwanese-solar-cells--modules_100016164/#ixzz3G82CpLFc.

82 Roseland, 2014.

83 http://www.ncuc.commerce.state.nc.us/reps/reps.htm provides additional details on the policies governing North Carolina's renewable energy development.

84 NCDOR, "Guidelines for Determining the Tax Credit for Investing in Renewable Energy Property," 2014, retrieved Nov. 4, 2014 from www.dornc.com/taxes/corporate/renewable_energy_credits.pdf.

85 See DSIRE database, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NC19F&re=0&ee=0.

86 Personal communication with Larry Shirley, Duke University Nicholas Institute for Environmental Policy Solutions, November 4, 2014.

87 John Murawski, "Push to End NC's Renewable Energy Program Dies in Committee," *News & Observer,* 24 April, 2013, http://www.newsobserver.com/2013/04/24/2847114_nc-house-committee-defeats-proposal.html.

88 FERC standards apply to transmission, not generation, for "small generators" up to 20MW. However, many states follow FERC standards for interconnection agreements. FERC standards are available at the DSIRE database: http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=US06R&re=1&ee=1.

89 DSIRE database, http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=NC04R&re=1&ee=1.

90 Free the Grid, http://freeingthegrid.org/#state-grades/north-carolina.

91 IREC, 2014. Although the IREC statement was made in reference to commercial installations, it is true too of utility-scale projects.

92 Personal communication with FLS Energy, October 2014.

93 Jensen, T. 2014 "The Solar Industry's Tax Credit Conundrum," Greentech Media, July 21.

94 Jensen, 2014.

95 Honeyman, C. 2014. "Utility-Scale Solar is Back from the Dead" Greentech Media, August 5.

96 The Lawrence Berkeley National Lab report can be found at http://emp.lbl.gov/publications/financial-impacts-net-metered-pv-utilities-and-ratepayers-scoping-study-two-prototypica. Readers should also see Benjamin Paulos, 2014 "Study: Solar Will Cause Some Financial Trouble for U.S. Utilities, But Won't Drive Up Rates," Greentech Media, 25 Sept.

97 *The Economic, Utility Portfolio, and Rate Impact of Clean Energy Development in North Carolina*, prepared by RTI International and LaCapra Associates (2013), and the *Economic Impact Analysis of Clean Energy Development in North Carolina—2014 Update*, prepared by RTI International for the North Carolina Sustainable Energy Association.

AFFIDAVIT

I, Amanda N. Smith, hereby certify that I have sent by first class mail one copy each of the attached notices of public hearings to all adjacent property owners listed hereinbelow pursuant to Section 15.2-2204, Code of Virginia, 1950 as amended.

STATE OF VIRGINIA

COUNTY OF SOUTHAMPTON, to-wit:

Cynthia Jarratt Edwards
Commonwealth of Virginia
Notary Public
Commission No. 7553181
My Commission Expires 01/31/2017

This day, Amanda N. Smith appeared before me, Cynthia Jarratt Edwards, a Notary Public for the County of Southampton and being duly sworn, deposed and said that the above certification is true and correct.

Taken, subscribed and sworn to me this 14th day of September 2016.

My Commission Expires: 1-31 2017.

Cynthia Jarratt Edwards
Notary Public

Tax Map/Parcel #	Name/Address of Adjacent Property Owner
	See Attached

Richard W. Vaughn
136 S Garris Street
Lasker, NC 27845

John Bryant
PO Box 681
Franklin, VA 23851

Fuller Farms of VA LLC
PO Box 129
Newsoms, VA 23874

Larry Felts
30346 Shiloh Road
Boykins, VA 23827

Charles Felts
30365 Vicks Millpond Road
Branchville, VA 23828

Lilly Hawthorne and Lisa Haver
11424 Briarcrest Drive
Richmond, Va 23236

Millard Whitehead Jr.
201 Dogwood Drive
Murfreesboro, NC 27855

Smithview Farms LLC
PO Box 321
Boykins, VA 23827

Town of Boykins
18206 Virginia Avenue
Boykins, VA 23827

SOUTHAMPTON COUNTY
Board of Supervisors
Notice of Public Hearing

Notice is hereby given pursuant to Section(s) 15.2-1427 and 15.2-2204 of the Code of Virginia, 1950, as amended that the Southampton County Board of Supervisors will hold a public hearing on Monday, September 26, 2016 at 7:00 p.m., or as soon thereafter as may be heard, in the Board Room of the Southampton County Office Center at 26022 Administration Center Drive in Courtland, Virginia to consider the following matter:

1. **CPA 2016:01**, Request by Southampton Solar LLC, applicant, on behalf of the following owners: Powell Farms LLC, Powell Farms #2, LLC, SDK Prairie LLC, Lilly Hawthorne and Lisa Haver, Hugh C. Vincent, Jr., Dean Vincent, Charles Felts, Larry Felts, Dennis and Elizabeth Vick, Millard Whitehead, Jr., James and Linda Vick, Smithview Farms LLC, Farm & Food Industries Inc., Betty Stephenson TR, Margaret Murray, Stephen Bryant and Robyn Pickeral, for a Comprehensive Plan Amendment from Agriculture/Forest/Open Space/Rural Residential and Low Density Residential in the Boykins-Branchville-Newsoms Planning Area, to Institutional, on a portion of each of the properties listed below. The properties are in the Boykins Voting and Magisterial Districts and total approximately 3,685 acres. The properties are as follows:
    - Tract A: Tax Parcels 99-6A, 99-19, 99-19A, 100-2, 100-11, 99-19B, west of Meherrin Road (SR 35), north and south of Old Branchville Road (SR 666).
    - Tract B: Tax Parcels 100-34, 100-33A, 100-48, 100-49, 100-50, 101-2, 101-3, 101-4, 101-12, north of General Thomas Highway (SR 671) between Meherrin Road (SR 35) and Three Bees Road (SR 721).
    - Tract C: Tax Parcel 101-1C, northeast side of Three Bees Road (SR 721) approximately 2500' north of its intersection with General Thomas Highway (SR 671).
    - Tract D: Tax Parcel 101-21, north and south of General Thomas Highway (SR 671) 1400' east of its intersection with Three Bees Road (SR 721).
    - Tract E: Tax Parcels 100-52, 100-53, 100-54, 100-56, 101-50, 101-52, 101-53, 101-53A, south of General Thomas Highway (SR 671) between Burnt Reed Road (SR 743) and Odom Chapel Road (SR 716).
    - Tract F: Tax Parcels 112-8 and 113-2, at the intersection of Number 8 Schoolhouse Road (SR 670) and Burnt Reed Road (SR 743).

2. **RZA 2016:04,** Request by Southampton Solar LLC, applicant, on behalf of the owners as listed above (in the notice for CPA 2016:01) for a Zoning Map Amendment from A-1 Agriculture, which permits general agriculture, farming and forestry, and certain residential, institutional, commercial, and industrial uses to CM-2, Conditional General Industrial with conditions to permit a solar power generating facility, and general agriculture, farming, forestry, raising of livestock, and single family dwelling accessory to a farm of ten (10) acres or more on a portion of each of the properties listed above in the notice for CPA

2016:01. The properties are in the Boykins Voting and Magisterial Districts and total approximately 3,685 acres. The properties identified as Tax Parcels 99-6A, 99-19, 99-19A, 100-2, 100-11, 99-19B, 100-34, 100-33A, 101-1C, 101-52, 101-53, 101-53A, 112-8, and 113-2, are all designated "Agriculture, Forestry, Open Space, Rural Residential" in the 2015-2025 Southampton County Comprehensive Plan, and the density range in that classification provides "limited low-density residential development and accessory units may be permitted subject to the current options outlined in the Rural Residential section of the Zoning Ordinance." The properties identified above as Tax Parcels 100-48, 100-49, 100-50, 101-2, 101-3, 101-4, 101-12, 101-21. 100-52, 100-53, 100-54, 100-56, 101-50, are all designated "Low Density Residential" in the 2015-2025 Southampton County Comprehensive Plan with a density range of (1) to (3) units per developable acre. The properties are all listed above in the notice for CPA 2016:01.

3. **CUP 2016:05**, Request by Southampton Solar LLC, applicant, on behalf of the owners as listed above for a Conditional Use Permit to construct a solar power generating facility per Southampton Code Sec. 18-313(38) on a portion of each of the properties listen in item 1 above. The properties are in the Boykins Voting and Magisterial Districts and total approximately 3,685 acres. The properties are as listed above.

4. **CPA 2016:02**, Request by GEENEX c/o Jürgen Fehr, applicant, on behalf of Richard W. Vaughn, owner, for a Comprehensive Plan Amendment from Agriculture/Forest/Open Space/Rural Residential in the Boykins-Branchville-Newsoms Planning Area to Institutional. The properties are located in the general area of 31118 Meherrin Road, Boykins, are generally located on both side of Meherrin Road (SR 35) between General Thomas Highway (SR 671) and Lassiters Drive, a private road, and total approximately 422.72 acres. The properties include Tax Parcels 100-14, 100-14C, 100-14D, 100-31, 100-31A, 100-31B, 100-31C, and 100-31D and are located in the Boykins Voting and Magisterial Districts.

5. **RZA 2016:05**, Request by GEENEX c/o Jürgen Fehr, applicant, on behalf of Richard W. Vaughn, owner, for a Zoning Map Amendment from A-1, Agriculture, which permits general agriculture, farming and forestry, and certain residential, institutional, commercial, and industrial uses to CM-2, Conditional General Industrial with conditions to construct a solar power generating facility and general agriculture, farming and forestry and single family dwelling ancillary to general agriculture on a portion of each of the properties referenced in item 4 above (CPA 2016:02). The properties are located in the general area of 31118 Meherrin Road, Boykins, are generally located on both side of Meherrin Road (SR 35) between General Thomas Highway (SR 671) and Lassiters Drive, a private road, and total approximately 422.72 acres. The properties identified as Tax Parcels 100-14, 100-14C, 100-14D, 100-31, 100-31A, 100-31B, 100-31C and 100-31D are all designated "Agriculture, Forestry, Open Space, Rural Residential" in the 2015-2025 Southampton County Comprehensive Plan, and the density range

in that classification provides "limited low-density residential development and accessory units may be permitted subject to the current options outlined in the Rural Residential section of the Zoning Ordinance." The properties are all listed above in item number 4 (CPA 2016:02) and are located in the Boykins Voting and Magisterial Districts.

6. **CUP 2016:06**, Request by GEENEX c/o Jürgen Fehr, applicant, on behalf of Richard W. Vaughn, owner, for a Conditional Use Permit to construct a solar power generating facility under Section 18-313(38) of the Southampton County Code. The properties are located in the general area of 31118 Meherrin Road, Boykins, are generally located on both side of Meherrin Road (SR 35) between General Thomas Highway (SR 671) and Lassiters Drive, a private road, and total approximately 422.72 acres. The properties include Tax Parcels 100-14, 100-14C, 100-14D, 100-31, 100-31, 100-31A, 100-31B, 100-31C, and 100-31D and are located in the Boykins Voting and Magisterial Districts.

7. **RZA 2016:06,** Request by The Curtis Group, Inc., applicant, on behalf of The Cheroenhaka (Nottoway) Indian Tribal Heritage Foundation, owner, for a zoning map amendment from A-2, Agricultural to A-1, Agricultural for Tax Parcel 75-12E. The property is approximately 100 acres in size, is located at 27345 Old Bridge Road, Courtland, and is located approximately 1,100 feet south of the intersection of Old Bridge Road (SR 742) and Southampton Parkway (US 58) The property is in the Franklin Voting and Magisterial Districts.

8. **CUP 2016:07,** Request by The Curtis Group, Inc., applicant, on behalf of The Cheroenhaka (Nottoway) Indian Tribal Heritage Foundation, owner, for a Conditional Use Permit to establish a sand mining operation to provide material for the construction of the interchange located at Bus 58 and US 58 in Courtland. The property is known as Tax Parcel 75-12E. The property is approximately 100 acres in size, with approximately 8.54 acres to be used for mineral extraction. The property is located at 27345 Old Bridge Road, Courtland, and is located approximately 1,100 feet south of the intersection of Old Bridge Road (SR 742) and Southampton Parkway (US 58) The property is in the Franklin Voting and Magisterial Districts.

Information associated with these matters is on file and available for public inspection in the County Administrator's office, 26022 Administration Center Drive, Courtland, Virginia during normal office hours of 8:30 a.m. to 5:00 p.m., Monday through Friday.

Any person desiring to be heard on these matters should appear at the time and place referenced herein above and offer his or her comments to the Board of Supervisors.

The hearing is held at a public facility designed to be accessible to persons with disabilities. Any persons with questions on the accessibility of the facility or need for reasonable accommodations should contact Michael W. Johnson, Clerk, at (757) 653-

3015. Persons needing interpreter services for the deaf must notify Mr. Johnson at least seven (7) days in advance of the hearing.

Southampton County Board of Supervisors
Michael W. Johnson, Clerk