



**SPower Solar Facility  
Special Use Permit Proposal SUP18-0001**

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December 5, 2018

Via email delivery: PWhite@spotsylvania.va.us

Patrick White  
Spotsylvania County Planning Department  
9019 Old Battlefield Blvd., Suite 320  
Spotsylvania, VA 22553

Re: SUP Application for Sustainable Property Holdings, LLC a.k.a. sPower  
Solar Facility SUP18-0001

Dear Patrick:

I hope this finds you well. Below is our response to the Staff Report for the December 5, 2018 Planning Commission hearing, regarding the above referenced matter. Please consider this response as a supplement to the pending application referenced above. Please feel free to contact me if you have any questions regarding our response.

With regard to the Recommendation for Plans (V. 1 through 4), the Applicant is preparing these items and will immediately submit to the County upon completion.

With regard to the County staff's proposed conditions, the Applicant accepts most of the proposed conditions, with the exception of the following:

**A. General**

9. Any lighting on the Property not included in or expressly exempted from the Spotsylvania County ordinances shall be located, screened or shielded so that adjacent residential lots and adjacent roads are not directly illuminated and shall not exceed 0.5 footcandles at the Property boundary.

**Applicant Response: We believe construction lighting was not intended to be limited for the purposes expressed above and respectfully request this be clarified. Please note the following suggested edits:**

*"9. During the operations phase of the Project, any lighting on the Property not included in or expressly exempted from the Spotsylvania County ordinances shall be located, screened or shielded so that adjacent residential lots and adjacent roads*

*are not directly illuminated and shall not exceed 0.5 footcandles at the Property boundary.”*

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## **B. Construction**

6. Entrances 2 and 8 as depicted on the GDP page EX-2-2 shall be restricted access for employees and light deliveries only. Vehicles with more than two axels are prohibited from using these entrances.

**Applicant Response:** We agree to a certain extent as these entrances must be able to also accept light and other deliveries. However, in order to address what we believe to be the underlying concern, we propose restricting access to any wide load deliveries. Please also note these access points include private access easements. In this regard, we have been in communication with the underlying property owners and they are comfortable with our proposed planning. **Please note the following suggested edits:**

*“6. Entrances 2 and 8 as depicted on the GDP page EX-2-2 shall be restricted access for employees and deliveries only, and no wide load deliveries shall be allowed at these entrances.”*

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7. All construction activity on the Property shall be limited to the following:
  - a) All clearing, grading, and construction of the Property shall be limited to the hours of 7:00 a.m. to 7:00 p.m. Monday through Friday and 8:00 a.m. to 6:00 p.m. Saturday and Sunday;

**Applicant Response:** We propose an adjustment to earlier hours to address the ability to start early during the summer months and keep a regular start time on the weekends. **Please note the following suggested edits:**

*“a) All clearing, grading, and construction of the Property shall be limited to the hours of 6:00 a.m. to 7:00 p.m. Monday through Friday and 7:00 a.m. to 6:00 p.m. Saturday and Sunday;”*

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11. Construction staging areas, parking areas, and solid waste collection areas shall be set back a minimum of 500 feet from any property containing a residential structure and, if such an area is located within 1,000 feet from a residential structure, then the area shall be shielded from view, and shall employ sound dampening shrouds, barriers, fencing, and/or berms to reduce noise impacts.

**Applicant Response:** We cannot accept this condition as written and respectfully request it be amended. This condition would unreasonably retrain our ability to move fluidly throughout the site which creates inefficiencies in timing to complete the project. I believe it

is all of our goals to complete the construction process as soon as reasonably possible, which also reduces any impacts on surrounding property owners. Thus, we suggest the following edits:

*“Construction staging areas, parking areas, and solid waste collection areas shall be set back a minimum of 500 feet from any adjoining residential structure and all portable sanitation facilities will be screened from any adjoining residential property owner’s view into the Project area.”*

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12. Portable sanitation facilities shall be set back a minimum of 1,000 feet from the perimeter boundaries of the Property.

**Applicant Response:** Given our comments above, we believe this condition should be deleted.

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14. The Applicant shall post surety for the estimated cost of repairs to public roads at 120% of the approved Applicant’s engineer’s estimate prior to issuance of a land disturbing permit based on an estimate reviewed and approved by the County’s Transportation Planner, currently Doug Morgan, and VDOT.

**Applicant Response:** As it is not reasonably possible to estimate the amount of potential future damage, and since the referenced public roads are owned and maintained by VDOT, we propose this condition be amended as follows:

*“14. The Applicant shall post surety for the estimated cost of repairs to public roads in accordance with VDOT’s permitting requirements.”*

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15. Any pavement damage to roads, including shoulders and aprons, attributable to construction of the Facility shall be repaired by the Applicant within 120 days of issuance of the final Certificate of Occupancy for the Facility at the Applicant’s expense or within forty eight (48) hours after receiving notice from the County’s Transportation Planner that the damage has made a road unsafe.

**Applicant Response:** We believe the above edits to #14 address this issue and suggest deleting this condition.

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### **C. Erosion and Sediment Control**

1. Stormwater Conveyance Channels and Sediment Basins
  - c. Sediment basins shall be equipped with measuring devices to accurately determine the sediment capacity of the basin. Sediment shall be removed from basins when accumulation reaches 25% of the required wet storage volume for

each individual basin. In no case shall sediment cleanout levels be higher than one (1) foot below the bottom of the de-watering device. Remediation crews shall be of sufficient size to remove sediment or to be able to correct any ESC issues within 24 hours. Remediation crews shall consist of a minimum five (5) member team including one (1) foreman, two (2) equipment operators, and two (2) laborers, with equipment as needed, per 200-acre disturbance area. The daily presence of these crews shall be indicated in the monitoring report. When Sediment Basins or traps are cleaned out the intended use and location of that material shall be indicated in the monitoring report.

**Applicant Response:** The time period of 24 hours will be very difficult to accomplish and believe more reasonable to conform to the time periods established by applicable State and County requirements. Also, to conform with other conditions, we propose one crew per 400-acre area. **We suggest the following minor edits:**

*1. Stormwater Conveyance Channels and Sediment Basins*

*“c. Sediment basins shall be equipped with measuring devices to accurately determine the sediment capacity of the basin. Sediment shall be removed from basins when accumulation reaches 25% of the required wet storage volume for each individual basin. In no case shall sediment cleanout levels be higher than one (1) foot below the bottom of the de-watering device. **Remediation crews shall be of sufficient size to remove sediment in accordance with applicable county and state requirements.** Remediation crews shall consist of a minimum five (5) member team including one (1) foreman, two (2) equipment operators, and two (2) laborers, with equipment as needed, per **400**-acre disturbance area. The daily presence of these crews shall be indicated in the monitoring report. When Sediment Basins or traps are cleaned out the intended use and location of that material shall be indicated in the monitoring report.”*

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2. Monitoring and Reporting

- a. The Project shall have one Responsible Land Disturber (“RLD”) and at least one certified Erosion Control Inspector (“ECI”) per land-disturbing activity area. These land-disturbing activity areas shall not exceed 400 acres in aggregate at any one time. . The RLD and ECI shall both be required to be knowledgeable of environmental permit compliance requirements, be experienced in ESC and Storm Water Management (“SWM”) Best Management Practice (“BMP”) installation, operation, and maintenance requirements. The RLD will also keep a daily log of activity documenting all Facility activities, including, but not limited to, construction, related to environmental permit compliance and corrective measures implemented, site visitors (i.e. non-project staff), a waterbody and wetland crossing log, and ESC installation and maintenance activities.

**Applicant Response:** In accordance with our prior conversations on this matter and to ensure efficient construction sequences, we must be able to undertake land-disturbing

activity in two watersheds at any one time. We propose allowing land-disturbing activity to be conducted in 400 acres, in each of two watersheds, as follows:

2. *Monitoring and Reporting*

*“a. The Project shall have one Responsible Land Disturber (“RLD”) and at least one certified Erosion Control Inspector (“ECI”) per land-disturbing activity area. These land-disturbing activity areas shall not exceed 400 acres per watershed, within any two watersheds at any one time. Once the disturbance area has been temporarily or permanently stabilized, it will not count towards the 400 acre per watershed threshold. The RLD and ECI shall both be required to be knowledgeable of environmental permit compliance requirements, be experienced in ESC and Storm Water Management (“SWM”) Best Management Practice (“BMP”) installation, operation, and maintenance requirements. The RLD will also keep a daily log of activity documenting all Facility activities, including, but not limited to, construction, related to environmental permit compliance and corrective measures implemented, site visitors (i.e. non-project staff), a waterbody and wetland crossing log, and ESC installation and maintenance activities.”*

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- d. Water quality testing shall occur through the use of a stream gauge, which collects data on rainfall, turbidity and sediment loads, and pollutant loads. These gauges shall be placed at each intake and discharge point on the site, as determined by the Program Administrator. The testing shall be reported in a monthly Water Quality Discharge Report which shall provide a summary of marginal increases or decreases of the measurements.

**Applicant Response:** We believe this condition is unreasonable and we propose it be deleted especially given all of the other on-site and outside monitoring and reporting occurring with this Project.

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3. Site Stabilization Conditions

- a. Windrows or slope breaks shall be constructed interior to array fields using soil or mulch to reduce runoff velocity and sediment. Windrows or berms shall be a minimum six (6) inches in height above final grading. Windrows shall be installed parallel to slope with a maximum spacing of 200 feet, or as needed based on slope. Windrows or berms shall be maintained during site stabilization process and may remain during operation.

**Applicant Response:** Per discussions with County, we propose the following minor edits:

3. Site Stabilization Conditions

*“a. Windrows, **filter socks** or slope breaks shall be constructed interior to array fields using soil, **organic material**, or mulch to reduce runoff velocity and sediment. **These devices shall be a minimum six (6) inches in height above final grading. These***

*devices shall be installed parallel to slope with a maximum spacing of 200 feet, or as needed based on slope **and drainage area**. These devices or berms shall be maintained during site stabilization process and may remain during operation.”*

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- c. Sediment barriers shall be inspected daily by the Applicant in accordance with Virginia Erosion and Sediment Control Program (“VESCP”) and VSMP guidelines to identify any damage incurred during construction and after each runoff-producing rainfall as defined in C.2.c herein. The inspection reports shall be emailed to the Program Administrator within 24 hours of a qualifying rainfall event. Sediment barriers that are not functioning properly must be cleaned out and restored to good working condition or replaced immediately.

**Applicant Response: Daily inspections are not required and we propose to modify this condition to remove that timing and we will comply with VESCP and VSMP guidelines. Please note the following:**

*“c. Sediment barriers shall be **inspected in accordance** with Virginia Erosion and Sediment Control Program (“VESCP”) and VSMP guidelines to identify any damage incurred during construction and after each runoff-producing rainfall as defined in C.2.c herein. The inspection reports shall be emailed to the Program Administrator within 24 hours of a qualifying rainfall event. Sediment barriers that are not functioning properly must be cleaned out and restored to good working condition or replaced immediately.”*

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- d. All disturbed soils shall be stabilized within seven (7) days after final grade is reached on any portion of the site. Seed mixes used for permanent stabilization shall provide self-propagating, low maintenance groundcover that will minimize erosion and sedimentation while providing wildlife and pollinator habitat benefits.

**Applicant Response: We propose the following minor edits:**

*“d. All disturbed soils shall be **seeded and temporarily stabilized** within seven (7) days after final grade is reached on any portion of the site. Seed mixes used for permanent stabilization shall provide self-propagating, low maintenance groundcover that will minimize erosion and sedimentation while providing wildlife and pollinator habitat benefits.”*

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- f. Slopes 33% (3:1) or steeper shall be stabilized with steep slope soil stabilization blankets or erosion control fabric, such as bonded fiber blankets or jute thatching. The blanket shall be nontoxic to vegetation and to the germination of seed and shall be entwined and anchored to the slope.

**Applicant Response:** Certain slopes may not need blankets or fabric, depending on time of the year and/or location of the slope. We propose making this condition “as applicable.”

*“f. Slopes 33% (3:1) or steeper shall be stabilized with steep slope soil stabilization blankets or erosion control fabric, such as bonded fiber blankets or jute thatching. The blanket shall be nontoxic to vegetation and to the germination of seed and shall be entwined and anchored to the slope. When seeding is planned to be done during optimal growing seasons (spring and fall), the contractor may elect to not utilize matting on steep slopes. If seeding does not germinate enough to stabilize the slope, matting shall be applied to steep slopes.”*

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**D. Burning and Fire, Rescue, and Emergency Management (FREM)**

2. The burning of timber waste shall be done only if via open pit incineration using an incinerator such as, but not limited to, an Airburner 3000. The burning of waste other than timber waste is prohibited. Open pit incineration shall be done in accordance with the above-referenced Emergency Management Plan - Construction, except that any open pit incineration shall be set back a minimum of 3,000 feet from any boundary line of the Property.

**Applicant Response:** We propose reducing the distance to 2,000 feet from any residence, not property line, which is still a greater distance than the basic County requirements and the same distance required from schools, nursing homes and hospitals. As per County regulations, we will not be allowed to burn from May through September.

*“2. The burning of timber waste shall be done only if via open pit incineration using an incinerator such as, but not limited to, an Airburner 3000. The burning of waste other than timber waste is prohibited. Open pit incineration shall be done in accordance with the above-referenced Emergency Management Plan - Construction, except that any open pit incineration shall be set back a minimum of 2,000 feet from any residential dwelling.”*

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7. Access road aggregate material shall be placed in accordance with the requirements of the applicable specifications governing the type of material or construction being used and shall be compacted at optimum moisture, within  $\pm$  two (2) percentage points of optimum per Appendix C of VDOT’s Road & Bridge Specifications. These access roads shall further be designed and constructed to International Code Council Section 503 for adequate FREM access.

**Applicant Response:** This is very confusing and not sure what county staff is recommending here. These are private roads within the Project. The Applicant, prior to site plan stage and

**in conjunction with FREM, will identify the access areas and roads within the Project that FREM will utilize in the case of an emergency. Please note the following suggested edits:**

*“7. The Applicant, prior to site plan approval and in conjunction with FREM, will identify access areas into the Project and internal roads to be utilized by FREM in responding to an emergency. Such access and internal roads will be designed and constructed to International Code Council Section 503 for adequate FREM access.”*

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8. All internal crossings shall be permanent and be designed to a minimum of FAST Act standards for EV2 and EV3 class vehicles, with a rating defined as H-20 per the VDOT IIM-S&B-86.1 guidance document.

**Applicant Response: Again, a little confused as to what is being recommended here and believe the above suggested edits address this issue.**

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9. The Applicant shall install and maintain video cameras throughout the Facility to provide comprehensive remote surveillance of the entire Facility. The cameras shall be monitored 24 hours a day by the Applicant for potential security, hazard, and general maintenance concerns. These camera feeds shall be recorded and recordings shall be retained a minimum of six (6) months and shall be made available upon request by the County Fire Marshal or the County Sheriff.

**Applicant Response: This should be clarified as follows:**

*“9. **During operations**, the Applicant shall install and maintain video cameras throughout the Facility to provide comprehensive remote surveillance of the entire Facility. The cameras shall be monitored 24 hours a day by the Applicant for potential security, hazard, and general maintenance concerns. These camera feeds shall be recorded and recordings shall be retained a minimum of six (6) months and shall be made available upon request, and in accordance with applicable law, by the County Fire Marshal or the County Sheriff. **During the construction phase of the Project**, the Applicant will also maintain security personnel on site in accordance with the Applicant’s construction management planning.”*

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11. A minimum eight (8) foot wide fire break shall be maintained within the Property between the arrays, inverters, and generators and the Property boundary. Portions of the fire break that are vegetative shall be mowed and maintained to a height of four (4) inches or less.

**Applicant Response: The seed chosen, and discussed with the County, is meant to be grown to twenty-four inches tall not four inches. This would create significant maintenance hurdles and is inconsistent with how other similar facilities are operated. Please note the following suggested edits:**

*“11. A minimum eight (8) foot wide fire break shall be maintained within the Property between the arrays, inverters, and generators and the Property boundary. Portions of the fire break that are vegetative shall be mowed and maintained to a height of twenty-four (24) inches or less.”*

**E. Setbacks and Buffers**

1. Inverters and generators shall be set back a minimum of 400 feet from the boundary of the Property.

**Applicant Response:** We propose this be changed to 400 feet from the boundary of any existing residential property, to accommodate for the substation.

*“1. Inverters and generators shall be set back a minimum of 400 feet from the boundary of any existing residential property adjoining the Project and not to include any accessory use to said residence.”*

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2. No structure, improvement, or equipment, including but not limited to, solar arrays and supporting structures, shall be located within 350 feet of any property on which a residence is currently located. This shall not apply to construction or maintenance equipment, which is temporary in nature, during the periods when it is actively being used during construction or maintenance activities.

**Applicant Response:** This uniform requirement is simply not possible given the various configurations of the Projects and boundaries for the same. We suggest the following all with the priority of ensuring screening and buffering from the facility:

*“2. No structure or equipment, including but not limited to the solar arrays and supporting structures (collectively the “Facilities”), shall be located within 350 feet of any adjoining property boundary on which a residence (to exclude accessory use areas) is currently located. This shall not apply to construction or maintenance equipment, which is temporary in nature, during the periods when it is actively being used during construction or maintenance activities. Notwithstanding anything to the contrary under this condition, in the event the Facilities are located closer than the aforesaid 350 foot set-back, but in no event shall the set-back be less than 100 feet, the Applicant, subject to county approval, shall provide adequate shielding to include any of the following: berming, additional plantings and/or maintaining natural vegetation in accordance with the Applicant’s approved landscaping and buffering plan.”*

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6. Buffer plantings shall be planted in accordance with the GDP’s Landscaping Plan except that:

- a) Residential structures adjacent to the Property, which are not separated from the Property by a minimum of forty (40) feet of the Applicant’s preserved woodlands, and which are located 300 feet or less from the Property’s

- boundary shall be screened with a bermed buffer consisting of a minimum eight (8) foot high earthen berm planted with a minimum of one (1) evergreen tree with a minimum height of six (6) feet every ten (10) feet, one (1) large deciduous tree with a minimum trunk caliper of two (2) inches measured six (6) inches from the ground every fifteen (15) feet, one (1) understory deciduous tree with a minimum trunk caliper of two (2) inches measured six (6) inches from the ground every fifteen (15) feet, one (1) evergreen shrub with a minimum height of four (4) feet every ten (10) feet.
- b) Residential structures located 300 feet or less from the Property boundary which are separated from the Property by a minimum of forty (40) feet of the Applicant's preserved woodlands, or residential structures located 600 feet or less from the Property's boundary, or adjacent to VDOT right-of-way, shall be screened with a buffer consisting a minimum of one (1) evergreen tree with a minimum height of six (6) feet every fifteen (15) feet and one (1) large deciduous tree with a minimum trunk caliper of two (2) inches measured six (6) inches from the ground every ten (10) feet.
  - c) At site plan, all buffers shall be designed by a certified landscape designer or landscape architect to minimize visibility, maximize survivability, and minimize losses from deer or other wildlife consumption.
  - d) Landscape berms installed shall have a minimum six (6) foot planting area on top of the berm. Berms shall not exceed a slope of (1) one foot of vertical rise to two (2) feet of horizontal distance.
  - e) Plantings shall be placed atop, or outside of any landscape berm, relative to the interior of the Property boundary.
  - f) Landscape berms shall be located outside of any fencing, relative to the interior of the Property boundary.
  - g) Landscape berms shall be installed with each phase of the Facility's development during site grading and prior to the driving of pilings within 1,000 feet of the required berm.

**Applicant Response: Subject to proposed changes to Section E.2, we recommend deleting this condition as it will be captured in E.2, as well as the landscape buffering plan recommended in Section V. Recommendation and Conditions #1.**

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#### **F. Biological**

- 4. Fertilizers shall not contain phosphorus, unless they contain non-leaching phosphorus.

**Applicant Response: We propose this be modified to reflect this is in accordance with County requirements and will apply after stabilization, as phosphorus may be necessary to aid in stabilization.**

*"4. After the Applicant has finalized stabilization for the Project, fertilizers shall not contain phosphorus, unless they contain non-leaching phosphorus."*

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5. Pesticides shall be limited to biorational pesticides that target mosquitoes.

**Applicant Response: In the case that pesticides are necessary to address other pests, we propose to remove the reference to mosquitoes.**

*“5. Pesticides shall be limited to biorational pesticides.”*

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### **G. Cultural**

2. The Applicant shall grant trail easements for future trail development for the segments of the Virginia Central Railroad, Po River, Todds Tavern Spur, and Lake Anna State Park Connector located on the site, as depicted on GDP page Ex-2-3. The easements shall be granted to the County at no cost pursuant to the County’s Trailways Master Plan. The Applicant will strive not to obstruct the trail easements with barriers including, but not limited to, fences and locked gates. In the event obstructions are present, the County will work with the Applicant to address any obstructed area(s) at the time the trail is constructed. The trail easements, consistent with the County’s DSM, shall be granted within six (6) months of the issuance of the Certificate of Occupancy for the Facility. The trail easements granted shall in no way legally or practically encumber the County’s or other party’s ability to construct or utilize the easements for the segments of the Virginia Central Railroad, Po River, Todds Tavern Spur, and Lake Anna State Park Connector located on the site, as depicted on GDP page Ex-2-3 as determined by County Staff.

**Applicant Response: The Applicant will strive not to obstruct the easements and will review with County at site plan stage. We propose this be modified as shown below to address any area(s) that may require obstructions.**

*“2. The Applicant shall grant trail easements for future trail development for the segments of the Virginia Central Railroad, Po River, Todds Tavern Spur, and Lake Anna State Park Connector located on the site, as depicted on GDP page Ex-2-3. The easements shall be granted to the County at no cost pursuant to the County’s Trailways Master Plan. **The Applicant will strive not to obstruct the trail easements with barriers including, but not limited to, fences and locked gates. In the event obstructions are present, the County will work with the Applicant to address any obstructed area(s) at the time the trail is constructed.** The trail easements, consistent with the County’s DSM, shall be granted within six (6) months of the issuance of the Certificate of Occupancy for the Facility. The trail easements granted shall in no way legally or practically encumber the County’s or other party’s ability to construct or utilize the easements for the segments of the Virginia Central Railroad, Po River, Todds Tavern Spur, and Lake Anna State Park Connector located on the site, as depicted on GDP page Ex-2-3 as determined by County Staff.”*

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We appreciate your time and attention to this matter. Please feel free to contact me with any questions and/or comments.

Respectfully,



Charles W. Payne, Jr

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## V. Recommendation and Conditions

### A. General:

1. The solar energy facility (“Facility”) to be developed on current Tax Parcels 28-A-1, 28-A-78, 29-A-1, 17-A-7, 18-A-16, 30-A-1, 17-5-19, 17-A-3, 17-A-3A, 17-A-4, 17-A-48, 16-A-1, 17-A-47, 18-A-15, 18-A-20, 28-A-71, 28-A-77, 29-A-2, 29-A-2A, 29A-22, 29-A-24, 29-A-25, 29-A-26, 29-A-27, 29-A-28, 29-A-7 north of West Catharpin Road, and 28-A-79 (the “Property”) pursuant to special use permit SUP18-0001, shall be developed in conformance with the Generalized Development Plan titled “Generalized Development Plans Spotsylvania Solar Energy Center A Special Use Permit—SUP 18-0001 Livingston Magisterial District Spotsylvania County, VA”, dated March 14, 2018, as last revised November 20, 2018 (“GDP”) which is attached hereto and incorporated herein by reference. To the extent that the conditions herein are contrary to the GDP, the conditions herein shall supersede the GDP and control.
2. This Special Use Permit is issued to Sustainable Property Holdings, LLC (“Applicant”). The Applicant is wholly owned or is otherwise controlled by its parent company FTP Power, LLC, also known as sPower. These conditions shall bind any and all owners, occupants, and users of the Property. All bonding or posting of sureties for the project shall be by and in the name of the parent company, FTP Power, LLC and the then current owner of the Property.
3. The Applicant shall maintain liability insurance at industry standards throughout the construction and operation of the Facility and proof of same shall be submitted annually, the first business day of January, to the Spotsylvania County Zoning Administrator (“Zoning Administrator”), currently Troy Tignor.
4. Access to the Property and the Facility for inspections or monitoring by the County, including its employees, agents and representatives, shall be provided to any of these parties within 24 hours of the date and time written notice is provided to the Applicant.
5. The storage of electricity utilizing chemical batteries on the Property is prohibited.
6. The use of biosolids on the Property is prohibited.
7. Vehicle speeds within the Property and any privately-owned access roads and easements leading to the Property shall be restricted to a maximum of fifteen (15) miles per hour.
8. Inverters and solar panels, measured from the grade of the ground on which the structure sits to their highest possible point, shall not exceed a height of fifteen (15) feet.
9. During the operations phase of the Project, any lighting on the Property not included in or expressly exempted from the Spotsylvania County ordinances shall be located, screened or shielded so that adjacent residential lots and adjacent roads are not directly illuminated and shall not exceed 0.5 footcandles at the Property boundary.
10. The Applicant shall perform soil screenings for cadmium and other heavy metals prior to construction as a baseline in accordance with the Virginia Department of Environmental Quality (DEQ) requirements and pursuant to the recommendations set out in the Engineering Review #1 report prepared by Dewberry Engineers, Inc., dated November 26, 2018, which is attached hereto and incorporated herein by reference.

11. A sealed dry-waste container shall be maintained at the Facility for the disposal of any damaged solar panels.

B. Construction:

5. Construction and operational traffic shall only use the access points to the Property identified on the GDP.
6. Entrances 2 and 8 as depicted on the GDP page EX-2-2 shall be restricted access for employees and deliveries only, and no wide load deliveries shall be allowed at these entrances.
7. All construction activity on the Property shall be limited to the following:
  - a) All clearing, grading, and construction of the Property shall be limited to the hours of 6:00 a.m. to 7:00 p.m. Monday through Friday and 7:00 a.m. to 6:00 p.m. Saturday and Sunday;
  - b) Pile driving within 500 feet of any residence shall cease at 5:00 p.m. daily and shall be prohibited all day on every first and third Sunday of the month; and
  - c) Wide load deliveries are prohibited on Orange Plank Road, West Catharpin Road, and Post Oak Road during prime school bus traffic hours of 6:10 a.m. - 8:40 a.m. and 2:45 p.m. - 4:30 p.m., or any amendment thereof due to inclement weather, during the Spotsylvania County Public Schools instructional year. "Wide Load" shall be defined as any load which extends beyond the painted lines on any public right of way either extending into the shoulder or across the center line or both.
8. The Applicant shall designate at least one public liaison and publicize a toll-free phone number and email address for communication with the liaison in the Free Lance-Star biweekly during construction. The liaison shall act as a point of contact between citizens and construction crews. The liaison shall be available in person and by phone during active construction hours and shall respond to any questions related to the Facility or Property. The liaison role shall commence prior to issuance of a land-disturbing permit and remain a minimum of six (6) months following issuance of the final Certificate of Occupancy for the Facility. The liaison shall prepare a monthly report detailing the complaint, complaint date, resolution, and resolution date. The report shall be provided to the Zoning Administrator on the first business day of each month throughout the construction period and an additional six (6) months following issuance of the final Certificate of Occupancy for the Facility.
9. Advance notice shall be mailed by first class mail to properties within 1,000 feet of a pile driving location no less than seven (7) days prior to the start of such activities and shall include the estimated start date, estimated end date, and the liaison's contact information. The notice and a list of recipient addresses shall also be mailed to the Zoning Administrator.
10. The following noise-reducing practices shall be followed to reduce construction noise:
  - a) Trucks and engine-powered equipment shall include mufflers and engine shrouds no less effective than those originally installed by the manufacturer;
  - b) Trucks and engine-powered equipment shall be maintained in proper tune according to manufacturers' specifications;
  - c) Truck engine exhaust braking shall be limited to emergencies; and

- d) The use of noise-producing signals, including horns, whistles, alarms, and bells shall be for safety warning purposes only.
- 11. Construction staging areas, parking areas, and solid waste collection areas shall be set back a minimum of 500 feet from any adjoining residential structure and all portable sanitation facilities will be screened from any adjoining residential property owner's view into the Project area.
- 12. Intentionally deleted.
- 13. The Applicant shall participate in a Joint Construction Traffic Reaction Team, which shall also include County Staff and Virginia Department of Transportation (VDOT), to identify and expeditiously resolve or mitigate traffic issues that arise during the construction phase.
- 14. The Applicant shall post surety for the estimated cost of repairs to public roads in accordance with VDOT's permitting requirements.
- 15. Intentionally deleted.
- 16. Wildlife corridors shall be established through the preservation of on-site RPA's and the supplementation of raised wildlife-compatible fencing in order to establish a minimum of three (3) passages, each of which each shall cross the entirety of the site to allow small wildlife unimpeded passage through the Facility, including:
  - a. Raised wildlife-compatible fencing shall be used to connect the Whitehall Creek RPA, to the isolated wetland immediately west, to the intermittent stream further west on GDP page EX 1-7.
  - b. Raised wildlife-compatible fencing shall be used to connect the Shanty Bridge Creek Stream with the two unnamed streams to the south, opposite of the enclosed array area on GDP page EX 1-5.

### C. Erosion and Sediment Control

Unless specifically defined in this Section C, all terms and abbreviations used herein shall be as defined in Spotsylvania County Code of Ordinances, Chapters 6A, 8, and 19A.

- 1. Stormwater Conveyance Channels and Sediment Basins
  - a. Stormwater conveyance channels ("SCC") and diversion ditches shall be designed for permanent stormwater control and shall utilize check dams or weirs to control sediment transport. Rock check dams shall be installed in SCC immediately following construction and the establishment of final grade. Check dams shall be installed per the Virginia Erosion and Sediment Control Handbook (VESCH) or per Virginia Department of Transportation (VDOT) detail EC-4 standards and details as applicable. Check dams should be evaluated for sediment accumulation after each runoff-producing storm event and remediated as necessary to maintain function.
  - b. SCC, vegetated swales, or diversion dikes shall be installed to divert overland sheet flow or shallow concentrated flow to a stabilized outlet or a sediment trapping facility during construction. When used at the top of a slope, the structure shall protect exposed slopes by diverting storm run-off away from the slopes to a stabilized outlet or sediment trapping device. When used at the base of a slope, the SCC shall protect downslope areas by diverting sediment-laden runoff to a sediment-trapping facility or stabilized outlet.

- c. Sediment basins shall be equipped with measuring devices to accurately determine the sediment capacity of the basin. Sediment shall be removed from basins when accumulation reaches 25% of the required wet storage volume for each individual basin. In no case shall sediment cleanout levels be higher than one (1) foot below the bottom of the de-watering device. Remediation crews shall be of sufficient size to remove sediment in accordance with applicable State and County requirements. Remediation crews shall consist of a minimum five (5) member team including one (1) foreman, two (2) equipment operators, and two (2) laborers, with equipment as needed, per 400-acre disturbance area. The daily presence of these crews shall be indicated in the monitoring report. When Sediment Basins or traps are cleaned out the intended use and location of that material shall be indicated in the monitoring report.
- d. Erosion and Sediment Control (“ESC”) measures shall be installed as a first step in any land disturbing activity area and shall be made functional before upslope land disturbance takes place. Unless subject to stricter standards set out herein, all ESC measures shall at a minimum comply with VESCH and VDOT standards and details as applicable. Unless subject to stricter standards set out herein, the overall ESC plan shall comply with VESCH minimum standards.

## 2. Monitoring and Reporting

- a. The Project shall have one Responsible Land Disturber (“RLD”) and at least one certified Erosion Control Inspector (“ECI”) per land-disturbing activity area. These land-disturbing activity areas shall not exceed 400 acres per watershed, within any two watersheds at any one time. Once the disturbance area has been temporarily or permanently stabilized, it will not count towards the 400 acre per watershed threshold. The RLD and ECI shall both be required to be knowledgeable of environmental permit compliance requirements, be experienced in ESC and Storm Water Management (“SWM”) Best Management Practice (“BMP”) installation, operation, and maintenance requirements. The RLD will also keep a daily log of activity documenting all Facility activities, including, but not limited to, construction, related to environmental permit compliance and corrective measures implemented, site visitors (i.e. non-project staff), a waterbody and wetland crossing log, and ESC installation and maintenance activities.
- b. The RLD shall provide e-reporting to a central File Transfer Protocol (“FTP”) site that the Erosion and Sediment Control / Virginia Stormwater Management Program Administrator (“Program Administrator”), currently Troy Tignor, shall be granted access to. Reports will be submitted no later than next day following any inspections and shall include the inspection report for each disturbed area of development. Site inspections and reports shall be conducted and reported at a minimum as required by the Virginia Stormwater Management Program (“VSMP”) permit. Any corrective actions done in the field shall be e-mailed to the Program Administrator within 24 hours of completion.
- c. Post-rainfall event inspections shall be required for any runoff-producing event (equal to or greater than 0.25 inches of rain within a 24-hour time

period) and shall be maintained on site and logged in an e-report uploaded to a central FTP server that the Program Administrator shall be granted access to. Inspectors shall evaluate erosion control measures and sediment basins to determine if maintenance is required. Any remediation that is required shall be performed immediately and reported to the Program Administrator within 24 hours.

d. Intentionally deleted.

### 3. Site Stabilization Conditions

- a. Windrows, filter socks, or slope breaks shall be constructed interior to array fields using soil, organic material, or mulch to reduce runoff velocity and sediment. These devices shall be a minimum six (6) inches in height above final grading. These devices shall be installed parallel to slope with a maximum spacing of 200 feet, or as needed based on slope and drainage area. These devices or berms shall be maintained during site stabilization process and may remain during operation.
- b. Sediment barriers such as silt fences, mulch berms, or brush barriers shall be used to temporarily intercept and detain small amounts of sediment from disturbed areas of limited extent and to decrease the velocity of sheet flows. Temporary sediment barriers shall be installed at the base of slopes adjacent to road crossings until disturbed vegetation has been reestablished.
- c. Sediment barriers shall be inspected in accordance with Virginia Erosion and Sediment Control Program (“VESCP”) and VSMP guidelines to identify any damage incurred during construction and after each runoff-producing rainfall as defined in C.2.c herein. The inspection reports shall be emailed to the Program Administrator within 24 hours of a qualifying rainfall event. Sediment barriers that are not functioning properly must be cleaned out and restored to good working condition or replaced immediately.
- d. All disturbed soils shall be seeded and temporarily stabilized within seven (7) days after final grade is reached on any portion of the site. Seed mixes used for permanent stabilization shall provide self-propagating, low maintenance groundcover that will minimize erosion and sedimentation while providing wildlife and pollinator habitat benefits.
- e. Drill seeding shall be used as the primary mechanism for installation of seed. In areas where access is limited, hydroseed or spraying of seed is an approved method of application. In areas that are drill seeded, mulch shall not exceed a depth which inhibits germination, as field-determined. All seeding installation, bed preparations, seed mixes, lime, fertilizer, and mulch shall meet VESCH minimum standards and specifications for permanent and/or temporary seeding as applicable.
- f. Slopes 33% (3:1) or steeper shall be stabilized with steep slope soil stabilization blankets or erosion control fabric, such as bonded fiber blankets or jute thatching. The blanket shall be nontoxic to vegetation and to the germination of seed and shall be entwined and anchored to the slope. When seeding is planned to be done during optimal growing seasons (spring and fall), the contractor may elect to not utilize matting on steep slopes. If seeding does not germinate enough to stabilize the slope, matting shall be applied to steep slopes.

#### D. Burning and Fire, Rescue, and Emergency Management (FREM)

1. The Applicant shall follow the policies and procedures contained in the “Emergency Management Plan – Construction”, prepared by sPower and dated November 19, 2018, attached hereto and incorporated herein throughout the course of the Facility’s construction.
2. The burning of timber waste shall be done only if via open pit incineration using an incinerator such as, but not limited to, an Airburner 3000. The burning of waste other than timber waste is prohibited. Open pit incineration shall be done in accordance with the above-referenced Emergency Management Plan - Construction, except that any open pit incineration shall be set back a minimum of 2,000 feet from any residential dwelling.
3. The Applicant shall use all due diligence to use or dispose of mulched timber waste off site prior to pit incineration.
4. The Applicant shall follow the policies and procedures contained in the “Emergency Response Plan – Operations”, prepared by sPower dated November 19, 2018 attached hereto and incorporated herein
5. The Applicant shall follow the policies and procedures contained in the “Site Specific Safety Plan – Construction”, prepared by sPower and dated November 19, 2018 attached hereto and incorporated herein.
6. The Applicant shall install signage within the Facility and provide a Wayfinding Map, that shows each road segment within the Facility with a designated name and/or identifier and each array with an individual identifier, to the Fire Chief, currently Jay Cullinan, prior to the approval of any site plan or land disturbing permit.
7. The Applicant, prior to site plan approval and in conjunction with FREM, will identify access areas into the Project and internal roads to be utilized by FREM in responding to an emergency. Such access and internal roads will be designed and constructed to International Code Council Section 503 for adequate FREM access.
8. Intentionally deleted.
9. During operations, the Applicant shall install and maintain video cameras throughout the Facility to provide comprehensive remote surveillance of the entire Facility. The cameras shall be monitored 24 hours a day by the Applicant for potential security, hazard, and general maintenance concerns. These camera feeds shall be recorded and recordings shall be retained a minimum of six (6) months and shall be made available upon request, and in accordance with applicable law, by the County Fire Marshal or the County Sheriff. During the construction phase of the Project, the Applicant will also maintain security personnel on site in accordance with the Applicant’s construction management planning.
10. Two (2) 50,000 gallon water tanks shall be located on the Property and those tanks shall provide off-site access for FREM use in an emergency at a location approved by the Fire Chief. The tanks shall remain fifty (50) percent full at all times in order to serve potential FREM needs.
11. A minimum eight (8) foot wide fire break shall be maintained within the Property between the arrays, inverters, and generators and the Property boundary. Portions of

the fire break that are vegetative shall be mowed and maintained to a height of twenty-four (24) inches or less.

E. Setbacks and Buffers:

1. Inverters and generators shall be set back a minimum of 400 feet from the boundary of any existing residential property adjoining the Project and not to include any accessory use to said residence.
2. No structure or equipment, including but not limited to the solar arrays and supporting structures (collectively the “Facilities”), shall be located within 350 feet of any adjoining property boundary on which a residence (to exclude accessory use areas) is currently located. This shall not apply to construction or maintenance equipment, which is temporary in nature, during the periods when it is actively being used during construction or maintenance activities. Notwithstanding anything to the contrary under this condition, in the event the Facilities are located closer than the aforesaid 350 foot set-back, but in no event shall the set-back be less than 100 feet, the Applicant, subject to county approval, shall provide adequate shielding to include any of the following: berming, additional plantings and/or maintaining natural vegetation in accordance with the Applicant’s approved landscaping and buffering plan.
3. The minimum setback of any structure, improvement, or equipment, including but not limited to, inverters, generators, and solar arrays and supporting structures, from any VDOT right-of-way shall be fifty (50) feet. This shall not apply to construction and maintenance equipment which is temporary in nature during the periods when it is actively being used during construction or maintenance activities.
4. Fencing, berms, landscaping, access roads, bridges, above-ground utility poles are exempt from these setbacks.
5. No trees shall be removed from any fifty (50) foot setback area or fifty (50) foot preserved buffer as shown on the GDP except for the removal of non-native species (which is anything not included in the native species list in the County’s Design Standards Manual (DSM)), hand-clearing for safety or the removal of dead or dying trees, or any clearing necessary for ingress/egress or infrastructure connectivity.
6. Intentionally deleted.

F. Biological:

1. A minimum of a four (4) person landscaping team with necessary equipment, supplemented by additional staffing and equipment as needed during high growth rate periods, shall minimize uncontrolled and/or undesired growth.
2. Herbicide use shall be limited to non-residual herbicides that break down in the soil within fourteen (14) days.
3. Herbicides and fertilizers shall be applied following manufacturers specifications and shall not be applied during rain, when wind speed exceeds ten (10) miles per hour, or within fifty (50) feet of any surface water body.
4. After the Applicant has finalized stabilization for the Project, fertilizers shall not contain phosphorus, unless they contain non-leaching phosphorus.
5. Pesticides shall be limited to biorational pesticides.
6. Only biodegradable soap and water may be used for cleaning of solar panels during operation of the Facility.

7. Soil samples shall be taken during the first year of the Facility's operations at a minimum of fifty (50) locations spaced equally on a grid pattern across the Property. The samples shall be analyzed for constituents indicative of agricultural productivity. The data shall be provided to the Zoning Administrator within 120 days of collection. When the Facility is decommissioned, the soil shall be resampled at the same locations. Any significant difference that may, in the opinion of County Staff, adversely affect agricultural productivity shall be remediated during decommissioning by the Applicant at its sole cost.
8. No disturbance shall occur within the identified potential Small Whorled Pogonia Suitable Habitat and high-visibility fencing shall be placed coincident with this area clearing identifying that the area as protected.
9. The Applicant shall ensure employees are trained to identify the Loggerhead shrike and the Northern long-eared bat, and be instructed to contact the Virginia Department of Game and Inland Fisheries should either species be spotted.

#### G. Cultural:

1. No land disturbance is to occur within 100 feet of the cemeteries identified on GDP pages EX-1-4 and EX-1-6 and high-visibility fencing shall be placed coincident with this buffer clearly identifying the area as protected.
2. The Applicant shall grant trail easements for future trail development for the segments of the Virginia Central Railroad, Po River, Todds Tavern Spur, and Lake Anna State Park Connector located on the site, as depicted on GDP page Ex-2-3. The easements shall be granted to the County at no cost pursuant to the County's Trailways Master Plan. The Applicant will strive not to obstruct the trail easements with barriers including, but not limited to, fences and locked gates. In the event obstructions are present, the County will work with the Applicant to address any obstructed area(s) at the time the trail is constructed. The trail easements, consistent with the County's DSM, shall be granted within six (6) months of the issuance of the Certificate of Occupancy for the Facility. The trail easements granted shall in no way legally or practically encumber the County's or other party's ability to construct or utilize the easements for the segments of the Virginia Central Railroad, Po River, Todds Tavern Spur, and Lake Anna State Park Connector located on the site, as depicted on GDP page Ex-2-3 as determined by County Staff.

#### H. Water:

1. The Applicant shall only utilize public water during the construction and operations phases of the Facility, except in the event that sufficient public water is not available to the Applicant, in which event the Applicant may utilize ground water during the construction phase only.
2. Any connection by the Applicant to the public water system for bulk use (greater than a single 3/4" meter) shall be controlled by the Utilities Department in a manner that will not negatively impact the existing distribution system. Said connection shall include a pressure sustaining function and flow control function, with the setting of those functions at the discretion and direct control of Spotsylvania County Utilities. The County does not guarantee any volume of bulk withdrawal available to the Applicant
3. Bulk withdrawal from a connection to the existing public water system shall be limited to between the hours of 10 p.m. and 4 a.m. with a maximum volume usage

of 69,000 gallons/day from October to April and 56,000 gallons/day May to September.

4. Bulk withdrawal from a connection to an upgraded public water system shall be limited to between the hours of 10 p.m. and 4 a.m. with a maximum volume usage of 166,000 gallons/day from October to April and 153,000 gallons/day from May to September. Upgraded public water system referenced above shall be defined as increasing the water transmission main size from 12 inches to 16 inches from the existing Lake Bottom Booster Station to the main 12 inch loop feed within the Fawn Lake Subdivision. This will include all appurtenances (i.e. fire hydrants, pressure reduction valves, etc.) as required by Spotsylvania County Utilities Department.
5. The cumulative on-site ground water withdrawal shall be limited to a maximum of 50,000 gallons per day and for no more than ten (10) days per calendar month during the construction phase.
  - a) No additional wells shall be allowed other than those already permitted by VDH;
  - b) All wells shall be equipped with meters to track water withdrawal;
  - c) Meters for each well shall be read and the total withdrawal amount documented by the Applicant each day that the facility is under construction; and
  - d) Monitoring reports shall be created by the Applicant for each well and shall track the meter readings, calculating daily, weekly, and monthly withdrawals.
    1. Monitoring reports shall include any prior month(s) withdraws, and information from the reports shall not be deleted from any subsequent monthly report;
    2. Monitoring reports shall be updated by the Applicant daily and provided to the Zoning Administrator on the fifth (5<sup>th</sup>) business day of each month documenting the daily water draw for each well during the prior month;
    3. A monitoring report shall be provided by the Applicant within one (1) business day upon receipt of written request by the Zoning Administrator and shall contain the cumulative prior months usage with updated figures, including the date prior to the Zoning Administrator's request; and
    4. Virginia Department of Health (VDH) permitted abandonment of a well will end the monitoring requirement for that specific well. If a well is abandoned as permitted by VDH, no water shall be drawn from that abandoned well.
  - e) Water quality samples shall be collected from the site monitoring well network before well withdrawal commences to document background conditions and then collected biannually thereafter. The water samples shall be measured for turbidity, temperature, pH, and specific conductivity. The reports shall be provided to the Zoning Administrator within five (5) business days of preparation.

## V. Recommendation and Conditions

### A. General:

1. The solar energy facility (“Facility”) to be developed on current Tax Parcels 28-A-1, 28-A-78, 29-A-1, 17-A-7, 18-A-16, 30-A-1, 17-5-19, 17-A-3, 17-A-3A, 17-A-4, 17A-48, 16-A-1, 17-A-47, 18-A-15, 18-A-20, 28-A-71, 28-A-77, 29-A-2, 29-A-2A, 29A-22, 29-A-24, 29-A-25, 29-A-26, 29-A-27, 29-A-28, 29-A-7 north of West Catharpin Road, and 28-A-79 (the “Property”) pursuant to special use permit SUP18-0001, shall be developed in conformance with the Generalized Development Plan titled “Generalized Development Plans Spotsylvania Solar Energy Center A Special Use Permit—SUP 18-0001 Livingston Magisterial District Spotsylvania County, VA”, dated March 14, 2018, as last revised November 20, 2018 (“GDP”) which is attached hereto and incorporated herein by reference. To the extent that the conditions herein are contrary to the GDP, the conditions herein shall supersede the GDP and control.
2. This Special Use Permit is issued to Sustainable Property Holdings, LLC (“Applicant”). The Applicant is wholly owned or is otherwise controlled by its parent company FTP Power, LLC, also known as sPower. These conditions shall bind any and all owners, occupants, and users of the Property. All bonding or posting of sureties for the project shall be by and in the name of the parent company, FTP Power, LLC and the then current owner of the Property.
3. The Applicant shall maintain liability insurance at industry standards throughout the construction and operation of the Facility and proof of same shall be submitted annually, the first business day of January, to the Spotsylvania County Zoning Administrator (“Zoning Administrator”), currently Troy Tignor.
4. Access to the Property and the Facility for inspections or monitoring by the County, including its employees, agents and representatives, shall be provided to any of these parties within 24 hours of the date and time written notice is provided to the Applicant.
5. The storage of electricity utilizing chemical batteries on the Property is prohibited.
6. The use of biosolids on the Property is prohibited.
7. Vehicle speeds within the Property and any privately-owned access roads and easements leading to the Property shall be restricted to a maximum of fifteen (15) miles per hour.
8. Inverters and solar panels, measured from the grade of the ground on which the structure sits to their highest possible point, shall not exceed a height of fifteen (15) feet.
9. ~~Any~~ During the operations phase of the Project, any lighting on the Property not included in or expressly exempted from the Spotsylvania County ordinances shall be located, screened or shielded so that adjacent residential lots and adjacent roads are not directly illuminated and shall not exceed 0.5 footcandles at the Property boundary.
10. The Applicant shall perform soil screenings for cadmium and other heavy metals prior to construction as a baseline in accordance with the Virginia Department of Environmental Quality (DEQ) requirements and pursuant to the recommendations set out in the Engineering Review #1 report prepared by Dewberry Engineers, Inc., dated November 26, 2018, which is attached hereto and incorporated herein by reference.

11. A sealed dry-waste container shall be maintained at the Facility for the disposal of any damaged solar panels.

B. Construction:

5. Construction and operational traffic shall only use the access points to the Property identified on the GDP.
6. Entrances 2 and 8 as depicted on the GDP page EX-2-2 shall be restricted access for employees and light deliveries only. ~~Vehicles with more than two axels are prohibited from using these,~~ and no wide load deliveries shall be allowed at these entrances.
7. All construction activity on the Property shall be limited to the following:
  - a) All clearing, grading, and construction of the Property shall be limited to the hours of ~~7~~6:00 a.m. to 7:00 p.m. Monday through Friday and ~~8~~7:00 a.m. to 6:00 p.m. Saturday and Sunday;
  - b) Pile driving within 500 feet of any residence shall cease at 5:00 p.m. daily and shall be prohibited all day on every first and third Sunday of the month; and
  - c) Wide load deliveries are prohibited on Orange Plank Road, West Catharpin Road, and Post Oak Road during prime school bus traffic hours of 6:10 a.m. - 8:40 a.m. and 2:45 p.m. - 4:30 p.m., or any amendment thereof due to inclement weather, during the Spotsylvania County Public Schools instructional year. "Wide Load" shall be defined as any load which extends beyond the painted lines on any public right of way either extending into the shoulder or across the center line or both.
8. The Applicant shall designate at least one public liaison and publicize a toll-free phone number and email address for communication with the liaison in the Free Lance-Star biweekly during construction. The liaison shall act as a point of contact between citizens and construction crews. The liaison shall be available in person and by phone during active construction hours and shall respond to any questions related to the Facility or Property. The liaison role shall commence prior to issuance of a land-disturbing permit and remain a minimum of six (6) months following issuance of the final Certificate of Occupancy for the Facility. The liaison shall prepare a monthly report detailing the complaint, complaint date, resolution, and resolution date. The report shall be provided to the Zoning Administrator on the first business day of each month throughout the construction period and an additional six (6) months following issuance of the final Certificate of Occupancy for the Facility.
9. Advance notice shall be mailed by first class mail to properties within 1,000 feet of a pile driving location no less than seven (7) days prior to the start of such activities and shall include the estimated start date, estimated end date, and the liaison's contact information. The notice and a list of recipient addresses shall also be mailed to the Zoning Administrator.
10. The following noise-reducing practices shall be followed to reduce construction noise:
  - a) Trucks and engine-powered equipment shall include mufflers and engine shrouds no less effective than those originally installed by the manufacturer;
  - b) Trucks and engine-powered equipment shall be maintained in proper tune according to manufacturers' specifications;

- c) Truck engine exhaust braking shall be limited to emergencies; and
  - d) The use of noise-producing signals, including horns, whistles, alarms, and bells shall be for safety warning purposes only.
11. Construction staging areas, parking areas, and solid waste collection areas shall be set back a minimum of 500 feet from any ~~property containing a~~adjoining residential structure and, ~~if such an area is located within 1,000 feet from a residential structure, then the area shall be shielded from view, and shall employ sound dampening shrouds, barriers, fencing, and/or berms to reduce noise impacts~~ all portable sanitation facilities will be screened from any adjoining residential property owner's view into the Project area.
  12. ~~Portable sanitation facilities shall be set back a minimum of 1,000 feet from the perimeter boundaries of the Property.~~Intentionally deleted.
  13. The Applicant shall participate in a Joint Construction Traffic Reaction Team, which shall also include County Staff and Virginia Department of Transportation (VDOT), to identify and expeditiously resolve or mitigate traffic issues that arise during the construction phase.
  14. The Applicant shall post surety for the estimated cost of repairs to public roads ~~at 120% of the approved Applicant's engineer's estimate prior to issuance of a land disturbing permit based on an estimate reviewed and approved by the County's Transportation Planner, currently Doug Morgan, and~~ in accordance with VDOT's permitting requirements.
  15. ~~Any pavement damage to roads, including shoulders and aprons, attributable to construction of the Facility shall be repaired by the Applicant within 120 days of issuance of the final Certificate of Occupancy for the Facility at the Applicant's expense or within forty eight (48) hours after receiving notice from the County's Transportation Planner that the damage has made a road unsafe.~~Intentionally deleted.
  16. Wildlife corridors shall be established through the preservation of on-site RPA's and the supplementation of raised wildlife-compatible fencing in order to establish a minimum of three (3) passages, each of which each shall cross the entirety of the site to allow small wildlife unimpeded passage through the Facility, including:
    - a. Raised wildlife-compatible fencing shall be used to connect the Whitehall Creek RPA, to the isolated wetland immediately west, to the intermittent stream further west on GDP page EX 1-7.
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### C. Erosion and Sediment Control

Unless specifically defined in this Section C, all terms and abbreviations used herein shall be as defined in Spotsylvania County Code of Ordinances, Chapters 6A, 8, and 19A.

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Control Handbook (VESCH) or per Virginia Department of Transportation (VDOT) detail EC-4 standards and details as applicable. Check dams should be evaluated for sediment accumulation after each runoff-producing storm event and remediated as necessary to maintain function.

- b. SCC, vegetated swales, or diversion dikes shall be installed to divert overland sheet flow or shallow concentrated flow to a stabilized outlet or a sediment trapping facility during construction. When used at the top of a slope, the structure shall protect exposed slopes by diverting storm run-off away from the slopes to a stabilized outlet or sediment trapping device. When used at the base of a slope, the SCC shall protect downslope areas by diverting sediment-laden runoff to a sediment-trapping facility or stabilized outlet.
- c. Sediment basins shall be equipped with measuring devices to accurately determine the sediment capacity of the basin. Sediment shall be removed from basins when accumulation reaches 25% of the required wet storage volume for each individual basin. In no case shall sediment cleanout levels be higher than one (1) foot below the bottom of the de-watering device. Remediation crews shall be of sufficient size to remove sediment ~~or to be able to correct any ESC issues within 24 hours~~ in accordance with applicable State and County requirements. Remediation crews shall consist of a minimum five (5) member team including one (1) foreman, two (2) equipment operators, and two (2) laborers, with equipment as needed, per ~~200~~400-acre disturbance area. The daily presence of these crews shall be indicated in the monitoring report. When Sediment Basins or traps are cleaned out the intended use and location of that material shall be indicated in the monitoring report.
- d. Erosion and Sediment Control (“ESC”) measures shall be installed as a first step in any land disturbing activity area and shall be made functional before upslope land disturbance takes place. Unless subject to stricter standards set out herein, all ESC measures shall at a minimum comply with VESCH and VDOT standards and details as applicable. Unless subject to stricter standards set out herein, the overall ESC plan shall comply with VESCH minimum standards.

## 2. Monitoring and Reporting

- a. The Project shall have one Responsible Land Disturber (“RLD”) and at least one certified Erosion Control Inspector (“ECI”) per land-disturbing activity area. These land-disturbing activity areas shall not exceed 400 acres ~~in aggregate~~ per watershed, within any two watersheds at any one time. Once the disturbance area has been temporarily or permanently stabilized, it will not count towards the 400 acre per watershed threshold. The RLD and ECI shall both be required to be knowledgeable of environmental permit compliance requirements, be experienced in ESC and Storm Water Management (“SWM”) Best Management Practice (“BMP”) installation, operation, and maintenance requirements. The RLD will also keep a daily log of activity documenting all Facility activities, including, but not limited to, construction, related to environmental permit compliance and corrective measures

implemented, site visitors (i.e. non-project staff), a waterbody and wetland crossing log, and ESC installation and maintenance activities.

- b. The RLD shall provide e-reporting to a central File Transfer Protocol (“FTP”) site that the Erosion and Sediment Control / Virginia Stormwater Management Program Administrator (“Program Administrator”), currently Troy Tignor, shall be granted access to. Reports will be submitted no later than next day following any inspections and shall include the inspection report for each disturbed area of development. Site inspections and reports shall be conducted and reported at a minimum as required by the Virginia Stormwater Management Program (“VSMP”) permit. Any corrective actions done in the field shall be e-mailed to the Program Administrator within 24 hours of completion.
- c. Post-rainfall event inspections shall be required for any runoff-producing event (equal to or greater than 0.25 inches of rain within a 24-hour time period) and shall be maintained on site and logged in an e-report uploaded to a central FTP server that the Program Administrator shall be granted access to. Inspectors shall evaluate erosion control measures and sediment basins to determine if maintenance is required. Any remediation that is required shall be performed immediately and reported to the Program Administrator within 24 hours.
- d. ~~Water quality testing shall occur through the use of a stream gauge, which collects data on rainfall, turbidity and sediment loads, and pollutant loads. These gauges shall be placed at each intake and discharge point on the site, as determined by the Program Administrator. The testing shall be reported in a monthly Water Quality Discharge Report which shall provide a summary of marginal increases or decreases of the measurements. Intentionally deleted.~~

### 3. Site Stabilization Conditions

- a. Windrows, filter socks, or slope breaks shall be constructed interior to array fields using soil, organic material, or mulch to reduce runoff velocity and sediment. ~~Windrows or berms~~ These devices shall be a minimum six (6) inches in height above final grading. ~~Windrows~~ These devices shall be installed parallel to slope with a maximum spacing of 200 feet, or as needed based on slope. ~~Windrows and drainage area. These devices~~ or berms shall be maintained during site stabilization process and may remain during operation.
- b. Sediment barriers such as silt fences, mulch berms, or brush barriers shall be used to temporarily intercept and detain small amounts of sediment from disturbed areas of limited extent and to decrease the velocity of sheet flows. Temporary sediment barriers shall be installed at the base of slopes adjacent to road crossings until disturbed vegetation has been reestablished.
- c. Sediment barriers shall be inspected ~~daily by the Applicant~~ in accordance with Virginia Erosion and Sediment Control Program (“VESCP”) and VSMP guidelines to identify any damage incurred during construction and after each runoff-producing rainfall as defined in C.2.c herein. The inspection reports shall be emailed to the Program Administrator within 24 hours of a qualifying rainfall event. Sediment barriers that are not functioning properly

must be cleaned out and restored to good working condition or replaced immediately. ▯

- d. All disturbed soils shall be seeded and temporarily stabilized within seven (7) days after final grade is reached on any portion of the site. Seed mixes used for permanent stabilization shall provide self-propagating, low maintenance groundcover that will minimize erosion and sedimentation while providing wildlife and pollinator habitat benefits.
- e. Drill seeding shall be used as the primary mechanism for installation of seed. In areas where access is limited, hydroseed or spraying of seed is an approved method of application. In areas that are drill seeded, mulch shall not exceed a depth which inhibits germination, as field-determined. All seeding installation, bed preparations, seed mixes, lime, fertilizer, and mulch shall meet VESCH minimum standards and specifications for permanent and/or temporary seeding as applicable.
- f. Slopes 33% (3:1) or steeper shall be stabilized with steep slope soil stabilization blankets or erosion control fabric, such as bonded fiber blankets or jute thatching. The blanket shall be nontoxic to vegetation and to the germination of seed and shall be entwined and anchored to the slope. When seeding is planned to be done during optimal growing seasons (spring and fall), the contractor may elect to not utilize matting on steep slopes. If seeding does not germinate enough to stabilize the slope, matting shall be applied to steep slopes.

#### D. Burning and Fire, Rescue, and Emergency Management (FREM)

1. The Applicant shall follow the policies and procedures contained in the “Emergency Management Plan – Construction”, prepared by sPower and dated November 19, 2018, attached hereto and incorporated herein throughout the course of the Facility’s construction.
2. The burning of timber waste shall be done only if via open pit incineration using an incinerator such as, but not limited to, an Airburner 3000. The burning of waste other than timber waste is prohibited. Open pit incineration shall be done in accordance with the above-referenced Emergency Management Plan - Construction, except that any open pit incineration shall be set back a minimum of ~~3,000~~2,000 feet from any ~~boundary line of the Property~~residential dwelling.
3. The Applicant shall use all due diligence to use or dispose of mulched timber waste off site prior to pit incineration.
4. The Applicant shall follow the policies and procedures contained in the “Emergency Response Plan – Operations”, prepared by sPower dated November 19, 2018 attached hereto and incorporated herein
5. The Applicant shall follow the policies and procedures contained in the “Site Specific Safety Plan – Construction”, prepared by sPower and dated November 19, 2018 attached hereto and incorporated herein.
6. The Applicant shall install signage within the Facility and provide a Wayfinding Map, that shows each road segment within the Facility with a designated name and/or identifier and each array with an individual identifier, to the Fire Chief,

currently Jay Cullinan, prior to the approval of any site plan or land disturbing permit.

7. ~~Access road aggregate material shall be placed in accordance with the requirements of the applicable specifications governing the type of material or construction being used and shall be compacted at optimum moisture, within  $\pm$  two (2) percentage points of optimum per Appendix C of VDOT's Road & Bridge Specifications. These~~ The Applicant, prior to site plan approval and in conjunction with FREM, will identify access areas into the Project and internal roads to be utilized by FREM in responding to an emergency. Such access and internal roads shall further will be designed and constructed to International Code Council Section 503 for adequate FREM access.
8. ~~All internal crossings shall be permanent and be designed to a minimum of FAST Act standards for EV2 and EV3 class vehicles, with a rating defined as H-20 per the VDOT IIM S&B 86.1 guidance document.~~ Intentionally deleted.
9. ~~The~~ During operations, the Applicant shall install and maintain video cameras throughout the Facility to provide comprehensive remote surveillance of the entire Facility. The cameras shall be monitored 24 hours a day by the Applicant for potential security, hazard, and general maintenance concerns. These camera feeds shall be recorded and recordings shall be retained a minimum of six (6) months and shall be made available upon request, and in accordance with applicable law, by the County Fire Marshal or the County Sheriff. During the construction phase of the Project, the Applicant will also maintain security personnel on site in accordance with the Applicant's construction management planning.
10. Two (2) 50,000 gallon water tanks shall be located on the Property and those tanks shall provide off-site access for FREM use in an emergency at a location approved by the Fire Chief. The tanks shall remain fifty (50) percent full at all times in order to serve potential FREM needs.
11. A minimum eight (8) foot wide fire break shall be maintained within the Property between the arrays, inverters, and generators and the Property boundary. Portions of the fire break that are vegetative shall be mowed and maintained to a height of twenty-four (24) inches or less.

#### E. Setbacks and Buffers:

1. Inverters and generators shall be set back a minimum of 400 feet from the boundary of ~~the Property~~ any existing residential property adjoining the Project and not to include any accessory use to said residence.
2. No structure, ~~improvement,~~ or equipment, including but not limited to, ~~the~~ solar arrays and supporting structures (collectively the "Facilities"), shall be located within 350 feet of any adjoining property boundary on which a residence (to exclude accessory use areas) is currently located. This shall not apply to construction or maintenance equipment, which is temporary in nature, during the periods when it is actively being used during construction or maintenance activities. Notwithstanding anything to the contrary under this condition, in the event the Facilities are located closer than the aforesaid 350 foot set-back, but in no event shall the set-back be less than 100 feet, the Applicant, subject to county approval, shall provide adequate shielding to include any of the following: berming, additional plantings and/or

[maintaining natural vegetation in accordance with the Applicant's approved landscaping and buffering plan.](#)

3. The minimum setback of any structure, improvement, or equipment, including but not limited to, inverters, generators, and solar arrays and supporting structures, from any VDOT right-of-way shall be fifty (50) feet. This shall not apply to construction and maintenance equipment which is temporary in nature during the periods when it is actively being used during construction or maintenance activities.
4. Fencing, berms, landscaping, access roads, bridges, above-ground utility poles are exempt from these setbacks.
5. No trees shall be removed from any fifty (50) foot setback area or fifty (50) foot preserved buffer as shown on the GDP except for the removal of non-native species (which is anything not included in the native species list in the County's Design Standards Manual (DSM)), hand-clearing for safety or the removal of dead or dying trees, or any clearing necessary for ingress/egress or infrastructure connectivity.
- ~~6. Buffer plantings shall be planted in accordance with the GDP's Landscaping Plan except that:
  - a) Residential structures adjacent to the Property, which are not separated from the Property by a minimum of forty (40) feet of the Applicant's preserved woodlands, and which are located 300 feet or less from the Property's boundary shall be screened with a bermed buffer consisting of a minimum eight (8) foot high earthen berm planted with a minimum of one (1) evergreen tree with a minimum height of six (6) feet every ten (10) feet, one (1) large deciduous tree with a minimum trunk caliper of two (2) inches measured six (6) inches from the ground every fifteen (15) feet, one (1) understory deciduous tree with a minimum trunk caliper of two (2) inches measured six (6) inches from the ground every fifteen (15) feet, one (1) evergreen shrub with a minimum height of four (4) feet every ten (10) feet.
  - b) Residential structures located 300 feet or less from the Property boundary which are separated from the Property by a minimum of forty (40) feet of the Applicant's preserved woodlands, or residential structures located 600 feet or less from the Property's boundary, or adjacent to VDOT right of way, shall be screened with a buffer consisting a minimum of one (1) evergreen tree with a minimum height of six (6) feet every fifteen (15) feet and one (1) large deciduous tree with a minimum trunk caliper of two (2) inches measured six (6) inches from the ground every ten (10) feet.
  - c) At site plan, all buffers shall be designed by a certified landscape designer or landscape architect to minimize visibility, maximize survivability, and minimize losses from deer or other wildlife consumption.
  - d) Landscape berms installed shall have a minimum six (6) foot planting area on top of the berm. Berms shall not exceed a slope of (1) one foot of vertical rise to two (2) feet of horizontal distance.
  - e) Plantings shall be placed atop, or outside of any landscape berm, relative to the interior of the Property boundary.
  - f) Landscape berms shall be located outside of any fencing, relative to the interior of the Property boundary.~~

- ~~6. g) Landscape berms shall be installed with each phase of the Facility's development during site grading and prior to the driving of pilings within 1,000 feet of the required berm. Intentionally deleted.~~

F. Biological:

1. A minimum of a four (4) person landscaping team with necessary equipment, supplemented by additional staffing and equipment as needed during high growth rate periods, shall minimize uncontrolled and/or undesired growth.
2. Herbicide use shall be limited to non-residual herbicides that break down in the soil within fourteen (14) days.
3. Herbicides and fertilizers shall be applied following manufacturers specifications and shall not be applied during rain, when wind speed exceeds ten (10) miles per hour, or within fifty (50) feet of any surface water body.
4. ~~Fertilizers~~After the Applicant has finalized stabilization for the Project, fertilizers shall not contain phosphorus, unless they contain non-leaching phosphorus.
5. Pesticides shall be limited to biorational pesticides ~~that target mosquitoes.~~
6. Only biodegradable soap and water may be used for cleaning of solar panels during operation of the Facility.
7. Soil samples shall be taken during the first year of the Facility's operations at a minimum of fifty (50) locations spaced equally on a grid pattern across the Property. The samples shall be analyzed for constituents indicative of agricultural productivity. The data shall be provided to the Zoning Administrator within 120 days of collection. When the Facility is decommissioned, the soil shall be resampled at the same locations. Any significant difference that may, in the opinion of County Staff, adversely affect agricultural productivity shall be remediated during decommissioning by the Applicant at its sole cost.
8. No disturbance shall occur within the identified potential Small Whorled Pogonia Suitable Habitat and high-visibility fencing shall be placed coincident with this area clearing identifying that the area as protected.
9. The Applicant shall ensure employees are trained to identify the Loggerhead shrike and the Northern long-eared bat, and be instructed to contact the Virginia Department of Game and Inland Fisheries should either species be spotted.

G. Cultural:

1. No land disturbance is to occur within 100 feet of the cemeteries identified on GDP pages EX-1-4 and EX-1-6 and high-visibility fencing shall be placed coincident with this buffer clearly identifying the area as protected.
2. The Applicant shall grant trail easements for future trail development for the segments of the Virginia Central Railroad, Po River, Todds Tavern Spur, and Lake Anna State Park Connector located on the site, as depicted on GDP page Ex-2-3. The easements shall be granted to the County at no cost pursuant to the County's Trailways Master Plan. The Applicant will strive not to obstruct the trail easements ~~shall not be obstructed by~~with barriers including, but not limited to, fences and locked gates. In the event obstructions are present, the County will work with the Applicant to address any obstructed area(s) at the time the trail is constructed. The trail easements, consistent with the County's DSM, shall be granted within six (6) months of the issuance of the Certificate of Occupancy for the Facility. The trail

easements granted shall in no way legally or practically encumber the County's or other party's ability to construct or utilize the easements for the segments of the Virginia Central Railroad, Po River, Todds Tavern Spur, and Lake Anna State Park Connector located on the site, as depicted on GDP page Ex-2-3 as determined by County Staff.

H. Water:

1. The Applicant shall only utilize public water during the construction and operations phases of the Facility, except in the event that sufficient public water is not available to the Applicant, in which event the Applicant may utilize ground water during the construction phase only.
2. Any connection by the Applicant to the public water system for bulk use (greater than a single  $\frac{3}{4}$ " meter) shall be controlled by the Utilities Department in a manner that will not negatively impact the existing distribution system. Said connection shall include a pressure sustaining function and flow control function, with the setting of those functions at the discretion and direct control of Spotsylvania County Utilities. The County does not guarantee any volume of bulk withdrawal available to the Applicant
3. Bulk withdrawal from a connection to the existing public water system shall be limited to between the hours of 10 p.m. and 4 a.m. with a maximum volume usage of 69,000 gallons/day from October to April and 56,000 gallons/day May to September.
4. Bulk withdrawal from a connection to an upgraded public water system shall be limited to between the hours of 10 p.m. and 4 a.m. with a maximum volume usage of 166,000 gallons/day from October to April and 153,000 gallons/day from May to September. Upgraded public water system referenced above shall be defined as increasing the water transmission main size from 12 inches to 16 inches from the existing Lake Bottom Booster Station to the main 12 inch loop feed within the Fawn Lake Subdivision. This will include all appurtenances (i.e. fire hydrants, pressure reduction valves, etc.) as required by Spotsylvania County Utilities Department.
5. The cumulative on-site ground water withdrawal shall be limited to a maximum of 50,000 gallons per day and for no more than ten (10) days per calendar month during the construction phase.
  - a) No additional wells shall be allowed other than those already permitted by VDH;
  - b) All wells shall be equipped with meters to track water withdrawal;
  - c) Meters for each well shall be read and the total withdrawal amount documented by the Applicant each day that the facility is under construction; and
  - d) Monitoring reports shall be created by the Applicant for each well and shall track the meter readings, calculating daily, weekly, and monthly withdrawals.
    1. Monitoring reports shall include any prior month(s) withdraws, and information from the reports shall not be deleted from any subsequent monthly report;
    2. Monitoring reports shall be updated by the Applicant daily and provided to the Zoning Administrator on the fifth (5<sup>th</sup>) business day of each month documenting the daily water draw for each well during the prior month;

3. A monitoring report shall be provided by the Applicant within one (1) business day upon receipt of written request by the Zoning Administrator and shall contain the cumulative prior months usage with updated figures, including the date prior to the Zoning Administrator's request; and
  4. Virginia Department of Health (VDH) permitted abandonment of a well will end the monitoring requirement for that specific well. If a well is abandoned as permitted by VDH, no water shall be drawn from that abandoned well.
- e) Water quality samples shall be collected from the site monitoring well network before well withdrawal commences to document background conditions and then collected biannually thereafter. The water samples shall be measured for turbidity, temperature, pH, and specific conductivity. The reports shall be provided to the Zoning Administrator within five (5) business days of preparation.

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## **SPower PV Plant: Expert Testimony on Environmental Hazards**

Vasilis Fthenakis, PhD

December 4, 2018

Report prepared for sPower

### **Author's Qualifications**

I am a chemical and environmental scientist and engineer with B.S. and M.S. degrees in chemistry and chemical engineering and a Ph.D. in fluid dynamics and atmospheric science. Currently, I am an adj. Professor and founding Director of the Center for Life Cycle Analysis at the Department of Earth and Environmental Engineering of Columbia University, and Senior Scientist Emeritus at Brookhaven National Laboratory (BNL) where I served for 36 years. I specialize on solar energy environmental health and safety (EH&S) assessment, and energy-environmental life cycle analysis with focus on photovoltaics (PV). I have co-authored two books, edited three more and wrote more than 400 publications in these areas; my publications have been cited about 9,700 times and my Google Scholar h-index is 48. During my career, I guided the PV industry in maintaining safe and environmentally-friendly facilities, as the Head of the Department of Energy (DOE) Photovoltaics Environmental Health and Safety Assistance (EHS) Center at BNL. The DOE-sponsored research encompasses all commercial PV technologies and special focus was given during 2003-2013 to CdTe PV technologies because of concerns regarding potential exposures to cadmium. My research on CdTe PV has been reviewed positively by environmental expert committees in more than a dozen countries (Germany, France, Spain, Italy, Thailand, India, Japan, Middle East, China, Chile, Brazil South Africa, and has guided PV deployment world-wide.

For my work, I have been honored with several distinctions from the US-DOE, NREL, BNL and elected a Fellow of the American Institute of Chemical Engineers, Fellow of the International Energy Foundation, and Board member of the Global Clean Water Desalination Alliance. Also, I managed the International Energy Agency Task on PV Sustainability and led the NSF International PV Sustainability Standards Committee. Earlier this year (June 2018) I was honored with the Institute of Electric and Electronic Engineers (IEEE) most prestigious William Chery Award “for pioneering research at the interface of energy and the environment that catalyzed photovoltaic technology advancement and deployment world-wide.” My opinions summarized below regarding environmental impacts associated with photovoltaic power are based on my own studies, expert reviews of other studies in the literature and materials provided by sPower, describing their proposed 500 MW solar power plant development in Spotsylvania.



## EXECUTIVE SUMMARY

Photovoltaic (PV) technologies have distinct environmental advantages for generating electricity over conventional technologies. The operation of photovoltaic systems does not produce any noise, toxic-gas emissions, greenhouse gases or pollutants in any form. Photovoltaic electricity generation, regardless of which technology is used, is a zero-emissions process. Photovoltaic energy can not only help meet a growing demand for electricity, but it can do so without incurring the high economic and environmental costs of installing power lines or burning fossil fuels. Relative to burning coal, every gigawatt-hour of electricity generated by photovoltaics would prevent the emission of about 10 tons of SO<sub>2</sub>, 4 tons of NO<sub>x</sub>, 0.7 tons of particulates and up to 1000 tons of CO<sub>2</sub>. PV's land-use requirements are similar to those for coal production and combustion. PV's material requirements are extremely low (e.g., 1 MWh/g semiconductor material).<sup>1</sup>

However, as with any energy source or product, there are environmental, health, and safety (EHS) hazards associated with the manufacture of solar cells and potentially with their end-of-life. Addressing EHS concerns has been the focus of numerous studies of the Photovoltaic EHS Assistance Center at Brookhaven National Laboratory, operated under the auspices of the US Department of Energy (DOE), which was directed by Dr. Fthenakis from 1990 through 2013. More than 150 articles highlighting these studies are posted in the Center's website ([www.bnl.gov/pv](http://www.bnl.gov/pv)) and the website of the Center for Life Cycle Analysis at Columbia University ([www.clca.columbia.edu](http://www.clca.columbia.edu)) founded and directed by Dr. Fthenakis. His opinions, based on his studies, expert reviews of other studies, and materials provided by sPower, are summarized as follows:

The site preparation for ground-mount PV installations can produce some noise and dust if grading/leveling is needed, but there are well established industry practices to suppress dust generation. Comparing to other uses of the same land, site preparation and PV installation should produce minimum noise and traffic concerns.

The operation of photovoltaic systems does not produce any noise, toxic-gas emissions, or greenhouse gases, or any kind of environmental pollutants. Inverters and transformers could produce a low-level noise which is not heard outside the perimeter of the facility.

The PV modules specified at the Spotsylvania solar project (both First Solar and Jinko modules) are very well encapsulated and no PV materials or chemical components can leach or volatilize to the environment, even during rain, storms, snow or other foreseeable climatic processes.

The First Solar CdTe PV modules score higher than any other PV technology on environmental sustainability metrics, including maximum Energy Return on Energy Investment, minimum life-cycle green-house and toxic emissions, and proven end-of-life recycling.

Slight increases of air temperatures are expected due to solar heating of the panels during sunny days within the PV site but such heat dissipates quickly with height and distance from the site so temperature increases will not be felt at the surrounding communities. As a result, no so-called "Heat Island Effect" will be felt by the neighborhoods adjacent to the Spotsylvania solar project.

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<sup>1</sup> Fthenakis V.M. and Moskowitz P.D., Photovoltaics: Environmental, Safety and Health Issues and Perspectives, Progress in Photovoltaics: Research and Applications 8, 27-38, 2000.

End-of life decommissioning and recycling is an industry-wide practice in Europe and is expected to also become a practice in the United States as the value of recovered materials could make recycling a profitable enterprise. I also understand that sPower has agreed to set a bond to cover the expense of recycling in case it may not be profitable. Therefore, it should be expected that when the Spotsylvania solar project reaches the end of its useful life 30-35 years from now, that all associated PV materials will be recycled.

## DOCUMENTATION

The Spotsylvania Solar Energy Center Project (Project) is a 500-megawatt (MW) photovoltaic (PV) solar energy facility proposed in Western Spotsylvania County, Virginia. The Project consists of approximately 6,350 acres of timbered land (of which approximately 3,500 acres will be developed for the Project) separated into three non-contiguous boundaries. The Project is expected to utilize First Solar Series 6 and Jinko PV panels that will be installed on a one-axis sun-tracking system.

Add description from project schematics -pending

### 1. Environmental Impacts of Solar Materials

Photovoltaic electricity generation, regardless of which technology is used, is a zero-emissions process. However, as with any energy source or product, there are environmental, health, and safety (EHS) hazards associated with the manufacture of solar cells and potentially with their end-of-life if they are not recycled. There are no documented environmental hazards associated with the normal, long-term operation of solar power. Most investigations of environmental impacts from solar power use a life cycle assessment (LCA) framework, and typically focus on greenhouse gas emissions and energy payback time. A smaller number of papers consider other impacts, i.e., hazardous materials emissions, land use intensity, water usage, wildlife impacts, and albedo effects. The LCA method details mass and energy flows throughout a product’s life cycle, from extraction of raw materials, to manufacturing necessary equipment, to installation and operation phases, and finally to disposal or recycling phases (Figure 1).

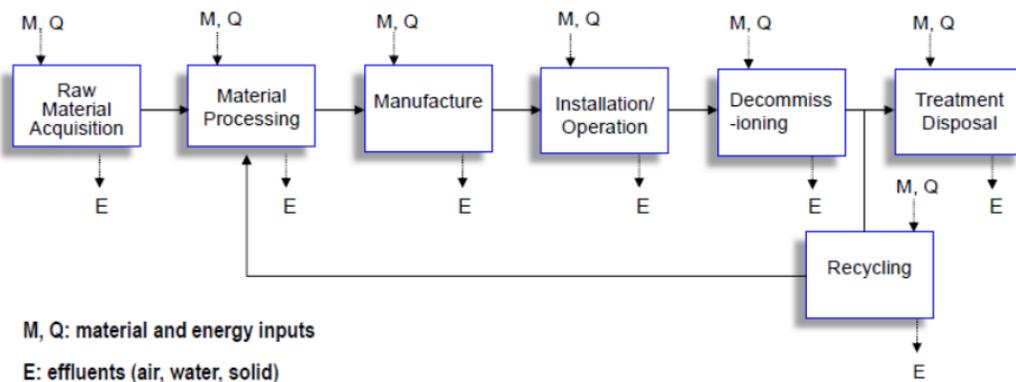


Fig. 1. The Life Cycle Stages of Photovoltaics

The PV industry uses toxic and flammable substances during manufacturing, although in smaller amounts than many other industries, and use of hazardous chemicals can involve occupational and environmental hazards. Addressing EHS concerns has been the focus of numerous studies of the Photovoltaic EHS Assistance Center at Brookhaven National Laboratory, operated under the auspices of the US Department of Energy (DOE), which was directed by Dr. Vasilis Fthenakis from 1990 through 2013. More than 150 articles highlighting these studies are posted on the Center’s website ([www.pv.bnl.gov](http://www.pv.bnl.gov)) and on the website of the Center for Life Cycle Analysis at Columbia University currently directed by Dr. Fthenakis. The manufacturing of crystalline silicon photovoltaics will occur off-site and as such, documented public health and environmental issues associated with the manufacturing of these products are not relevant.

## **2. Environmental Impacts during Installation and Operation**

The potential for environmental impacts from the installation and operation phases of large solar farms has been investigated by this author and others and largely demonstrates that solar energy has beneficial impacts on land, human health, climate, geo-hydrological resources, and wildlife and habitat when compared to traditional power generation. Turney and Fthenakis<sup>2</sup> investigated 32 categories of impacts related to solar energy use and deployment and were able to categorize such impacts as either beneficial or neutral, with the exception of the “local climate” effects for which we concluded that research and observation are needed. Subsequent research on this topic is summarized in section 2.1 below.

Therefore, I can state with certainty that the long-term operation of the Spotsylvania solar facility will not adversely impact local groundwater, soil or air quality, nor will the project adversely impact local public health. Conversely, I believe the operation of the Spotsylvania solar project will beneficially impact the environment and public health, as it will displace traditional power generation sources.

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<sup>2</sup> Turney D. and Fthenakis V., Environmental Impacts from the Installation and Operation of Large-Scale Power Plants, Renewable and Sustainable Energy Reviews, 15, 3261-3270, 2011

## 2.1 Heat Island Effect

Fthenakis and Wu conducted a detailed analysis and numerical simulations of the Potential for a Heat Island Effect in Large Solar Farms based on 18 months of data from the 80 MW solar farm in Ontario, Canada (Latitude 42.97 ° N) and FLUENT computational fluid dynamics computer code.<sup>3</sup> Both the field data and the simulations show that in the middle of the summer when the modules reach temperatures up to 50 C, the air temperatures in the center of a 3 km by 3 km PV field are not higher than up to 1.9°C above the ambient temperature, and this thermal energy completely dissipates to the environment at heights of 5 to 18 m (Figures 2-7).

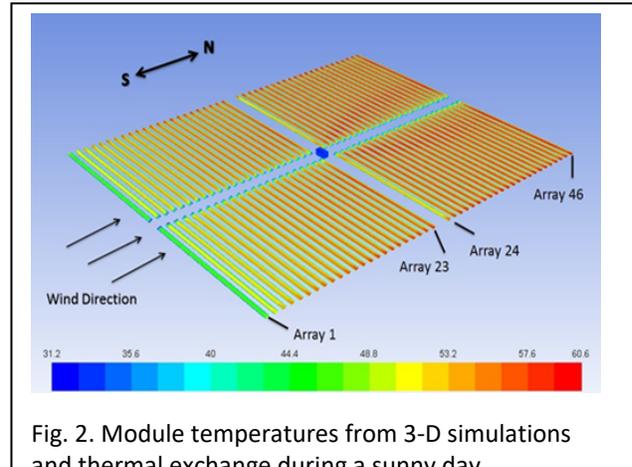


Fig. 2. Module temperatures from 3-D simulations and thermal exchange during a sunny day

Actually, the air temperatures at night within the PV solar farm are typically lower than those in the surroundings. The data also show a prompt dissipation of thermal energy with distance from the solar farm, with the air temperatures reducing to the ambient (within 0.5 °C) at about 100 m away of the perimeter of the solar farm. Analysis of 18 months of detailed data showed that in most days, the solar array was completely cooled at night, and, thus, a heat island effect did not occur.

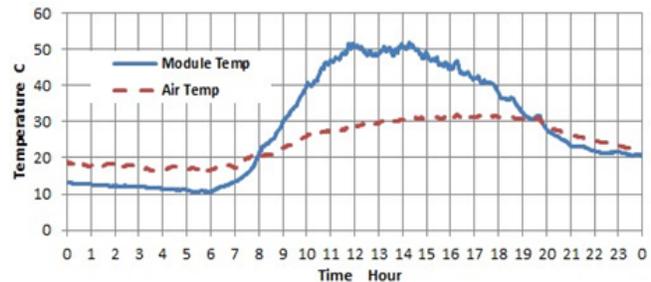


Fig. 5. Ontario 80 MW Solar Farm: Comparison of module temperature and air temperature 2.5 m off the ground on a sunny day (July 1, 2011).

### 2.1.1 Comparisons with other studies

Our study agreed with and shed more light to results reported earlier in the literature. Donovan<sup>4</sup> assumed that the albedo of ground-mounted PV panels is similar to that of underlying grassland and, using simple calculations, postulated that the heat island effect from installing PV on grassy land would be negligible. Yenchu et al.<sup>5</sup> investigated the potential for large scale of roof-top PV installations in Tokyo to alter the heat island effect of

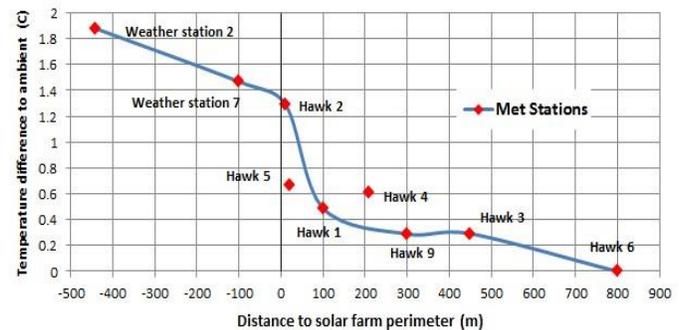


Fig. 6. Air temperature difference as a function of distance from the perimeter of the solar farm.

<sup>3</sup> Fthenakis V. and Yu Y., Analysis of the Potential for a Heat Island Effect in Large Solar Farms, IEEE Photovoltaic Specialists Conference, June 17-21, 2005.

<sup>4</sup> M. Donovan, "Memorandum: impact of PV systems on the heat island effect in Tokyo," in Fifth Conference on Urban Heat Islands, 2002.

<sup>5</sup> Y. Genchi, M. Ishisaki, Y. Ohashi, H. Takahashi, & A. Iwano, "The heat island effect in Tokyo," in Fifth Conference on Urban Heat Islands, 2002.

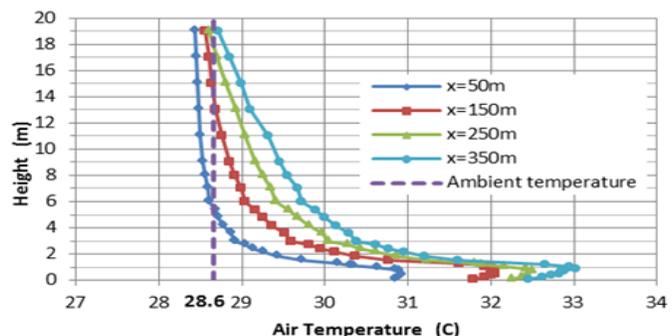


Fig. 7. Air temperatures within the solar farm, as a function of height and downwind distance; 2 pm sunny summer day

the city and found this to be negligible if PV systems are installed on black roofs.

Based on my studies and the review of other studies, I believe that a “heat island effect” would not happen in the considered north Virginia installation. Heat build-up quickly dissipate with height and distance from a solar park, as shown in figures 6 and 7 above and will not be felt at the surrounding community.

### **3. End-of-Life Management and Recycling**

PV modules will have to be decommissioned at the end of their useful life, 25–30 years after their initial installation. In decommissioning these devices, the principal concern will be associated with the presence of Cd in CdTe modules and the presence of Pb in c-Si modules if they contain Pb-based solder. If these modules end in a municipal waste incinerator (MWI), the heavy metals will gasify and a fraction of those will be released in the atmosphere. If the MWI is equipped with electrostatic precipitator (ESP) this fraction can be as small as 0.5% with the balance of the heavy metals remaining in the ash. The ash itself will have to be disposed of in controlled landfills.

If the modules end in municipal landfills, then the potential for the heavy metals to leach out in the soil exist. The leachability of metals in landfills, is currently characterized by the Environmental Protection Agency (EPA) Toxicity Characterization Leachate Profile (TCLP). In this test, small pieces (<1 cm<sup>2</sup>) of broken modules are suspended and rotated in an eluent for 24 hours. The metals present in the eluent are then measured and compared with limits prescribed by each testing protocol. If the metal concentration exceeds the limits, the modules are demonstrating the metal’s leachability and may need to be recycled or disposed of in a hazardous waste landfill: if the metals are not leaching in excessive quantities, the modules can be disposed of in a commercial landfill. It should be noted that the TCLP test is conservative, as it requires breakage of the whole module to very small pieces, whereas the photovoltaic layer will often be sandwiched between two layers of glass and reasonably isolated from the environment.

The ultimate solution to the PV waste and end-of-life management is recycling of useful materials<sup>6</sup>. Recent studies showed that recycling, based on current collection/recycling infrastructure and on emerging recycling technologies, is technologically and economically feasible<sup>7</sup>. Reclaiming metals from used solar panels in large centralized applications can be done in metal smelting/refining facilities which recover the metals by incorporating them in their product streams and use the glass as a fluxing agent. Our studies show that with the right logistics, the value of the recovered materials can cover the expense of decommissioning and recycling making recycling of PV at the end of their useful life a profitable enterprise. Furthermore studies of large scale penetration of PV into global electricity grids show that recycling of PV modules is imperative for maintaining a secondary source of materials.<sup>8</sup>

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<sup>6</sup> Fthenakis V., End-of Life Management and Recycling of PV Modules, Energy Policy, 28, 1051-1058, 2000

<sup>7</sup> -Choi J-K. and Fthenakis V.M., Economic Feasibility of Photovoltaic Module Recycling: Survey and Model, Journal of Industrial Ecology, 14 (6), 947- 964, 2010

-Choi J-K. and Fthenakis V., Crystalline Silicon Photovoltaic Recycling Planning: Macro and Micro Perspectives, Journal for Cleaner Production, 66 (1), pp, 443-449, 2014

<sup>8</sup> -Fthenakis V.M., Sustainability metrics for extending thin-film photovoltaics to terawatt levels. MRS Bulletin, 37(4), 425-430, 2012

Thus, it is my opinion that PV recycling will be the standard practice within the US solar industry within the useful life of the Spotsylvania solar project and that it is likely the PV panels used for the Spotsylvania solar facility will be recycled rather than landfilled.

#### **4. CONCLUSION**

Based on my personal research on PV health and environmental effects, expert reviews of other studies, and materials provided by sPower specifically related to the proposed Spotsylvania solar facility in Spotsylvania County, Virginia, my opinions are summarized as follows:

- The operation of the Spotsylvania solar facility will not result in any environmental contamination or negative impacts to public health.
- The operation of the Spotsylvania solar facility will not result in an observed “heat island effect,” and;
- The PV materials utilized at the Spotsylvania solar facility will more likely than not be recycled upon decommissioning 30-35 years from now.

**COMMONWEALTH OF VIRGINIA**

**SPOTSYLVANIA COUNTY**

**SPECIAL USE PERMIT FOR  
SOLAR ENERGY FACILITY** )  
)  
)

**AFFIDAVIT OF  
THOMAS CLEVELAND, III, PE**

**IN RE: Spotsylvania Solar Energy Center (A, B, & C), Special Use Permits # SUP  
18-0001, 18-0002, and 18-0003  
Location: Livingston Magisterial District**

NOW COMES the undersigned Affiant, who, being first duly sworn deposes and says of his own personal knowledge as follows:

1. I am over the age of eighteen years of age and competent to testify as to the matters set forth in this Affidavit.

2. I am a professional engineer, licensed in North Carolina, and hold a Bachelor’s of Science and a Master’s of Science degree in Mechanical Engineering, both from North Carolina State University. As of April 2017, I am a Solar Engineer at Advanced Energy, a non-profit energy engineering consulting firm based in Raleigh, NC. My primary role at Advanced Energy is interconnection commissioning of utility-scale solar facilities connecting to Duke Energy systems in North and South Carolina. For the previous twelve years, I was an engineer with the NC Clean Energy Technology Center (previously the North Carolina Solar Center), a public service center in the College of Engineering at North Carolina State University. For the last several years at the Center I was the Renewable Energy Project Coordinator where I led the Center’s solar energy program, which included providing technical support to a wide range of solar projects and stakeholders. My CV is attached as Exhibit A.

3. sPOWER proposes to construct a solar farm on 6,350 acres across three sites (Site A, Site B, and Site C) that would disturb +/- 3,500 acres (the “Property”).

4. I was the lead author of a North Carolina Clean Energy Technology Center at NC State University white paper on the Health and Safety Impacts of Photovoltaics. The purpose of this paper was to address concerns of public health and safety for utility-scale solar photovoltaic (PV) projects. After broad and deep research of the academic literature and interviews with national experts, potential negative health and safety impacts of photovoltaics were categorized in the four following sections: (1) Toxicity, (2) Electromagnetic Fields, (3) Electric Shock and Arc Flash, and (4) Fire. In each of these sections, the negative health and safety impacts of utility-scale PV development were found to be negligible, while the public health and safety benefits of installing these facilities are significant and far outweigh any negative impacts. The full North Carolina State University white paper is attached as Exhibit B.

5. Electricity is vital for our everyday modern lives and our growing economy, and aging traditional generation plants, such as coal and nuclear, will need to be shut down and replaced with new generation facilities. These conventional sources of electricity are finite resources that require significant cost, environmental disruption, and public safety risk to extract

and utilize. Solar photovoltaics provide low-cost electricity generation with dramatically lower environmental disruption and public safety risk.

6. Electricity generation by grid-tied solar photovoltaic systems reduces the burning of fossil fuels for electricity generation. This reduction of fossil fuel use reduces air and water pollution, resulting in cleaner air and water, which has a positive public health benefit, especially to the portion of the population most vulnerable to the impacts of poor air and water quality.

7. The proposed solar facility will primarily consist of photovoltaic (PV) modules ("Panels") mounted on racks that are driven into the ground, inverters that convert the DC electricity generated by the panels to grid-synchronized AC electricity, and transformers to adjust the voltage to match that of the power grid. All electric components will be certified to be in compliance with the appropriate Underwriters Laboratories (UL) standards and will comply with the edition of the National Electrical Code in effect at the time of construction.

8. Thin-film Cadmium Telluride (CdTe) solar technology like that proposed for the Property, is not new; similar solar panels have been researched for over 50 years and in operation for more than 20 years in the United States. These Panels are safe and create no site emissions. Solar facilities enjoy widespread support from environmental organizations.

9. Cadmium is a naturally occurring in soil and minerals. It is commonly found in moderate concentration in phosphorous fertilizer.

10. CdTe PV Panels pose negligible toxicity risk to public health and safety while significantly reducing the public's exposure to cadmium by reducing coal emissions. CdTe panels have the lowest lifecycle impacts of any photovoltaic technology.

11. Cadmium telluride is a very stable compound that is non-volatile and non-soluble in water. Even in the case of a fire, research shows that less than 0.1% of the cadmium is released when a CdTe panel is exposed to fire.

12. In 2013, researchers at the University of Tokyo conducted an analysis of worst-case scenarios for environmental impact from CdTe PV panels, including earthquakes, fires, and floods. After reviewing the extensive international body of research on CdTe PV technology, their report concluded, "Even in the worst-case scenarios, it is unlikely that the Cd concentrations in air and sea water will exceed the environmental regulation values."

13. First Solar, the manufacturer of the Panels, has stated and shown a commitment to providing a commercially attractive recycling solution for owners of their PV modules. First Solar provides global recycling services to their customers to collect and recycle panels once they reach the end of productive life whether due to age or damage. These recycling service agreements are structured to be financially attractive to both First Solar and the solar panel owner. For First Solar, the contract provides the company with an affordable source of raw materials needed for new panels and presumably a diminished risk of undesired release of Cd. The contract also benefits the solar panel owner by allowing them to avoid waste disposal fees.

14. From my education and experience, I know that PV systems such as the one proposed, do not pose a threat to public health or safety. Modern c-Si modules contain about 76%

glass, 10% polymer (plastics), 8% aluminum, 5% silicon, 1% copper and less than 0.1% of silver, tin and lead. CdTe thin-film is about 97% glass and 3% polymer, with other trace amounts of metals including nickel, zinc, tin and cadmium telluride.

15. Solar panels absorb the vast majority of the solar energy that hits them, close to 20% of this energy is converted into electricity that is sent to the electric grid, and the rest of the absorbed energy goes to heating the solar panel. If the solar panel were not there, the same solar energy would have hit the ground and/or vegetation, which would have absorbed almost as much solar energy, but converted a much lower percentage into useable energy (carbohydrates). The Panels are little more than two sheets of glass and an aluminum frame, so they do not store much thermal energy. So, once the sun sets, the modules cool to about the air temperature. This scenario is very different than the urban heat island effect where large amounts of concrete and other dense materials hold significant heat through the night, and longer, resulting in consistently warmer conditions than the surrounding non-urban areas. The amount of heat produced by the PV facility is tiny compared to the energy-moving capability of the air that is constantly moving at/around the solar facility. The latest research suggests that any heating effect in the solar array is dissipated within 100 feet of the array.

16. Based upon the facts stated herein, my training and experience as an engineer in the solar power industry, and my familiarity with this proposed project, it is my professional opinion that the proposed solar facility will not endanger the public health or safety, if located and constructed according to the plan and approved.

Further the Affiant Sayeth Not.

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SIGNATURE & NOTARY FOLLOW**

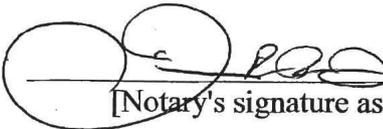
This, the 4 day of December, 2018.

  
\_\_\_\_\_  
THOMAS CLEVELAND, III, PE

ORANGE COUNTY, NORTH CAROLINA

Signed and sworn to or affirmed before me this day by Thomas Cleveland, III, PE.

Date: DECEMBER 4, 2018

  
\_\_\_\_\_  
[Notary's signature as name appears on seal]

JUROTHER R. ALSTON JR., Notary Public  
[Notary's printed name as name appears on



My commission expires: AUGUST 28, 2021

[Affix Official Seal in Space Above]

## Thomas (Tommy) H. Cleveland, P.E.

4141 Laurel Hills Rd. Raleigh, NC

thcleveland@gmail.com

919-923-5490

### Education & Training

North Carolina State University, Mechanical Engineering M.S. 2004

North Carolina State University, Mechanical Engineering B.S., Business Mgmt. minor 2001 - Summa Cum Laude  
Lumberton Sr. High School, Lumberton, NC, 1997 – Valedictorian

Professional Engineer (P.E.), licensed in North Carolina (#033711), 2008 - Present

### Professional Experience

*Solar PV Engineer, Advanced Energy, Raleigh, NC, April 2017–Present*

- Evaluation of utility scale solar PV facilities to assess the quality of design, construction, and operation
- Engineering analysis and concise presentation of results to customers
- Failure investigation of commercial PV facility

*Solar Energy Engineer (various progressive titles), North Carolina Solar Center/NC Clean Energy Technology Center, North Carolina State University, 2005–April, 2017*

- Lead solar engineer at the Center (2008-2017)
- Conducted detailed PV + storage feasibility study for community solar project for a NC municipal utility that included development of battery control model to optimize storage size and validate value production
- Provided quality assurance and technical support to development of in-house training program of solar farm construction for a leading regional utility-scale photovoltaic EPC firm
- Guided design of prototype residential Plug and Play PV system and collected AHJ feedback (Department of Energy SunShot project)
- Co-led stakeholder process to develop Template Solar Development Ordinance for North Carolina
- Led design and development of ISO-17025 accredited solar thermal collector testing lab, only the 5<sup>th</sup> in U.S.
- Designed and installed PV field performance monitoring system, conducted performance analysis
- Conducted renewable energy site assessments for commercial, industrial, and institutional clients
- Presented to local government officials, community leaders, and general public on solar energy
- Provided technical support to a wide variety of energy consumers and stakeholders across North Carolina

*Expert Witness, Private consultant for over 15 solar developer clients, 2012-Present*

- Provides expert witness testimony at special/conditional use and re-zoning public hearings regarding the health, safety, and environmental impact of utility-scale solar photovoltaic systems. Experience in NC, SC, VA, and FL (over 60 projects to date)
- Provides respectful clear answers to sometimes ill-informed and/or hostile questions
- Conducted site-specific studies of EMF, sound, and solar glare hazard

*Instructor of 1-Day Continuing Education Course on Solar Energy for Professional Engineers, UNC-Charlotte, Fall 2015, 2016, 2017*

- Developed all course content for this 8-hour in-person course
- Course provides introduction to solar energy in North Carolina today for working engineering professionals. The course covers solar energy resource, photovoltaic technology, photovoltaic products, system design, state and federal policy, grid interconnection, project economics, and more
- Based on great attendance and student feedback, twice invited back to teach course for additional year

*Instructor of ET 220 Solar Photovoltaic Assessment, Department of Forestry and Environmental Resources, North Carolina State University, 2014-Present*

- Developed all course content for this new three credit hour online course
- Course covers all aspects of photovoltaic site assessment including energy use, solar resource, system design, utility tariffs, estimating, economics, and more
- Course is optional course for an Environmental Technology and Management degree
- Course is required for a Renewable Energy Assessment minor

*Instructor of MAE 421 Design of Solar Energy Systems, Mechanical and Aerospace Engineering Department of North Carolina State University, 2009-2014*

- Instructor of the solar energy engineering course, MAE 421, in the NC State University Mechanical and Aerospace Engineering department
- The course was offered during the spring semester and typically had 30 to 50 undergraduate and up to twelve graduate engineering students
- Previously co-instructor of the course for two years (2007, 2009)

*Research Assistant, North Carolina Solar Center, North Carolina State University, 2003–2005*

- Developed and validated a TRNSYS simulation model of a unique solar thermal concentrating collector
- Assisted with the installation of photovoltaic systems ranging in capacity from 1 kW to 5 kW

### **Selected Publications**

“Balancing Agricultural Productivity with Ground-Based Photovoltaic Development”, NCCETC/NCSU white paper, August 2017, <https://nccleantech.ncsu.edu/wp-content/uploads/Balancing-Ag-and-Solar-final-version-update.pdf>

“Health and Safety Impacts of Photovoltaics”, NCCETC/NCSU white paper, May 2017, [https://nccleantech.ncsu.edu/wp-content/uploads/Health-and-Safety-Impacts-of-Solar-Photovoltaics-2017\\_white-paper-1.pdf](https://nccleantech.ncsu.edu/wp-content/uploads/Health-and-Safety-Impacts-of-Solar-Photovoltaics-2017_white-paper-1.pdf)

“Community Solar (+ Storage) Program Design for Fayetteville Public Works Commission”, NCSU/NCCETC report, March 2017, (Public version) [https://nccleantech.ncsu.edu/wp-content/uploads/FPWC\\_CommunitySolar\\_Public\\_Version.pdf](https://nccleantech.ncsu.edu/wp-content/uploads/FPWC_CommunitySolar_Public_Version.pdf)

T. Cleveland, “What is Solar?”, NCSU Cooperative Extension & NCCETC factsheet, October 2016, <https://content.ces.ncsu.edu/what-is-solar>

T. Cleveland, H. Tsai, “Charlotte-Mecklenburg Schools Roadmap to 100% Renewable Electricity” & “Durham Public Schools Roadmap to 100% Renewable Electricity”, NCCETC, February 2016

T. Cleveland, et al, “Template Solar Energy Development Ordinance for North Carolina”, NCCETC & NCSEA, December 2013, [www.go.ncsu.edu/template-solar-ordinance](http://www.go.ncsu.edu/template-solar-ordinance)

M. Sheehan, T. Cleveland, “Updated Recommendations for Federal Energy Regulatory Commission Small Generator Interconnection Procedures Screens”, Solar America Board for Codes and Standards Study Report, 64 p., July 2010, [www.solarabcs.org/about/publications/reports/ferc-screens/pdfs/ABCS-FERC\\_studyreport.pdf](http://www.solarabcs.org/about/publications/reports/ferc-screens/pdfs/ABCS-FERC_studyreport.pdf)

T. Cleveland, et al, “Optimizing Solar Thermal Resource Use at Commercial Buildings”, Solar 2010 – ASES National Solar Energy Conference 2010, 6 p., May 2010, [www.ases.org/papers/101.pdf](http://www.ases.org/papers/101.pdf)

T. Cleveland, “Description and Performance of a TRNSYS Model of the Solargenix Tracking Power Roof™”, Solar 2005 – ASES National Solar Energy Conference, 6 p.

T. Cleveland, K. Creamer, & Dr. R. Johnson, “Energy Metering of Solar Domestic Hot Water Systems for Inclusion in Green Power and Renewable Portfolio Standards Programs”, Solar 2004 – ASES National Solar Energy Conference 2004, 6 p.

T. Cleveland, *“Effective Energy Metering of Solar Domestic Hot Water Systems for Inclusion in Green Power and Renewable Portfolio Standards”*, Master’s Thesis, North Carolina State University, Raleigh, 191 p., April 2004, <http://repository.lib.ncsu.edu/ir/handle/1840.16/1152>

### **Selected Recent Presentations**

T. Cleveland, A. Huang, “Plug and Play Residential PV System Innovation and Demonstration”, Solar Power International Conference 2015

T. Cleveland, *“Make Solar Energy Economical”*, recorded video lecture for E102: Grand Challenges of Engineering course at NC State University, January 2015

T. Cleveland, M. Clark, *“Template Solar Ordinance for North Carolina”*, Solar Power International Conference 2014

### **Synergistic Activities**

- Member of IEEE 1547 Conformity Assessment Committee
- Member of International Code Council (ICC) Renewable Energy Membership Advisory Council (REMAC) (2015-2018)
- Member of the Board of Directors of the Solar Rating and Certification Corporation (SRCC) (2009-2015)
- Solar America Board for Codes and Standards (Solar ABCs) steering committee (2009-2013)
- Member of North Carolina Sustainable Energy Association



# **NC CLEAN ENERGY**

## **TECHNOLOGY CENTER**

# **Health and Safety Impacts of Solar Photovoltaics**

## **MAY 2017**



## **Health and Safety Impacts of Solar Photovoltaics**

The increasing presence of utility-scale solar photovoltaic (PV) systems (sometimes referred to as solar farms) is a rather new development in North Carolina's landscape. Due to the new and unknown nature of this technology, it is natural for communities near such developments to be concerned about health and safety impacts. Unfortunately, the quick emergence of utility-scale solar has cultivated fertile grounds for myths and half-truths about the health impacts of this technology, which can lead to unnecessary fear and conflict.

Photovoltaic (PV) technologies and solar inverters are not known to pose any significant health dangers to their neighbors. The most important dangers posed are increased highway traffic during the relative short construction period and dangers posed to trespassers of contact with high voltage equipment. This latter risk is mitigated by signage and the security measures that industry uses to deter trespassing. As will be discussed in more detail below, risks of site contamination are much less than for most other industrial uses because PV technologies employ few toxic chemicals and those used are used in very small quantities. Due to the reduction in the pollution from fossil-fuel-fired electric generators, the overall impact of solar development on human health is overwhelmingly positive. This pollution reduction results from a partial replacement of fossil-fuel fired generation by emission-free PV-generated electricity, which reduces harmful sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), and fine particulate matter (PM<sub>2.5</sub>). Analysis from the National Renewable Energy Laboratory and the Lawrence Berkeley National Laboratory, both affiliates of the U.S. Department of Energy, estimates the health-related air quality benefits to the southeast region from solar PV generators to be worth 8.0 ¢ per kilowatt-hour of solar generation.<sup>1</sup> This is in addition to the value of the electricity and suggests that the air quality benefits of solar are worth more than the electricity itself.

Even though we have only recently seen large-scale installation of PV technologies, the technology and its potential impacts have been studied since the 1950s. A combination of this solar-specific research and general scientific research has led to the scientific community having a good understanding of the science behind potential health and safety impacts of solar energy. This paper utilizes the latest scientific literature and knowledge of solar practices in N.C. to address the health and safety risks associated with solar PV technology. These risks are extremely small, far less than those associated with common activities such as driving a car, and vastly outweighed by health benefits of the generation of clean electricity.

This paper addresses the potential health and safety impacts of solar PV development in North Carolina, organized into the following four categories:

- (1) Hazardous Materials
- (2) Electromagnetic Fields (EMF)
- (3) Electric Shock and Arc Flash
- (4) Fire Safety

# 1. Hazardous Materials

One of the more common concerns towards solar is that the panels (referred to as “modules” in the solar industry) consist of toxic materials that endanger public health. However, as shown in this section, solar energy systems may contain small amounts of toxic materials, but these materials do not endanger public health. To understand potential toxic hazards coming from a solar project, one must understand system installation, materials used, the panel end-of-life protocols, and system operation. This section will examine these aspects of a solar farm and the potential for toxicity impacts in the following subsections:

## (1.2) Project Installation/Construction

### (1.2) System Components

#### 1.2.1 Solar Panels: Construction and Durability

#### 1.2.2 Photovoltaic technologies

##### (a) Crystalline Silicon

##### (b) Cadmium Telluride (CdTe)

##### (c) CIS/CIGS

#### 1.2.3 Panel End of Life Management

#### 1.2.4 Non-panel System Components

## (1.3) Operations and Maintenance

## 1.1 Project Installation/Construction

The system installation, or construction, process does not require toxic chemicals or processes. The site is mechanically cleared of large vegetation, fences are constructed, and the land is surveyed to layout exact installation locations. Trenches for underground wiring are dug and support posts are driven into the ground. The solar panels are bolted to steel and aluminum support structures and wired together. Inverter pads are installed, and an inverter and transformer are installed on each pad. Once everything is connected, the system is tested, and only then turned on.



Figure 1: Utility-scale solar facility (5 MW<sub>AC</sub>) located in Catawba County. Source: Strata Solar

## 1.2 System Components

### 1.2.1 Solar Panels: Construction and Durability

Solar PV panels typically consist of glass, polymer, aluminum, copper, and semiconductor materials that can be recovered and recycled at the end of their useful life.<sup>2</sup> Today there are two PV technologies used in PV panels at utility-scale solar facilities, silicon, and thin film. As of 2016, all thin film used in North Carolina solar facilities are cadmium telluride (CdTe) panels from the US manufacturer First Solar, but there are other thin film PV panels available on the market, such as Solar Frontier's CIGS panels. Crystalline silicon technology consists of silicon wafers which are made into cells and assembled into panels, thin film technologies consist of thin layers of semiconductor material deposited onto glass, polymer or metal substrates. While there are differences in the components and manufacturing processes of these two types of solar technologies, many aspects of their PV panel construction are very similar. Specifics about each type of PV chemistry as it relates to toxicity are covered in subsections a, b, and c in section 1.2.2; on crystalline silicon, cadmium telluride, and CIS/CIGS respectively. The rest of this section applies equally to both silicon and thin film panels.

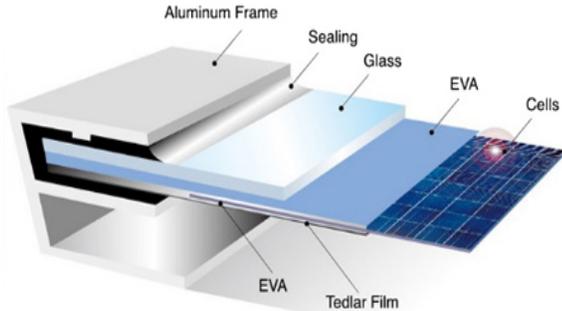


Figure 2: Components of crystalline silicon panels. The vast majority of silicon panels consist of a glass sheet on the topside with an aluminum frame providing structural support. Image Source: [www.riteksolar.com.tw](http://www.riteksolar.com.tw)

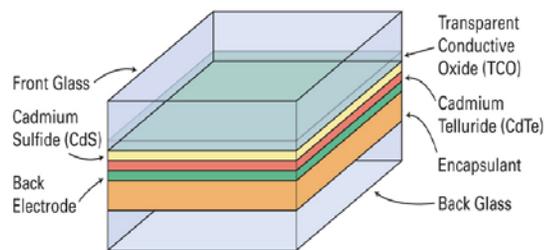


Figure 3: Layers of a common frameless thin-film panel (CdTe). Many thin film panels are frameless, including the most common thin-film panels, First Solar's CdTe. Frameless panels have protective glass on both the front and back of the panel. Layer thicknesses not to scale. Image Source: [www.homepower.com](http://www.homepower.com)

To provide decades of corrosion-free operation, PV cells in PV panels are encapsulated from air and moisture between two layers of plastic. The encapsulation layers are protected on the top with a layer of tempered glass and on the backside with a polymer sheet. Frameless modules include a protective layer of glass on the rear of the panel, which may also be tempered. The plastic ethylene-vinyl acetate (EVA) commonly provides the cell encapsulation. For decades, this same material has been used between layers of tempered glass to give car windshields and hurricane windows their great strength. In the same way that a car windshield cracks but stays intact, the EVA layers in PV panels keep broken panels intact (see Figure 4). Thus, a damaged module does not generally create small pieces of debris; instead, it largely remains together as one piece.



Figure 4: The mangled PV panels in this picture illustrate the nature of broken solar panels; the glass cracks but the panel is still in one piece. Image Source: [http://img.alibaba.com/photo/115259576/broken\\_solar\\_panel.jpg](http://img.alibaba.com/photo/115259576/broken_solar_panel.jpg)

PV panels constructed with the same basic components as modern panels have been installed across the globe for well over thirty years.<sup>3</sup> The long-term durability and performance demonstrated over these decades, as well as the results of accelerated lifetime testing, helped lead to an industry-standard 25-year power production warranty for PV panels. These power warranties warrant a PV panel to produce at least 80% of their original nameplate production after 25 years of use. A recent SolarCity and DNV GL study reported that today's quality PV panels should be expected to reliably and efficiently produce power for thirty-five years.<sup>4</sup>

Local building codes require all structures, including ground mounted solar arrays, to be engineered to withstand anticipated wind speeds, as defined by the local wind speed requirements. Many racking products are available in versions engineered for wind speeds of up to 150 miles per hour, which is significantly higher than the wind speed requirement anywhere in North Carolina. The strength of PV mounting structures were demonstrated during Hurricane Sandy in 2012 and again during Hurricane Matthew in 2016. During Hurricane Sandy, the many large-scale solar facilities in New Jersey and New York at that time suffered only minor damage.<sup>5</sup> In the fall of 2016, the US and Caribbean experienced destructive winds and torrential rains from Hurricane Matthew, yet one leading solar tracker manufacturer reported that their numerous systems in the impacted area received zero damage from wind or flooding.<sup>6</sup>

In the event of a catastrophic event capable of damaging solar equipment, such as a tornado, the system will almost certainly have property insurance that will cover the cost to cleanup and repair the project. It is in the best interest of the system owner to protect their investment against such risks. It is also in their interest to get the project repaired and producing full power as soon as possible. Therefore, the investment in adequate insurance is a wise business practice for the system owner. For the same

reasons, adequate insurance coverage is also generally a requirement of the bank or firm providing financing for the project.

## 1.2.2 Photovoltaic (PV) Technologies

### a. Crystalline Silicon

This subsection explores the toxicity of silicon-based PV panels and concludes that they do not pose a material risk of toxicity to public health and safety. Modern crystalline silicon PV panels, which account for over 90% of solar PV panels installed today, are, more or less, a commodity product. The overwhelming majority of panels installed in North Carolina are crystalline silicon panels that are informally classified as Tier I panels. Tier I panels are from well-respected manufacturers that have a good chance of being able to honor warranty claims. Tier I panels are understood to be of high quality, with predictable performance, durability, and content. Well over 80% (by weight) of the content of a PV panel is the tempered glass front and the aluminum frame, both of which are common building materials. Most of the remaining portion are common plastics, including polyethylene terephthalate in the backsheet, EVA encapsulation of the PV cells, polyphenyl ether in the junction box, and polyethylene insulation on the wire leads. The active, working components of the system are the silicon photovoltaic cells, the small electrical leads connecting them together, and to the wires coming out of the back of the panel. The electricity generating and conducting components makeup less than 5% of the weight of most panels. The PV cell itself is nearly 100% silicon, and silicon is the second most common element in the Earth's crust. The silicon for PV cells is obtained by high-temperature processing of quartz sand ( $\text{SiO}_2$ ) that removes its oxygen molecules. The refined silicon is converted to a PV cell by adding extremely small amounts of boron and phosphorus, both of which are common and of very low toxicity.

The other minor components of the PV cell are also generally benign; however, some contain lead, which is a human toxicant that is particularly harmful to young children. The minor components include an extremely thin antireflective coating (silicon nitride or titanium dioxide), a thin layer of aluminum on the rear, and thin strips of silver alloy that are screen-printed on the front and rear of cell.<sup>7</sup> In order for the front and rear electrodes to make effective electrical contact with the proper layer of the PV cell, other materials (called glass frit) are mixed with the silver alloy and then heated to etch the metals into the cell. This glass frit historically contains a small amount of lead (Pb) in the form of lead oxide. The 60 or 72 PV cells in a PV panel are connected by soldering thin solder-covered copper tabs from the back of one cell to the front of the next cell. Traditionally a tin-based solder containing some lead (Pb) is used, but some manufacturers have switched to lead-free solder. The glass frit and/or the solder may contain trace amounts of other metals, potentially including some with human toxicity such as cadmium. However, testing to simulate the potential for leaching from broken panels, which is discussed in more detail below, did not find a potential toxicity threat from these trace elements. Therefore, the tiny amount of lead in the glass frit and the solder is the only part of silicon PV panels with a potential to create a negative health impact. However, as described below, the very limited amount of lead involved and its strong physical and chemical attachment to other components of the PV panel means that even in worst-case scenarios the health hazard it poses is insignificant.

As with many electronic industries, the solder in silicon PV panels has historically been a lead-based solder, often 36% lead, due to the superior properties of such solder. However, recent advances in lead-free solders have spurred a trend among PV panel manufacturers to reduce or remove the lead in their panels. According to the 2015 Solar Scorecard from the Silicon Valley Toxics Coalition, a group that tracks environmental responsibility of photovoltaic panel manufacturers, fourteen companies (increased from twelve companies in 2014) manufacture PV panels certified to meet the European Restriction of

Hazardous Substances (RoHS) standard. This means that the amount of cadmium and lead in the panels they manufacture fall below the RoHS thresholds, which are set by the European Union and serve as the world's de facto standard for hazardous substances in manufactured goods.<sup>8</sup> The Restriction of Hazardous Substances (RoHS) standard requires that the maximum concentration found in any homogenous material in a produce is less than 0.01% cadmium and less than 0.10% lead, therefore, any solder can be no more than 0.10% lead.<sup>9</sup>

While some manufacturers are producing PV panels that meet the RoHS standard, there is no requirement that they do so because the RoHS Directive explicitly states that the directive does not apply to photovoltaic panels.<sup>10</sup> The justification for this is provided in item 17 of the current RoHS Directive: "The development of renewable forms of energy is one of the Union's key objectives, and the contribution made by renewable energy sources to environmental and climate objectives is crucial. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources (4) recalls that there should be coherence between those objectives and other Union environmental legislation. Consequently, this Directive should not prevent the development of renewable energy technologies that have no negative impact on health and the environment and that are sustainable and economically viable."

The use of lead is common in our modern economy. However, only about 0.5% of the annual lead consumption in the U.S. is for electronic solder for all uses; PV solder makes up only a tiny portion of this 0.5%. Close to 90% of lead consumption in the US is in batteries, which do not encapsulate the pounds of lead contained in each typical automotive battery. This puts the lead in batteries at great risk of leaching into the environment. Estimates for the lead in a single PV panel with lead-based solder range from 1.6 to 24 grams of lead, with 13g (less than half of an ounce) per panel seen most often in the literature.<sup>11</sup> At 13 g/panel<sup>12</sup>, each panel contains one-half of the lead in a typical 12-gauge shotgun shell. This amount equates to roughly 1/750<sup>th</sup> of the lead in a single car battery. In a panel, it is all durably encapsulated from air or water for the full life of the panel.<sup>14</sup>

As indicated by their 20 to 30-year power warranty, PV modules are designed for a long service life, generally over 25 years. For a panel to comply with its 25-year power warranty, its internal components, including lead, must be sealed from any moisture. Otherwise, they would corrode and the panel's output would fall below power warranty levels. Thus, the lead in operating PV modules is not at risk of release to the environment during their service lifetime. In extreme experiments, researchers have shown that lead can leach from crushed or pulverized panels.<sup>15, 16</sup> However, more real-world tests designed to represent typical trash compaction that are used to classify waste as hazardous or non-hazardous show no danger from leaching.<sup>17, 18</sup> For more information about PV panel end-of-life, see the Panel Disposal section.

As illustrated throughout this section, silicon-based PV panels do not pose a material threat to public health and safety. The only aspect of the panels with potential toxicity concerns is the very small amount of lead in some panels. However, any lead in a panel is well sealed from environmental exposure for the operating lifetime of the solar panel and thus not at risk of release into the environment.

## **b. Cadmium Telluride (CdTe) PV Panels**

This subsection examines the components of a cadmium telluride (CdTe) PV panel. Research demonstrates that they pose negligible toxicity risk to public health and safety while significantly reducing the public's exposure to cadmium by reducing coal emissions. As of mid-2016, a few hundred MWs of

cadmium telluride (CdTe) panels, all manufactured by the U.S. company First Solar, have been installed in North Carolina.

Questions about the potential health and environmental impacts from the use of this PV technology are related to the concern that these panels contain cadmium, a toxic heavy metal. However, scientific studies have shown that cadmium telluride differs from cadmium due to its high chemical and thermal stability.<sup>19</sup> Research has shown that the tiny amount of cadmium in these panels does not pose a health or safety risk.<sup>20</sup> Further, there are very compelling reasons to welcome its adoption due to reductions in unhealthy pollution associated with burning coal. Every GWh of electricity generated by burning coal produces about 4 grams of cadmium air emissions.<sup>21</sup> Even though North Carolina produces a significant fraction of our electricity from coal, electricity from solar offsets much more natural gas than coal due to natural gas plants being able to adjust their rate of production more easily and quickly. If solar electricity offsets 90% natural gas and 10% coal, each 5-megawatt (5 MW<sub>AC</sub>, which is generally 7 MW<sub>DC</sub>) CdTe solar facility in North Carolina keeps about 157 grams, or about a third of a pound, of cadmium *out of our environment*.<sup>22, 23</sup>

Cadmium is toxic, but all the approximately 7 grams of cadmium in one CdTe panel is in the form of a chemical compound cadmium telluride,<sup>24</sup> which has 1/100<sup>th</sup> the toxicity of free cadmium.<sup>25</sup> Cadmium telluride is a very stable compound that is non-volatile and non-soluble in water. Even in the case of a fire, research shows that less than 0.1% of the cadmium is released when a CdTe panel is exposed to fire. The fire melts the glass and encapsulates over 99.9% of the cadmium in the molten glass.<sup>27</sup>

It is important to understand the source of the cadmium used to manufacture CdTe PV panels. The cadmium is a byproduct of zinc and lead refining. The element is collected from emissions and waste streams during the production of these metals and combined with tellurium to create the CdTe used in PV panels. If the cadmium were not collected for use in the PV panels or other products, it would otherwise either be stockpiled for future use, cemented and buried, or disposed of.<sup>28</sup> Nearly all the cadmium in old or broken panels can be recycled which can eventually serve as the primary source of cadmium for new PV panels.<sup>29</sup>

Similar to silicon-based PV panels, CdTe panels are constructed of a tempered glass front, one instead of two clear plastic encapsulation layers, and a rear heat strengthened glass backing (together >98% by weight). The final product is built to withstand exposure to the elements without significant damage for over 25 years. While not representative of damage that may occur in the field or even at a landfill, laboratory evidence has illustrated that when panels are ground into a fine powder, very acidic water is able to leach portions of the cadmium and tellurium,<sup>30</sup> similar to the process used to recycle CdTe panels. Like many silicon-based panels, CdTe panels are reported (as far back as 1998<sup>31</sup>) to pass the EPA's Toxic Characteristic Leaching Procedure (TCLP) test, which tests the potential for crushed panels in a landfill to leach hazardous substances into groundwater.<sup>32</sup> Passing this test means that they are classified as non-hazardous waste and can be deposited in landfills.<sup>33,34</sup> For more information about PV panel end-of-life, see the Panel Disposal section.

There is also concern of environmental impact resulting from potential catastrophic events involving CdTe PV panels. An analysis of worst-case scenarios for environmental impact from CdTe PV panels, including earthquakes, fires, and floods, was conducted by the University of Tokyo in 2013. After reviewing the extensive international body of research on CdTe PV technology, their report concluded, "Even in the worst-case scenarios, it is unlikely that the Cd concentrations in air and sea water will exceed the environmental regulation values."<sup>35</sup> In a worst-case scenario of damaged panels abandoned on the ground, insignificant amounts of cadmium will leach from the panels. This is because this scenario is

much less conducive (larger module pieces, less acidity) to leaching than the conditions of the EPA's TCLP test used to simulate landfill conditions, which CdTe panels pass.<sup>36</sup>

First Solar, a U.S. company, and the only significant supplier of CdTe panels, has a robust panel take-back and recycling program that has been operating commercially since 2005.<sup>37</sup> The company states that it is “committed to providing a commercially attractive recycling solution for photovoltaic (PV) power plant and module owners to help them meet their module (end of life) EOL obligation simply, cost-effectively and responsibly.” First Solar global recycling services to their customers to collect and recycle panels once they reach the end of productive life whether due to age or damage. These recycling service agreements are structured to be financially attractive to both First Solar and the solar panel owner. For First Solar, the contract provides the company with an affordable source of raw materials needed for new panels and presumably a diminished risk of undesired release of Cd. The contract also benefits the solar panel owner by allowing them to avoid tipping fees at a waste disposal site. The legal contract helps provide peace of mind by ensuring compliance by both parties when considering the continuing trend of rising disposal costs and increasing regulatory requirements.

### c. CIS/CIGS and other PV technologies

Copper indium gallium selenide PV technology, often referred to as CIGS, is the second most common type of thin-film PV panel but a distant second behind CdTe. CIGS cells are composed of a thin layer of copper, indium, gallium, and selenium on a glass or plastic backing. None of these elements are very toxic, although selenium is a regulated metal under the Federal Resource Conservation and Recovery Act (RCRA).<sup>38</sup> The cells often also have an extremely thin layer of cadmium sulfide that contains a tiny amount of cadmium, which is toxic. The promise of high efficiency CIGS panels drove heavy investment in this technology in the past. However, researchers have struggled to transfer high efficiency success in the lab to low-cost full-scale panels in the field.<sup>39</sup> Recently, a CIGS manufacturer based in Japan, Solar Frontier, has achieved some market success with a rigid, glass-faced CIGS module that competes with silicon panels. Solar Frontier produces the majority of CIS panels on the market today.<sup>40</sup> Notably, these panels are RoHS compliant,<sup>41</sup> thus meeting the rigorous toxicity standard adopted by the European Union even though this directive exempts PV panels. The authors are unaware of any completed or proposed utility-scale system in North Carolina using CIS/CIGS panels.

## 1.2.3 Panel End-of-Life Management

Concerns about the volume, disposal, toxicity, and recycling of PV panels are addressed in this subsection. To put the volume of PV waste into perspective, consider that by 2050, when PV systems installed in 2020 will reach the end of their lives, it is estimated that the global annual PV panel waste tonnage will be 10% of the 2014 global e-waste tonnage.<sup>42</sup> In the U.S., end-of-life disposal of solar products is governed by the Federal Resource Conservation and Recovery Act (RCRA), as well as state policies in some situations. RCRA separates waste into hazardous (not accepted at ordinary landfill) and solid waste (generally accepted at ordinary landfill) based on a series of rules. According to RCRA, the way to determine if a PV panel is classified as hazardous waste is the Toxic Characteristic Leaching Procedure (TCLP) test. This EPA test is designed to simulate landfill disposal and determine the risk of hazardous substances leaching out of the landfill.<sup>43,44,45</sup> Multiple sources report that most modern PV panels (both crystalline silicon and cadmium telluride) pass the TCLP test.<sup>46,47</sup> Some studies found that some older (1990s) crystalline silicon panels, and perhaps some newer crystalline silicon panels (specifics are not given about vintage of panels tested), do not pass the lead (Pb) leachate limits in the TCLP test.<sup>48,</sup>

The test begins with the crushing of a panel into centimeter-sized pieces. The pieces are then mixed in an acid bath. After tumbling for eighteen hours, the fluid is tested for forty hazardous substances that all must be below specific threshold levels to pass the test. Research comparing TCLP conditions to conditions of damaged panels in the field found that simulated landfill conditions provide overly conservative estimates of leaching for field-damaged panels.<sup>50</sup> Additionally, research in Japan has found no detectable Cd leaching from cracked CdTe panels when exposed to simulated acid rain.<sup>51</sup>

Although modern panels can generally be landfilled, they can also be recycled. Even though recent waste volume has not been adequate to support significant PV-specific recycling infrastructure, the existing recycling industry in North Carolina reports that it recycles much of the current small volume of broken PV panels. In an informal survey conducted by the NC Clean Energy Technology Center survey in early 2016, seven of the eight large active North Carolina utility-scale solar developers surveyed reported that they send damaged panels back to the manufacturer and/or to a local recycler. Only one developer reported sending damaged panels to the landfill.

The developers reported at that time that they are usually paid a small amount per panel by local recycling firms. In early 2017, a PV developer reported that a local recycler was charging a small fee per panel to recycle damaged PV panels. The local recycling firm known to authors to accept PV panels described their current PV panel recycling practice as of early 2016 as removing the aluminum frame for local recycling and removing the wire leads for local copper recycling. The remainder of the panel is sent to a facility for processing the non-metallic portions of crushed vehicles, referred to as “fluff” in the recycling industry.<sup>52</sup> This processing within existing general recycling plants allows for significant material recovery of major components, including glass which is 80% of the module weight, but at lower yields than PV-specific recycling plants. Notably almost half of the material value in a PV panel is in the few grams of silver contained in almost every PV panel produced today. In the long-term, dedicated PV panel recycling plants can increase treatment capacities and maximize revenues resulting in better output quality and the ability to recover a greater fraction of the useful materials.<sup>53</sup> PV-specific panel recycling technologies have been researched and implemented to some extent for the past decade, and have been shown to be able to recover over 95% of PV material (semiconductor) and over 90% of the glass in a PV panel.<sup>54</sup>

A look at global PV recycling trends hints at the future possibilities of the practice in our country. Europe installed MW-scale volumes of PV years before the U.S. In 2007, a public-private partnership between the European Union and the solar industry set up a voluntary collection and recycling system called PV CYCLE. This arrangement was later made mandatory under the EU’s WEEE directive, a program for waste electrical and electronic equipment.<sup>55</sup> Its member companies (PV panel producers) fully finance the association. This makes it possible for end-users to return the member companies’ defective panels for recycling at any of the over 300 collection points around Europe without added costs. Additionally, PV CYCLE will pick up batches of 40 or more used panels at no cost to the user. This arrangement has been very successful, collecting and recycling over 13,000 tons by the end of 2015.<sup>56</sup>

In 2012, the WEEE Directive added the end-of-life collection and recycling of PV panels to its scope.<sup>57</sup> This directive is based on the principle of extended-producer-responsibility. It has a global impact because producers that want to sell into the EU market are legally responsible for end-of-life management. Starting in 2018, this directive targets that 85% of PV products “put in the market” in Europe are recovered and 80% is prepared for reuse and recycling.

The success of the PV panel collection and recycling practices in Europe provides promise for the future of recycling in the U.S. In mid-2016, the US Solar Energy Industry Association (SEIA) announced that they are starting a national solar panel recycling program with the guidance and support of many

leading PV panel producers.<sup>58</sup> The program will aggregate the services offered by recycling vendors and PV manufacturers, which will make it easier for consumers to select a cost-effective and environmentally responsible end-of-life management solution for their PV products. According to SEIA, they are planning the program in an effort to make the entire industry landfill-free. In addition to the national recycling network program, the program will provide a portal for system owners and consumers with information on how to responsibly recycle their PV systems.

While a cautious approach toward the potential for negative environmental and/or health impacts from retired PV panels is fully warranted, this section has shown that the positive health impacts of reduced emissions from fossil fuel combustion from PV systems more than outweighs any potential risk. Testing shows that silicon and CdTe panels are both safe to dispose of in landfills, and are also safe in worst case conditions of abandonment or damage in a disaster. Additionally, analysis by local engineers has found that the current salvage value of the equipment in a utility scale PV facility generally exceeds general contractor estimates for the cost to remove the entire PV system.<sup>59, 60, 61</sup>

#### **1.2.4 Non-Panel System Components (racking, wiring, inverter, transformer)**

While previous toxicity subsections discussed PV panels, this subsection describes the non-panel components of utility-scale PV systems and investigates any potential public health and safety concerns. The most significant non-panel component of a ground-mounted PV system is the mounting structure of the rows of panels, commonly referred to as “racking”. The vertical post portion of the racking is galvanized steel and the remaining above-ground racking components are either galvanized steel or aluminum, which are both extremely common and benign building materials. The inverters that make the solar generated electricity ready to send to the grid have weather-proof steel enclosures that protect the working components from the elements. The only fluids that they might contain are associated with their cooling systems, which are not unlike the cooling system in a computer. Many inverters today are RoHS compliant.

The electrical transformers (to boost the inverter output voltage to the voltage of the utility connection point) do contain a liquid cooling oil. However, the fluid used for that function is either a non-toxic mineral oil or a biodegradable non-toxic vegetable oil, such as BIOTEMP from ABB. These vegetable transformer oils have the additional advantage of being much less flammable than traditional mineral oils. Significant health hazards are associated with old transformers containing cooling oil with toxic PCBs. Transformers with PCB-containing oil were common before PCBs were outlawed in the U.S. in 1979. PCBs still exist in older transformers in the field across the country.

Other than a few utility research sites, there are no batteries on- or off-site associated with utility-scale solar energy facilities in North Carolina, avoiding any potential health or safety concerns related to battery technologies. However, as battery technologies continue to improve and prices continue to decline we are likely to start seeing some batteries at solar facilities. Lithium ion batteries currently dominate the world utility-scale battery market, which are not very toxic. No non-panel system components were found to pose any health or environmental dangers.

### **1.4 Operations and Maintenance – Panel Washing and Vegetation Control**

Throughout the eastern U.S., the climate provides frequent and heavy enough rain to keep panels adequately clean. This dependable weather pattern eliminates the need to wash the panels on a regular basis. Some system owners may choose to wash panels as often as once a year to increase production, but most in N.C. do not regularly wash any PV panels. Dirt build up over time may justify panel washing a few times over the panels' lifetime; however, nothing more than soap and water are required for this activity.

The maintenance of ground-mounted PV facilities requires that vegetation be kept low, both for aesthetics and to avoid shading of the PV panels. Several approaches are used to maintain vegetation at NC solar facilities, including planting of limited-height species, mowing, weed-eating, herbicides, and grazing livestock (sheep). The following descriptions of vegetation maintenance practices are based on interviews with several solar developers as well as with three maintenance firms that together are contracted to maintain well over 100 of the solar facilities in N.C. The majority of solar facilities in North Carolina maintain vegetation primarily by mowing. Each row of panels has a single row of supports, allowing sickle mowers to mow under the panels. The sites usually require mowing about once a month during the growing season. Some sites employ sheep to graze the site, which greatly reduces the human effort required to maintain the vegetation and produces high quality lamb meat.<sup>62</sup>

In addition to mowing and weed eating, solar facilities often use some herbicides. Solar facilities generally do not spray herbicides over the entire acreage; rather they apply them only in strategic locations such as at the base of the perimeter fence, around exterior vegetative buffer, on interior dirt roads, and near the panel support posts. Also unlike many row crop operations, solar facilities generally use only general use herbicides, which are available over the counter, as opposed to restricted use herbicides commonly used in commercial agriculture that require a special restricted use license. The herbicides used at solar facilities are primarily 2-4-D and glyphosate (Round-up®), which are two of the most common herbicides used in lawns, parks, and agriculture across the country. One maintenance firm that was interviewed sprays the grass with a class of herbicide known as a growth regulator in order to slow the growth of grass so that mowing is only required twice a year. Growth regulators are commonly used on highway roadsides and golf courses for the same purpose. A commercial pesticide applicator license is required for anyone other than the landowner to apply herbicides, which helps ensure that all applicators are adequately educated about proper herbicide use and application. The license must be renewed annually and requires passing of a certification exam appropriate to the area in which the applicator wishes to work. Based on the limited data available, it appears that solar facilities in N.C. generally use significantly less herbicides per acre than most commercial agriculture or lawn maintenance services.

## **2. Electromagnetic Fields (EMF)**

PV systems do not emit any material during their operation; however, they do generate electromagnetic fields (EMF), sometimes referred to as radiation. EMF produced by electricity is non-ionizing radiation, meaning the radiation has enough energy to move atoms in a molecule around (experienced as heat), but not enough energy to remove electrons from an atom or molecule (ionize) or to damage DNA. As shown below, modern humans are all exposed to EMF throughout our daily lives without negative health impact. Someone outside of the fenced perimeter of a solar facility is not exposed to significant EMF from the solar facility. Therefore, there is no negative health impact from the EMF

produced in a solar farm. The following paragraphs provide some additional background and detail to support this conclusion.

Since the 1970s, some have expressed concern over potential health consequences of EMF from electricity, but no studies have ever shown this EMF to cause health problems.<sup>63</sup> These concerns are based on some epidemiological studies that found a slight increase in childhood leukemia associated with average exposure to residential power-frequency magnetic fields above 0.3 to 0.4  $\mu\text{T}$  (microteslas) (equal to 3.0 to 4.0 mG (milligauss)).  $\mu\text{T}$  and mG are both units used to measure magnetic field strength. For comparison, the average exposure for people in the U.S. is one mG or 0.1  $\mu\text{T}$ , with about 1% of the population with an average exposure in excess of 0.4  $\mu\text{T}$  (or 4 mG).<sup>64</sup> These epidemiological studies, which found an association but not a causal relationship, led the World Health Organization's International Agency for Research on Cancer (IARC) to classify ELF magnetic fields as "possibly carcinogenic to humans". Coffee also has this classification. This classification means there is limited evidence but not enough evidence to designate as either a "probable carcinogen" or "human carcinogen". Overall, there is very little concern that ELF EMF damages public health. The only concern that does exist is for long-term exposure above 0.4  $\mu\text{T}$  (4 mG) that may have some connection to increased cases of childhood leukemia. In 1997, the National Academies of Science were directed by Congress to examine this concern and concluded:

"Based on a comprehensive evaluation of published studies relating to the effects of power-frequency electric and magnetic fields on cells, tissues, and organisms (including humans), the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human-health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects, or reproductive and developmental effects."<sup>65</sup>

There are two aspects to electromagnetic fields, an electric field and a magnetic field. The electric field is generated by voltage and the magnetic field is generated by electric current, i.e., moving electrons. A task group of scientific experts convened by the World Health Organization (WHO) in 2005 concluded that there were no substantive health issues related to *electric* fields (0 to 100,000 Hz) at levels generally encountered by members of the public.<sup>66</sup> The relatively low voltages in a solar facility and the fact that electric fields are easily shielded (i.e., blocked) by common materials, such as plastic, metal, or soil means that there is no concern of negative health impacts from the electric fields generated by a solar facility. Thus, the remainder of this section addresses magnetic fields. Magnetic fields are not shielded by most common materials and thus can easily pass through them. Both types of fields are strongest close to the source of electric generation and weaken quickly with distance from the source.

The direct current (DC) electricity produced by PV panels produce stationary (0 Hz) electric and magnetic fields. Because of minimal concern about potential risks of stationary fields, little scientific research has examined stationary fields' impact on human health.<sup>67</sup> In even the largest PV facilities, the DC voltages and currents are not very high. One can illustrate the weakness of the EMF generated by a PV panel by placing a compass on an operating solar panel and observing that the needle still points north.

While the electricity throughout the majority of a solar site is DC electricity, the inverters convert this DC electricity to alternating current (AC) electricity matching the 60 Hz frequency of the grid. Therefore, the inverters and the wires delivering this power to the grid are producing non-stationary EMF, known as extremely low frequency (ELF) EMF, normally oscillating with a frequency of 60 Hz. This frequency is at the low-energy end of the electromagnetic spectrum. Therefore, it has less energy than

other commonly encountered types of non-ionizing radiation like radio waves, infrared radiation, and visible light.

The wide use of electricity results in background levels of ELF EMFs in nearly all locations where people spend time – homes, workplaces, schools, cars, the supermarket, etc. A person’s average exposure depends upon the sources they encounter, how close they are to them, and the amount of time they spend there.<sup>68</sup> As stated above, the average exposure to magnetic fields in the U.S. is estimated to be around one mG or 0.1  $\mu$ T, but can vary considerably depending on a person’s exposure to EMF from electrical devices and wiring.<sup>69</sup> At times we are often exposed to much higher ELF magnetic fields, for example when standing three feet from a refrigerator the ELF magnetic field is 6 mG and when standing three feet from a microwave oven the field is about 50 mG.<sup>70</sup> The strength of these fields diminish quickly with distance from the source, but when surrounded by electricity in our homes and other buildings moving away from one source moves you closer to another. However, unless you are inside of the fence at a utility-scale solar facility or electrical substation it is impossible to get very close to the EMF sources. Because of this, EMF levels at the fence of electrical substations containing high voltages and currents are considered “generally negligible”<sup>71, 72</sup>

The strength of ELF-EMF present at the perimeter of a solar facility or near a PV system in a commercial or residential building is significantly lower than the typical American’s average EMF exposure.<sup>73,74</sup> Researchers in Massachusetts measured magnetic fields at PV projects and found the magnetic fields dropped to very low levels of 0.5 mG or less, and in many cases to less than background levels (0.2 mG), at distances of no more than nine feet from the residential inverters and 150 feet from the utility-scale inverters.<sup>75</sup> Even when measured within a few feet of the utility-scale inverter, the ELF magnetic fields were well below the International Commission on Non-Ionizing Radiation Protection’s recommended magnetic field level exposure limit for the general public of 2,000 mG.<sup>76</sup> It is typical that utility scale designs locate large inverters central to the PV panels that feed them because this minimizes the length of wire required and shields neighbors from the sound of the inverter’s cooling fans. Thus, it is rare for a large PV inverter to be within 150 feet of the project’s security fence.

Anyone relying on a medical device such as pacemaker or other implanted device to maintain proper heart rhythm may have concern about the potential for a solar project to interfere with the operation of his or her device. However, there is no reason for concern because the EMF outside of the solar facility’s fence is less than 1/1000 of the level at which manufacturers test for ELF EMF interference, which is 1,000 mG.<sup>77</sup> Manufacturers of potentially affected implanted devices often provide advice on electromagnetic interference that includes avoiding letting the implanted device get too close to certain sources of fields such as some household appliances, some walkie-talkies, and similar transmitting devices. Some manufacturers’ literature does not mention high-voltage power lines, some say that exposure in public areas should not give interference, and some advise not spending extended periods of time close to power lines.<sup>78</sup>

### **3. Electric Shock and Arc Flash Hazards**

There is a real danger of electric shock to anyone entering any of the electrical cabinets such as combiner boxes, disconnect switches, inverters, or transformers; or otherwise coming in contact with voltages over 50 Volts.<sup>79</sup> Another electrical hazard is an arc flash, which is an explosion of energy that can occur in a short circuit situation. This explosive release of energy causes a flash of heat and a shockwave, both of which can cause serious injury or death. Properly trained and equipped technicians and electricians know how to safely install, test, and repair PV systems, but there is always some risk of

injury when hazardous voltages and/or currents are present. Untrained individuals should not attempt to inspect, test, or repair any aspect of a PV system due to the potential for injury or death due to electric shock and arc flash, The National Electric Code (NEC) requires appropriate levels of warning signs on all electrical components based on the level of danger determined by the voltages and current potentials. The national electric code also requires the site to be secured from unauthorized visitors with either a six-foot chain link fence with three strands of barbed wire or an eight-foot fence, both with adequate hazard warning signs.

## 4. Fire Safety

The possibility of fires resulting from or intensified by PV systems may trigger concern among the general public as well as among firefighters. However, concern over solar fire hazards should be limited because only a small portion of materials in the panels are flammable, and those components cannot self-support a significant fire. Flammable components of PV panels include the thin layers of polymer encapsulates surrounding the PV cells, polymer backsheets (framed panels only), plastic junction boxes on rear of panel, and insulation on wiring. The rest of the panel is composed of non-flammable components, notably including one or two layers of protective glass that make up over three quarters of the panel's weight.

Heat from a small flame is not adequate to ignite a PV panel, but heat from a more intense fire or energy from an electrical fault can ignite a PV panel.<sup>80</sup> One real-world example of this occurred during July 2015 in an arid area of California. Three acres of grass under a thin film PV facility burned without igniting the panels mounted on fixed-tilt racks just above the grass.<sup>81</sup> While it is possible for electrical faults in PV systems on homes or commercial buildings to start a fire, this is extremely rare.<sup>82</sup> Improving understanding of the PV-specific risks, safer system designs, and updated fire-related codes and standards will continue to reduce the risk of fire caused by PV systems.

PV systems on buildings can affect firefighters in two primary ways, 1) impact their methods of fighting the fire, and 2) pose safety hazard to the firefighters. One of the most important techniques that firefighters use to suppress fire is ventilation of a building's roof. This technique allows superheated toxic gases to quickly exit the building. By doing so, the firefighters gain easier and safer access to the building, Ventilation of the roof also makes the challenge of putting out the fire easier. However, the placement of rooftop PV panels may interfere with ventilating the roof by limiting access to desired venting locations.

New solar-specific building code requirements are working to minimize these concerns. Also, the latest National Electric Code has added requirements that make it easier for first responders to safely and effectively turn off a PV system. Concern for firefighting a building with PV can be reduced with proper fire fighter training, system design, and installation. Numerous organizations have studied fire fighter safety related to PV. Many organizations have published valuable guides and training programs. Some notable examples are listed below.

- The International Association of Fire Fighters (IAFF) and International Renewable Energy Council (IREC) partnered to create an online training course that is far beyond the PowerPoint click-and-view model. The self-paced online course, "Solar PV Safety for Fire Fighters," features rich video content and simulated environments so fire fighters can practice the knowledge they've learned. [www.iaff.org/pvsafetytraining](http://www.iaff.org/pvsafetytraining)
- [Photovoltaic Systems and the Fire Code](#): Office of NC Fire Marshal
- [Fire Service Training](#), Underwriter's Laboratory

- Firefighter Safety and Response for Solar Power Systems, National Fire Protection Research Foundation
- Bridging the Gap: Fire Safety & Green Buildings, National Association of State Fire Marshalls
- Guidelines for Fire Safety Elements of Solar Photovoltaic Systems, Orange County Fire Chiefs Association
- Solar Photovoltaic Installation Guidelines, California Department of Forestry & Fire Protection, Office of the State Fire Marshall
- PV Safety & Firefighting, Matthew Paiss, Homepower Magazine
- PV Safety and Code Development: Matthew Paiss, Cooperative Research Network

## Summary

The purpose of this paper is to address and alleviate concerns of public health and safety for utility-scale solar PV projects. Concerns of public health and safety were divided and discussed in the four following sections: (1) Toxicity, (2) Electromagnetic Fields, (3) Electric Shock and Arc Flash, and (4) Fire. In each of these sections, the negative health and safety impacts of utility-scale PV development were shown to be negligible, while the public health and safety benefits of installing these facilities are significant and far outweigh any negative impacts.

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<sup>1</sup> Wisner, Ryan, Trieu Mai, Dev Millstein, Jordan Macknick, Alberta Carpenter, Stuart Cohen, Wesley Cole, Bethany Frew, and Garvin A. Heath. 2016. *On the Path to SunShot: The Environmental and Public Health Benefits of Achieving High Penetrations of Solar Energy in the United States*. Golden, CO: National Renewable Energy Laboratory. Accessed March 2017, [www.nrel.gov/docs/fy16osti/65628.pdf](http://www.nrel.gov/docs/fy16osti/65628.pdf)

<sup>2</sup> IRENA and IEA-PVPS (2016), “End-of-Life Management: Solar Photovoltaic Panels,” International Renewable Energy Agency and International Energy Agency Photovoltaic Power Systems.

<sup>3</sup> National Renewable Energy Laboratory, *Overview of Field Experience – Degradation Rates & Lifetimes*. September 14, 2015. Solar Power International Conference. Accessed March 2017, [www.nrel.gov/docs/fy15osti/65040.pdf](http://www.nrel.gov/docs/fy15osti/65040.pdf)

<sup>4</sup> Miesel et al. *SolarCity Photovoltaic Modules with 35 Year Useful Life*. June 2016. Accessed March 2017. <http://www.solarcity.com/newsroom/reports/solarcity-photovoltaic-modules-35-year-useful-life>

<sup>5</sup> David Unger. *Are Renewables Stormproof? Hurricane Sandy Tests Solar, Wind*. November 2012. Accessed March 2017. <http://www.csmonitor.com/Environment/Energy-Voices/2012/1119/Are-renewables-stormproof-Hurricane-Sandy-tests-solar-wind> & <http://www.csmonitor.com/Environment/Energy-Voices/2012/1119/Are-renewables-stormproof-Hurricane-Sandy-tests-solar-wind>

<sup>6</sup> NEXTracker and 365 Pronto, *Tracking Your Solar Investment: Best Practices for Solar Tracker O&M*. Accessed March 2017. [www.nextracker.com/content/uploads/2017/03/NEXTracker\\_OandM-WhitePaper\\_FINAL\\_March-2017.pdf](http://www.nextracker.com/content/uploads/2017/03/NEXTracker_OandM-WhitePaper_FINAL_March-2017.pdf)

<sup>7</sup> Christiana Honsberg, Stuart Bowden. *Overview of Screen Printed Solar Cells*. Accessed January 2017. [www.pveducation.org/pvcdrom/manufacturing/screen-printed](http://www.pveducation.org/pvcdrom/manufacturing/screen-printed)

<sup>8</sup> Silicon Valley Toxics Coalition. *2015 Solar Scorecard*. Accessed August 2016. [www.solarscorecard.com/2015/2015-SVTC-Solar-Scorecard.pdf](http://www.solarscorecard.com/2015/2015-SVTC-Solar-Scorecard.pdf)

<sup>9</sup> European Commission. *Recast of Reduction of Hazardous Substances (RoHS) Directive*. September 2016. Accessed August 2016. [http://ec.europa.eu/environment/waste/rohs\\_eee/index\\_en.htm](http://ec.europa.eu/environment/waste/rohs_eee/index_en.htm)

<sup>10</sup> Official Journal of the European Union, *DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment*. June 2011. Accessed May 2017. <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011L0065&from=en>

<sup>11</sup> Giancarlo Giacchetta, Mariella Leporini, Barbara Marchetti. *Evaluation of the Environmental Benefits of New High Value Process for the Management of the End of Life of Thin Film Photovoltaic Modules*. July 2013. Accessed August 2016. [www.researchgate.net/publication/257408804\\_Evaluation\\_of\\_the\\_environmental\\_benefits\\_of\\_new\\_high\\_value\\_process\\_for\\_the\\_management\\_of\\_the\\_end\\_of\\_life\\_of\\_thin\\_film\\_photovoltaic\\_modules](http://www.researchgate.net/publication/257408804_Evaluation_of_the_environmental_benefits_of_new_high_value_process_for_the_management_of_the_end_of_life_of_thin_film_photovoltaic_modules)

- <sup>12</sup> European Commission. *Study on Photovoltaic Panels Supplementing The Impact Assessment for a Recast of the Weee Directive*. April 2011. Accessed August 2016. <http://ec.europa.eu/environment/waste/weee/pdf/Study%20on%20PVs%20Bio%20final.pdf>
- <sup>14</sup> The amount of lead in a typical car battery is 21.4 pounds. Waste 360. Chaz Miller. *Lead Acid Batteries*. March 2006. Accessed August 2016. [http://waste360.com/mag/waste\\_leadacid\\_batteries\\_3](http://waste360.com/mag/waste_leadacid_batteries_3)
- <sup>15</sup> Okkenhaug G. *Leaching from CdTe PV module material results from batch, column and availability tests*. Norwegian Geotechnical Institute, NGI report No. 20092155-00-6-R; 2010
- <sup>16</sup> International Journal of Advanced Applied Physics Research. Renate Zapf-Gottwick1, et al. *Leaching Hazardous Substances out of Photovoltaic Modules*. January 2015. Accessed January 2016. [www.cosmoscholars.com/phms/index.php/ijaapr/article/download/485/298](http://www.cosmoscholars.com/phms/index.php/ijaapr/article/download/485/298)
- <sup>17</sup> *ibid*
- <sup>18</sup> Parikhith Sinha, et al. Evaluation of Potential Health and Environmental Impacts from End-Of-Life Disposal of Photovoltaics, Photovoltaics, 2014. Accessed May 2016
- <sup>19</sup> Bonnet, D. and P. Meyers. 1998. *Cadmium-telluride—Material for thin film solar cells*. J. Mater. Res., Vol. 13, No. 10, pp. 2740-2753
- <sup>20</sup> V. Fthenakis, K. Zweibel. *CdTe PV: Real and Perceived EHS Risks*. National Center of Photovoltaics and Solar Program Review Meeting, March 24-26, 2003. [www.nrel.gov/docs/fy03osti/33561.pdf](http://www.nrel.gov/docs/fy03osti/33561.pdf). Accessed May 2017
- <sup>21</sup> International Energy Agency Photovoltaic Power Systems Programme. *Life Cycle Inventories and Life Cycle Assessments of Photovoltaic Systems*. March 2015. Accessed August 2016. <http://iea-pvps.org/index.php?id=315>
- <sup>22</sup> Data not available on fraction of various generation sources offset by solar generation in NC, but this is believed to be a reasonable rough estimate. The SunShot report entitled The Environmental and Public Health Benefits of Achieving High Penetrations of Solar Energy in the United States analysis contributes significant (% not provided) offsetting of coal-fired generation by solar PV energy in the southeast.
- <sup>23</sup>  $7 \text{ MW}_{\text{DC}} * 1.5 \text{ GWh/MW}_{\text{DC}} * 25 \text{ years} * 0.93 \text{ degradation factor} * (0.1 * 4.65 \text{ grams/GWh} + 0.9 * 0.2 \text{ grams/GWh})$
- <sup>24</sup> Vasilis Fthenakis. *CdTe PV: Facts and Handy Comparisons*. January 2003. Accessed March 2017. [https://www.bnl.gov/pv/files/pdf/art\\_165.pdf](https://www.bnl.gov/pv/files/pdf/art_165.pdf)
- <sup>25</sup> Kaczmar, S., *Evaluating the Read-Across Approach on CdTe Toxicity for CdTe Photovoltaics*, SETAC North America 32nd Annual Meeting, Boston, MA, November 2011. Available at: <ftp://ftp.co.imperial.ca.us/icpds/eir/campo-verde-solar/final/evaluating-toxicity.pdf>, Accessed May 2017
- <sup>27</sup> V. M. Fthenakis et al, *Emissions and Encapsulation of Cadmium in CdTe PV Modules During Fires* Renewable Progress in Photovoltaics: Research and Application: Res. Appl. 2005; 13:1–11, Accessed March 2017, [www.bnl.gov/pv/files/pdf/abs\\_179.pdf](http://www.bnl.gov/pv/files/pdf/abs_179.pdf)
- <sup>28</sup> Fthenakis V.M., *Life Cycle Impact Analysis of Cadmium in CdTe Photovoltaic Production*, Renewable and Sustainable Energy Reviews, 8, 303-334, 2004. [www.clca.columbia.edu/papers/Life\\_Cycle\\_Impact\\_Analysis\\_Cadmium\\_CdTe\\_Photovoltaic\\_production.pdf](http://www.clca.columbia.edu/papers/Life_Cycle_Impact_Analysis_Cadmium_CdTe_Photovoltaic_production.pdf), Accessed May 2017
- <sup>29</sup> International Renewable Energy Agency. Stephanie Weckend, Andreas Wade, Garvin Heath. *End of Life Management: Solar Photovoltaic Panels*. June 2016. Accessed November 2016.
- <sup>30</sup> International Journal of Advanced Applied Physics Research. Renate Zapf-Gottwick1, et al. *Leaching Hazardous Substances out of Photovoltaic Modules*. January 2015. Accessed January 2016. [www.cosmoscholars.com/phms/index.php/ijaapr/article/download/485/298](http://www.cosmoscholars.com/phms/index.php/ijaapr/article/download/485/298)
- <sup>31</sup> Cunningham D., Discussion about TCLP protocols, Photovoltaics and the Environment Workshop, July 23-24, 1998, Brookhaven National Laboratory, BNL-52557
- <sup>32</sup> Parikhith Sinha, et al. Evaluation of Potential Health and Environmental Impacts from End-Of-Life Disposal of Photovoltaics, Photovoltaics, 2014. Accessed May 2016
- <sup>33</sup> Practical Handbook of Photovoltaics: Fundamentals and Applications. T. Markvart and L. Castaner. *Chapter VII-2: Overview of Potential Hazards*. December 2003. Accessed August 2016. [https://www.bnl.gov/pv/files/pdf/art\\_170.pdf](https://www.bnl.gov/pv/files/pdf/art_170.pdf)
- <sup>34</sup> Norwegian Geotechnical Institute. *Environmental Risks Regarding the Use and End-of-Life Disposal of CdTe PV Modules*. April 2010. Accessed August 2016. <https://www.dtsc.ca.gov/LawsRegsPolicies/upload/Norwegian-Geotechnical-Institute-Study.pdf>
- <sup>35</sup> First Solar. Dr. Yasunari Matsuno. December 2013. August 2016. *Environmental Risk Assessment of CdTe PV Systems to be considered under Catastrophic Events in Japan*. [http://www.firstsolar.com/-/media/Documents/Sustainability/Peer-Reviews/Japan\\_Peer-Review\\_Matsuno\\_CdTe-PV-Tsunami.ashx](http://www.firstsolar.com/-/media/Documents/Sustainability/Peer-Reviews/Japan_Peer-Review_Matsuno_CdTe-PV-Tsunami.ashx)
- <sup>36</sup> First Solar. Parikhith Sinha, Andreas Wade. *Assessment of Leaching Tests for Evaluating Potential Environmental Impacts of PV Module Field Breakage*. 2015 IEEE
- <sup>37</sup> See p. 22 of First Solar, Sustainability Report. Available at: [www.firstsolar.com/-/media/First-Solar/Sustainability-Documents/03801\\_FirstSolar\\_SustainabilityReport\\_08MAR16\\_Web.ashx](http://www.firstsolar.com/-/media/First-Solar/Sustainability-Documents/03801_FirstSolar_SustainabilityReport_08MAR16_Web.ashx), Accessed May 2017

- <sup>38</sup> 40 CFR §261.24. *Toxicity Characteristic*. May 2017. Accessed May 2017. [https://www.ecfr.gov/cgi-bin/text-idx?node=se40.26.261\\_124&rgn=div8](https://www.ecfr.gov/cgi-bin/text-idx?node=se40.26.261_124&rgn=div8)
- <sup>39</sup> Office of Energy Efficiency & Renewable Energy. *Copper Indium Gallium Diselenide*. Accessed March 2017. <https://www.energy.gov/eere/sunshot/copper-indium-gallium-diselenide>
- <sup>40</sup> Mathias Maehlum. *Best Thin Film Solar Panels – Amorphous, Cadmium Telluride or CIGS?* April 2015. Accessed March 2017. <http://energyinformative.org/best-thin-film-solar-panels-amorphous-cadmium-telluride-cigs/>
- <sup>41</sup> RoHS tested certificate for Solar Frontier PV modules. TUV Rheinland, signed 11.11.2013
- <sup>42</sup> International Renewable Energy Agency. Stephanie Weckend, Andreas Wade, Garvin Heath. *End of Life Management: Solar Photovoltaic Panels*. June 2016. Accessed November 2016. [http://www.irena.org/DocumentDownloads/Publications/IRENA\\_IEAPVPS\\_End-of-Life\\_Solar\\_PV\\_Panels\\_2016.pdf](http://www.irena.org/DocumentDownloads/Publications/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf)
- <sup>43</sup> 40 C.F.R. §261.10. *Identifying the Characteristics of Hazardous Waste and for Listing Hazardous Waste*. November 2016. Accessed November 2016 <http://www.ecfr.gov/cgi-bin/text-idx?SID=ce0006d66da40146b490084ca2816143&mc=true&node=pt40.26.261&rgn=div5#sp40.28.261.b>
- <sup>44</sup> 40 C.F.R. §261.24 *Toxicity Characteristic*. November 2016. Accessed November 2016. [http://www.ecfr.gov/cgi-bin/text-idx?SID=ce0006d66da40146b490084ca2816143&mc=true&node=pt40.26.261&rgn=div5#se40.28.261\\_124](http://www.ecfr.gov/cgi-bin/text-idx?SID=ce0006d66da40146b490084ca2816143&mc=true&node=pt40.26.261&rgn=div5#se40.28.261_124)
- <sup>45</sup> International Renewable Energy Agency. Stephanie Weckend, Andreas Wade, Garvin Heath. *End of Life Management: Solar Photovoltaic Panels*. June 2016. Accessed November 2016. [http://www.irena.org/DocumentDownloads/Publications/IRENA\\_IEAPVPS\\_End-of-Life\\_Solar\\_PV\\_Panels\\_2016.pdf](http://www.irena.org/DocumentDownloads/Publications/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf)
- <sup>46</sup> TLCP test results from third-party laboratories for REC, Jinko, and Canadian Solar silicon-based panels. Provided by PV panel manufacturers directly or indirectly to authors
- <sup>47</sup> Sinovoltaics, *Introduction to Solar Panel Recycling*, March 2014. Accessed October 2016. <http://sinovoltaics.com/solar-basics/introduction-to-solar-panel-recycling/>
- <sup>48</sup> Brookhaven National Laboratory. Vasilis Fthenakis, *Regulations on Photovoltaic Module Disposal and Recycling*. January 29, 2001.
- <sup>49</sup> Parikhit Sinha, et al. Evaluation of Potential Health and Environmental Impacts from End-Of-Life Disposal of Photovoltaics, Photovoltaics, 2014.
- <sup>50</sup> First Solar. Parikhit Sinha, Andreas Wade. *Assessment of Leaching Tests for Evaluating Potential Environmental Impacts of PV Module Field Breakage*. October 2015. Accessed August 2016. <http://www.firstsolar.com/-/media/Documents/Sustainability/PVSC42-Manuscript-20150912--Assessment-of-Leaching-Tests-for-Evaluating-Potential-Environmental-Impa.ashx>
- <sup>51</sup> First Solar. Dr. Yasunari Matsuno. December 2013. *Environmental Risk Assessment of CdTe PV Systems to be considered under Catastrophic Events in Japan*. [http://www.firstsolar.com/-/media/Documents/Sustainability/Peer-Reviews/Japan\\_Peer-Review\\_Matsuno\\_CdTe-PV-Tsunami.ashx](http://www.firstsolar.com/-/media/Documents/Sustainability/Peer-Reviews/Japan_Peer-Review_Matsuno_CdTe-PV-Tsunami.ashx)
- <sup>52</sup> Phone interview, February 3, 2016, TT&E Iron & Metal, Garner, NC [www.ncscrapmetal.com/](http://www.ncscrapmetal.com/)
- <sup>53</sup> Wen-His Huang, et al. *Strategy and Technology To Recycle Water-silicon Solar Modules*. Solar Energy, Volume 144, March 2017, Pages 22-31
- <sup>54</sup> International Renewable Energy Agency. Stephanie Weckend, Andreas Wade, Garvin Heath. *End of Life Management: Solar Photovoltaic Panels*. June 2016. Accessed November 2016. [http://www.irena.org/DocumentDownloads/Publications/IRENA\\_IEAPVPS\\_End-of-Life\\_Solar\\_PV\\_Panels\\_2016.pdf](http://www.irena.org/DocumentDownloads/Publications/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf)
- <sup>55</sup> Official Journal of the European Union. *Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on Waste Electrical and Electronic Equipment*. July 2012. Accessed November 2016. <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0019>
- <sup>56</sup> PV CYCLE. *Annual Report 2015*. Accessed November 2016. <https://pvcyclepublications.cld.bz/Annual-Report-PV-CYCLE-2015/6-7>
- <sup>57</sup> Official Journal of the European Union. *Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on Waste Electrical and Electronic Equipment*. July 2012. Accessed November 2016. <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0019>
- <sup>58</sup> SEIA National PV Recycling Program: [www.seia.org/seia-national-pv-recycling-program](http://www.seia.org/seia-national-pv-recycling-program)
- <sup>59</sup> RBI Solar, Decommissioning Plan submitted to Catawba County associated with permitting of a 5MW solar project in June 2016. Accessed April 2017. [www.catawbacountync.gov/Planning/Projects/Rezoning/RZ2015-05\\_DecommissioningPlan.pdf](http://www.catawbacountync.gov/Planning/Projects/Rezoning/RZ2015-05_DecommissioningPlan.pdf)
- <sup>60</sup> Birdseye Renewables, Decommissioning Plan submitted to Catawba County associated with permitting of a 5MW solar project in May 2015. Accessed April 2017. [www.catawbacountync.gov/Planning/Projects/Rezoning/RZ2015-04\\_DecommissioningPlan.pdf](http://www.catawbacountync.gov/Planning/Projects/Rezoning/RZ2015-04_DecommissioningPlan.pdf)
- <sup>61</sup> Cypress Creek Renewables, Decommissioning Plan submitted to Catawba County associated with permitting of a 5MW solar project in September 2016. Accessed April 2017. [www.catawbacountync.gov/Planning/Projects/Rezoning/RZ2016-06decommission.pdf](http://www.catawbacountync.gov/Planning/Projects/Rezoning/RZ2016-06decommission.pdf)
- <sup>62</sup> Sun Raised Farms: <http://sunraisedfarms.com/index.html>
- <sup>63</sup> National Institute of Environmental Health Sciences and National Institutes of Health, EMF: Electric and Magnetic Fields Associated with Electric Power: Questions and Answers, June 2002

- <sup>64</sup> World Health Organization. *Electromagnetic Fields and Public Health: Exposure to Extremely Low Frequency Fields*. June 2007. Accessed August 2016. <http://www.who.int/peh-emf/publications/facts/fs322/en/>
- <sup>65</sup> Committee on the Possible Effects of Electromagnetic Fields on Biologic Systems, National Research Council, Possible Health Effects of Exposure to Residential Electric and Magnetic Fields, ISBN: 0-309-55671-6, 384 pages, 6 x 9, (1997) This PDF is available from the National Academies Press at: <http://www.nap.edu/catalog/5155.html>
- <sup>66</sup> World Health Organization. *Electromagnetic Fields and Public Health: Exposure to Extremely Low Frequency Fields*. June 2007. Accessed August 2016. <http://www.who.int/peh-emf/publications/facts/fs322/en/>
- <sup>67</sup> World Health Organization. *Electromagnetic Fields and Public Health: Static Electric and Magnetic Fields*. March 2006. Accessed August 2016. <http://www.who.int/peh-emf/publications/facts/fs299/en/>
- <sup>68</sup> Asher Sheppard, Health Issues Related to the Static and Power-Frequency Electric and Magnetic Fields (EMFs) of the Soitec Solar Energy Farms, April 30, 2014. Accessed March 2017: [www.sandiegocounty.gov/content/dam/sdc/pds/ceqa/Soitec-Documents/Final-EIR-Files/Appendix\\_9.0-1\\_EMF.pdf](http://www.sandiegocounty.gov/content/dam/sdc/pds/ceqa/Soitec-Documents/Final-EIR-Files/Appendix_9.0-1_EMF.pdf)
- <sup>69</sup> Massachusetts Clean Energy Center. *Study of Acoustic and EMF Levels from Solar Photovoltaic Projects*. December 2012. Accessed August 2016.
- <sup>70</sup> Duke Energy Corporation. *Frequently Asked Questions: Electric and Magnetic Fields*. Accessed August 2016. [https://www.duke-energy.com/about-energy/frequently\\_asked\\_questions.asp](https://www.duke-energy.com/about-energy/frequently_asked_questions.asp)
- <sup>71</sup> National Institute of Environmental Health Sciences, *Electric and Magnetic Fields Associate with the use of Electric Power: Questions and Answers*, 2002. Accessed November 2016 [www.niehs.nih.gov/health/materials/electric\\_and\\_magnetic\\_fields](http://www.niehs.nih.gov/health/materials/electric_and_magnetic_fields)
- <sup>72</sup> Duke Energy Corporation. *Frequently Asked Questions: Electric and Magnetic Fields*. Accessed August 2016. [https://www.duke-energy.com/about-energy/frequently\\_asked\\_questions.asp](https://www.duke-energy.com/about-energy/frequently_asked_questions.asp)
- <sup>73</sup> R.A. Tell et al, *Electromagnetic Fields Associated with Commercial Solar Photovoltaic Electric Power Generating Facilities*, Journal of Occupational and Environmental Hygiene, Volume 12, 2015,- Issue 11. Abstract Accessed March 2016: <http://www.tandfonline.com/doi/full/10.1080/15459624.2015.1047021>
- <sup>74</sup> Massachusetts Department of Energy Resources, Massachusetts Department of Environmental Protection, and Massachusetts Clean Energy Center. *Questions & Answers: Ground-Mounted Solar Photovoltaic Systems*. June 2015. Accessed August 2016. <http://www.mass.gov/eea/docs/doer/renewables/solar/solar-pv-guide.pdf>
- <sup>75</sup> Ibid.
- <sup>76</sup> Ibid.
- <sup>77</sup> *EMFs and medical devices*, Accessed March 2017. [www.emfs.info/effects/medical-devices/](http://www.emfs.info/effects/medical-devices/)
- <sup>78</sup> Ibid.
- <sup>79</sup> Damon McCluer. *Electrical Construction & Maintenance: NFPA 70E's Approach to Considering DC Hazards*. September 2013. Accessed October 2016. <http://ecmweb.com/safety/nfpa-70e-s-approach-considering-dc-hazards>,
- <sup>80</sup> Hong-Yun Yang, et. al. *Experimental Studies on the Flammability and Fire Hazards of Photovoltaic Modules, Materials*. July 2015. Accessed August 2016. <http://www.mdpi.com/1996-1944/8/7/4210/pdf>
- <sup>81</sup> Matt Fountain. The Tribune. *Fire breaks out at Topaz Solar Farm*. July 2015. Accessed August 2016. [www.sanluisobispo.com/news/local/article39055539.html](http://www.sanluisobispo.com/news/local/article39055539.html)
- <sup>82</sup> Cooperative Research Network. Matthew Paiss. *Tech Surveillance: PV Safety & Code Developments*. October 2014. Accessed August 2016. [http://www.nreca.coop/wp-content/uploads/2013/06/ts\\_pv\\_fire\\_safety\\_oct\\_2014.pdf](http://www.nreca.coop/wp-content/uploads/2013/06/ts_pv_fire_safety_oct_2014.pdf)

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December 3, 2018

Spotsylvania County Board of Supervisors  
Mr. Greg Benton  
P.O. Box 99  
Spotsylvania, Virginia 22553

Re: Commitment to Spotsylvania County

Mr. Benton.

sPower appreciates the opportunity to invest in Spotsylvania County. We are also very appreciative of all of the time, effort and consideration of our special use permit applications to develop a solar generating facility within the county. sPower understands that this investment is challenging to some, but want to ensure you and the entire board our proposal will be safe, reliable and generate positive tax revenues and new jobs for the citizens of the county.

We have worked closely with the diligent and thoughtful planning staff over the last year to address their concerns and those of the community. In response to these discussions, we have increased setbacks, modified designs to avoid areas of concern, increased open space and incorporated road, water, and other community improvements into our project design and construction budgets.

In regard to community benefits, the project will generate approximately \$10 million dollars in new real estate and personal property taxes. In addition, if the project is constructed, we are committing up to \$3.5 million dollars toward improvements of the municipal water line, which we understand will also improve utility systems for the residents at Fawn Lake. Our use of this waterline will be limited and will allow us to utilize public water versus having to tap into the local underground aquifers. We will also construct two 50,000-gallon water tanks which will allow onsite water storage and use by the county's fire department to assist with local emergencies. We have built similar water storage tanks at other projects we own and they have been extremely helpful to local fire departments as emergencies have arisen in their communities.

sPower is further committed in providing the county \$1 million dollars in solar arrays and panels to assist the county in reducing its energy costs. We will work with the county staff in best identifying the location for the installation of the arrays and panels. It is our estimate that over the life of the project, these arrays and panels could save the county over \$30 million dollars in electricity costs.

Because we desire to be a positive corporate citizen and to further emphasize our commitment to the county, sPower, in addition to the abovementioned benefits, would donate the following to the County:



- \$15 million dollars in monetary benefits, over the life of the project upon the commencement of operations for Section A of the project;
- An estimated \$4.5 million dollars toward the construction of a new county fire station. sPower would stay involved in the design and construction of the fire station in order to leverage its construction experience.
- The construction of certain road improvements with a priority at the intersection of Brock and Orange Plank Roads to be started after the approval of operations for Section A of the project (estimated \$500,000 cost); and
- \$500,000 toward the completion of Belmont Park to be paid upon the commencement of operations for Section A of the project.

Again, we appreciate the opportunity to invest in Spotsylvania County and look forward to our long-term partnership. Thank you for your time and consideration of this matter.

Very truly,

A handwritten signature in blue ink, appearing to read 'Ryan Creamer', with a long horizontal line extending to the right.

Ryan Creamer, CEO

# SPower Solar Facility

SUP Proposals SUP18-0001, -0002 & -0003

# Introduction

- Applicant
- SCC Approval
- Project Overview
- Economic Development Benefits & Community Investments
- Environmental & Cultural Resources
- Open Space & Buffering
- Construction
- Fire, Rescue & Emergency Management
- Comprehensive Plan
- Maintenance & Operations
- Transportation
- Decommissioning Plan

# Applicant

- The applicant/developer is Sustainable Power Group (sPower).
- Headquartered in Salt Lake City, with offices in San Francisco, Long Beach, Richmond, and just recently, Spotsylvania.
- sPower is a leading independent power producer (IPP) that owns and operates more than 150 utility and commercial distributed electric generation systems in 12 states.
- sPower is owned by two major investors: AES Corp. (HQ in VA and a Fortune 500 Company) and Alberta Investment Management Investment Corp (one of world's largest institutional investment companies).

# SCC Approval

- The State Corporation Commission, which regulates state utilities, issued a certificate of public convenience and necessity on August 8, 2018.
- The SCC report found that:
  - construction of the Project will have no adverse effect on reliability of electric service provided by regulated public utilities in Virginia.
  - the proposed Project will likely generate direct and indirect economic benefits to Spotsylvania County and the Commonwealth as a result of employment and spending from construction and operation of the proposed Project.
  - based on the conditions imposed in the report, the Project will comply with all necessary federal, state and local environmental permits.
  - the Project is not “contrary to the public interest”.

# Project Overview

- Subject parcels (Sites A-C) are zoned A-3 and require an SUP to operate the solar facility.
- Project includes a 21<sup>st</sup> century, innovative 500-megawatt solar energy facility.
- The total area evaluated in the permit application includes 6,350 acres.
- The Project will utilize approximately 3,500 acres for the solar power plant while over 2,800 acres will be preserved.
- Project will utilize photovoltaic (PV) solar panels (CAD-Tel and Silicon) installed on a tracking single-axis tracker system.
- Under A-3 zoning, the Property could otherwise be developed by right for approximately 250 single family residential units. Currently and historically utilized for silviculture activities.
- The Property was selected due to its rural location (contiguous area of vacant land) and proximity to the existing adjacent Dominion Substation, which eliminates the need for further transmission lines spanning across County.

# Economic Development Benefits

- The overall Project investment is over \$600 million.
- Approximately \$9-10 million in total tax revenues will be generated through the life of the project.
- Current taxes generated from the site are approximately \$20,000 annually. Projecting this out will yield (without inflationary input) about \$700,000 for 35 years.
- 1<sup>st</sup> year alone of projected tax revenues will generate approximately \$1.3 million in tax revenues (property tax plus \$575,000 in roll back tax).
- In addition to the above, sPower intends to contribute, over the life of the project, an additional \$25 million for the benefit of County community priorities.

# Economic Development Benefits

- \$54 million in immediate labor benefits plus approximately 700 direct new jobs and training during construction (plus spin-off jobs and revenues).
- Creation of 25-30 full time positions after construction, which will generate approximately \$2.5 million annually in additional labor income (average salary over \$95k).
- Investment of approximately \$3.5 million to improve public water lines servicing the project, which will also benefit immediate communities utilizing public water (pressure and fire flow).
- Development and installation of a County solar array at a cost of \$1 million which will yield over \$30 million in electricity savings to the County over the life of the project.
- As part of the project, inclusion of up to two (2) new 50,000 gallon water tanks which will assist in supporting public safety for the entire area.
- Working with Verizon to locate a cell tower on the site.
- The Applicant will continue to:
  - contribute to and support for County school programs
  - partner with local colleges and universities
  - be a long term community partner and key marketing point for data center recruitment
  - be committed to long term future economic development partnership

# Environmental

- Project is environmentally friendly and not hazardous to our neighbors.
- Project will protect & preserve over 2,500 acres of open-rural space, including all RPAs.
- Project includes permanent, innovative stormwater management and soil erosion control measures with stormwater management facilities throughout the entire project.
- sPower will plant native pollinator plants as recommended by the County and DEQ.
- Virginia Department of Environmental Quality, Department of Forestry, Department of Game and Inland Fisheries, and US Army Corps of Engineers have all reviewed the Project and made recommendations which have been incorporated into this Project.
- County and all applicable State and Federal agencies will maintain regulatory control over the Project.

# Environmental

- The Project is being designed to avoid impacts to wetlands and all panels and equipment will be located outside of wetlands in accordance with state and county requirements.
- Preservation and Protection of Water Supply
  - Project goal is to utilize 100% of its water supply during construction from County utilities and will not impact local aquifers during construction
  - After construction, water utilization will be at a minimum
  - sPower does not anticipate needing much water during the life of the Project as the natural precipitation in the area will more than suffice for panel washing.
- The Project's security fence will include sections that are wildlife friendly, allowing wildlife to safely navigate through the Property.

# Cultural Resources

- The Project will be designed to avoid impacts to civil war battlefields or other cultural and historical resources.
- sPower has conducted cultural and historical surveys and received a determination from the Virginia Department of Historic Resources that the project does not have adverse effects on cultural and historical resources.
- Project will protect cemeteries located on the site.

# Open Space & Buffering

- Approximately 2,800 acres will be preserved and remain open space.
- Will conserve existing trails running through the property to the most reasonable extent possible.
- Setbacks will include a minimum of 50 feet in natural vegetation and tree buffer which are included within set back areas ranging from 100-400 feet along the entire project perimeter, plus at least 6 to 8 foot tall landscaped berms (complete shielding) in areas requiring additional screening.
- Open space areas will also include stormwater management ponds located throughout the Project to control runoff.

# Construction

- If approved, construction could begin in early 2019, and be completed by the summer of 2020.
- The Project is anticipated to employ 700-800 construction employees during peak construction. On average, there will be approximately 350 construction workers on-site on a daily basis.
- Construction traffic, including deliveries will be planned to avoid school bus traveling hours and most construction AM and PM peak traffic will be going against (not with) typical traffic patterns for this area. On-site parking and staging areas will be provided for employees and construction vehicles. We will also establish a carpooling system for employees.

# Fire, Rescue & Emergency Management

- An Emergency Response Plan (during construction and operations) has been developed for the Project consistent with Occupational Safety and Health Administration (OSHA) and Spotsylvania County requirements.
- All employees working on the Project during operations will be trained in emergency and shutdown procedures. Signs will be clearly marked at the Project Site for emergency vehicle ingress and egress.
- sPower will facilitate training for emergency providers to the specific hazards for the Project.
- Remaining timber material left on site will be removed through a combination of mulching/chipping and trench burning. Burning (which is not allowed from May through September) will conform to all applicable State and County regulations as well as additional guidance by the Fire Marshal.

# Comp Plan

- Project is consistent with the County's comprehensive plan (added Solar this past May 2018 as guiding principle and policy and economic development within the proposed area).
- Project is designed in a manner to mitigate any impacts to our neighbors.
- Project meets Commonwealth of Virginia renewable energy goals and priorities (5000 MW by 2023).
- The Project will not increase electric utility costs for citizens.
- Project locates a 21<sup>st</sup> Century industry in Spotsylvania County without impacts to County core services like schools, roads, public safety and parks.
- Project has already attracted long-term partners such as Microsoft, Apple and the University of Richmond to secure the viability of the Project.
- Spotsylvania County has the potential to benefit from increased tax assessment, new employment for residents, and economic stimulation for local businesses and economic marketing.

# Maintenance & Operations

- The Project is anticipated to employ 25-30 full-time positions at the project site once construction is complete.
- sPower is committed to recruit from the local workforce. This will include local career job fairs and training.
- During operations, the Project would be operated and maintained by on-site staff and backed remotely 24/7 from sPower's Salt Lake City control room.
- General maintenance will consist of landscaping (replanting) and equipment inspection and repair.

# Transportation

- Project will include a traffic management plan to address and mitigate construction traffic impacts on peak hour and school traffic.
- Transportation management plan will be reviewed and approved by the Virginia Department of Transportation and County prior to site plan approval.
- Access to and from the Project during construction will include eight (8) controlled access points.
- Long term operations will require very few trips.

# Decommissioning Plan

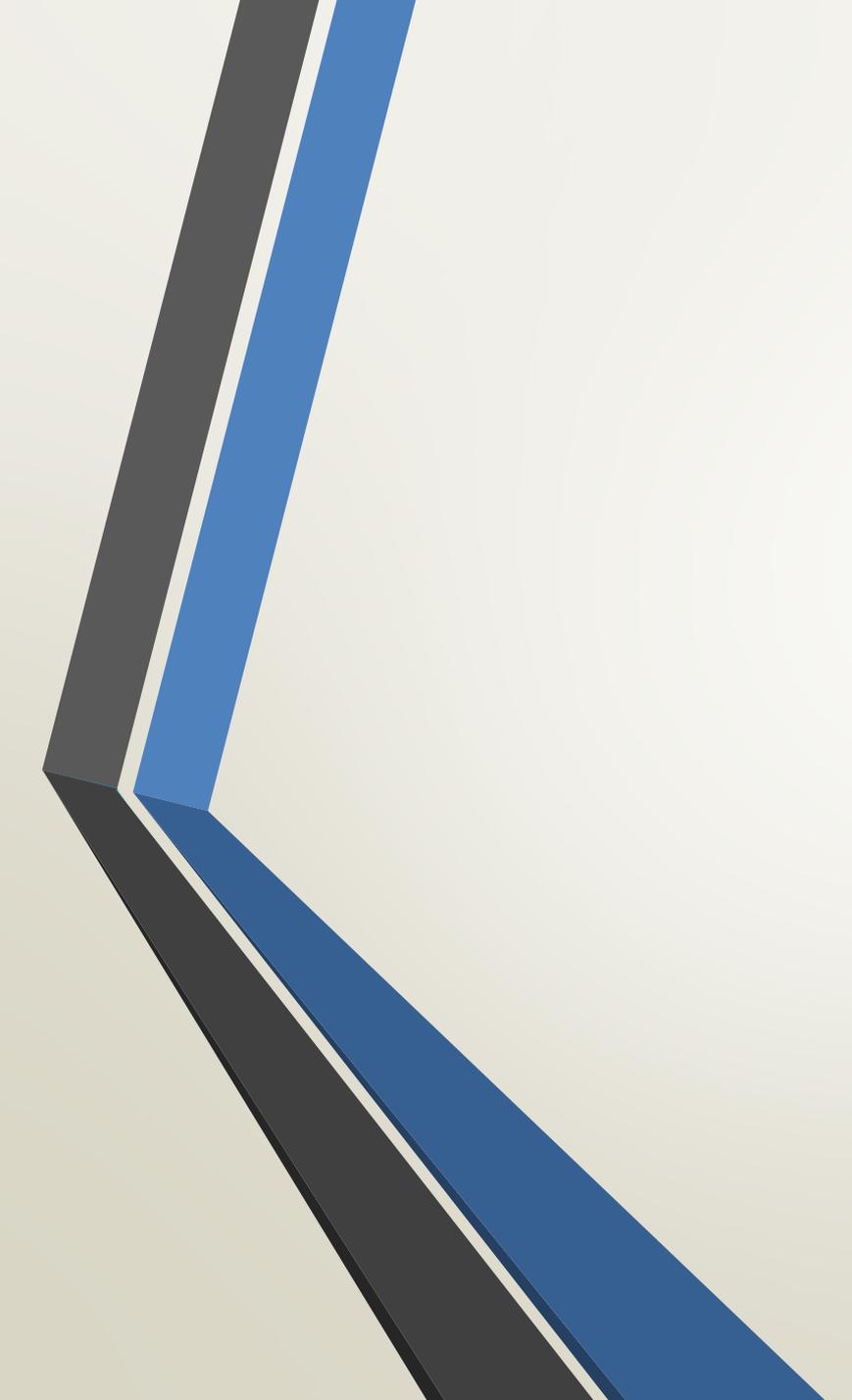
- Decommission plan includes all costs to remove solar equipment and return the site to its pre-existing condition.
- Updated every two (2) years.
- Includes bonding requirements adjusted according to aforesaid update.
- In approximately 35 years, the Project will be decommissioned and returned to its previous land use.

# Summary of Benefits to the County

- Over \$600 Million Investment in the County to Develop a 21<sup>st</sup> Century Innovative and Clean Energy Generating Facility
- Creation of over 700-800 local new jobs that will immediately pump approximately \$54 million in the local and regional economy
- New and expanded County tax revenue generation exceeding \$10 million over the life of the project vs. approximately \$700,000 under current use during the same period or approximately a 1,328% greater return
- Payment of over \$575,000 in County rollback taxes upon the approval of the SUP
- Commitment to invest up to \$25 million in County priorities including parks, fire and rescue, roads and schools
- Preservation of over 2,800 acres of land and elimination of new housing development expansion in the subject area
- Contribution of \$3.5 million to construct an improved waterline through the Fawn Lake community
- Community commitment to invest up to \$4.5 Million towards a new fire station.

# Summary of Benefits to the County

- Development and installation of solar arrays to allow the County to generate up to 10 MW of power which will save the County approximately \$1 million annually or more than \$30 million over the life of the project
- Creation of 25-30 full time employees during the life of the project with average incomes exceeding \$94,056 annually
- Establishment of two 50,000 gallon water tanks which will assist with fire suppression in the immediate area
- Partnering with Verizon to locate a new cell tower on the site, which should benefit wireless users in the immediate area
- Continued support for non-profit community initiatives, including support for public schools and institutions for higher learning
- Economic development partner with the County to assist the County in attracting a greater number of technology companies and uses



Questions?



R. Rex Parris Mayor  
Marvin E. Crist Vice Mayor  
Ken Mann Council Member  
Angela E. Underwood-Jacobs Council Member  
Raj Malhi Council Member  
Mark V. Bozgian City Manager

November 7, 2018

Mr. Greg Benton  
Livingston District Supervisor  
P. O. Box 99  
Spotsylvania, VA 22553

Dear Supervisor Benton,

It is my understanding that Sustainable Power Group, LLC ("sPower") is seeking a special use permit to build a solar project in Spotsylvania, VA. On behalf of the City of Lancaster, I am pleased to write this letter of support and share with you the positive experience and strong relationship our organization has developed with sPower.

Several years ago, sPower began its development of alternative energy projects in the City of Lancaster, a city I have been proud to represent for over 23 years and where I currently serve as City Manager. While we are located on the west coast, about 60 miles northeast of the city of Los Angeles, our community is not too different from Spotsylvania. With an approximate 160,000 residents, Lancaster is a community with large tracts of rural land that have proven to be invaluable sites for solar facilities. These renewable energy projects provide significant economic benefits without burdensome service and infrastructure costs that can sometimes be associated with non-solar project developments.

Today Lancaster is the proud home to more than 20 sPower projects totaling over 550 megawatts and another 100 megawatts that are just starting construction. sPower's \$1.5 billion investment in Lancaster has had profound direct and indirect economic impact, including supporting 700 construction employees for the last three years and creating 50 full time permanent jobs. Tax revenue to Lancaster increased dramatically and our local businesses continue to be benefactors of their investment in the area.

While Lancaster's projects and goals to develop over 1,000 megawatts with sPower may be larger than what the company is pursuing in Spotsylvania, it is important to know that the disturbance, risk, and construction impact has been little to none for our local community. sPower has been incredibly diligent in minimizing noise while building, has ensured roads do not become congested or closed, and we have not had any environmental issues with these developments.

Without question, sPower is an renewable energy industry leader who has been an integral part of our community. Each year they support community events, STEM education curriculum, trade and apprentice programs, youth sports, and our first responders. I'll never forget two years ago when our title sponsor for our prestigious fireworks show canceled their funding just weeks before the 4th of July event. When sPower heard about the issue, they doubled down on their previous sponsorship and rescued the fireworks show for our residents. I have no doubt that sPower will be the first to step up in a time of need and be a great neighbor to your residents.

As your county continues to consider sPower's special use permit, I hope you will look to Lancaster as a resource for any questions or concerns you may have. Please don't hesitate to contact me if you would like to talk more about sPower's impact and partnership.

We look forward to continued partnering and collaboration with sPower in achieving our mutual goal of establishing a greener community. Should you have any questions or if I can be of further assistance, please contact me at (661) 723-6133 or via my mobile at (661) 510-4213.

Sincerely,



Mark V. Bozigian  
City Manager

MVB:aw



November 12, 2018

Mr. Daniel Menahem  
Sustainable Power Group  
2180 South 1300 East, Suite 600  
Salt Lake City, UT 84106

Dear Mr. Menahem:

The Thurman Brisben Homeless Shelter Inc. (Brisben Center) supports the planning and use of clean energy and good stewardship of natural resources, and we are committed to the application of solar power to reduce reliance upon the external power grid and to reduce carbon emissions, including the installation of solar power at the Brisben Center.

Therefore, in consideration of our commitment to increase clean solar energy, reduce carbon emissions, increase environmental stewardship, and develop livable wage jobs in the solar energy industry, the Brisben Center is supportive of these endeavors as planned by the Sustainable Power Group (sPower) for the Spotsylvania Solar Energy Center.

Sincerely,

N. David Cooper  
Executive Director

Eric Watkins  
President of the Board



100 First Stamford Place  
Suite 700  
Stamford, Connecticut 06902

November 20, 2018

VIA EMAIL: [BOS@spotsylvania.va.us](mailto:BOS@spotsylvania.va.us)

Spotsylvania County Board of Supervisors  
PO Box 99  
Spotsylvania, VA 22553

Re: Battlefield BOS District

Dear Spotsylvania County Board of Supervisors,

We are writing to express our support of the sPower Spotsylvania Solar Energy Center. This project will be beneficial for Spotsylvania, aligns with the county's long-term economic development goals, and brings needed renewable energy to Virginia.

The investment sPower is making will generate new revenue for the county and create good, high-paying, high tech jobs for our residents. We have been told that the \$615 million investment will create over 700 construction jobs and 25 permanent jobs. Additionally, sPower has advised us that it will make needed improvements to water and transportation. Finally, the company plans to install \$1 million worth of solar panels on county schools and buildings saving Spotsylvania thousands in power bills each year.

sPower has proven they will be a good steward of our land. They have gone above and beyond to ensure the environment is protected, worked with the locality and state agencies to build in larger than required buffers with native plants and trees to help hide the solar panels from view, and ensured they will be diligent about water usage and erosion control. This is the type of corporate neighbor we want in Spotsylvania.

Ultimately, this project will prove to be an important economic development project to our county. That is why we encourage the Board of Supervisors to support the sPower Spotsylvania Solar Energy Center.

Sincerely,

A handwritten signature in black ink, appearing to read 'Westley Parks', written over a horizontal line.

Westley Parks  
Region Vice President

cc: **via e-mail:** [ben.saunders@spower.com](mailto:ben.saunders@spower.com)

**From:** Steven Schumaker  
**Sent:** Monday, December 03, 2018 7:55 PM  
**To:** BOS@spotsylvania.va.us  
**Subject:** sPower Spotsylvania Solar Energy Center

Spotsylvania County Board of Supervisors  
PO Box 99  
Spotsylvania, VA 22553

12-3-18

Dear Spotsylvania County Board of Supervisors,

I am writing to express my support for the sPower Spotsylvania Solar Energy Center. This project will be beneficial for Spotsylvania, aligns with the county's long-term economic development goals, and brings needed renewable energy to Virginia.

This project will create good, high-paying jobs for residents and generate new tax revenue for the county. The \$615 million investment will create over 700 construction jobs and 25 permanent jobs. These construction jobs will provide generous wages to local workers and bring millions in revenue to local restaurants, hotels and other service businesses in the area.

The project will provide many benefits to the county. sPower will assist with substantial improvements to the local water and transportation system. The company also plans to install \$1 million worth of solar panels on county schools and buildings, greatly reducing Spotsylvania County power bills each year. The company has already provided scholarships to Spotsylvania high school students and continues to support our first responders.

sPower has proven they will be a good steward of our land. They have gone above and beyond to ensure the environment is protected, worked with the locality and state agencies to build larger than required buffers with native plants and trees to screen the solar panels from view, and ensured they will be diligent about water usage and provide enhanced erosion control measures. This is the type of corporate neighbor and development we want in Spotsylvania.

This is a good economic development project for Spotsylvania. That is why I encourage the Board of Supervisors to support the sPower Spotsylvania Solar Energy Center.

Sincerely,

**Steven Schumaker**  
Machine Rentals and Sales  
434-821-6904 (direct)  
434-321-2215 (mobile)

**Carter Machinery Co., Inc.**  
208 Caterpillar Dr.  
LaCrosse, VA 23950

888-344-RENT (main office)  
[cartermachinery.com](http://cartermachinery.com)

**From:** [milerww@aol.com](mailto:milerww@aol.com)  
**To:** [Ben Saunders](#)  
**Subject:** Please support the sPower Spotsylvania Solar Energy  
**Date:** Saturday, December 1, 2018 9:47:52 PM

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Our family has been life long residents of Spotsylvania County. I have lived here for 70 years and have watched this county grow. There seems to be quite a bit of misinformation floating around about sPower. We feel this project would be very beneficial for the growth of Spotsylvania.

We live in the Chancellor District but within very few miles of the location of this project.

Our family would appreciate your support of this project.

Miller Farms  
Wayne Miller  
12101 Orange Plank Rd.  
Locust Grove, Va. 22508

**From:** [Dave Wilson](#)  
**To:** [BOS@spotsylvania.va.us](mailto:BOS@spotsylvania.va.us); [Ben Saunders](#)  
**Date:** Monday, December 3, 2018 12:37:37 PM

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Good day,

My name is David Wilson and I reside at 9814 Deer Park Drive, Spotsylvania.

I am writing this letter in response to "Spotsylvania residents push back against proposed solar farm":

I am so tired of reading about the Fawn Lake community being upset about S-Power's solar project. This is a great project for Spotsylvania and the type of economic development we should all want in this community and be working to attract. The Concerned Citizens of Fawn Lake continue to complain about water usage, leaching, and soil erosion, and are getting more absurd, even calling the project a "Nazi Death Camp" at the last Board of Supervisors meeting. The environmental issues are either blatantly false or S-Power has addressed, to the point that they even redesigned their project to ensure it is as environmentally friendly as possible. Leaching is not a real issue – the only case of leaching was in a simulated lab test. To address water issues, S-Power is paying for half the cost to improve the main water line in the area, which will help Fawn Lake residents. S-Power's soil erosion measures go above and beyond state and federal standards. The recent article makes it sound like hundreds of citizens are upset about this project, when in fact it is just a small handful of people in one community. Many of us in Spotsylvania see this as a positive economic development project that will attract high-tech jobs and millions of dollars of new, much-needed investment to our county. That's why I am supporting the Spotsylvania Solar Energy Center.

My home and property backs to the proposed solar project, so I am speaking directly as person who's home and land is directly connected to the site. I have owned my home and land for well over 20 years and seen how the land is currently used, which is not treated in an environmentally friendly manner. This land is owned by a tree farm which they constantly deforest on a regular basis. The land is left barren and in disarray for many years before a stand of pine reaches a timbering height. This is an on going and never ending process in which they clear trees constantly, destroy the terrain, and congest our roads with dangerous logging trucks that all of us fight on going battles with. (Which as a mention none of the entrances to the logging areas are located on route 621 which is the Fawn Lake main road, all of the logging entrances are located on Catharpin and West Catharpin, where we the residents of these roads are tone ones directly affected by the tree farming)

This land has been sold and passed hands of different companies over the years that I have resided here. We never have a moment of peace and quiet as they move from parcel to parcel with noisy equipment. For residents like myself who are directly connected to these properties it is a blessing to have S-Power purchase this land. Myself and many others residents directly connected to these proposed sites feel this project will be the best scenario we could hope for. We are complete in support of this project and excited to have S-Power in

our County as well as our neighbor.

As a homeowner and land owner directly connected to this property I would like to express my support of this project and S-Power.

Thank you, David Wilson

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Spotsylvania County Board of Supervisors  
PO Box 99  
Spotsylvania, VA 22553

Brooks E. Lewis  
155 Robinson Drive  
Fayetteville, GA 30214

11/29/2018

Dear Spotsylvania County Board of Supervisors,

I am writing to express my support for the sPower Spotsylvania Solar Energy Center. This project will be beneficial for Spotsylvania, aligns with the county's long-term economic development goals, and brings needed renewable energy to Virginia.

This project will create good, high-paying jobs for residents and generate new tax revenue for the county. The \$615 million investment will create over 700 construction jobs and 25 permanent jobs. These construction jobs will provide generous wages to local workers and bring millions in revenue to local restaurants, hotels and other service businesses in the area.

The project will provide many benefits to the county. sPower will assist with substantial improvements to the local water and transportation system. The company also plans to install \$1 million worth of solar panels on county schools and buildings, greatly reducing Spotsylvania County power bills each year. The company has already provided scholarships to Spotsylvania high school students and continues to support our first responders.

sPower has proven they will be a good steward of our land. They have gone above and beyond to ensure the environment is protected, worked with the locality and state agencies to build larger than required buffers with native plants and trees to screen the solar panels from view, and ensured they will be diligent about water usage and provide enhanced erosion control measures. This is the type of corporate neighbor and development we want in Spotsylvania.

This is a good economic development project for Spotsylvania. That is why I encourage the Board of Supervisors to support the sPower Spotsylvania Solar Energy Center.

Sincerely,



Brooks E. Lewis

**From:** Wallace Morton <wwmorton@verizon.net>

**Sent:** Saturday, December 1, 2018 12:41 PM

**To:** Ben Saunders <ben.saunders@spower.com>; Danny Pemberton <danlen2001@aol.com>

**Subject:** sPower support

Attached is a copy of my support letter for the sPower Solar Project.

William W. Morton, Jr  
7100 Courthouse Road  
Spotsylvania, VA 22551  
Livingston District

Dear Spotsylvania County Board of Supervisors:

I am the land owner of 550-acre Maple Grove Farm at 7100 Courthouse Road. This farm has been in my family since 1821. I am writing to express my support for the sPower Solar Energy Project. I have been to sPower briefings and have studied articles both for and against this project in the Free-Lance Star.

sPower has been responsive to citizens concerns and made numerous modifications to improve their proposed project. Sufficient buffers will be provided so that the solar panels will not be visible from the ground. The company promised to be diligent in water usage during construction and erosion control measures will be employed.

There will be an economic benefit in real estate taxes. Construction will create 700 new jobs with 25 permanent jobs following the construction period. Planned installation of \$1 million worth of solar panels on Spotsylvania schools will greatly reduce the county school power bills.

Governor Northam has called for the development of renewable energy facilities capable of delivering 3,000 megawatts of electric power. This sPower project will supply 500 megawatts toward that goal.

I encourage the Board of Supervisors to support the sPower Solar Project.

Sincerely.,

William W. Morton, Jr.

From: Talmadge Harris <[talmadgeharris@gmail.com](mailto:talmadgeharris@gmail.com)<<mailto:talmadgeharris@gmail.com>>>  
Date: December 4, 2018 at 8:20:23 PM EST  
To: [ben.saunders@spower.com](mailto:ben.saunders@spower.com)<<mailto:ben.saunders@spower.com>>, Nikki Olofson  
<[nolofson@spower.com](mailto:nolofson@spower.com)<<mailto:nolofson@spower.com>>>  
Subject: Fwd: Lending support for the Spotsylvania County sPower project

Hello Nikki and Ben,  
I am forwarding my email to the Spotsylvania BOS with letter attached.  
All the best on the project,  
Talmadge Harris

----- Forwarded message -----

From: Talmadge Harris <[talmadgeharris@gmail.com](mailto:talmadgeharris@gmail.com)<<mailto:talmadgeharris@gmail.com>>>  
Date: Tue, Dec 4, 2018 at 8:17 PM  
Subject: Lending support for the Spotsylvania County sPower project  
To: <[BOS@spotsylvania.va.us](mailto:BOS@spotsylvania.va.us)<<mailto:BOS@spotsylvania.va.us>>>

Dear Spotsylvania County Board of Supervisors,

Please find attached my letter of support for the sPower project envisioned for Spotsylvania County.

Thank You,

Talmadge Harris

Spotsylvania County Board of Supervisors  
PO Box 99  
Spotsylvania, VA 22553

Talmadge Harris  
11531 Mill Road  
Glen Allen, VA 23059

December 4, 2018

Dear Spotsylvania County Board of Supervisors,

In serving as the Business Services Coordinator for the Fredericksburg Area Workforce Center I met with the representatives of sPower. They attended a Spotsylvania County Business Week event in which I was among the presenters. They showed great interest in helping provide employment for area residents in support of this long-term project. I am writing to express my support for the sPower Spotsylvania Solar Energy Center. This project will be beneficial for Spotsylvania, aligns with the county's long-term economic development goals, and brings needed renewable energy to Virginia.

The investment sPower is making will generate immediate new revenue for the county and create good, high-paying, high tech jobs for our residents. The \$615 million investment will create over 700 construction jobs and 25 permanent jobs. These construction jobs will provide generous wages to local workers and bring millions in revenue to local restaurants, hotels and other service businesses throughout the county.

The project will be beneficial to the county. sPower will assist with substantial improvements to the local water and transportation system. The company also plans to install \$1 million worth of solar panels on county schools and buildings greatly reducing Spotsylvania County power bills each year. The company has already provided scholarships to Spotsylvania high school students and continues to support our first responders.

sPower has proven they will be a good steward of our land. They have gone above and beyond to ensure the environment is protected, worked with the locality and state agencies to build larger than required buffers with native plants and trees to screen the solar panels from view, and ensured they will be diligent about water usage and provide enhanced erosion control measures. This is the type of corporate neighbor and development we want in Spotsylvania.

Ultimately, this project will prove to be an important economic development project to our county. That is why I encourage the Board of Supervisors to support the sPower Spotsylvania Solar Energy Center.

Sincerely,

Talmadge Harris

Spotsylvania County Board of Supervisors  
PO Box 99  
Spotsylvania, VA 22553

TownePlace Suites Fredericksburg by Marriott  
4700 Market Street.  
Fredericksburg, VA. 22408  
LEE HILL

12.4.18

Dear Spotsylvania County Board of Supervisors,

I am writing to express my support for the sPower Spotsylvania Solar Energy Center. This project will be beneficial for Spotsylvania, aligns with the county's long-term economic development goals, and brings needed renewable energy to Virginia.

The investment sPower is making will generate immediate new revenue for the county and create good, high-paying, high tech jobs for our residents. The \$615 million investment will create over 700 construction jobs and 25 permanent jobs. These construction jobs will provide generous wages to local workers and bring millions in revenue to local restaurants, hotels and other service businesses throughout the county.

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Ultimately, this project will prove to be an important economic development project to our county. That is why I encourage the Board of Supervisors to support the sPower Spotsylvania Solar Energy Center.

Sincerely,

Khurram Burney

From: Rhett Bunce <[rhettbunce@hbc-inc.com](mailto:rhettbunce@hbc-inc.com)<<mailto:rhettbunce@hbc-inc.com>>>  
Sent: Tuesday, December 4, 2018 12:00 PM  
To: David Stimson <[david.stimson@spower.com](mailto:david.stimson@spower.com)<<mailto:david.stimson@spower.com>>>  
Cc: Jack Horne <[jackhorne@hbc-inc.com](mailto:jackhorne@hbc-inc.com)<<mailto:jackhorne@hbc-inc.com>>>; Tom Kosto <[tomkosto@hbc-inc.com](mailto:tomkosto@hbc-inc.com)<<mailto:tomkosto@hbc-inc.com>>>; Victoria Crumpler <[victoria@hbc-inc.com](mailto:victoria@hbc-inc.com)<<mailto:victoria@hbc-inc.com>>>  
Subject: Highlander Solar Support Letter

David,

Please see our attached personalized letter showing our support for the proposed Highlander Solar project. Please let me know if you have any questions

Rhett Bunce  
Horne Brothers Construction  
910-824-1954

Spotsylvania County Board of Supervisors  
PO Box 99  
Spotsylvania, VA 22553

Horne Brothers Construction  
PO box 205  
Fayetteville, NC 28302

11-30-2018

Dear Spotsylvania County Board of Supervisors,

As a Solar Subcontractor for the proposed Solar project in Spotsylvania County, I am writing to express my support for the S-Power Spotsylvania Solar Energy Center. As we understand, this project will be beneficial for Spotsylvania as it aligns with the county's long-term economic development goals, and brings needed renewable energy to Virginia. Our company has been involved in multiple installations similar to this project and we have witnessed and participated in the positive economic impact a project such as this can have on the local community.

This project will create quality, high-paying jobs for residents and generate new tax revenue for the county. The \$615 million investment will create over 700 construction jobs and 25 permanent jobs. These construction jobs will provide generous wages to local workers and bring millions in revenue to local restaurants, hotels and other service businesses in the area.

The project will provide many benefits to the county. S-Power will assist with substantial improvements to the local water and transportation system. The company also plans to install \$1 million worth of solar panels on county schools and buildings, greatly reducing Spotsylvania County power bills each year. The company has already provided scholarships to Spotsylvania high school students and continues to support our first responders.

S-Power has proven they will be a good steward of the land. They have gone above and beyond to ensure the environment is protected by working with the local and state agencies to build larger than required buffers with native plants and trees to screen the solar panels from view, as well as ensuring they will be diligent about water usage and provide enhanced erosion control measures. This is the type of corporate neighbor and development you would want in Spotsylvania.

This is a good economic development project for Spotsylvania. That is why I encourage the Board of Supervisors to support the S-Power Spotsylvania Solar Energy Center.

Sincerely,

Jack Horne  
President  
Horne Brothers Construction.

Spotsylvania County Board of Supervisors  
PO Box 99  
Spotsylvania, VA 22553

Fortress Fencing LLC  
Jason Truesdale  
401 Jones Ferry Rd.  
Carrboro, NC 27510

December 5, 2018

Dear Spotsylvania County Board of Supervisors,

As a recent recipient of solar farm fence contracts in Spotsylvania, I am writing to express my support for the sPower Spotsylvania Solar Energy Center. This project will be beneficial for Spotsylvania, aligns with the county's long-term economic development goals, and brings needed renewable energy to Virginia.

This project will create good, high-paying jobs for residents and generate new tax revenue for the county. The \$615 million investment will create over 700 construction jobs and 25 permanent jobs. These construction jobs will provide generous wages to local workers and bring millions in revenue to local restaurants, hotels and other service businesses in the area.

The project will provide many benefits to the county. sPower will assist with substantial improvements to the local water and transportation system. The company also plans to install \$1 million worth of solar panels on county schools and buildings, greatly reducing Spotsylvania County power bills each year. The company has already provided scholarships to Spotsylvania high school students and continues to support our first responders.

sPower has proven they will be a good steward of our land. They have gone above and beyond to ensure the environment is protected, worked with the locality and state agencies to build larger than required buffers with native plants and trees to screen the solar panels from view, and ensured they will be diligent about water usage and provide enhanced erosion control measures. This is the type of corporate neighbor and development we want in Spotsylvania.

This is a good economic development project for Spotsylvania. That is why I encourage the Board of Supervisors to support the sPower Spotsylvania Solar Energy Center.

Sincerely,

Jason Truesdale, President



Spotsylvania County Board of Supervisors PO Box 99 Spotsylvania VA 22553

Kenneth M Distasio  
Sunbelt Rentals Inc.  
1250 Belman Rd  
Fredericksburg Va

Dear Spotsylvania County Board of Supervisors:

As a business operating in Spotsylvania County I am writing to express my support for the S Power Spotsylvania Solar Energy Center, I believe it will be very beneficial to the county both in the long term and short term.

This project will create good, high-paying jobs for residents and generate new tax revenue for the county. The \$615 million investment will create over 700 construction jobs and 25 permanent jobs. These construction jobs will provide generous wages to local workers and bring millions in revenue to local restaurants, hotels and other service businesses in the area.

The project will provide many benefits to the county. sPower will assist with substantial improvements to the local water and transportation system. The company also plans to install \$1 million worth of solar panels on county schools and buildings, greatly reducing Spotsylvania County power bills each year. The company has already provided scholarships to Spotsylvania high school students and continues to support our first responders.

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This is a good economic development project for Spotsylvania. That is why I encourage the Board of Supervisors to support the sPower Spotsylvania Solar Energy Center.

Sincerely,

Kenneth M Distasio  
Western Territory Manager  
Sunbelt Rentals Inc.  
540-379-5783  
[Kenny.Distasio@Sunbeltrentals.com](mailto:Kenny.Distasio@Sunbeltrentals.com)

Spotsylvania County Board of Supervisors  
PO Box 99  
Spotsylvania, VA 22553

Jennifer Mackowski  
7803 Chancellors Pond Lane  
Fredericksburg, VA 22407  
Chancellor District

November 27, 2018

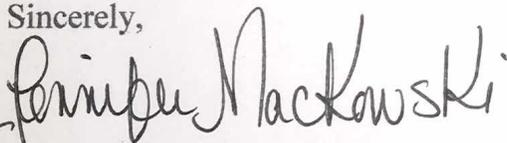
Dear Spotsylvania County Board of Supervisors,

I am writing to express my support for the sPower Spotsylvania Solar Energy Center. This is what Spotsylvania needs to move forward towards energy sustainability. If we want to be competitive and attract the types of residents and businesses that value innovation and sustainability, then we need to demonstrate it ourselves. That will come at the cost of support from a few individuals and perhaps businesses. I do not belittle or dismiss the concerns of those individuals, but as the Board of Supervisors, your constituents rely on you to make decisions that benefit the County as a whole.

This project will bring jobs to the region, tax revenue that we need, assist with infrastructure improvements, and position us a leader in this growing industry.

I encourage you all to vote in support of the project and I will stand beside you in my support!

Sincerely,

A handwritten signature in cursive script that reads "Jennifer Mackowski". The signature is written in dark ink and is positioned above the printed name.

Jennifer Mackowski

**From:** Lenka Nichols  
**Sent:** Wednesday, December 05, 2018 12:51 PM  
**To:** 'BOS@spotsylvania.va.us'  
**Cc:** 'bensaunders@spower.com'  
**Subject:** SUPPORT LETTER FOR THE SPOWER SPOTSYLAVANIA SOLAR ENERGY CENTER

To: Spotsylvania County Board of Supervisors  
PO Box 99  
Spotsylvania, VA 22553

Lenka Nichols  
Country Inn & Suites  
5327 Jefferson Davis Highway  
Fredericksburg, VA 22408

Lee Hill District

12/05/2018

Dear Spotsylvania County Board of Supervisors,

I am writing to express my support for the sPower Spotsylvania Solar Energy Center. This project will be beneficial for Spotsylvania, aligns with the county's long-term economic development goals, and brings needed renewable energy to Virginia.

The investment sPower is making will generate immediate new revenue for the county and create good, high-paying, high tech jobs for our residents. The \$615 million investment will create over 700 construction jobs and 25 permanent jobs. These construction jobs will provide generous wages to local workers and bring millions in revenue to local restaurants, hotels and other service businesses throughout the county.

The project will be beneficial to the county. sPower will assist with substantial improvements to the local water and transportation system. The company also plans to install \$1 million worth of solar panels on county schools and buildings greatly reducing Spotsylvania County power bills each year. The company has already provided scholarships to Spotsylvania high school students and continues to support our first responders.

sPower has proven they will be a good steward of our land. They have gone above and beyond to ensure the environment is protected, worked with the locality and state agencies to build larger than required buffers with native plants and trees to screen the solar panels from view, and ensured they will be diligent about water usage and provide enhanced erosion control measures. This is the type of corporate neighbor and development we want in Spotsylvania.

Ultimately, this project will prove to be an important economic development project to our county. That is why I encourage the Board of Supervisors to support the sPower Spotsylvania Solar Energy Center.

Sincerely,

**Lenka Nichols**

Director of Sales

Country Inn and Suites by Radisson Fredericksburg South

5327 Jefferson Davis Highway

Fredericksburg, VA 22408

[Lnichols@SharConMgt.com](mailto:Lnichols@SharConMgt.com)

(540) 898-1800

## **COUNTRY INN & SUITES / FREDERICKSBURG, VA**

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