MEMORANDUM
Community Development Division

To:	Albemarle County Planning Commission Bill Fritz, Development Process Manager Albemarle County, VA
From:	Michael Zehner, AICP, ENV SP, Director of Planning and Community Development Lindsay Edwards, ENV SP, Environmental Planner Luke Peters, ENV SP, Environmental Planner
Date:	February 20, 2023
Subject:	Solar Land Use Regulation Overview

INTRODUCTION

In preparation for the February 28, 2023 Planning Commission meeting, we are providing an overview of solar energy generation facilities from a land use regulatory perspective, presenting general information on solar facilities and their development that are most often the focus of local regulations and discretionary permit review, and outlining regulatory best practices. It is important to note that the focus of this project is on utility-scale solar energy generation facilities, rather than small-scale facilities, such as roof-mounted solar panels on a home. While consideration of small-scale facilities are important, and the consultant will work to avoid impacting these facilities with respect to regulations, the County may wish to consider addressing these facilities separately, as necessary.

It is understood that this initiative is in large part based on recent and growing interest in the development of solar facilities in the County, and given the scale and potential impacts – both positive and those less so – the County is seeking a better understanding of the land use issues particular to solar energy generation facilities and how those issues may be better addressed through regulations, permit review, and procedures. Based on this, the goals of this work session with the Planning Commission are 1) to identify aspects of solar facility development or regulatory topics where the Commission needs additional information, 2) to understand Commission perspectives with regard to principal opportunities or areas of concern potentially resulting from the development of solar facilities, and 3) to seek input from the Commission on potential regulatory provisions.

OVERVIEW OF SOLAR DEVELOPMENT

Since 2010, the United States has seen a dramatic increase in installed solar photovoltaic capacity, growing from about two gigawatts (GW)[1] in 2010 to approximately 130 GW installed at the end of the first half of 2022. This increase is due to many factors:

[1] One (1) Gigawatt equals 1,000 Megawatts.

1. The cost of solar energy facility technology has decreased dramatically (80%) since 2010;
2. Growing demand for renewably generated energy from the private sector;
3. Instability in the availability and costs of traditional fossil fuels due to geopolitical conditions;
4. State policies and incentives to achieve carbon emissions goals and to reduce reliance upon fossil fuels; and
5. Economic and financial opportunity for landowners, especially farmers.

The growth in solar energy generation capacity in Virginia has similarly increased, with installed solar capacity increasing from 17 megawatts (MW) in 2014, to 470 MW in 2020. From geographic and climate perspectives, the state is an attractive place for the installation of solar energy facilities. Most of the state has an average solar insolation[2] of nearly four (4) kilowatt hours (kWh) per square meter of sunlight per day, a percentage of which can be captured by photovoltaic solar panels. Additionally, from a policy and regulatory perspective, the Commonwealth's adoption of the 2020 Clean Energy Act requires Dominion Energy Virginia and American Electric Power (aka Appalachian Power) to produce 100 percent (100%) of their electricity from renewable sources by 2045 and 2050, respectively. And further, the 2018 Virginia Energy Plan calls for targets of 3,000 MW of solar plus onshore wind capacity to be deployed by 2022, and 5,500 MW by 2028. These factors have contributed to interest in the development of solar energy generation facilities throughout the state and to the Commonwealth's inclusion in the upward trajectory of utility-scale solar development taking place across the country.

While the growth of solar is a national and statewide phenomenon, it is important to recognize that this is due to developments occurring at the local level. Solar developers, whether they are regional or international companies, work at the local level, as they are required to identify potential sites for development, contact and negotiate with private landowners, and prepare applications based upon local policies and regulations. To date, the following solar facilities have been reviewed and/or are pending review by the County:

Facility Name	Project Owner	Capacity (MW_{ac})	Acreage
Woodridge Solar*	Hexagon Energy	138 MW	2,300
Midway Solar	Central VA Electric Co-op	8 MW	136
Ivy Landfill Solar	Community Power Group	1 MW	15
Rivanna Solar	Apex Clean Energy	12.5 MW	150

*Pending review

[2] Insolation — The solar power density incident on a surface of stated area and orientation, usually expressed as Watts per square meter or Btu per square foot per hour. See also diffuse insolation and direct insolation. Source: U.S. Department of Energy https://www.energy.gov/eere/solar/solar-energy-glossary

REGULATORY CONSIDERATIONS FOR SOLAR DEVELOPMENT

There are many regulatory aspects to consider with the development of utility-scale solar projects; commonly, these include the following:

Changes in Land Use, Location, and Composition

Ground mounted utility-scale solar facilities rely on a significant amount of land. According to the Solar Energy Industries Association, utility-scale solar projects require approximately 6 to 7 acres of land for every MW of generation capacity; however, based on geographic conditions, such as topography and the presence of streams or creeks, 10 acres per MW is also a good rule of thumb. Consequently, a 5 MW facility would likely require between 30 to 50 acres.

While these facilities can be sited most anywhere, the need for significant land usually results in these projects being sited on undeveloped open and forested lands, and often agricultural lands. Also, financial considerations generally result in the proposed use of lands that have less development potential for residential, industrial, or commercial use, which presumes a lower value per acre. From both technical and cost perspectives, most facilities or at least some portions thereof are going to be located within 1 to 2 miles of existing transmission line infrastructure to aid in interconnection.

In terms of physical composition, utility-scale solar facilities consist of photovoltaic (PV) solar panels mounted on racks, which are attached to ground-mounted structural supports; additionally, there are inverters installed in the facility, usually on concrete pads, which convert the variable direct current (DC) output of PV solar panels into a utility frequency alternating current (AC) that can be fed into an electrical grid, along with a substation, switchyard, and generator lead lines (gen-tie lines) to interconnect the facility and the generated electricity to electrical grid transmission lines. Finally, it is becoming more and more common for facilities to include battery energy storage systems (BESS), where generated electricity can be stored for optimized transmission to the grid.

In many ways, especially when compared to preceding undeveloped or agricultural land uses, utility-scale solar facilities can be considered semi-industrial uses given the various components of these facilities. Additionally, these facilities have an expected lifespan of 30-40 years, if not longer based upon maintenance, the replacement of equipment, and the evolution and upgrading of technologies.

Infrastructure, Environmental and Visual Impacts

The design, development, and operation of utility-scale solar facilities do have infrastructure and environmental impacts that should be considered. These impacts may include, but are not limited to, the following:

- Impacts to roadway conditions and traffic safety during development, especially where sites may be served directly only by rural roads, due to the frequency of deliveries, the size of vehicles, and the number of vehicles trips;
- The reduction of wildlife mobility resulting from facility design and the use of fencing;
- The alteration of existing topography through grading;
- Impacts to soil conditions due to the removal of topsoil and/or compaction;
- Erosion and sedimentation and stormwater runoff issues during development phases, but also once facilities are in operation; and
- The removal of existing trees and forested areas.

Additionally, the physical components of these facilities may have visual impacts, perceived as benign or negative based upon their siting; for example, a facility sited on a former industrial *brownfield* site would not likely be perceived as having a negative visual impact on community character, whereas a facility sited on undeveloped or former agricultural lands, or formerly forested lands, may be perceived as detracting from the rural character of areas or compromising scenic viewsheds.

Impacts to Agriculture

As noted, the need for significant land usually results in utility-scale solar facilities being sited on undeveloped open and forested lands and/or former, recently active, or currently active agricultural lands. With recent statewide concerns about the impact of utility-scale solar facilities on soils and new laws requiring rule changes on how much prime agricultural land can be disturbed without additional review, it is important to understand how prime agricultural land status is determined. Prime agricultural land has a legal definition under both Virginia code and USDA regulations, and is understood to be land with plenty of water and soils with a composition that can support crops with less intervention and inputs than may be necessary with lesser soils. A convenient way to view levels of suitability is through Virginia DCR's Natural Heritage Data Explorer. However, there have been concerns that prime agricultural lands have not been properly confirmed, or that the classification is outdated. Similarly, with respect to forested areas, some localities have discovered that what should be "prime" forest land was actually degraded pine farm land. Even disregarding concerns about returning the soil to its previous state after solar facility installation, solar land uses utilize very large tracts of land for up to 40 years, so it is important to both consider protection of existing prime agricultural land and to independently verify that the lands identified for protection or proposed for development actually constitute prime agricultural lands.

Additionally, one of the most important considerations to implementing utility-scale ground-mounted solar facilities as a land use (or any other type of land use) is whether land to be utilized land can be reverted to another use at will or if it is permanently transmuted. This is especially important for solar, as the most convenient and cost-effective sites for installation are flat agricultural lands. Because solar facility sites operate for 30 to 40 years and the wide-scale utilization of solar began more recently, it is not obvious what the total impact to land and soils will be. However, there is a growing concern that large-scale grading and topsoil removal, ground compaction, and deep turning of certain soils will have a nearly irreversible impact on land that may have been formerly suitable for agriculture. In addition, removing the natural contours of a parcel through grading can have negative impacts on the retention and flow of stormwater, creating higher velocity sheet flow.

Recent and ongoing research led by Dr. Lee Daniels of Virginia Tech suggests that such disturbances may irrevocably degrade soils, and that mitigation or remediation takes a significant amount of effort spanning years. As noted Virginia DEQ is currently developing stricter regulations to prevent the loss of prime agricultural lands, as well as forestal lands, and it is recommended that localities strongly consider the amount of prime and even non-prime agricultural land they devote to solar facility land use.

Agrivoltaics

Agrivoltaics describes the simultaneous use of land for both solar photovoltaic power generation and agriculture. One example is in Rockport, Maine, where the largest agrivoltaic site in the U.S. is located, combining solar and the cultivation of blueberries in one farm. The berries are planted underneath and in-between panels on a 10-acre site with a generation capacity of4.2 MW. The project was developed by BlueWave, who partnered with the University of Maine to maintain its agrivoltaic activities.

An additional example in Newfield, New York, consists of a 30-acre, 7.5 MW community solar project owned by Nexamp, which contains approximately 23,000 panels. The project incorporates solar grazing in which sheep and lambs are utilized for maintenance; which seems to be a “win-win-win” situation because:

- Less expensive than paying people to mow;
- Greener than using gas-powered landscaping equipment; and
- Safer for the solar equipment – no harm to wires from landscaping equipment.

The system of solar grazing also seems to be beneficial for the sheep farmers as an additional source of income.

Stormwater Management

Stormwater management is one of the biggest concerns when installing utility-scale solar facilities, especially those that encompass hundreds of acres. Solar panels create a semi-impermeable cover, where, technically, the cross-section of the pilings used for the rack support structure are the only 100 percent impervious structures, but the panels themselves create vast areas of impervious surface close to the ground that increase rainfall velocity and produce driplines that can erode the soil. As noted above, the installation of solar facilities often produces compacted soils that can have infiltration coefficients similar to concrete, and reducing the potential area for natural infiltration exacerbates the problem.

On March 22, 2022, Virginia DEQ released a memo stating that for future volume calculations, solar panels would be treated as impervious surfaces. This was revised shortly after to take effect only for projects without an interconnection agreement in place by December 31, 2024. Regardless, stormwater management is one of the biggest complaints for both locality permitting and monitoring staff and for local residents. Best management practices should be put in place to reduce the overall impact. This includes not only mandated retention BMPs but also practices such as enhancing setbacks from property lines and streams, retaining existing trees and native vegetation in these setbacks, and restricting total developed land during construction to 100-500 acres or less until site/soil stabilization.

Native and Pollinator-Friendly Plantings

Native plants are critical not only for enhancing the ecosystem and providing habitat for pollinators and other insects, small mammals, and bird species, but also for providing low-maintenance ground cover and soil stabilization. Once established, native plants only require as much sunlight and rainwater as nature provides. It is also important to only select plants native to the locality as opposed to the whole state or region, both to prevent introduced species from becoming invasive and to maintain the locality's cultural heritage. One issue with using natives can be selecting for appropriate plant height and their large-scale commercial availability. Virginia DCR's Solar Site Native Plant Finder accounts for both of those issues in its easy-to-use searchable online database. Any suitable groundcover will help protect from some of the deleterious effects of grading and soil compaction, but native plants have the added benefit of enhancing certain ecosystem functions.

Decommissioning

In addition to general land use considerations associated with the location of utility-scale facilities, as well as environmental and visual impacts associated with the development and operation of facilities, it is important to plan for the decommissioning of these facilities once they are no longer in operation. Additionally, pursuant to §15.2-2241.2., *Bonding provisions for decommissioning of solar energy equipment, facilities, or devices*, of the Code of Virginia, "As part of the local legislative approval process or as a condition of approval of a site plan," a decommissioning agreement is required for solar facility projects.

Decommissioning is the process of removing equipment and installed components of the facility, as well as restoring the land to conditions that approximate pre-developed conditions.[3] While it is not out of the realm of possibility that a permitted and developed facility could continue to operate well into the future, panels and associated technologies have lifespans that exceed reasonable abilities to plan for the evolution of energy generation technologies and well as energy needs.

Similar to the development of these facilities, decommissioning can cost millions, and, consequently, applicants should be required to submit a plan describing the process for decommissioning of a site, cost estimates, a bond or security to be held in escrow through the life of the project, and expectations for periodic reevaluation of decommissioning cost estimates and increasing security amounts as may be necessary. The focus of planning for decommissioning should be to ensure applicant and project owner responsibility into the future, removing the potential exposure to the public for future costs.

Disposal

To dispose of solar panels, which contain hazardous materials, the regulations under the Resource Conservation and Recovery Act (RCRA) must be followed to ensure they are safely disposed of or recycled. Because solar panels become solid waste at the end of its lifespan, when discarded they must follow RCRA Subtitle D[4] and through state and local government programs. They must also follow RCRA Subtitle C[5] when determined to be hazardous by meeting the characteristics of toxicity.

Recycling

Waste from end-of-life solar panels can present opportunities to recover valuable materials and create jobs through recycling. Most solar panels are made from crystalline silicon, comprised of an aluminum frame, glass, copper wire, polymer layers and a backsheet, silicon solar cells and a

[3] §15.2-2241.2. defines decommissioning as "the removal and proper disposal of solar energy equipment, facilities, or devices on real property that has been determined by the locality to be subject to § 15.2-2232 and therefore subject to this section. "Decommission" includes the reasonable restoration of the real property upon which such solar equipment, facilities, or devices are located, including (i) soil stabilization and (ii) revegetation of the ground cover of the real property disturbed by the installation of such equipment, facilities, or devices."
[4] https://www.epa.gov/rcra/resource-conservation-and-recovery-act-rcra-overview#subtitleD
[5] https://www.epa.gov/rcra/resource-conservation-and-recovery-act-rcra-overview#subtitleC

plastic junction box. And many of these components are recyclable – glass, aluminum, copper, and plastic.

According to the EPA the recycling process includes the following:

- Removal of aluminum frame and plastic junction box;
- Separation of glass and silicon wafer through thermal, mechanical, or chemical processes; and/or
- Separation and purification of silicon cells and specialty metals (e.g., silver, tin, lead, copper) through chemical and electrical techniques.

Recycling industries already include glass, metals, and electronic materials, which can accommodate solar panels and other solar power system components. Another means to utilize used solar panels is through panel *reuse* – directly or after refurbishment; although there are numerous electrical grid interconnection regulations, as well as fire, building, and electrical codes that must be examined when planning for solar panel reuse.

Potential for Contamination

According to the EPA, hazardous waste testing on solar panels has indicated the different types of panels have different metals present. Some metals such as lead or cadmium, are considered harmful to human health and the environment at high levels. When these metals are present at high concentrations in the panels, then the panel waste could be considered hazardous waste under the RCRA. Generally, the potential risk for contamination from panels is most associated with panels that may be damaged, necessitating proactive management practices.

The following are some types of solar panels that do or may contain toxic materials:

- Cadmium telluride (CDTe) – due to cadmium;
- Gallium arsenide – due to arsenic;
- Older crystalline silicon (c-Si) panels – due to hexavalent chromium coatings; and
- Newer thin-film panels that contain Copper indium selenide (CIS)/Copper indium gallium (di)selenide (CIGS) – due to copper and/or selenium

The North Carolina DEQ found that end-of-life photovoltaic panels require Toxicity Characteristic Leaching Procedures (TCLP) testing to be considered as non-hazardous. Furthermore, some energy storage system batteries exhibit hazardous characteristics and existing regulations for managing batteries characterized as such indeed apply to battery energy storage systems (BESS).

Beyond the panels themselves, there is the potential for zinc from galvanized steel racking and support components to leach into soils. This has been identified as potentially negative to at least the cultivation of peanuts.

Administration Impacts and Needs

In addition to physical impacts, solar facilities can have impacts on local government administration and operations. In many cases, these facilities will be larger than any development project previously seen by a community, and permitting and plan review, inspections, and enforcement tasks and responsibilities for any singular project can far exceed the resources available. The timeline for project development, often in phases over multiple years, can also impact resource availability. Finally, project components, especially battery energy storage systems, have unique safety and fire suppression needs, and may necessitate dedicated, specific, and on-going training requirements for Fire/EMS personnel.

EXISTING REGULATIONS FOR SOLAR FACILITIES AND BEST PRACTICES

As seen, utility-scale solar facilities are unique land uses with unique regulatory considerations, and as such, should have clearly defined regulations and standards for their siting and design intended to address anticipated impacts. Currently, the County's Zoning Ordinance only defines the use ("Solar Energy System") and allows the use subject to a special use permit. In practice, it is understood that the County has relied upon its special use permit process to essentially develop regulations and standards for individual projects. Clearly defined regulations and standards create consistency for all projects and provide predictability for developers, the County, and the public.

Regulatory Best Practices

The following are recommended components and considerations for utility-scale solar land use regulations; these are common best practices, while individual localities may have specific conditions or issues requiring additional consideration:

- **Define the Use:** It is recommended that solar facilities be defined based upon the size of potential projects, either by acreage and/or rated electrical capacity in MW. For example:
  - Small-Scale: rated capacity of one megawatt (1 MW) alternating current or less;
  - Medium-Scale: rated capacity greater than one megawatt (1 MW) and less than five megawatts (5 MW); and
  - Utility- or Large-Scale: rated capacity of five megawatts (MW) alternating current or greater.

Additional uses, features, and components should also be identified and defined and/or clarified, such as when solar is mounted to a roof as an accessory use to a residential of commercial use, or the technical equipment installed in conjunction with a solar facility. Further, some communities define *community solar*[6] as a separate use from other utility-scale solar facilities, and the County may wish to consider whether these uses are allowed and regulated differently, and whether there is a preference for community solar facilities and how to facilitate their development.

- **Determine Zoning:** Based upon how the various uses are defined, determine the appropriate zoning districts, and when and for which uses a Special Use Permit may be required, versus when the uses are considered by-right.

- **Establish Procedures and Minimum Application Content:** For both by-right and Special Use Permits, establish minimum application content requirements and specific review and approval procedures. For larger facilities, especially those requiring a Special Use Permit, establishing a separate review pursuant to §15.2-2232 of the Code of Virginia for public utility facilities is recommended.[7] For Special Use Permits themselves, specific *findings* to be considered and affirmed by the Planning Commission and Board of Supervisors in their consideration of applications should be adopted.

- **Siting Agreements:** Establish requirements for siting agreements pursuant to §15.2-2316.7 of the Code of Virginia as part of zoning ordinance provisions.[8]

- **Revenue Share:** Consider whether it is in the best interest of the community to adopt a requirement to assess a revenue share pursuant to §58.1-2636 of the Code of Virginia.[9]

- **Establish Minimum Development Standards:** Adopt minimum development standards regulating the design and siting of facilities; such standards should address:

    - Minimum and/or maximum area of facilities, or rated capacities;
    - Maximum lot/site coverage and/or minimum percentage of open space;

[6] https://www.energy.gov/eere/solar/community-solar-basics
[7] https://law.lis.virginia.gov/vacode/title15.2/chapter22/section15.2-2232/
[8] https://law.lis.virginia.gov/vacode/title15.2/chapter22/section15.2-2316.7/
[9] https://law.lis.virginia.gov/vacode/title58.1/chapter26/section58.1-2636/

  - Minimum distances from towns or cities;
  - Minimum distances from other solar facilities;
  - Minimum distances from identified natural, historic, cultural, or similar resources;
  - Street and property line setbacks specific to the use;
  - Maximum height, including the maximum height of the lowest edge of panels;
  - Total density of facilities, either county-wide or within a defined area;
  - Development on steep slopes;
  - Landscaped buffers and screening;
  - Landscaping and groundcover;
  - Fencing and security measures;
  - Wildlife corridors;
  - Lighting;
  - Signage;
  - Noise;
  - Transmission lines and other support infrastructure;
  - Groundwater and stormwater monitoring;
  - Coordination with local emergency services; and
  - Maintenance.

- **Construction Mitigation:** A requirement for a construction mitigation plan addressing phasing, timelines, staging and storage, transportation routes, and overall mitigation of construction impacts on the public and infrastructure.

- **Decommissioning:** As addressed earlier, decommissioning of solar projects and the requirement for a decommissioning agreement are required by the Commonwealth to occur in some manner; it is recommended that specific requirements for decommissioning and decommissioning agreements be established as part of a community's ordinance. These requirements should address minimum steps that project owners will take when decommissioning a project (including site restoration), establish a requirement for a decommissioning plan to be submitted at the time of project permitting (to be revisited and reevaluated periodically), and establish requirements for an appropriate financial surety to ensure decommissioning.

QUESTIONS FOR CONSIDERATION

In their consideration of regulations and standards for solar facilities, the Commission should address the following questions:

1. What zoning districts should solar facilities be allowed in; prohibited in?

2. Should community solar be defined and regulated differently from utility-scale solar facilities?

3. Should there be a maximum area for individual projects?

4. Should there be a maximum combined area for all utility-scale solar projects?

5. What setbacks and/or buffer dimensions are appropriate? Should there be different setbacks/buffers from residences or abutting lots with residences? What about from property lines along certain roads/streets?

6. Should there be requirements for minimum distances of facilities from one another?

7. Should there be a buffer around or setback from municipal or development area boundaries where solar facilities are not permitted?

8. Should there be minimum required distances from historical sites, natural resources, or agricultural and forestal districts? Are there historical site or natural resources that warrant more/specific protection?

9. Should facilities be required to be within a certain distance of transmission lines?

10. Should there be regulations limiting significant impacts to existing forested land?

11. Should there be regulations that prohibit development of solar facilities on land with prime agricultural soils, lands that have recently been utilized for agricultural production, or lands historically used for pine/timber production?

12. Are there project elements that should be incentivized or some preference established? For instance, agrivoltaics or shared solar/ag, establishment of conservation easements for undeveloped area, creation of public recreational opportunities or other public benefits?