

# **South Carolina Department of Health and Environmental Control**

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Director



## **Final Report on the Activities Conducted to Establish a Program for End-of-Life Management of Photovoltaic Modules and Energy Storage Systems**

Pursuant to R-116, H.4100, the Fiscal Year 2021-2022 General  
Appropriations Act, Part 1B, Section 34, Proviso 34.62 and 2022 Act  
No. 119

June 30, 2022



TO: Chairman of the Senate Judiciary Committee  
Chairman of the House Labor, Commerce and Industry Committee

FROM: Dr. Edward D. Simmer, Director  
S.C. Department of Health and Environmental Control

DATE: June 30, 2022

SUBJECT: Photovoltaic Modules and Energy Storage Systems

Enclosed is the final report with findings on the research conducted to establish a program for end-of-Life management of photovoltaic modules and energy storage systems pursuant to R-116, H.4100 of the fiscal year 2021-2022 General Appropriations Act, Part 1B, Section 34, Proviso 34.62 and 2022 Act No. 119.

# **Final Report on the Activities Conducted to Establish a Program for End-of-Life Management of Photovoltaic Modules and Energy Storage Systems**

## **I. Summary**

- Executive Summary

- Commonly Used Acronyms & Abbreviations

- Summary of Recommendations

## **II. Background**

## **III. Matters Entrusted to the Department**

- Budget Proviso 34.62

- Act No. 119

## **IV. Proviso Matters**

- 34.62(1)

- 34.62(2)

- 34.62(3)

- 34.62(4)

- 34.62(5)

- 34.62(6)

## **V. Regulation Development**

## **VI. Appendix**

- List of Stakeholders

- Summary of stakeholder meetings

- Chart of Ordinances

- Landfill Information

- Notices of Drafting

- Stakeholder Comments

## I. Summary

### *Executive Summary*

Pursuant to R-116, H.4100, the Fiscal Year 2021-2022 General Appropriations Act, Part 1B, Section 34, Proviso 34.62, the Department of Health and Environmental Control must submit a final report with findings, including stakeholder input, to the Chairman of the Senate Judiciary Committee and the Chairman of the House Labor, Commerce, and Industry Committee by no later than June 30, 2022. This final report details the research and recommendations of the Department after considering the six matters described by Proviso 34.62 and conducting a stakeholder group with representatives from the solar industry, local governments, the solid waste industry, environmentalists, recyclers, and other interested parties. It also provides an update on ongoing regulation development efforts.

### *Commonly Used Acronyms & Abbreviations*

**The Department** – The Department of Health and Environmental Control

**EOL** – End-of-life

**EPA** – U.S. Environmental Protection Agency

**FY** – Fiscal Year

**GW** – Gigawatts (1000 MW)

**kW** – Kilowatts (1000 W)

**MW** – Megawatts (1000 kW)

**Proviso 34.62** - R-116, H.4100, the Fiscal Year 2021-2022 General Appropriations Act, Part 1B, Section 34, Proviso 34.62

**PV module** – Photovoltaic module or solar panel

**SEIA** – Solar Energy Industries Association

**SWMF** – Solid waste management facility

**TCLP** – Toxicity Characteristic Leaching Procedure

**W** - Watts

**WEEE** – The European Union’s Waste Electrical and Electronic Equipment Directive

## *Summary of Recommendations*

### 34.62(1) – Hazardous Waste Characterization of EOL Photovoltaic Modules and Equipment

1. Whether PV modules, storage system batteries, or accompanying equipment is considered a hazardous waste is dependent on the results of a hazardous waste determination, which can be done by using generator knowledge, or by using an approved testing method, such as the TCLP test.
2. If a PV module exhibits characteristics of hazardous waste as shown by generator knowledge or TCLP results, then it must be managed according to the hazardous waste rules and regulations South Carolina is authorized to enforce by the EPA.
3. Crystalline silicon solar panels contain traces of silver, tin and lead which can be considered hazardous at some levels in South Carolina and federal regulations. Some thin-filmed panels contain traces of copper, zinc, and cadmium, which are potentially hazardous. From the limited research available, most panels are reported to pass the TCLP test.
4. The Department would encourage South Carolina to adopt PV modules as a universal waste should the EPA issue a rule that does so. Declaring certain solar panels to be universal waste could reduce some regulatory burden, reduce the amount of PV modules from being disposed, and encourage recycling if some conditions are met. Some batteries are already eligible to be managed as universal waste.

### 34.62(2) - Preferred Methods to Manage EOL Photovoltaic Modules and Equipment

1. The Department recommends the waste hierarchy as a good framework to manage all EOL PV modules and storage system batteries. Manufacturers should engineer products to produce as little waste as possible at the EOL stage. EOL PV modules and batteries should preferably be reused, recycled, and properly disposed, in that order.
2. EOL PV modules and storage system batteries that test for or are considered hazardous waste due to generator knowledge must be managed according to the state's hazardous waste regulations.
3. The Department supports the continued development of the recycling capacity in the solar and lithium-ion battery industries. As more dedicated recyclers that specialize in recycling these products emerge, process improvements are expected, and modules should be recycled more efficiently with reduced recycling costs.

### 34.62(3) – Impact of PV module equipment on South Carolina Landfills

1. Using the estimates developed by staff, the Department does not expect the amount of PV module and storage system battery waste to overwhelm the landfill capacity of South Carolina.
2. The Department encourages landfill operators, local governments and staff to take into consideration the potential operational difficulties of handling and compacting large, bulky panels at landfills.

#### 34.62(4) – Financial Assurance and Decommissioning Requirements

1. The Department believes that decommissioning requirements and a level of financial assurance are necessary to ensure proper end-of-life management and diminish the possibility of large numbers of EOL PV modules being undisposed. Some county governments have already implemented decommissioning and/or financial assurance requirements.
2. The Department is currently engaging in regulation development activities with stakeholders to put together regulations for decommissioning requirements for large solar facilities that cease operations.

#### 34.62(5) - Infrastructure Needed to Manage EOL Photovoltaic Modules and Equipment

The Department does not recommend a specialized collection infrastructure in South Carolina for EOL PV modules and batteries at this time. Transportation will likely be managed directly from the generation point to a SWMF for disposal or recycling. The Department supports the continued development of the recycling infrastructure to lower the cost of managing these EOL products.

#### 34.62(6) – Feasibility of a Stewardship Program for EOL PV Modules and Batteries

1. The Department does not recommend establishing a stewardship program for PV modules or storage system batteries at this time. Recycling markets for these EOL products are still developing, and recycling requirements could increase financial burdens on local governments, the solar industry, consumers and disincentivize investment in South Carolina’s solar industry.
2. The Department is monitoring implementation of stewardship programs in the state of Washington and Niagara County, New York to observe potential benefits of a policy of product stewardship in South Carolina.

## II. Background

Solar panels are a relatively new and increasingly critical part of the South Carolina energy economy. Solar energy provides renewable power and employs several thousand people in our state. 2.78% of the state's electricity is generated through solar power. As of 2021, according to the Solar Energy Industries Association, South Carolina has 1923.8 MW of installed Photovoltaics, with 1472.46 MW expected to be installed over the next 5 years; a trend likely helped by legislation from the State, such as the 2019 Energy Freedom Act<sup>1</sup>.

According to SEIA, nationwide, the U.S. Solar capacity is 121.4 GW of installed photovoltaic systems with nearly 3.3 million solar energy systems installed across the country. This industry supports 231,000 jobs across the United States<sup>2</sup>.

With the exciting opportunities that solar energy gives South Carolinians, it also brings some challenges that policymakers must consider. Solar panels are intricate pieces of technology that can create multiple issues at the end of their lifespan. Communities where large-scale solar projects are located will eventually deal with decommissioning of solar panels that could create issues for some municipalities as solar panels become more widely used. Issue has also been raised with potential hazardous substances that can be leached out of solar panels, such as lead. Some believe that financial assurance must be required for larger solar projects to ensure that localities are not left cleaning up decommissioned panels.

The Department of Health and Environmental Control believes it is in the best interest of South Carolina to continue to promote the use of solar energy in our state to decrease energy costs, promote economic development, increase consumer choice in energy consumption and hopefully reduce pollution and emissions. We must also be sure not to compromise human and environmental health in the process of installing and decommissioning solar energy facilities.

There are currently no statewide regulations specifically for the disposal of EOL PV modules and other devices other than standard rules for management of solid and hazardous wastes. This responsibility is currently managed by local government regulations, if at all. The legislature asked the Department to investigate the issue of EOL PV modules and provide recommendations based on six matters as described in Proviso 34.62.

Due to the requirements outlined in Proviso 34.62 and Act No. 119, the Department invited a diverse group of stakeholders to provide information and recommendations on these issues. Several meetings were held, with more meetings to come while the Department is going through the rule-making process. This final report is the culmination of all research and discussion the Department has completed on the topic.

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<sup>1</sup> "State Solar Spotlight – South Carolina" <https://www.seia.org/sites/default/files/2022-03/South%20Carolina%20Solar-Factsheet-2021-YearinReview.pdf>

<sup>2</sup> "Solar State By State" <https://www.seia.org/states-map>

The Department has held six meetings with the solar stakeholder group (a summary of these meetings can be read in the Appendix) as well as multiple meetings with individual groups of stakeholders. Three quarterly reports have been published to document meetings held, materials gathered, stakeholders participating and other relevant activities of the Department during this stakeholder process. The Department created a webpage on the DHEC website which gathers presentation materials, quarterly reports and other information regarding EOL PV modules which can be accessed using the following URL:

<https://scdhec.gov/environment/land-management/solar-panel-stakeholder-group>



### III. Matters Entrusted to the Department

#### *Budget Proviso 34.62*

Pursuant to Budget Proviso 34.62, the Department is to consider six matters when developing regulations for the managing of solar panels and energy battery systems and the decommissioning of utility-scale solar projects. The Department is directed to collaborate with stakeholders to consider:

1. Whether photovoltaic modules, energy storage system batteries, their materials, or other equipment used in utility-scale solar projects exhibit any of the characteristics of hazardous waste, as identified in 40 C.F.R. Part 261, or under rules adopted pursuant to the S.C. Hazardous Waste Management Act, Section 44-56-10 of the 1976 Code, or if any such equipment is properly characterized as solid waste under State and Federal law.

2. Preferred methods to responsibly manage end-of-life photovoltaic modules, energy storage system batteries, or the constituent materials thereof, or other equipment used in utility-scale solar projects, including the extent to which such equipment may be:

(a) reused, if not damaged or in need of repair, for a similar purpose;

(b) refurbished, if not substantially damaged, and reused for a similar purpose;

(c) recycled with recovery of materials for similar or other purposes;

(d) safely disposed of in construction and demolition or municipal solid waste landfills for material that does not exhibit any of the characteristics of hazardous waste under state or federal law; or

(e) safely disposed of in accordance with state and federal requirements governing hazardous waste for materials that exhibit any of the characteristics of hazardous waste under state or federal law.

3. The volume of photovoltaic modules and energy storage system batteries currently in use in the State, and projections, based upon the data on life cycle identified currently on impacts that may be expected to the State's landfill capacity if landfill disposal is permitted for such equipment at end-of-life.

4. Whether adequate financial assurance requirements are necessary to ensure proper decommissioning of solar projects in excess of thirteen acres upon cessation of operations.

5. Infrastructure that may be needed to develop a practical, effective, and cost-effective means to collect and transport end-of-life photovoltaic modules, energy storage system batteries, and

other equipment used in utility-scale solar projects for reuse, refurbishment, recycling, or disposal.

6. Whether or not manufacturer or installer stewardship programs for the recycling of end-of-life photovoltaic modules and energy storage system batteries should be established for applications other than utility-scale solar project installations, and if so, fees that should be established for these manufacturers and installers to support the implementation of such requirements.

*Act No. 119*

In addition to requirements from R-116, H.4100, the Fiscal Year 2021-2022 General Appropriations Act, Part 1B, Section 34, Proviso 34.62, the stakeholder group is also complying with Act No. 119, which went into effect on January 27, 2022. Section 5 of this act directs the Department to submit regulations for the management of end-of-life photovoltaic modules which will include requirements for local approval of a site plan and the submission of a nonbinding decommissioning plan. The rules may also include other requirements as the stakeholder group recommends.

## IV. Proviso Matters

### Hazardous Waste Characterization of EOL Photovoltaic Modules and Equipment

Proviso 34.62(1) asks that the Department consider:

*Whether photovoltaic modules, energy storage system batteries, their materials, or other equipment used in utility-scale solar projects exhibit any of the characteristics of hazardous waste, as identified in 40 C.F.R. Part 261, or under rules adopted pursuant to the S.C. Hazardous Waste Management Act, Section 44-56-10 of the 1976 Code, or if any such equipment is properly characterized as solid waste under State and Federal law.*

To answer this matter, the Department referred to the state's hazardous waste regulations and solid waste statutes and rules. The Environmental Protection Agency and the South Carolina Hazardous Waste Management Act (Title 44, Chapter 56) give authority to the Department to issue R. 61-79, Hazardous Waste Management Regulations<sup>3</sup>, in which the Department puts forth and enforces standards regarding the generation, treatment, storage and disposal of hazardous waste in the state of South Carolina.

#### *Hazardous Waste in South Carolina*

PV modules and equipment that are in operation are not under consideration in the creation of this memo. The parameters of proviso 34.62(1) only apply to those materials that are at the end of their useful life due to wear, damage, or defect. PV modules that can legitimately be used for its intended purpose are not yet a waste.

The waste characterization process is governed under R.61-79-262.11, which details the process waste generators use to determine whether waste is hazardous or nonhazardous. Wastes characterized as solid waste are governed in South Carolina under the Solid Waste Policy and Management Act. PV module waste generated from households would not be governed under hazardous waste requirements as household hazardous wastes would be regulated under solid waste rules.

Non-excluded wastes are categorized as hazardous if they exhibit ignitability, corrosivity, reactivity, or toxicity. Waste generators are expected first to apply knowledge of the hazardous characteristics of the waste to make a determination. This can involve knowledge of the production process, the manufacturing process, and chemical or physical characterization of the waste or the process used to create the waste. The generator may also use Department approved tests (other than the test method laid out in R.61-79.261, subpart C), but such tests by themselves do not provide for a definitive determination.

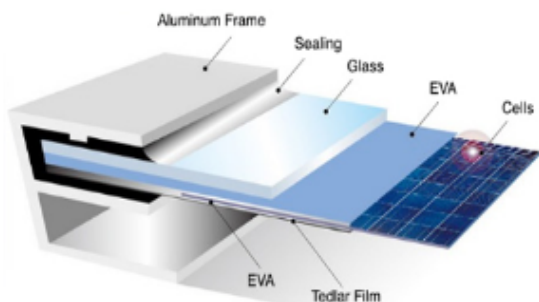
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<sup>3</sup> "Laws and Regulations - Hazardous Waste" <https://scdhec.gov/environment/land-management/hazardous-waste/laws-regulations-hazardous-waste>

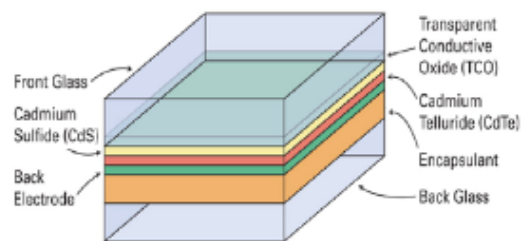
When there is not enough information available to make an accurate determination, the generator must test the waste according to the methods set forth in R.61-79.261, subpart C, or an equivalent method approved by the Department in accordance with the state’s standards. A TCLP test will determine if the waste displays constituent materials that are below or exceeds the toxicity thresholds shown in R.61-79.261.24 by determining the risk of hazardous substances leaching out of the landfill.

Hazardous waste regulations can be streamlined for certain categories that are designated as universal wastes. The universal waste requirements in South Carolina, which currently apply to batteries, pesticides, mercury-containing equipment, lamps, and aerosol cans are regulated by R. 61-79.273, Universal Waste Rule. This allows certain types of wastes to be collected and recycled, the regulatory burden on some generators to be eased, and encourages the development of programs to reduce these types of wastes going into landfills. While South Carolina only governs those declared by the EPA as a universal waste as such, other states may add additional universal wastes to their program. Photovoltaic modules are currently regulated as universal waste in California and Hawaii<sup>4</sup>.

### Material Characteristics of PV Modules



*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)*

Crystalline silicon solar panels are the primary model of solar panel technology that is manufactured. These devices are composed of more than 90% glass, polymer and aluminum<sup>5</sup>. These panels also include some materials such as silver, tin, and lead traces, which can be

<sup>4</sup> “State Universal Waste Programs in the United States” <https://www.epa.gov/hw/state-universal-waste-programs-united-states>

<sup>5</sup> “End of Life Management: Solar Photovoltaic Panels” [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA\\_IEAPVPS\\_End-of-Life\\_Solar\\_PV\\_Panels\\_2016.pdf](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf)

considered hazardous at some levels in South Carolina’s hazardous waste regulations<sup>6</sup>. The main component with potential toxicity concerns are panels containing a small amount of lead. According to research completed in 2017 by the North Carolina Clean Energy Center, crystalline silicon panels generally test below hazardous waste thresholds resulting from a TCLP test<sup>7</sup>.

Thin-film panels are not nearly as widely manufactured, but are also predominately glass, polymer, and aluminum with possible trace elements of copper and zinc, which are potentially hazardous. Most thin-film panels are categorized as Cadmium-telluride modules (CdTe), which also contain small amounts of cadmium, which is a toxic heavy metal. Like silicon-based panels, thin-film panels are reported to normally pass the TCLP test<sup>8</sup>.

### *Hazardous Waste Determination of Photovoltaic Modules*

Waste generators in South Carolina must go through several steps to make a hazardous waste determination for photovoltaic modules. The first step is to determine whether the PV module, and any accompanying equipment, can still be legitimately used for its intended purpose. If a PV module can still be used for its general purposes, it is not a waste, and therefore would not be regulated under any waste regulations. A PV module can also be excluded from hazardous waste regulations if they are generated from a household.

For PV modules that are wastes that are not household hazardous wastes, a generator must use knowledge of the production process, the manufacturing process, and chemical or physical characterization of the waste or the process used to create the waste to determine if a PV module is hazardous. If this is not possible, the generator should either cautiously declare the PV module to be hazardous waste without testing or use a TCLP test to determine if the PV module exhibits characteristics of hazardous waste.

This test involves crushing the panel into smaller pieces. The pieces are mixed in an acid bath. After eighteen hours, the fluid is tested for several hazardous substances that must be below a specific threshold to be declared non-hazardous<sup>9</sup>. If a PV module fails a TCLP test, it must be managed as a hazardous or universal waste.

### *Photovoltaic Modules as a Universal Waste*

The alternative to managing PV modules which show characteristics of hazardous waste would be regulating them as a universal waste. This cannot currently be done in most states because PV modules are not considered a federal universal waste and is only considered as such in

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<sup>6</sup> “End of Life Management: Solar Photovoltaic Panels” [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA\\_IEAPVPS\\_End-of-Life\\_Solar\\_PV\\_Panels\\_2016.pdf](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf)

<sup>7</sup> “Health and Safety Impacts of Solar Photovoltaics” <https://content.ces.ncsu.edu/health-and-safety-impacts-of-solar-photovoltaics>

<sup>8</sup> “Health and Safety Impacts of Solar Photovoltaics” <https://content.ces.ncsu.edu/health-and-safety-impacts-of-solar-photovoltaics>

<sup>9</sup> “Health and Safety Impacts of Solar Photovoltaics” <https://content.ces.ncsu.edu/health-and-safety-impacts-of-solar-photovoltaics>

California and Hawaii. The Department is waiting for a federal determination on PV modules to be made before moving forward with adding PV modules to our list of universal wastes.

### *Storage System Batteries*

According to the U.S. Energy Information Administration, lithium-ion batteries are the main type of large battery storage systems in use<sup>10</sup>. These types of batteries potentially contain toxic materials such as copper, nickel, lead, and organic chemicals, such as toxic and flammable electrolytes<sup>11</sup>. Lithium-ion batteries may meet the definition of hazardous waste if they exhibit one of the hazardous waste characteristics during a hazardous waste determination.

Lead-acid batteries are an older type of storage system battery (which are not widely used in modern times<sup>12</sup>) which contains substances such as lead and sulfuric acid. These batteries are subject to hazardous waste and universal waste relocations due to the lead. These devices are banned from being disposed in the garbage in South Carolina, and are subject to R. 61-107.18, SWM: Lead Acid Batteries<sup>13</sup>.

Nickel-based and Sodium-based batteries are also sometimes in-use as large-scale battery storage installations, but not nearly as widely used as lithium-ion batteries<sup>14</sup>. Like lithium-ion batteries there are no specific state rules for these batteries, but they are subject to hazardous waste or universal waste rules if they meet a characteristic of hazardous waste. Batteries are among the categories of materials that can be managed as universal wastes according to the EPA<sup>15</sup>.

### *Conclusion*

Some photovoltaic modules and storage system batteries are hazardous waste and others are not, depending on the presence of certain toxic materials in the PV module. This determination under current hazardous waste requirements must be made by the generator by running the appropriate test or using generator knowledge. PV modules that fail a TCLP test must be managed as hazardous waste.

Some storage system batteries exhibit hazardous characteristics that would apply to existing regulations for managing batteries characterized as such. Some batteries are already regulated,

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<sup>10</sup> "Battery Storage in the United States: An Update on Market Trends"

<https://www.eia.gov/analysis/studies/electricity/batterystorage/archive/2020/>

<sup>11</sup> "Problem of Used Lithium Ion Batteries" [https://law.ucdavis.edu/centers/environmental/files/2018-Spring-papers/The-Electrifying-Problem-of-Used-Lithium-Ion-Batteries\\_Murphy.pdf](https://law.ucdavis.edu/centers/environmental/files/2018-Spring-papers/The-Electrifying-Problem-of-Used-Lithium-Ion-Batteries_Murphy.pdf)

<sup>12</sup> "Battery Storage in the United States: An Update on Market Trends"

<https://www.eia.gov/analysis/studies/electricity/batterystorage/archive/2020/>

<sup>13</sup> "Solid Waste Management: Lead Acid Batteries" <https://scdhec.gov/sites/default/files/Library/Regulations/R.61-107.8.pdf>

<sup>14</sup> "Battery Storage in the United States: An Update on Market Trends"

<https://www.eia.gov/analysis/studies/electricity/batterystorage/archive/2020/>

<sup>15</sup> "Batteries" <https://www.epa.gov/hw/universal-waste#a1>

per the EPA's direction, as a universal waste. A specific regulatory program for storage system batteries is not needed at this time.

One suggestion the Department would recommend is to adopt any testing methods for PV modules that are developed by the American Society for Testing and Materials (ASTM) and approved by the EPA. This will ensure that the most efficient testing methods for PV modules and storage system batteries are being used by hazardous waste generators in the state.

The Department would also encourage the state to adopt PV modules as a universal waste should the EPA issue a rule that does so. Declaring certain solar panels to be universal waste could reduce some regulatory burden, reduce the amount of PV modules from being disposed, and encourage recycling if some conditions are met.

### **Preferred Methods to Manage EOL Photovoltaic Modules and Equipment**

Proviso 34.62(2) asks that the Department consider:

*Preferred methods to responsibly manage end-of-life photovoltaic modules, energy storage system batteries, or the constituent materials thereof, or other equipment used in utility-scale solar projects, including the extent to which such equipment may be:*

- (a) reused, if not damaged or in need of repair, for a similar purpose;*
- (b) refurbished, if not substantially damaged, and reused for a similar purpose;*
- (c) recycled with recovery of materials for similar or other purposes;*
- (d) safely disposed of in construction and demolition or municipal solid waste landfills for material that does not exhibit any of the characteristics of hazardous waste under state or federal law; or*
- (e) safely disposed of in accordance with state and federal requirements governing hazardous waste for materials that exhibit any of the characteristics of hazardous waste under state or federal law.*

To answer this matter, the Department consulted the solid waste management laws and regulations, the waste management hierarchy, and other resources.

#### *Waste Management Hierarchy*

A challenging aspect of managing solid waste is the understanding that the same circumstances that apply to some solid waste may not apply to other solid waste. The waste management hierarchy was modeled with this approach in mind, which ranks various waste management strategies from most to least conducive for environmental health.

The Department believes these strategies should apply to PV modules and storage system batteries as they do to all manners of solid waste in the below order:

1. Reduction of PV module/storage system battery waste at the source
2. Reuse of PV module/storage system batteries
3. Recycling and recovering PV modules/storage system batteries
4. Proper treatment and disposal of PV modules/storage system batteries

#### *Source reduction of PV modules*

Source reduction means reducing waste from its source. This can mean using more lightweight materials in products so that the end product will produce less waste when its useful lifespan ends. This can also mean manufacturing and encouraging the use of more efficient products that last longer, so less waste is disposed of.

The Department encourages this strategy be utilized first, if possible, as a means of managing PV modules. Manufacturers should consider material efficiency, using resources in a sustainable manner while minimizing impacts to the environment, as an important factor when developing their products. Manufacturers are encouraged to find ways to improve technology and manufacturing processes to increase efficiency in their products as to produce less waste materials. Consumers should also consider material efficiency an important factor when deciding to purchase a PV module. The Department also supports continuing progress on reducing the amount of hazardous materials in PV modules, which will reduce risks to human and environmental health.

According to the International Renewable Energy Agency, in their 2016 report on managing end-of-life PV modules, considerable research and efforts have been made in reducing lead, cadmium, and selenium in PV modules to reduce the threat of hazardous waste<sup>16</sup>.

Manufacturers and consumers should also keep the objectives set forth by the NSF/ANSI 457-2019 Standard in mind when manufacturing or purchasing PV modules. These standards, developed in 2017 and updated in 2019, issue a number of criteria to acknowledge those who conform to performance goals including management of substances, preferable materials use, life cycle assessment, energy efficiency & water use, end-of-life management & design for recycling, product packaging, and corporate responsibility<sup>17</sup>.

#### *Reuse of PV modules*

Reusing products means returning the product into the economic stream for use in the same kind of application as before without change in its function. The Department believes that PV modules should be refurbished and reused to the extent possible. If PV modules are damaged

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<sup>16</sup> “End-Of-Life Management: Solar Photovoltaic Panels” [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA\\_IEAPVPS\\_End-of-Life\\_Solar\\_PV\\_Panels\\_2016.pdf](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf)

<sup>17</sup> “Solar PV Modules – Sustainability Leadership Objectives” <https://blog.ansi.org/2020/05/solar-pv-sustainability-leadership-ansi-457/#gref>



or defective early enough in their lifespan, this presents opportunity for the module to be repaired and reused.

Before a PV module is repaired and reused, there should be quality tests to ensure value can be recovered and to check the safety of the PV module. Users of reused PV modules should also ensure they comply with electrical grid interconnection regulations and fire, building, and electrical codes. Repaired PV modules can be sold at a lower price and a market of such products would provide access to them for consumers with limited financial resources<sup>18</sup>. Not only does reusing PV modules and their components keep PV module waste out of the state's landfills but repairing and reusing PV modules can also create a good opportunity for a secondary market for used panels and those who can repair such products.

### *Recycling and recovering PV modules*

Recycling means processes by which materials that would otherwise become solid waste are collected, separated, or processed and reused or returned to use in the form of raw materials, or remanufacturing material into new products. The Department believes if PV modules cannot be reused, then at the end of their useful life, they should be recycled to the extent possible. If PV modules are determined to be hazardous, then they must be recycled as according to hazardous waste guidelines at an authorized facility who processes hazardous materials.

PV modules have started to enter the waste streams only recently and not in sufficient quantities to create recycling facilities dedicated purely to recycling PV modules on a large scale. Because of this, PV modules that are recycled in the short-term will likely be done at existing general recycling facilities. As the supply of discarded PV modules and demand for their disposal grows, the Department expects that the capacity of the recycling infrastructure will grow with it. As more dedicated recyclers that specialize in PV module recycling emerge, process improvements are expected, and modules should be recycled more efficiently with reduced recycling costs.

Typically, the recycling process for crystalline silicon PV modules begins with the removal of the cables, junction box, and frame from the PV module. Then the PV module is shredded, sorted, and separated. The materials, which are now separated, can be sent to specific recycling processes such as glass recyclers or aluminum recyclers<sup>19</sup>. The technologies involved in this process are still in need of further research and improvement, as current yields in valuable material have room for growth in order to make recycling enterprises for PV modules more profitable<sup>20</sup>.

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<sup>18</sup> "End-Of-Life Management: Solar Photovoltaic Panels" [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA\\_IEAPVPS\\_End-of-Life\\_Solar\\_PV\\_Panels\\_2016.pdf](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf)

<sup>19</sup> "A Review of Recycling Processes for Photovoltaic Modules" <https://www.intechopen.com/chapters/59381>

<sup>20</sup> "End-Of-Life Management: Solar Photovoltaic Panels" [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA\\_IEAPVPS\\_End-of-Life\\_Solar\\_PV\\_Panels\\_2016.pdf](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf)

For thin-filmed PV modules, a combination of mechanical and chemical treatments is used. A common process would include shredding and crushing a PV module panel. The semiconductor fills are removed in a slow leaching drum. The glass is exposed to a chemical treatment and then separated again. The glass is separated from the chunks of ethylene-vinyl-acetate using a vibrating screen and then cleaned to be sent for recycling. Metals are precipitated using sodium hydroxide and then sent to other recyclers for processing<sup>21</sup>. Recycling processes for thin-filmed PV modules are even less developed than more common crystalline silicon models due to not being as commonly used and are in need of more research and development.

The Solar Energy Industries Association has developed a national network of recyclers for PV modules, which specialize in recycling glass, polymerics, aluminum, scrap metal, and electronics. This working group contains 75 members, one of which, Cleanlites Recycling has a presence in Spartanburg, South Carolina<sup>22</sup>. Many SEIA members operate take-back and recycling programs for their products.

Adding PV modules to the types of wastes that can be managed as universal waste could streamline the hazardous waste standards, such as recordkeeping, labeling, and manifest requirements, for PV modules and promote recycling. Managing PV modules as a universal waste would likely reduce transportation costs. Handlers of universal wastes can accumulate PV modules for up to one year, while the general hazardous waste requirements would only allow so for 90 days. This allows handlers to transport PV modules in bulk rather than on a frequent basis<sup>23</sup>.

#### *Proper treatment and disposal of PV modules*

If a EOL PV module cannot be reused or recycled, then it is a waste and must be disposed of according to federal and state rules. A hazardous waste determination will need to be made. If it is not deemed hazardous, it can be sent to a class three landfill in South Carolina. PV modules that test positive for characteristics of hazardous waste must be disposed according to the hazardous waste regulations of the state.

Although the Department does not believe the quantity of PV modules will present a problem to the state's solid waste facilities, state and local officials and the waste management industry should take into consideration how landfills can handle increasing amounts of large, bulky panels. Some have raised concern about the difficulties of compacting PV modules. This presents an operational challenge that policymakers and landfill officials will consider in the future as more PV modules near the end of their lifespan.

#### *Preferred methods to manage EOL storage system batteries*

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<sup>21</sup> "A Review of Recycling Processes for Photovoltaic Modules" <https://www.intechopen.com/chapters/59381>

<sup>22</sup> "Cleanlites Recycling" <https://cleanlites.com/>

<sup>23</sup> "Laws and Regulations - Hazardous Waste" <https://scdhec.gov/environment/land-management/hazardous-waste/laws-regulations-hazardous-waste>

The main types of storage system batteries used are lithium-ion batteries, lead-acid batteries, and nickel-based batteries. Lead-acid batteries cannot be disposed in the garbage in South Carolina, which leads to recycling being the best option for dealing with lead-acid batteries. Lead-acid batteries due to state regulations and an established recycling market have a recycling rate up to 99%<sup>24</sup>. Lead-acid and nickel-based batteries can utilize universal waste regulations due to the properties of lead and nickel in their composition that can be recycled.

Reusing and refurbishing lithium-ion batteries are not economically viable at present in the United States, which leaves recycling as the most preferred option for lithium-ion battery storage systems. Lithium-ion batteries are by far the most common battery types for storage systems, but recycling markets for them are not as established and the components are not as easy to separate and recycle. The varied chemistry of these devices makes it difficult to create a standard process.

The Department has found 2 facilities for recycling lithium-ion batteries in the United States (with three more facilities being planned in the United States in Nevada, Alabama, and Arizona), with the closest facility to South Carolina being INMETCO in Ellwood City, Pennsylvania<sup>25</sup>. Lithium-ion storage systems are a relatively new phenomenon, and the recycling technologies will require more research to improve the process to make it more widespread and accessible. Batteries are among the categories of waste that the EPA has deemed can be collected and recycled as a universal waste.

In lieu of recycling, it is possible for EOL lithium-ion storage system batteries to be disposed of in South Carolina, either to a solid waste landfill or an appropriate hazardous waste landfill if it tests positive for a characteristic of hazardous waste. There are concerns of the ignitability of lithium-ion batteries when depositing them in landfills or in transporting them with other types of solid waste. This has led to some states, including New York and California to ban them from being disposed as solid waste.

### *Conclusion*

The Department believes the waste hierarchy provides a good framework to manage all EOL PV modules and storage system batteries, as well as all waste products generally. Products should be engineered to be as materially efficient as possible while remaining a minimal impact to the environment. Consumers should keep this factor in mind when deciding what products to purchase. EOL PV modules and storage system batteries should be reused and refurbished as possible, and if that is not practical, as much material as possible should be recycled. After these three options have been exhausted, EOL PV modules and storage system batteries should

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<sup>24</sup> "Advancing Sustainable Materials Management: 2015 Fact Sheet"  
[https://www.epa.gov/sites/default/files/2018-07/documents/2015\\_smm\\_msw\\_factsheet\\_07242018\\_fnl\\_508\\_002.pdf](https://www.epa.gov/sites/default/files/2018-07/documents/2015_smm_msw_factsheet_07242018_fnl_508_002.pdf)

<sup>25</sup> "Lithium-Ion Battery Recycling-Overview of Techniques and Trends"  
<https://pubs.acs.org/doi/10.1021/acseenergylett.1c02602>

be properly disposed in accordance with state and federal requirements. If a PV module or storage system battery is found to be hazardous waste, it must be treated accordingly to hazardous waste guidelines.

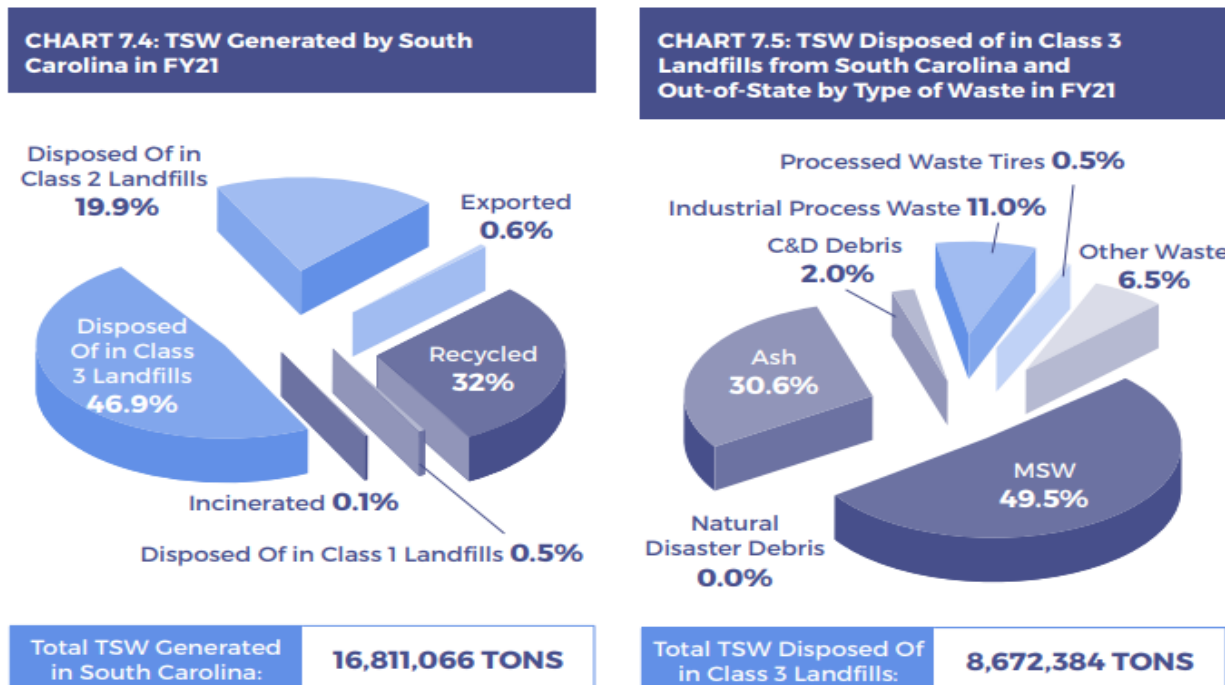
### Impact of PV module equipment on South Carolina Landfills

Part (3) of Proviso 34.62 stipulates that the Department should consider the volume of solar panels and energy storage system batteries currently and projected to be in use in South Carolina and its potential impact to the state’s landfill capacity if disposals of such equipment were permitted:

*(3) The volume of photovoltaic modules and energy storage system batteries currently in use in the State, and projections, based upon the data on life cycle identified currently on impacts that may be expected to the State's landfill capacity if landfill disposal is permitted for such equipment at end-of-life.*

To answer this, the Department researched methods with which to estimate the number and weight of PV modules and approximated the impact that future disposals of EOL PV modules will have on the state’s landfills.

#### Landfill Capacity of South Carolina



Information taken from the FY 2021 Solid Waste Management Annual Report<sup>26</sup>

<sup>26</sup> “South Carolina Solid Waste Management Annual Report”  
[https://scdhec.gov/sites/default/files/media/document/SC\\_SolidWasteManagementAnnualReport\\_FY21\\_OR-2302\\_1.pdf](https://scdhec.gov/sites/default/files/media/document/SC_SolidWasteManagementAnnualReport_FY21_OR-2302_1.pdf)

While the recycling capacity of the United States and South Carolina continues to develop, most EOL PV modules in the near future will be disposed of at a landfill. Class 1 landfills only accept land-clearing debris. Class 2 landfills accept construction and demolition debris, land-clearing debris, and industrial process waste. EOL PV modules when disposed will likely end up in a Class 3 landfill. There are currently 28 publicly and privately owned Class 3 landfills in the state. 11 of these facilities are non-commercial, which means that they only manage the solid waste generated during normal operations on property under the same ownership or control as the facility itself. The average tipping fee for a South Carolina Class 3 landfill in FY 2021 was \$38 dollars per ton.

In FY 2021, according to the Solid Waste Annual Report, 11,436,162 tons of solid waste were disposed of in South Carolina. Approximately 8,672,384 tons of solid waste were disposed of in one of the State's 28 Class 3 landfills. Nearly half of this material was municipal solid waste, or MSW. The combined permitted disposal rate of all of South Carolina's Class 3 landfills would be 22,648,539 tons of solid waste per year.

In the Appendix is Table 7.11 from the FY 2021 Solid Waste Annual Report which details how the permitted disposal rate, the amount disposed in FY2021, the estimated remaining airspace, the rate of compaction, and the estimated remaining capacity of each Class 3 landfill.

#### *Amount of EOL PV Modules in South Carolina*

To calculate the amount of potential PV module waste that will be taken to South Carolina landfills, the Department attempted to estimate using information provided by SEIA and the Energy Information Administration. SEIA on a quarterly basis, calculates the amount of solar power in megawatts that is installed in each state. As of Q4 2021, South Carolina has 1923.8 MW of solar installed. The Department attempted to gauge the accuracy of this number by crosschecking with EIA data. The EIA considers facilities connected to the local or regional electric power grid with a capacity rating of 1 MW or greater to be a utility-scale operation. Facilities meeting the minimum EIA criteria must report multiple datasets on an annual basis.

The two variables critical to providing an estimate of the number of PV modules in the state was the wattage for each panel and the weight for each panel. Based on research the Department had conducted on typical PV module measurements, it was decided for this simulation to conservatively assume a weight of 55 lbs. for each module. Based on the same market research, the Department decided to provide estimates for the most common range of panel wattages, which would be between 300-350 W for each panel.

Based on these assumptions, the Department calculated that there are an estimated 5,496,571-6,412,667 panels currently in the state and that this would approximately be around 151,156-176,348 tons of material that would need to be disposed of. If there was a 75% increase in the

PV capacity of South Carolina (which is similar to SEIA's growth projection of 1472.46 MW<sup>27</sup>) then these numbers by 2026 would increase to approximately 9,619,000-11,222,167 panels and 264,523-308,610 tons of material. Orangeburg County has nearly 20% of the estimated number of PV modules in the state with Calhoun, Allendale, Beaufort, Jasper, Aiken, and Chesterfield counties also possessing large quantities.

Even if, conservatively, all the estimated amount of material was disposed in the same year, this would amount to roughly a 4% increase in the amount of waste disposed per the last solid waste annual report. It would be a fraction of South Carolina's disposal rate from FY 2021 and an even smaller fraction of the permitted disposal rate. Based on these estimates, the Department does not presently see a danger to the state's landfill capacity from the expected disposal of PV modules.

Based on the estimated life span of 20 years for the life of each PV module, PV modules would not be disposed of in noticeable quantities until 2036. At that time the Department expects the recycling infrastructure for PV modules to have developed sufficiently that much of this expected volume of EOL PV modules will be recycled instead of disposed.

Although the Department does not believe that the future flows of PV modules will overwhelm the state's landfill capacity, state and local officials and the waste management industry should take into consideration how landfills can handle increasing amounts of large, bulky panels, especially as the state approaches 2036, where PV modules will likely start to come to South Carolina landfills in large quantities. If it is operationally difficult for landfills to handle PV modules, costs to manage EOL PV Module waste could increase to comply with landfill operator requirements.

### *Energy Storage System Batteries*

The Department does not presently have an easy method for determining how many energy storage systems exist in the state. According to the Energy Information Administration, MCRD Parris Island PV Hybrid, a 4 MW energy storage project which uses lithium-ion batteries, exists in Beaufort, SC. The U.S. Department of Energy Global Energy Storage Database does not report any other energy storage systems that use lithium-ion batteries in the state<sup>28</sup>.

It is expected that energy storage systems will start to increase in South Carolina due to favorable policies such as the South Carolina Energy Freedom Act, which in part directs the Public Service Commission to establish interconnection standards for renewable energy

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<sup>27</sup> "State Solar Spotlight" <https://www.seia.org/sites/default/files/2022-03/South%20Carolina%20Solar-Factsheet-2021-YearinReview.pdf>

<sup>28</sup> "DOE Global Energy Storage Database" <https://sandia.gov/ess-ssl/gesdb/public/projects.html>

facilities energy facilities that provide for timely and efficient processing of requests and provide a process for “amending existing requests to include energy storage.”<sup>29</sup>

The Department does not see any concern with the ability of the state’s landfills to absorb energy storage system batteries that are not hazardous. The main concern with batteries, especially lithium-ion batteries is that they contain many components that are hazardous (as described previously in this report), which prevent them from being disposed in Class 3 landfills. Those that test for a certain level of hazardous components must be disposed in a hazardous waste landfill, of which there are none in South Carolina. This increases the cost of handling hazardous waste batteries and adds increased incentive to develop the capability to recycle these devices.

### **Financial Assurance and Decommissioning Requirements**

Proviso 34.62 (4) asks that the Department consider:

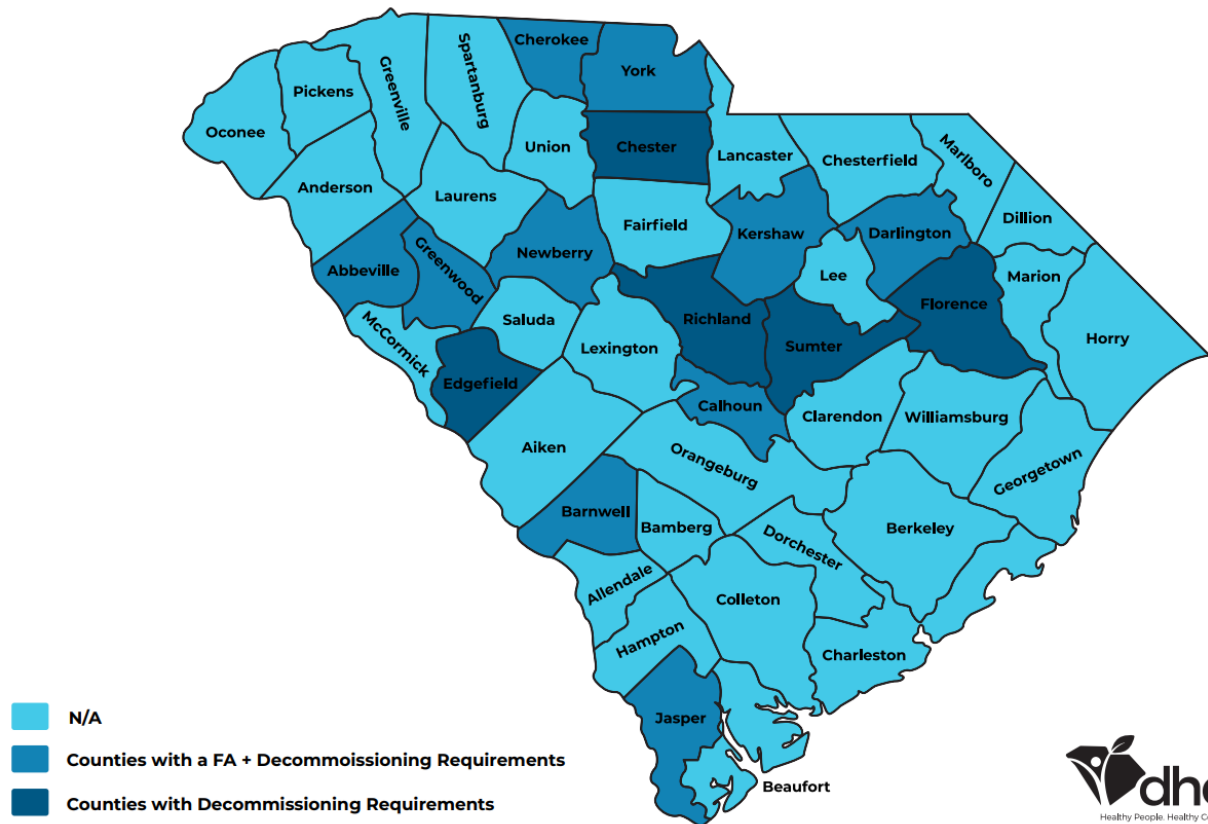
*Whether or not adequate financial assurance requirements are necessary to ensure proper decommissioning of solar projects in excess of thirteen acres upon cessation of operations.*

To make this determination, the Department looked at the rules, ordinances, regulations and other requirements developed by South Carolina’s local and state governments for the end-of-life management of PV modules and storage system batteries.

Fifteen counties in South Carolina have varying decommissioning requirements upon cessation of operations. The types of solar projects subject to these conditions vary. For example, Calhoun County’s requirements are for solar projects bigger than one acre. Barnwell County regulates those facilities with more than 1 MW of capacity. Abbeville County considers a solar farm a series of at least three ground-mounted solar collectors placed on a parcel for the purpose of generating power for resale purposes. Typically, these regulations require some sort of decommissioning plan along with applications to local governments. If after a period (6-12 months is used most commonly) of no electricity being generated, the facility will have to complete decommissioning in a certain period of time. Decommissioning usually entails removal of solar panels, buildings, cabling, electrical components, and any other associated facilities below grade as described in the decommissioning plan.

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<sup>29</sup> “Energy Storage for a Modern Electric Grid, Technology Trends and State Policy Options”  
[https://www.ncsl.org/Portals/1/Documents/energy/Energy\\_Storage\\_Modern\\_Electric\\_Grid\\_v02\\_36271.pdf](https://www.ncsl.org/Portals/1/Documents/energy/Energy_Storage_Modern_Electric_Grid_v02_36271.pdf)



\* Richland County’s Decommissioning Requirements are expected to go into effect with the rest of their rewritten Land Development Code on July 6, 2022.

Financial assurance requirements are utilized by ten counties in South Carolina. These requirements commonly require an applicant to provide the County with a surety or performance bond, certified check, or irrevocable letter of credit before they are given a building permit. The estimates are typically determined by an engineer licensed to practice in the State. The amount required can vary, but one of the most common amounts used in South Carolina would be \$50,000 or 125% of the estimated decommission cost, minus the salvageable value, whichever is greater.

Internal and external parties engaged in many discussions throughout the stakeholder process on the topic of decommissioning requirements and financial assurance. The purpose of these requirements would be to ensure that such sites would be cleaned up and the land remediated if necessary if the project were to become inactive. Some localities use nonfinancial mechanisms to enforce decommissioning, such as imposing civil penalties and fines or by imposing a lien on the property to pay for costs of removal.

Representatives from solar companies and clean-energy advocates were not averse to decommissioning or financial assurance requirements but made the stakeholder group aware that because of the large investments put into these projects, they had a financial incentive to maintain the site. Some of these groups suggested that financial assurance requirements be



“phased-in” due to the relatively long lifespan of PV modules. This could mean not demanding 100% of the demanded financial assurance at the start of the project, but perhaps after 10 years of service. Advocates for PV modules also insisted on being able to subtract the salvage value of material from their estimated decommissioning costs, which is a common characteristic of financial assurance requirements for solar facilities in some of South Carolina’s counties.

The objective of financial assurance requirements is to ensure that there are enough financial resources available to clean-up a site if the site’s owners abandon the site at any point. There is little purpose to have a financial assurance mechanism if it cannot adequately fund the disposal of all materials at a site at any time. The contention of some in the solar industry is that such requirements are unnecessary because of the large investment owners put into these projects; while the Department would agree that most solar projects will be managed responsibly, a lone bad actor by themselves can cause immense harm to human and environmental health and cost the state taxpayers millions of dollars in clean-up, such as the 2019 fire at Able Contracting in Jasper County.

A model decommissioning plan should specify when decommissioning should be initiated, and provide a description of the landowner agreement, if there is one (such as a lease). The person or organization responsible for decommissioning should be identified. The steps that “decommissioning” will encompass should be described, such as removal of all PV modules and accompanying equipment and how the site will be restored. Some agreements might prefer to leave some structures of the solar facility in place, such as fencing. It is also imperative to provide a financial estimate for the cost of decommissioning the site.

#### *Financial assurance in ongoing regulatory efforts*

Requiring financial assurance raised some important questions that policymakers must take into consideration when determining what requirements solar facilities should meet in order to operate in this state. The Department has attempted to address each matter in draft language:

1. In what instances and for what solar projects should financial assurance be required?

Per the parameters in Act No. 119, the Department is proposing to only require financial assurance requirements on solar projects in excess of thirteen acres.

2. How should cost estimates be calculated?

In draft language the Department is proposing, an applicant who wishes to operate a large solar project would need to provide a final decommissioning cost estimate (prepared by a third party) which depicts the cost to properly dispose of all components of a solar project and perform any post-closure care that is required. This should account for tipping fees, the costs of material loading, hauling costs, labor, to complete closure and restore the site to acceptable conditions.

3. Should financial assurance be required up-front? Or should there be a phase-in?

In draft language the Department is proposing, financial assurance would be required up-front that is sufficient to meet the final decommissioning cost estimate.

4. What mechanisms would be allowed?

In draft language the Department is proposing, the financial assurance mechanism shall consist of one or more of the following mechanisms: surety bond, irrevocable letter of credit, insurance, trust fund, or other evidence of financial responsibility assurance approved by the Department.

5. What is the approval process for submitting financial assurance?

In draft language the Department is proposing, the applicant must fund a financial assurance mechanism prior to the Department approving a permit.

6. Who will access the financial assurance if it is needed?

If a permitted large solar site is abandoned, the Department will take possession of the financial assurance mechanism to ensure that the decommissioning plan and post-closure care is implemented.

*Decommissioning requirements outside South Carolina*

Some states have varying levels of decommissioning requirements for various types of solar facilities. New Hampshire requires “renewable energy facilities”, which include facilities that use solar technologies of a capacity of greater than 30 MW to acquire a certificate. To apply for the certificate, an applicant must describe in reasonable detail the elements of and financial assurances for a facility decommissioning plan. Vermont requires all applications for net-metering systems with capacities greater than 150 KW to include a decommissioning plan that provides for the removal and safe disposal of project components and site restoration.

Hawaii requires solar energy facilities on certain agricultural lands be decommissioned at the owner’s expense within 12 months of the conclusion of operations as well as provide a proof of financial assurance. Louisiana requires that property leases for the exploration, development, and production of solar energy exhibit minimum requirements, including maintenance of the property, decommissioning, and final site closure upon termination of the lease. Virginia requires that localities require an owner, lessee, or developer of real property to enter into a written agreement to decommission solar energy equipment, facilities, or devices. The following table shows states where the Department found decommissioning requirements under at least some circumstances:

States with Decommissioning Requirements for PV Modules			
California	Texas	West Virginia	Hawaii
Montana	Minnesota	Virginia	Vermont
Wyoming	Wisconsin	Tennessee	New Hampshire
North Dakota	Illinois	Louisiana	Maine
South Dakota	Ohio	New Jersey	

As shown, many states do not have specific statewide decommissioning requirements for solar facilities. Like South Carolina, these states typically leave these matters for their local governments to determine policy. Most of South Carolina’s neighbors in EPA Region 4 have similar requirements with the exception of Tennessee which implemented requirements for landowner agreements with solar facilities exceeding 10 MW, which includes decommissioning and financial assurance requirements. North Carolina’s stakeholder discussions on this issue from 2020-2021 produced a recommendation to not create a statewide decommissioning requirement for PV modules at the current phase, preferring to leave the responsibility to the county governments while the state continued to study the issue. North Carolina does provide a model ordinance for their local governments.

Except for lands managed by the Bureau of Land Management, there are currently no federal requirements for the decommissioning and/or financial assurance for EOL PV modules, but the Solar Energy Technologies Office from the U.S. Department of Energy prepared an End-of-Life Action Plan with the goal of establishing safe, responsible, and economic EOL practices to allow for the greater deployment of solar energy while reducing the environmental impacts of utilizing PV modules. In November 2021, a stakeholder group also delivered a petition to add PV modules to the universal waste program under RCRA.

*Stakeholder Input*

Some stakeholders in the solar industry have expressed some concerns that draft language might impose costly financial burdens on the public and industry. The Department is currently in a stakeholder discussion with these and other interested parties to develop language that can provides protection for human and environmental health while also not providing a disincentive to investing in South Carolina’s solar industry.

*Conclusion*

The Department believes that decommissioning requirements and a level of financial assurance are necessary to protect human and environmental health from the possibility of large numbers of EOL PV modules being undisposed. To this end, the Department is currently engaging in regulation development procedures to put together rules and regulations for decommissioning requirements for large solar facilities that cease operations.

## Infrastructure Needed to Manage EOL Photovoltaic Modules and Equipment

Proviso 34.62(5) asks that the Department consider:

*Infrastructure that may be needed to develop a practical, effective, and cost-effective means to collect and transport end-of-life photovoltaic modules, energy storage system batteries, and other equipment used in utility-scale solar projects for reuse, refurbishment, recycling, or disposal.*

When planning for decommissioning and end-of-life management of PV modules and storage system batteries, solar operations installed in South Carolina should anticipate and prepare for expected logistical and financial hurdles when disposing of Solar equipment. Operators should keep locations of recycling and disposal services in mind when siting for potential areas for engaging in solar activities.

### *PV Modules*

The Department believes specialized infrastructure is not needed in South Carolina for managing EOL PV modules and accompanying equipment. As with solid waste generally, it is the responsibility of the waste generator to make the appropriate steps for collecting, packaging, and storing PV modules and ultimately transporting them to be reused, recycled or to a hazardous or solid waste management facility. This generally involves coordinating for direct transport from the solar site to the EOL management site, which negates the need for unique collection points for PV modules.

Large-scale solar operations are typically ground-mounted. Panels may be placed on racks of aluminum or steel with a concrete base. The electrical system is based on string or central inverters with a connection to the grid. For many operations, energy storage system batteries, typically lithium-ion batteries, may be present<sup>30</sup>. Decommissioning will at some point likely involve removing large numbers of PV modules as the facility's devices reach their end-of-life.

Dismantling, packing, storage, and the transportation of EOL PV modules are handled by the facility which owned the PV modules; however, the responsibility for decommissioning might vary depending on lease agreements between landowners and solar leasing companies. These services can also be contracted out. From the site, the EOL PV modules will be transported to be reused, recycled, or disposed of in accordance with local regulations. If a hazardous waste determination must be made, it is the responsibility of the waste generator to make the appropriate preparations.

The Electric Power Research Institute conducted a 2018 cost estimate of a hypothetical solar farm. This estimate included a \$13 per cubic yard hauling cost based around a 40 cubic yard capacity truck making a 65-mile one-way trip. The assumptions included that a cubic yard could

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<sup>30</sup> "End-Of-Life Management: Solar Photovoltaic Panels" [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA\\_IEAPVPS\\_End-of-Life\\_Solar\\_PV\\_Panels\\_2016.pdf](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf)

contain 13 modules with dimensions of roughly 65" X 39" X 1.4". The module is assumed to have a 285W capacity. This model also accounts for a 30% container void due to packing irregular shaped objects<sup>31</sup>. Under those expectations, a 40 cubic yard truck would be able to fit 364 PV modules. A 2 MW Facility under the same estimates would contain approximately 7,018 PV modules and would require 20 trucks to transport all PV modules from the area.

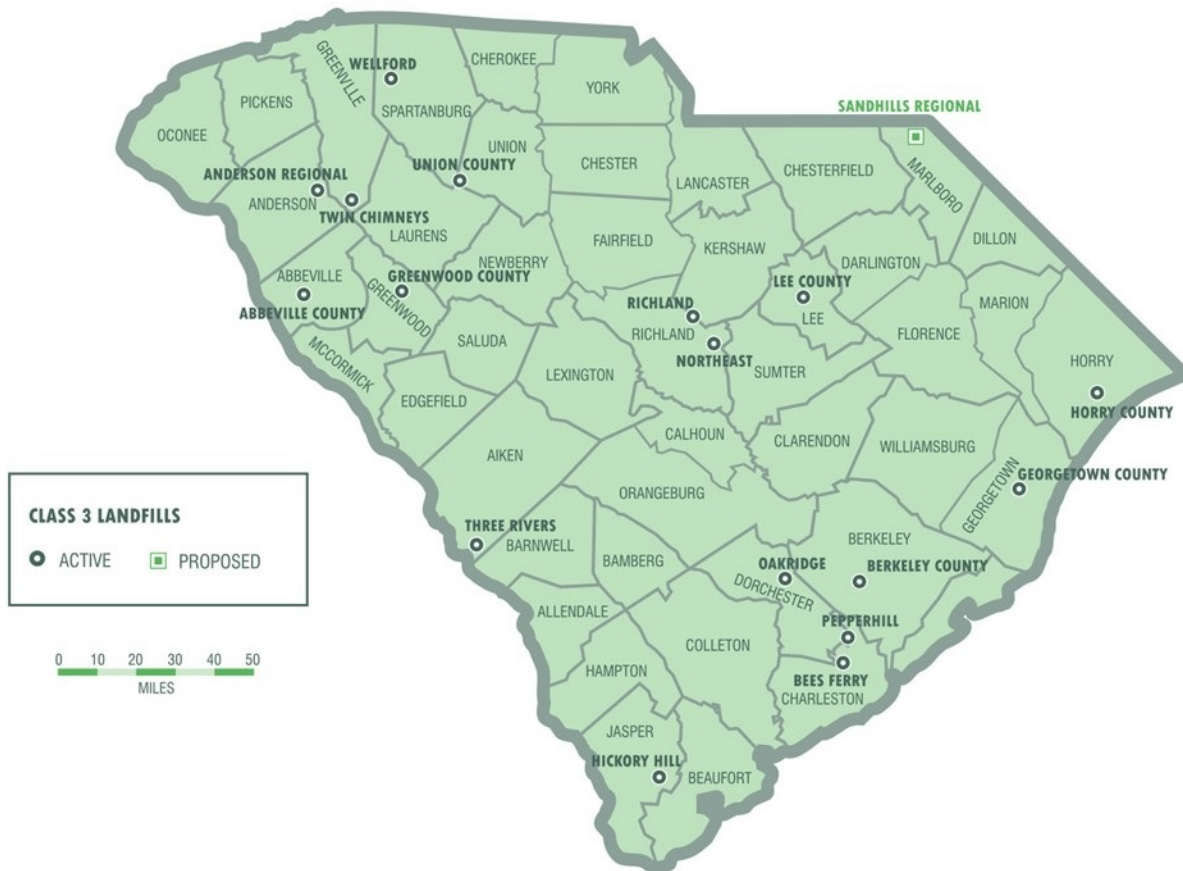
Keeping with the Department's preferred waste management strategies, progress needs to be made on expanding access to recycling technologies for PV modules in South Carolina. As the amount of decommissioned PV modules grows, the demand for such processes should encourage the growth of the recycling infrastructure for PV modules which should reduce the cost to transport and recycle PV modules. Currently the cost to recycle PV modules is estimated to be around \$15-\$45 per module due to this limited capacity<sup>32</sup>.

A solar facility can also send EOL PV modules to a landfill for disposal. Due to the prevalence of landfills and other appropriate solid waste management facilities in South Carolina, there will likely be shorter distances to travel than sending a PV module to be reused or recycled. Landfill operators however are not required to accept PV modules. Solar facilities must take into consideration before beginning operations which solid waste management facilities are willing and able to accept EOL PV modules. Class 3 Landfills are the most common facilities that are appropriate for such materials, which exist in South Carolina at the following locations:

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<sup>31</sup> "PV Plant Decommissioning Salvage Value" <https://www.epri.com/research/products/000000003002013116>

<sup>32</sup> "Solar Photovoltaic Module Recycling: A Survey of U.S. Policies and Initiatives," NREL, 2021.



PV modules that fail a hazardous waste determination can only be disposed to a permitted treatment or disposal facility for hazardous waste. There are 14 sites in South Carolina that exist for treating, storing, and disposing of hazardous waste and 7 sites that are listed as hazardous waste recyclers<sup>33</sup>. None of these sites are obligated to take specific streams of waste. Solar facilities must take into consideration before beginning operations which local hazardous waste facilities are willing and able to accept hazardous EOL PV modules.

### *Storage system batteries*

The Department believes specialized infrastructure is not needed in South Carolina for managing storage system batteries. Generators of such waste will coordinate for the collection, packaging, storage of, and ultimately transportation of EOL storage system batteries to their next destination for reuse, recycling, or disposal. Similarly, to PV modules, the main challenge for generators of storage system battery waste is a relatively undeveloped recycling industry which can lead to logistically difficult and costly efforts to transport to recycling facilities. The Department expects the capacity of the recycling infrastructure will grow as the supply of

<sup>33</sup> <https://rcrapublic.epa.gov/rcrainfoweb/action/modules/hd/handlerindex>

discarded storage system batteries and demand for their recycling grows. This will lead to more efficient recycling operations with reduced recycling costs.

### **Feasibility of a Stewardship Program for EOL PV Modules and Batteries**

Proviso 34.62(6) asks that the Department consider:

*Whether or not manufacturer or installer stewardship programs for the recycling of end-of-life photovoltaic modules and energy storage system batteries should be established for applications other than utility-scale solar project installations, and if so, fees that should be established for these manufacturers and installers to support the implementation of such requirements.*

To answer this, the Department consulted state, federal and international initiatives, that relate to establishing a stewardship program for PV modules and storage system batteries. Currently there are only a few such initiatives as described in Proviso 34.62(6) in other state and local governments. South Carolina however does run a similar program to facilitate the recycling of consumer electronic devices. The program combines a ban on disposing electronics into a landfill with recycling obligations for television and computer monitor manufacturers, based on the weight of material they had sold the previous year.

In practice, there is strong disappointment with how the e-waste program operates in South Carolina. County and local governments feel the cost of the program felt disproportionately on them. Many did not feel the benefits that come from the manufacturer recycling obligations. Television and computer monitor manufacturers have had trouble meeting their current pounds obligations due to fluctuations in sales during the COVID-19 pandemic.

#### *PV Modules*

Organizations such as the Product Stewardship Institute support the creation of extended producer responsibility laws that oblige solar panel manufacturers to provide for the collection and refurbishment of EOL PV modules. The first local government to adopt PSI's approach was Niagara County in New York in 2021<sup>34</sup>.

Under the Niagara County law, PV module manufacturers must provide collection services at no additional costs to all residents at convenient locations throughout the county. They must also meet performance goals for the recovery and responsible management of panels: recovering 100% of panels and reaching a combined reuse and recycling rate of sixty-five percent (65%) by

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<sup>34</sup> "Niagara County Passes Nation's 2nd Solar Panel Producer Responsibility Law"

<https://www.productstewardship.us/news/571089/Niagara-County-Passes-Nations-2nd-Solar-Panel-Producer-Responsibility-Law.htm#:~:text=Niagara%20County%2C%20N.Y.&text=Passed%20on%20June%2015%2C%20the,to%20meet%20environmentally%20protective%20standards.>

August 1, 2026. The recycling rate target rises to eighty-five percent (85%) on August 1, 2031. This law will go into effect on August 1, 2022.

The state of Washington passed Senate Bill 5939 in 2017, a portion of which required manufacturers of PV modules to provide the public a convenient and environmentally sound way to recycle all PV modules purchased after July 1, 2017. Manufacturers must prepare and submit a stewardship plan to the state by July 1, 2024 and starting in 2026 they will be required to provide to the state a report that documents implementation of their plan. By 2025, no manufacturer, distributor, retailer, or installer may sell or offer for sale a PV module in or into the state unless the manufacturer of the PV module has submitted a stewardship plan and received approval<sup>35</sup>.

The Washington Department of Ecology expects the full program to be implemented by July 1, 2025 and has already however completed guidance for PV module manufacturers on how to create a stewardship plan for a collection and recycling program. The stewardship program covers all PV modules used for residential, commercial, or agricultural purposes that are installed on, connected to, or integral with buildings and that were sold in or into the state after July 1, 2017.

The plan must establish performance goals, including the combined reuse and recycling of at least eighty-five percent (85%) of the total weight of what is collected every year. The plan must describe how stakeholders will receive information on how they can properly recycle PV modules (including but not limited to a website, video ads and publication materials). The plan must also provide for a collection system that does not charge a recycling fee and provide for some method to finance the program. Washington is authorized to assess a penalty up to \$10,000 dollars after sending a written warning to a manufacturer, installer, distributor, or retailer who is selling or installing a PV module from a manufacturer not participating in a stewardship program<sup>36</sup>.

The policy of producer responsibility has been in place in Europe under the Waste Electrical and Electronic Equipment Directive since 2013. PV modules are categorized as “large equipment” under the WEEE product categories. “Producer” is not defined as just the manufacturer and includes the company who brings the product to the market. The main attributes of WEEE include:

1. Financial responsibility. Producers of PV modules and other categories of e-waste must, via an individual scheme or collective compliance scheme, cover the cost of collection and recycling of products likely to be used by private households.

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<sup>35</sup> “Washington State Legislature,” <https://app.leg.wa.gov/rcw/default.aspx?cite=70A.510.010>

<sup>36</sup> “Manufacturer Plan Guidance for the Photovoltaic Module Stewardship Program” <https://apps.ecology.wa.gov/publications/documents/1907014.pdf>



2. Reporting responsibility. Producers must report on a monthly or annual basis on PV modules sold, taken back and forwarded for recycling.

3. Information responsibility. Producers are accountable for properly labeling PV modules as according to WEEE. Consumers must be informed of the correct methods of disposing of PV modules, and that takeback and recycling services are provided<sup>37</sup>.

All 27 EU states have taken initiatives for establishing requirements for PV module collection and handling in accordance with WEEE. In Germany for instance (the main user of photovoltaic energy), the government utilizes business-to-consumer transactions to ensure that producers can cover the costs of EOL management by implementing a collective producer compliance system to finance the cost of immediate collection and recycling of PV modules (“level 1”) and also to finance the management of future EOL PV modules (“level 2”). The costs of level 1 recycling are distributed by market share to PV module producers. The calculation for level 2 costs is made considering the average lifetime of PV modules, the return collection, and the handling and logistic costs<sup>38</sup>. It is difficult to assess the success of European methods because as in the United States, PV modules still have not reached EOL in significant quantities as of yet.

The proposal of setting collection targets for manufacturers presents some difficulties. Because PV modules are not being disposed of in large quantities in South Carolina yet, the demand for recycling them is still minimal, and with relatively inexpensive rates to dispose waste in South Carolina landfills, meeting collection targets would be difficult for a stewardship program to meet. To guarantee a viable supply of PV modules for manufacturers to meet targets, the state would likely have to prohibit disposal of PV modules in landfills, which increases burdens on local governments and financial burdens for the solar industry and consumers.

The Department does not recommend establishing a manufacturer or installer stewardship program at this time. With no other state or local government with a mature program to benchmark, it would be difficult for the Department to assess the feasibility of such a policy. As mentioned previously in this report, there is not an expansive recycling market for PV modules. With limited recycling opportunities at their disposal, implementing recycling requirements for PV modules would place a large financial burden on PV module manufacturers, consumers and other participants in the solar industry. This would create a disincentive for investment in the solar industry in South Carolina.

The Department believes that South Carolina would benefit from observing the implementation of stewardship initiatives in Europe, Niagara County and Washington and take note of the benefits and shortcomings of their programs. As the demand for recycling of PV modules grows,

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<sup>37</sup> “End-Of-Life Management: Solar Photovoltaic Panels” [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA\\_IEAPVPS\\_End-of-Life\\_Solar\\_PV\\_Panels\\_2016.pdf](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf)

<sup>38</sup> “Global review of policies & guidelines for recycling of solar PV modules” <http://www.ijsgce.com/uploadfile/2019/0806/20190806115026619.pdf>

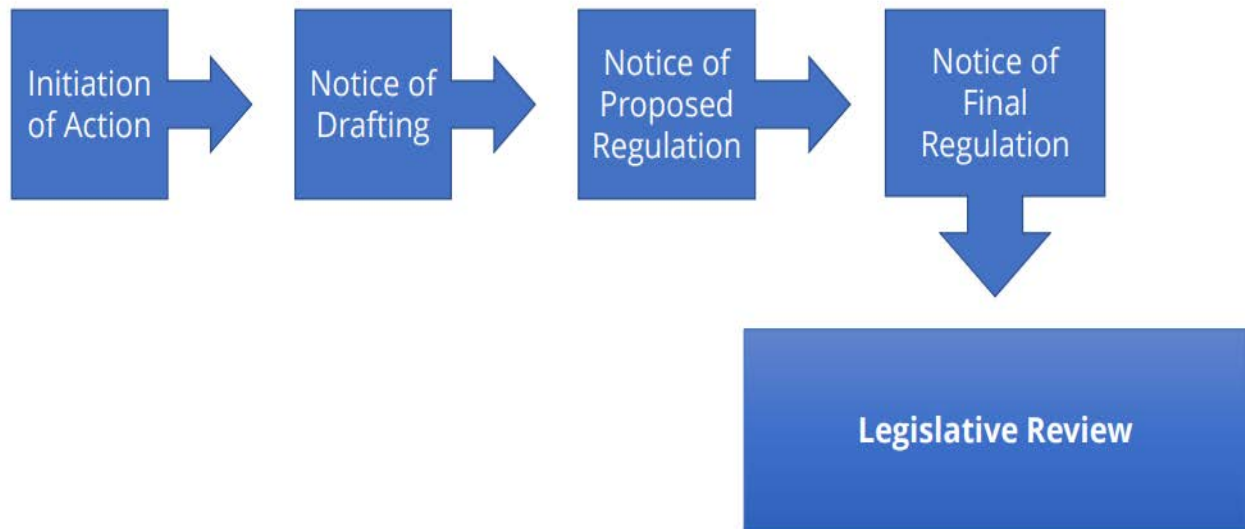
the recycling industry will expand, and the product stewardship approach might be more feasible in the future.

### *Storage System Batteries*

The Department does not recommend establishing a manufacturer or installer stewardship program at this time for EOL storage system batteries. As discussed previously in this report, lithium-ion batteries are by far the most commonly used type of battery for storing energy for PV modules. Recycling for these products is limited, and the components are not as easy to separate and recycle. The varied chemistry of these devices makes it difficult to create a standard process. Disposing these batteries also has problems however, as the ignitability of these batteries when transporting or disposing them creates additional issues.

Lithium-ion storage systems are a relatively new phenomenon, and the recycling technologies will require more research to improve the process to make it more widespread and accessible. Batteries are among the categories of waste that the EPA has deemed can be collected and recycled as a universal waste. The Department should review policy options once a recycling market becomes more established and look at policies other governments are looking at for the best methods of managing EOL storage system batteries.

## V. Regulation Development



Pursuant to 2022 Act No. 119, Section 5, the Department is directed to submit regulations for the management of end-of-life photovoltaic modules and energy storage system batteries on solar projects in excess of thirteen acres.

The regulation development process, as laid out in the Administrative Procedures Act, begins by requiring the Department to publish a Notice of Drafting in the State Register which notifies and provides the public with an opportunity to provide comment before regulatory text is drafted. A Notice of Proposed Regulation (NPR) provides new or amended text for promulgation, typically with input from internal and external stakeholders, as well as a public comment period, is then prepared and published in the State Register. Afterwards a Notice of Final Regulation (NFR) is prepared for the General Assembly, which upon their approval is published in the State Register. The S.C. Board of Health and Environmental Control must also approve an NPR and NFR before submittal.

The Department had a Notice of Drafting published in the February 25, 2022, State Register. A copy of the Notice of Drafting is in the appendix of this report. This notice supersedes the Notice of Drafting that was published in the South Carolina State Register Volume 45, Issue 7 on July 23, 2021. The Department received comments from zero parties by the March 28, 2022, close of the public comment period.

Internal Department staff and external stakeholders are putting together draft language for a new regulation, *R. 61-107.20, Solar Energy Systems*, to establish requirements for operating solar energy facilities in the state. The regulation is expected to incorporate financial assurance, decommissioning, and permitting requirements at the state level for some large solar projects. Once completed, this language will be sent in the form of a Notice of Proposed Regulation to the S.C. Board of Health and Environmental Control for approval.

The Department is planning on holding meetings with appropriate stakeholders and interested parties throughout 2022 to develop regulations for the management of EOL PV modules.

There is no funding mechanism provided in the language of Act 119. There are also no fees charged by the Department in the current draft of the regulation. The Department estimates there are at least seventy-eight (78) facilities currently in the state that would be brought under this new solar program. These sites would require permits, decommissioning requirements, financial assurance, and oversight to ensure compliance to the regulation. The oversight required by this proposed regulation would require additional resources beyond those currently appropriated to the Department.

## **VI. Appendix**

The appendix to this final report contains, in this order, the following:

### **1. List of Stakeholders**

A list of organizations that participated in the solar panel stakeholder group. These organizations will continue to participate in the Department's ongoing regulation development efforts.

### **2. Summary of stakeholder meetings**

A summary of stakeholder meetings held by the Department.

### **3. Chart of Ordinances**

A chart of country ordinances related to decommissioning of solar facilities. This chart includes information on the type of projects regulated, whether there are decommissioning or financial assurance requirements, and the timeframe provided to accomplish decommissioning.

### **4. Landfill Information**

This Table from the Solid Waste Annual Report provides detailed information on South Carolina's landfills, including the amount disposed during FY 2021 and the estimated remaining capacity of the facility.

### **5. Notices of Drafting**

A Notice of Drafting is used to initiate a drafting period for a proposed new regulation/amendment/repeal and provides the opportunity for initial public comment prior to drafting regulatory text. Copies of the July 23, 2021, and February 25, 2022, Notices of Drafting are attached here.

### **6. Stakeholder Comments**

The first draft of this final report was sent to the stakeholders in May. The stakeholders were invited to send the department their comments on the report. The Department have attached these comments and responded to them.

## **Organizations who Participated in the 2021-2022 Solar Stakeholder Group**

Parker Poe

SC Office of Regulatory Staff

Conservation Voters of SC

SC Association of Counties

SC Municipal Association

Dominion

Duke Energy

Santee Cooper

Electric Cooperatives of SC

Southern Alliance for Clean Energy

Sunstore

Southern Current

Gregory Electric

Richland County

Newberry County

United States Department of Agriculture

SC Department of Consumer Affairs

SC Coastal Conservation League

NP/Waste Management

Solar Energy Industries Association

SC Dept. of Commerce

SC Recyclers Association

SC Department of Health and Environmental Control

Dynamic Lifecycle Innovations

SC SWANA/ HDR Inc.

Capcon

SC Dept. of Agriculture

Carolinas Clean Energy Business Alliance

Pinegate Renewables

Cleanlites Recycling

Cypress Creek Renewables

Central Electric Power Cooperative, Inc.

Avangrid Renewables

Birds Eye Energy

## Summary of Stakeholder Meetings

The following provides a summary of each stakeholder meeting held by the Department from the enactment of Budget Proviso 34.62 on July 1, 2021 to the submission of this report on June 30, 2022.

1. The first Solar Panel Stakeholder Workgroup Meeting was held on August 4, 2021. Representatives from the Department, solar panel manufacturers, developers, and recyclers, energy producers, environmental organizations, other government participants and other interested parties were in attendance. This discussion provided a background of solar energy in South Carolina, the matters the stakeholder group is entrusted with considering, and a brief introduction of the various stakeholders invited to participate in the process.
2. The second Solar Panel Stakeholder Workgroup Meeting was held on September 14, 2021. Discussion was primarily focused on decommissioning requirements for large-scale solar projects and whether financial assurance requirements are necessary to ensure proper cessation of operations. Representatives from solar leasing companies, local governments, energy providers and other organizations offered their own experiences with the matter.
3. The third Solar Panel Stakeholder Workgroup Meeting was held on October 20, 2021. The group in this meeting reviewed ordinances related to photovoltaic modules from municipal, county, and other state governments to understand the important program aspects that each policy is designed to address, among them the types of projects affected, whether decommissioning is required, whether financial assurance is needed, the timeframe in which decommissioning must be complete, and other elements.
4. Stakeholder group members from Pinegate Renewables organized a field trip for other group members to a solar farm in Pelion, South Carolina on November 9, 2021, to understand how one operates, and how that can factor into end-of-life management.
5. The fourth Solar Panel Stakeholder Workgroup Meeting was held on November 16, 2021. Discussion was focused on potential components for decommissioning requirements for largescale solar projects and what elements would be essential to ensure proper site restoration. Stakeholder group members shared experiences from the November 9 site visit to a solar farm, which provided the group with knowledge as to how a utility-scale solar project operates.
6. The fifth Solar Panel Stakeholder Workgroup Meeting was held on February 17, 2022. The group in this meeting reviewed the progress made by the stakeholder group in previous meetings and engagements. The group also went over the effects that the enactment of Act No. 119 would have on the group's activities, including the beginning of a regulation development process. A basic timeframe for the regulation development of regulation to manage end-of-life PV modules was discussed.

7. The sixth Solar Panel Stakeholder Workgroup Meeting was held on April 8, 2022. The group in this meeting reviewed draft regulatory language that would establish statewide requirements for permitting, decommissioning, and financial assurance for large solar energy systems. Feedback from the group was received and further discussion on the topics of decommissioning and financial assurance were agreed to be discussed at future meetings with stakeholders.



County Name	Type of solar projects affected	Decommissioning Requirements	Financial Assurance	Timeframe
Abbeville	A solar farm is defined by this ordinance as a series of at least three (3) ground-mounted solar collectors placed on a parcel for the purpose of generating photovoltaic power ("PV") for resale purposes.	Yes	125% of the estimated decommission cost minus the salvageable value.	Following 6 months of no electricity generation, the permit holder will have 6 months to complete decommissioning.
Barnwell	Farms of more than one megawatt	Yes	\$50,000 or 125% of the estimated decommission cost minus the salvageable value, whichever is greater.	Following 6 months of no electricity generation, the permit holder will have 6 months to complete decommissioning.
Beaufort	N/A	N/A	N/A	N/A
Calhoun	More than 1 acre	Yes	\$50,000 or 125% of the estimated decommission cost minus the salvageable value, whichever is greater.	Following 6 months of no electricity generation, the permit holder will have 6 months to complete decommissioning.
Charleston	N/A	N/A	N/A	N/A
Cherokee	A series of ground-mounted solar collectors placed in an area for generating photovoltaic (PV) power as a commercial enterprise.	Yes	\$50,000	Following 6 months of no electricity generation, the permit holder will have 6 months to complete decommissioning.
Chester	Solar farms are defined as an area of land designated for the purpose of producing photovoltaic electricity.	Yes	N/A	It is the responsibility of the company managing and/or owning the Solar Farm, whether the property is outright owned by the company managing or owning the Solar Farm or whether property is being leased, to remove within twelve months all obsolete or unused systems to include the concrete pads, solar panels, wiring and all related equipment necessary for the operation of the Solar Farm.
Darlington	A series of ground mounted solar collectors placed in an area for generating photovoltaic (PV) power as a commercial enterprise. The minimum size for a solar energy system is one acre. The maximum megawatt output of a solar energy system is 75.	Yes	\$50,000	Following 6 months of no electricity generation, the permit holder will have 6 months to complete decommissioning.
Edgefield	Solar farms are defined as a series of ground mounted solar collectors (minimum of three) are placed in an area for generating photovoltaic power for resale purpose	Yes	N/A	Solar farms, which have not been in active and continuous service for a period of one year, shall be removed at the owner or operators expense, and the site shall be restored to as natural condition as possible within six months of removal.
Florence	The minimum size for a solar farm is five acres.	Yes	N/A	N/A
Greenville	N/A	N/A	N/A	N/A

County Name	Type of solar projects affected	Decommissioning Requirements	Financial Assurance	Timeframe
Greenwood	Where a series of ground mounted solar panels (minimum of three) are placed in an area for the purpose of generating photovoltaic power for resale purposes.	Yes	\$50,000 or 125% of the estimated decommission cost minus the salvageable value, whichever is greater.	Following 6 months of no electricity generation, the permit holder will have 6 months to complete decommissioning.
Jasper	The solar farm consists of a minimum of five acres	Yes	\$50,000 or 125% of the estimated decommission cost minus the salvageable value, whichever is greater.	Decommissioning will be required following a continuous period of 12 months in which no electricity is generated by the facility other than for mechanical, repair, replacement and/or maintenance purposes, following which must be completed in 12 months.
Kershaw	A series of three or more ground-mounted solar collectors installed on a site for the purpose of converting energy into electrical or thermal energy for on-site and/or off-site energy consumption. The area of the system includes all land inside the perimeter of the system and extends to any fencing. This term does not include building-integrated or building-mounted systems.	Yes	\$50,000 or 125% of the estimated decommission cost minus the salvageable value, whichever is greater.	Decommissioning will be required following a continuous six month period in which no electricity is generated by the facility. The permit holder will have 12 months to complete decommissioning of the solar farm.
Newberry	Any series of 3 or more ground-mounted solar collectors installed on a site for the purpose of converting energy into electrical or thermal energy for on-site and/or off-site energy consumption.	Yes	\$50,000 or 125% of the estimated decommission cost minus the salvageable value, whichever is greater.	Following 6 months of no electricity generation, the permit holder will have 12 months to complete decommissioning.
Richland	A system consisting of solar panels, modules, and related equipment (e.g., heat exchanger, pipes, inverter, wiring, storage) that collects solar radiation and transfers it as heat to a carrier fluid for use in hot water heating or space heating and cooling, and/or that collects solar energy and converts it into electricity. As a principal use, a solar energy conversion system is designed to meet demands for a large area and is typically mounted on the ground.	Yes	N/A	If the system ceases operating for a period of 18 consecutive months, the county shall deem it abandoned and shall provide a written notice of abandonment to the owner. Within 180 days after notice of abandonment is provided, the owner shall either complete all decommissioning activities and site restoration in accordance with the decommissioning plan or resume operations

County Name	Type of solar projects affected	Decommissioning Requirements	Financial Assurance	Timeframe
Sumter	<p>A ground-mounted photovoltaic solar facility with components and subsystems that generate electricity from sunlight, to be sold to a wholesale electricity market through a regional transmission organization and an inter-connection with the local utility power grid. The area of the facility includes all the land inside the perimeter of the system, which extends to any fencing, land area required for setbacks, landscaping and signage.</p>	Yes	N/A	N/A
York	<p>An energy generating facility or area principally used to convert solar energy to electricity, which includes, but is not limited to, the use of one or more solar energy systems. This definition shall exclude those facilities that are installed on the roof of a building, where the primary purpose of such building is not for the commercial production of solar energy.</p>	Yes	<p>\$50,000 or 125% of the estimated decommission cost minus the salvageable value, whichever is greater.</p>	<p>The maximum time permitted for decommissioning and restoring the site shall be six months. It will be considered abandoned after 12 months of no electricity being generated.</p>

**TABLE 7.11: Permitted Class 3 Landfills Remaining Capacity & Disposal in Tons in FY21**

NAME OF LANDFILL	COUNTY	PERMITTED DISPOSAL RATE (tons/year)	AMOUNT DISPOSED OF (tons)	ESTIMATED REMAINING AIRSPACE (cubic yard)	RATE OF COMPACTION (tons/cubic yard)	ESTIMATED REMAINING CAPACITY OF FACILITY (tons)	ESTIMATED REMAINING LIFE OF FACILITY BASED ON PERMITTED DISPOSAL RATE (years)	ESTIMATED REMAINING LIFE OF FACILITY BASED ON CURRENT DISPOSAL RATE (years)
<b>COMMERCIALY OPERATED LANDFILLS</b>								
<b>PUBLIC</b>								
Abbeville Co.	Abbeville	46,000	16,310	99,667	0.6	59,800	1.3	3.7
Bees Ferry	Charleston	316,709	178,874	5,531,447	0.7	3,872,013	12.2	21.6
Berkeley Co.	Berkeley	1,000,000	217,756	4,385,488	0.7	3,069,842	3.1	14.1
Georgetown Co.	Georgetown	229,582	82,556	3,477,815	1.0	3,477,815	15.1	42.1
Greenwood Co.	Greenwood	150,000	92,727	2,357,689	0.7	1,650,382	11.0	17.8
Horry County SWA	Horry	750,000	286,273	2,445,814	1.0	2,445,814	3.3	8.5
Three Rivers SWA	Aiken	500,000	299,641	39,223,938	0.7	27,848,996	55.7	92.9
Twin Chimneys	Greenville	500,000	362,267	37,194,223	0.8	29,755,378	59.5	82.1
Wellford	Spartanburg	260,000	167,695	7,205,516	0.7	4,971,806	19.1	29.6
<b>PRIVATE</b>								
Anderson Regional	Anderson	588,000	489,672	5,235,470	0.9	4,711,923	8.0	9.6
Hickory Hill	Jasper	302,000	197,338	2,094,235	1.0	2,094,235	6.9	10.6
Lee County	Lee	1,944,939	586,466	20,127,560	1.0	20,127,560	10.3	34.3
Northeast	Richland	529,600	154,034	5,294,906	1.0	5,294,906	10.0	34.4
Oakridge	Dorchester	1,144,000	789,919	15,168,198	1.0	15,168,198	13.3	19.2
Pepperhill	Dorchester	214,500	-	491,575	1.0	491,575	2.3	N/A
Richland	Richland	1,288,209	1,057,756	26,069,420	0.8	21,116,230	16.4	20.0
Upstate Regional	Union	910,000	858,979	65,074,100	0.9	57,915,949	63.6	67.4
<b>NON-COMMERCIAL PUBLICLY OWNED</b>								
Santee Cooper - Cross	Berkeley	1,615,000	94,135	23,720,585	1.4	16,249	0.0	0.2
Santee Cooper - Winyah	Georgetown	3,750,000	1,033,585	10,999,031	1.7	9,074	0.0	0.0
SRS Z-Area	Aiken	N/A	23,450	34,564,116	N/A	N/A	N/A	N/A
<b>NON-COMMERCIAL PRIVATELY OWNED</b>								
CMC - 1601	Lexington	N/A	-	N/A	N/A	N/A	N/A	N/A
CMC - 1602	Lexington	300,000	69,540	1,503,683	1,600	1,202,946	4.0	17.3
Dominion - Cope	Orangeburg	350,000	33,984	14,593,995	N/A	N/A	N/A	N/A
Dominion - Wateree	Richland	3,000,000	5,294	14,857,557	N/A	N/A	N/A	N/A
Dominion - Williams Hwy. 52	Berkeley	500,000	56,833	14,196,985	N/A	N/A	N/A	N/A
Duke Energy Progress - HB Robinson	Darlington	2,400,000	1,482,051	2,065,151	1.3	1,353	0.0	0.0
SI Group	Orangeburg	N/A	17,891	122,006	1.0	175,122	0.0	1.4
Sonoco Products	Darlington	60,000	17,351	1,241,558	2.0	N/A	N/A	N/A

**DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL**  
**CHAPTER 61**

Statutory Authority: R.116, H.4100, the Fiscal Year 2021-2022 General Appropriations Act, Part 1B, Section 34, Proviso 34.62; 1976 Code Sections 44-56-10 et. seq.; and 1976 Code Sections 44-96-10 et. seq.

**Notice of Drafting:**

The Department of Health and Environmental Control (“Department”) proposes drafting a new regulation for the management of end-of-life photovoltaic modules and energy storage system batteries on solar projects in excess of thirteen acres. Interested persons may submit comment(s) on the proposed new regulation to Juli Blalock of the Bureau of Land and Waste Management; S.C. Department of Health and Environmental Control, 2600 Bull Street, Columbia, S.C. 29201; [swregdev@dhec.sc.gov](mailto:swregdev@dhec.sc.gov). To be considered, the Department must receive comments no later than 5:00 p.m. on August 23, 2021, the close of the Notice of Drafting comment period.

**Synopsis:**

Pursuant to R.116, H.4100, the Fiscal Year 2021-2022 General Appropriations Act, Part 1B, Section 34, Proviso 34.62 (“Proviso”), the Department was directed to submit regulations which develop rules to guide all South Carolinians invested in, selling, installing, and using photovoltaic modules and energy storage system batteries in the management of end-of-life photovoltaic modules and energy storage system batteries on solar projects and the decommissioning of solar projects in excess of thirteen acres. The Department proposes promulgating a new regulation as directed in the Proviso. The new regulation will establish rules for the responsible management and disposal of materials and equipment used in utility-scale solar projects.

The Administrative Procedures Act, S.C. Code Section 1-23-120(A), requires General Assembly review of the proposed new regulation.

**DEPARTMENT OF LABOR, LICENSING AND REGULATION**  
**CHAPTER 10**

Statutory Authority: 1976 Code Sections 40-1-50, 40-7-50, and 40-7-60

**Notice of Drafting:**

The South Carolina Department of Labor, Licensing and Regulation proposes to amend the fee schedule for the Board of Barber Examiners whose fees appear in Chapter 10 of the South Carolina Code of Regulations, specifically in R.10-6. Interested persons may submit comments to Holly Beeson, Counsel to the Office of Communications and Governmental Affairs, South Carolina Department of Labor, Licensing and Regulation, Post Office Box 11329, Columbia, SC 29211.

**Synopsis:**

The South Carolina Department of Labor, Licensing and Regulation proposes to amend the fee schedule for the Board of Barber Examiners whose fees appear in R.10-6, in Chapter 10 of the South Carolina Code of Regulations. Specifically, fees will be added as they relate to portable barber operations and mobile barber shops, new licensure types created by Act No. 65 of 2021. Additionally, existing fees will be clarified and/or renamed, and other fees will be added as needed or as required by statute.

Legislative review of this amendment is required.

**DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL**  
**CHAPTER 61**

Statutory Authority: 1976 Code Sections 44-7-110 through 44-7-394, 44-37-40, 44-37-50, and 63-7-40

**Notice of Drafting:**

The Department of Health and Environmental Control (“Department”) proposes amending R.61-16, Minimum Standards for Licensing Hospitals and Institutional General Infirmaries. Interested persons may submit written comments to the Office of Policy and Communications, S.C. Department of Health and Environmental Control, 2600 Bull Street, Columbia, S.C. 29201; [HQRegs@dhec.sc.gov](mailto:HQRegs@dhec.sc.gov); or the [Healthcare Quality Public Comment Form](#). To be considered, the Department must receive comments no later than 5:00 p.m. on March 28, 2022, the close of the Notice of Drafting comment period.

**Synopsis:**

Pursuant to S.C. Code Section 44-7-260(A)(1), the Department establishes and enforces basic standards for the licensure, maintenance, and operation of health facilities and services to ensure the safe and adequate treatment of persons served in this state. The Department proposes amending R.61-16, Minimum Standards for Licensing Hospitals and Institutional General Infirmaries, to ensure alignment with current state laws and to update and revise definitions and requirements regarding licensure, inspections, enforcement, management, medical staff, nursing services, patient safety, policies and procedures, incident reporting, accommodations for patients, medical records, vital statistics, emergency preparedness and response, food service, maintenance, laundry, linen, housekeeping, refuse disposal, infection control, physical plant, design requirements, construction requirements, hazardous elements of construction, fire protection, fire prevention, engineering and exits, and standards for specialized departments or services.

The proposed amendments may also include corrections for clarity and readability, grammar, punctuation, codification, and other such regulatory text improvements.

The Administrative Procedures Act, S.C. Code Section 1-23-120(A), requires General Assembly review of these proposed amendments.

**DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL**  
**CHAPTER 61**

Statutory Authority: 2022 Act No. 119, Section 5, effective January 27, 2022

**Notice of Drafting:**

The Department of Health and Environmental Control (“Department”) proposes drafting a new regulation for the management of end-of-life photovoltaic modules and energy storage system batteries on solar projects in excess of thirteen acres. Interested persons may submit comment(s) on the proposed new regulation to Juli Blalock of the Bureau of Land and Waste Management; S.C. Department of Health and Environmental Control, 2600 Bull Street, Columbia, S.C. 29201; [swregdev@dhec.sc.gov](mailto:swregdev@dhec.sc.gov). To be considered, the Department must receive comments no later than 5:00 p.m. on March 28, 2022, the close of the Notice of Drafting comment period.

This notice supersedes the Notice of Drafting that was published in the South Carolina State Register Volume 45, Issue 7 on July 23, 2021.

## 20 DRAFTING NOTICES

### Synopsis:

Pursuant to Section 5 of 2022 Act No. 119 (the “Act”), the Department was directed to submit regulations which develop rules to guide all South Carolinians invested in, selling, installing, and using photovoltaic modules and energy storage system batteries in the management of end-of-life photovoltaic modules and energy storage system batteries on solar projects and the decommissioning of solar projects in excess of thirteen acres. The Department proposes promulgating a new regulation as directed in the Act. The new regulation will establish rules for the responsible management and disposal of materials and equipment used in utility-scale solar projects, including local approval of a site plan and the submission of a nonbinding management plan. The rules may also include financial assurance, stewardship, and reporting requirements.

The Administrative Procedures Act, S.C. Code Section 1-23-120(A), requires General Assembly review of the proposed new regulation.

### DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

#### CHAPTER 61

Statutory Authority: 1976 Code Sections 48-1-10 et seq.

### Notice of Drafting:

The Department of Health and Environmental Control (“Department”) proposes amending R.61-68, Water Classifications and Standards. Interested persons may submit comment(s) on the proposed amendments to Andrew Edwards, Water Quality Standards Coordinator of the Bureau of Water; S.C. Department of Health and Environmental Control, 2600 Bull Street, Columbia, S.C. 29201; [edwardaj@dhec.sc.gov](mailto:edwardaj@dhec.sc.gov). To be considered, the Department must receive comments no later than 5:00 p.m. on March 28, 2022, the close of the Notice of Drafting comment period.

### Synopsis:

Pursuant to Section 303(c) of the federal Clean Water Act (“CWA”), South Carolina’s water quality standards must be reviewed and revised, where necessary, at least once every three years. Referred to as the triennial review, this required process consists of reviewing the designated water uses, criteria, and antidegradation policy. The Department will review and adopt, where appropriate, the Environmental Protection Agency’s updated numeric and narrative criteria according to Section 304(a), Section 304(f), and Section 307(a) of the CWA. In reviewing its water classifications and standards, the Department will give consideration to the factors listed in S.C. Code Section 48-1-80 and update R.61-68, Water Classifications and Standards, where appropriate.

The Department proposes amending R.61-68 to adopt revised water quality standards as deemed necessary to comply with federal updates and recommendations. The Department also proposes amending R.61-68 as deemed necessary to comply with the Pollution Control Act, S.C. Code Sections 48-1-10 et seq.

The proposed amendments may also include corrections for clarity and readability, grammar, punctuation, codification, and other such regulatory text improvements.

The Administrative Procedures Act, S.C. Code Section 1-23-120(A), requires General Assembly review of these proposed amendments.

# Stakeholder comments on the Final Report on the Activities Conducted to Establish a Program for End-of-Life Management of Photovoltaic Modules and Energy Storage Systems

The first draft of this final report was sent to stakeholders in May. The stakeholders were invited to send the department their comments on the report. The Department have attached these comments and responded to them.

Name	Section
Solar Energy Industries Association	Financial Assurance and Decommissioning Requirements – Page 23
<p><b>Comment:</b></p> <p>SEIA’s recommendation is that the Department include salvage value within its Proposed Regulations regarding the calculation of financial assurance consistent with regular practice adopted in other states with solar-specific decommissioning policies, and the below copied redlines reflect this recommendation.</p> <p><b>Department Response:</b></p> <p>Because the market for solar panel recycling is not sufficiently mature, the Department is skeptical of allowing large solar energy facilities to reduce the cost estimate for decommissioning by subtracting the salvage value of materials. The ability for a solar site to get a reliable estimate of salvage value several years before decommissioning is uncertain and could pose a financial risk to the state if the Department had to use a discounted financial assurance mechanism to clean up an abandoned solar site. DHEC will take this opinion into consideration when developing regulations.</p>	
Name	Section
Solar Energy Industries Association	Financial Assurance and Decommissioning Requirements – Page 23
<p><b>Comment:</b></p> <p>A solar and storage facility is not analogous to the 2019 Able Contracting fire, which was an uncontrolled fire of a construction debris landfill. Solar modules and even some batteries commonly installed on large scale solar facilities do not spontaneously combust nor are they tightly packed together, such as the loose construction waste present in the Able Contracting fire.</p> <p>Additionally, unlike the Able Contracting plant, solar facilities do require permits to operate, as well as inspections throughout the development process, interconnection studies and assessment, and numerous other checks to ensure that a power generator that interacts with the electric grid functions in a way that is safe and compliant with building and electrical code and strict component safety standards, such as those published by IEEE.</p> <p>We respectfully request that the Department remove this reference to Able Contracting as it is not consistent with the topic at hand.</p> <p><b>Department Response:</b></p>	



DHEC agrees that an abandoned solar facility is unlikely to cause the environmental impacts as an abandoned construction and demolition debris recycling facility. However, although abandoned solar panel facilities are not likely to cause an environmental disaster like the fire at Able Contracting, an abandoned large solar energy system, however unlikely, would pose an enormous cost on taxpayers if the Department was responsible for cleaning up the site. No solar facilities operate with any statewide permits, decommissioning/FA requirements or inspections related to disposal of solid waste, which leaves the burden of overseeing the end-of-life process on the landowner and local government.

Name	Section
Solar Energy Industries Association	Financial Assurance and Decommissioning Requirements – Page 23

**Comment:**

SEIA suggests that the full financial assurance be posted on or before the 15th anniversary of the facility’s initial date of operation.

**Department Response:**

The Department is skeptical of allowing large solar energy systems to operate for fifteen years before providing financial assurance. The purpose of financial assurance in this instance is to ensure there are enough financial resources available to the state should a large solar energy system be abandoned. Solar panels are relatively new technology, and it would create a financial risk for the state if the Department allowed large solar energy systems to operate before a financial assurance mechanism is funded.

The Department estimates that the average site that would be regulated by this proposed regulation could potentially contain tens of thousands of solar panels. If abandoned, these devices would have to be handled, transported, and disposed of by the landowner or local or state governments. The cost of disposal itself is an unknown variable because of a limited amount of solid waste management facilities that will accept solar panels. This is the reason the regulation would issue financial assurance requirements before a permit is granted, that would be updated at least once every ten years.

Name	Section
Solar Energy Industries Association	Financial Assurance and Decommissioning Requirements – Page 25

**Comment:**

The industry recommends that these proposed rules act as a template for localities to adopt or amend at their sole discretion. We do not believe that a statewide mandate to adopt these regulations is in the best interest of all stakeholders. These projects are negotiated and permitted at the local level, and decommissioning and financial assurance have become a standard part of those conversations. DHEC should pose its regulations as expertise for local governments to incorporate into their economic development toolbox.

**Department Response:**

This regulation development effort is in response to a legislative directive established by Act 119. The Department does agree that local opinion is an important factor in considering language to include in this proposed language and will continue to solicit feedback from local governments and the solar industry.

Name	Section
Solar Energy Industries Association	Financial Assurance and Decommissioning Requirements – Page 23

**Comment:**

Furthermore, these proposed rules should only apply to projects that submit interconnection requests after 12/31/2023. This allows developers to understand and prepare for compliance for future projects.

**Department Response:**

The Department disagrees on exempting existing large solar energy systems and those that are created before 2024. There is estimated to be between 4.2-5 million solar panels currently installed on sites that would be subject to this proposed regulation. If such an exemption was provided this would leave a large amount of future waste whose disposal, if abandoned by a large solar energy system, would be unfunded.