

# Quarterly Interim Report on the Activities Conducted to Establish a Regulatory Program for the Management and Decommissioning of Renewable Energy Equipment

**Citation of Law or Resolution:** Section 2.(d) of S.L. 2019-132 (H329)  
**Due Date:** September 1, 2020 Quarterly

**Receiving Entities:**

The Environmental Review Commission  
The General Assembly

**Submitting Entity:**

Department of Environmental Quality

# **Quarterly Interim Report of the Department of Environmental Quality**

## **Executive Summary and Transmittal**

Pursuant to Section 2.(d) of S.L. 2019-132 (H329/Renewable Energy Amends), the North Carolina Department of Environmental Quality (Department or DEQ) and the Environmental Management Commission (Commission), must submit quarterly interim reports as to the activities conducted, including updates on the stakeholder process and the work to adopt rules governing the management of end-of-life (EOL) photovoltaic modules and energy storage battery systems and the decommissioning of utility-scale solar projects and wind energy facilities, to the Environmental Review Commission and the General Assembly. This is the fourth such quarterly report and covers the activities undertaken to implement this Section since the submission of the previous quarterly interim report, from June 1, 2020, through August 31, 2020.

## **Quarterly Interim Report of Activities**

In accordance with Section 2.(c) of S.L. 2019-132, the Department established a stakeholder process and convened two stakeholder meetings during this quarter, on June 3 and August 12, 2020. The agendas for, presentations to, and materials shared in association with these meetings are included as Appendix A to this report. To follow is a brief summary of the work undertaken by the Department and the stakeholders to implement this Section of the Act since the previous report was submitted.

### **DEQ Resources**

Due to the multi-disciplinary scope of the legislative directive to adopt rules governing the management of end-of-life (EOL) photovoltaic (PV) modules and energy storage battery systems and the decommissioning of utility-scale solar projects and wind energy facilities, staff from three DEQ units are assigned to support this effort. The Division of Waste Management, the Division of Environmental Assistance and Customer Service, and the State Energy Office are each represented and this team's work is coordinated by the Office of Governmental Affairs and Policy. Pursuant to Section 2.(d) of S.L. 2019-132, the Department submitted its recommendations regarding resources necessary to implement this Section in its April 1, 2020 interim report.

### **Stakeholder Organizations<sup>1</sup>**

The following public, private, and not-for-profit organizations have joined the stakeholder process since the last quarter. In addition to these entities, DEQ solicited stakeholder's feedback to broaden and include participation from all potentially interested Parties. A list of all participating stakeholders to-date is included in Appendix C of this report.

Cabarrus County Government

Caldwell County Government

Chatham County Government

Cherokee County Government

Columbus County Government

Cumberland County Government

Currituck County Government

Davidson County Government

Davie County Government

Gaston County Government

Granville County Government

Hoke County Government

Iredell County Government

Jones County Government

Northampton County Government

Onslow County Government

Orange County Government

Perquimans County

Randolph County Government

Rowan County Government

Transylvania County Government

Wilson County Government

Stanly County Government

Warren County Government

Yadkin County Government

### Matters Under Consideration

Pursuant to Section 2.(a), DEQ must consider nine matters in its development of the rules governing the management of EOL PV modules and energy storage battery systems and the decommissioning of utility-scale solar projects and wind energy facilities. The following table lists the matters DEQ, with assistance from stakeholders, has considered through the date on which this report was submitted. The shading in the table indicates matters that have been evaluated and are considered by DEQ to be complete.

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<sup>1</sup> Organizations with an asterisk (\*) have participated in the stakeholder meetings either in-person or by remote conference call.

S.L. 2019-132 / HB 329	Photovoltaic (PV) Modules	Wind Energy Facilities (WEF)	Energy Storage System Batteries	Status	Next Steps
<b>§2.(a)(1): Characteristics of hazardous waste identified</b>	<ul style="list-style-type: none"> <li>• Presentations on classifications of solar waste</li> <li>• TCLP methodology, results, and potential hazardous characteristics of modules has been thoroughly discussed</li> <li>• DEQ drafted a literature review on the hazardous characteristics of modules and TCLP methodology<sup>2</sup></li> </ul>	DEQ initiated literature review of the potential hazardous characteristics of turbines and related facility equipment	DEQ presentation on hazardous characteristics in common types of energy storage system batteries	PV modules have been thoroughly researched and discussed	<ul style="list-style-type: none"> <li>• DEQ to present recommendations for PV module waste classification for EMC consideration</li> <li>• DEQ coordinating with ASTM for publication of a TCLP guidance for PV modules</li> </ul>
<b>§2.(a)(2): Preferred methods to responsibly manage end-of-life (EOL) products</b>	Presentations on methods to manage EOL PV modules. Reuse, refurbish, recycle, and landfill disposal options has been researched by DEQ	DEQ initiated literature review on the preferred methods to manage EOL wind turbines	DEQ and stakeholder presentations on different EOL management options for several energy storage system battery technologies. Reuse, refurbish, recycle, and landfill disposal options has been researched by DEQ	EOL for PV modules and energy storage system batteries has been thoroughly researched and discussed	<ul style="list-style-type: none"> <li>• DEQ to draft proposed recommendations for EOL management of energy storage system batteries and wind energy facilities.</li> <li>• Coordinate presentations on EOL management for wind energy equipment</li> <li>• DEQ to draft white paper on preferred methods to manage EOL renewable energy equipment.</li> </ul>
<b>§2.(a)(3): Economic and environmental costs and benefits</b>	<ul style="list-style-type: none"> <li>• Stakeholder discussions on environmental costs/benefits</li> <li>• EOL management methods for PV modules reviewed by DEQ</li> </ul>		<ul style="list-style-type: none"> <li>• Stakeholder discussions on environmental costs/benefits</li> <li>• EOL management methods for batteries reviewed by DEQ</li> </ul>	Limited discussion of environmental costs/benefits information on recycling, reusing, and disposing of PV modules and energy storage system batteries	DEQ to conduct additional research and obtain information from stakeholders on the environmental and economic costs/benefits on different EOL management options for renewable energy equipment
<b>§2.(a)(4): Expected economically productive life</b>	<ul style="list-style-type: none"> <li>• Stakeholders have submitted resources on the economically productive life cycle of PV modules</li> <li>• Data on current NC PV module lifespan has been collected and presented<sup>3</sup></li> </ul>	Presentation on Amazon Wind, U.S. East, the State's only operational WEF, included this information	Stakeholders provided applicable resources for energy storage system batteries	<ul style="list-style-type: none"> <li>• NC solar facility lifespan data obtained and presented<sup>3</sup></li> <li>• Limited data on energy storage system batteries received</li> </ul>	DEQ to collect additional information, including NC site specific data, on the economically productive lifecycle of energy storage system batteries

<sup>2</sup> Executive Summary of the Literature Review of Hazardous Characteristics of Solar PV Equipment is included in Appendix B of the Quarterly Report submitted on March 1, 2020.

<sup>3</sup> Data on the number of modules, weight in tons, and estimated timeframes for decommissioning is included in the January 22, 2020 meeting materials in Appendix A2 of the Quarterly Report submitted on March 1, 2020.

S.L. 2019-132 / HB 329	Photovoltaic (PV) Modules	Wind Energy Facilities (WEF)	Energy Storage System Batteries	Status	Next Steps
<p><b>§2.(a)(5): The volume of photovoltaic modules, wind turbines, and energy storage system batteries currently in use in the State, and projections</b></p>	<ul style="list-style-type: none"> <li>The volume of PV modules currently installed in NC facilities was compiled by DEQ and presented in graphs<sup>3</sup></li> <li>DEQ compiled the capacity, panel type, and estimated volume of PV modules currently installed in NC solar facilities and the results were illustrated in graphs presented to the stakeholders in January 2020</li> </ul>	<p>The volume of turbines currently installed in NC has been researched and presented<sup>4</sup></p>		<p>Based on the data collected:</p> <ul style="list-style-type: none"> <li>the bulk of the solar PV facilities/ modules will not be decommissioned until early-to-mid 2030</li> <li>the Amazon Wind facility's 104 turbines have an expected life of at least 20 years, estimated decommissioning in 2036, at the earliest</li> </ul>	<ul style="list-style-type: none"> <li>DEQ to finalize the GIS map and list of utility-scale solar facilities that are currently installed in NC.</li> <li>DEQ will identify the utility-scale solar facilities that submitted NCUC applications that were not constructed</li> <li>DEQ will update PV module volume graphs with additional data provided by facility mapping</li> <li>DEQ evaluating impacts on landfill capacity if PV modules, wind turbines, and energy storage system batteries are disposed in landfills</li> <li>DEQ collecting information on energy storage system batteries in NC</li> </ul>
<p><b>§2.(a)(6): A survey of federal and other states' and countries' regulatory requirements</b></p>	<ul style="list-style-type: none"> <li>Federal, state, county, and EU regulatory requirements, including financial assurance (FA) requirements, researched and presented to stakeholders</li> <li>Discussions of solar ordinances adopted in NC counties</li> <li>Stakeholders provided list of solar decommissioning requirements in other states</li> <li>DEQ completed summary of current decommissioning requirements in NC counties</li> </ul>	<ul style="list-style-type: none"> <li>Stakeholders provided list of WEF decommissioning requirements in other states</li> <li>Federal and NC requirements for WEFs presented and discussed<sup>5</sup></li> </ul>	<ul style="list-style-type: none"> <li>Stakeholders provided list of battery decommissioning requirements in other states</li> <li>Federal and state regulatory requirements for energy storage system batteries has been collected</li> </ul>	<p>Completed evaluation of regulatory requirements at federal-, state-, NC county-, and international-level for management of EOL PV modules and WEFs</p>	<p>DEQ will research, work with stakeholders, and present energy storage system batteries' regulatory requirements at federal-, state-, and international-level</p>
<p><b>§2.(a)(7): Financial assurance requirements</b></p>	<ul style="list-style-type: none"> <li>FA requirements for PV modules in NC counties (per ordinance) have been collected and presented to stakeholders</li> <li>Stakeholders have discussed the need for and implementation of FA for PV modules</li> </ul>	<p><i>Not required per S.L. 2019-132</i></p>	<p><i>Not required per S.L. 2019-132</i></p>	<p>A subgroup of stakeholders was formed to dive into the need for, approach, and implementation of FA for PV modules</p>	<p>DEQ is collaborating with stakeholders to finalize draft language for FA requirements for PV modules</p>

<sup>4</sup> See February 10, 2020 presentation on WEF in North Carolina in Appendix A3 of the Quarterly Report submitted on March 1, 2020.

<sup>5</sup> See April 14, 2020 presentation on States with WEF Regulations in Appendix A of the Quarterly Report submitted on June 1, 2020.

S.L. 2019-132 / HB 329	Photovoltaic (PV) Modules	Wind Energy Facilities (WEF)	Energy Storage System Batteries	Status	Next Steps
<b>§2.(a)(8): Infrastructure that may be needed to collect and transport EOL products</b>				Little work has been done to-date as the stakeholders have been focused on quantifying the universe of and expected timeline for decommissioned EOL renewable energy equipment	DEQ will work with stakeholders to research and evaluate the infrastructure that may be needed to develop practical, effective, and cost-efficient means to collect and transport EOL PV modules, energy storage systems, and WEFs
<b>§2.(a)(9): Manufacturer stewardship programs</b>	Examples of existing manufacturer stewardship programs for recycling PV modules have been presented and discussed			Limited information on manufacturer stewardship programs for EOL PV modules has been received again, as the stakeholders' focus has been on quantifying the universe of EOL renewable energy equipment and the timeline	DEQ will research and discuss with stakeholders the potential and feasibility for creating a manufacturer stewardship programs for recycling of EOL PV modules and energy storage system batteries

### Materials Received from Stakeholders

To support the completion of the scope of work directed by the Session Law, DEQ continues to solicit assistance from the stakeholders to fill knowledge and data gaps. DEQ has received the following information from stakeholders since the last quarterly interim report was submitted:

- The National Renewable Energy Laboratory submitted a report discussing research and development priorities for photovoltaic module recycling.
- The Minnesota Pollution Control Agency submitted the materials from their June stakeholder meeting and an IEA study titled Human Health Risk Assessment Methods for PV Part 3: Module Disposal Risks.
- The North Carolina Clean Energy Technology Center forwarded a report regarding wind turbine blade recycling.

### Upcoming Activities

DEQ will convene the next stakeholder meeting on Wednesday, August 12, 2020, to discuss waste determination of PV modules and proposed PV module storage recommendations.

DEQ has a tentative plan to reconvene with NCUC public staff depending on future discussions with stakeholders and the pathways identified to comply with the remaining subparts of HB329.

DEQ anticipates convening monthly stakeholder meetings through 2020, as needed, to inform the Department's work to develop rules to govern the management of EOL PV modules and energy storage battery systems and the decommissioning of utility-scale solar projects and wind energy facilities. Further, DEQ expects to provide the ERC with legislative recommendations necessary to implement the processes contemplated by this work with the stakeholder community.



## **APPENDIX A**

### **Stakeholders Meeting Agendas and Associated Presentations**

#### **Decommissioning Renewable Energy Equipment Stakeholders (Per §2 of S.L. 2019-132/H329)**

Wednesday June 3, 2020

2:30 pm to 4:30 pm

Virtual Meeting via WebEx

Meeting number: 614 641 204//Password: H329JUNE

<https://ncdenrits.webex.com/ncdenrits/onstage/g.php?MTID=e83734b4552e7dd5a7f0b8b814153c98e>

**OR join by phone**

**Audio: +1-415-655-0003 US TOLL**

**Access code: 614 641 204**

#### **AGENDA**

1. Welcome and introductions
2. Presentations
  - a. Recap on PV Module Composition and Management  
Jessica Citrola, Environmental Specialist II  
DWM, DEQ
  - b. Proposed PV Module Management Options  
Jenny Patterson, Environmental Program Consultant  
DWM, DEQ
3. Discussion on updated draft language for PV module decommissioning and financial assurance requirements  
Daniel Brookshire (NCSEA)
4. Discuss topics for next stakeholders meeting
5. Adjourn

**Next Meeting:** Date to be determined

**Decommissioning Renewable Energy Equipment Stakeholders (Per §2 of S.L. 2019-132/H329)**

Wednesday August 12, 2020

3:00 pm to 5:00 pm

Virtual Meeting via WebEx

Meeting number: 161 706 1355 // Password: H329AUG

<https://ncdenrits.webex.com/ncdenrits/j.php?MTID=m4e9dc0ccfa6196a32f31f5a36e335b43>

**OR join by phone**

**Audio: +1-415-655-0003 US TOLL**

**Access code: 161 706 1355**

**AGENDA**

1. Welcome and introductions
2. Presentations & Discussions
  - a. Revisit hazard characterization of solar PV panels, document and flowchart, and NREL report  
Jenny Patterson, Environmental Program Consultant  
DWM, DEQ
  - b. Utility-scale solar decommissioning requirements draft proposal  
John Patrone, Environmental Specialist II  
Solid Waste Section, Division of Waste Management, DEQ
  - c. Definition of “utility-scale” solar project
  - d. Topic/s for next stakeholders meeting
    - i. NREL report: *Research and development priorities for silicon photovoltaic module recycling to support a circular economy*
    - ii. Others
3. Adjourn

**Next Meeting:** Date to be determined

## **Appendix B**

### **Executive Summary: NC DEQ Progress re: HB 329 Section 2(a)(1)**

NC DEQ was tasked with creating recommendations for a hazardous waste determination for photovoltaic modules (PV), as stated in Section 2(a)(1) of HB 329. During a series of discussions among NC DEQ staff, a recommendation of adding PV modules to the NC Universal Waste Rules was proposed. The universal waste program is a subset of hazardous waste rules that require less stringent regulations for certain waste streams. PV modules are appropriate candidates for universal waste rules and fit the common characteristics typically present in universal wastes. Universal wastes are generated in significant volumes and in a wide variety of settings, which can lead to difficulties implementing a management program to handle those wastes. In addition, PV modules are comprised of various technology and compositions where some modules might present toxic characteristics greater than regulatory thresholds. However, the risks of handling and transporting PV modules that exceed toxicity thresholds is low compared to other hazardous wastes. As a result, NC DEQ proposes adding PV modules as a waste category under state universal waste rules.

Following several discussions, staff in the Division of Waste Management, Hazardous Waste Section, created a guidance document for making a hazardous waste determination for PV modules. The document consists of a flow chart depicting different management options depending on the Toxicity Characteristic Leaching Procedure (TCLP) results of the PV module. The flow chart includes the proposed addition of PV modules to NC Universal Waste rules. If the TCLP results reveal a PV module is above toxicity thresholds or if the PV module was conservatively declared to be a hazardous waste without a TCLP test, then those PV modules would be managed as universal waste. If the TCLP test results are below the toxicity thresholds, then those PV modules will not be subject to hazardous or universal waste requirements. Hazardous Waste Section staff also drafted language to accompany the HB329 definition of a photovoltaic module and defined which components of the PV modules are subject to TCLP analysis when making a waste determination or for waste management. The proposed verbiage clarifies that photovoltaic modules that comprise a solar panel, including but not limited to the glass, encapsulant, solar cells, polymer backing and other components that cannot be readily detached from the panel shall be evaluated/managed. Components that are not integrated into the PV module such as brackets, braces, supports, wiring, inverters, and batteries should be evaluated and managed separately from the PV module. The flow chart can be found in Appendix A.

In May, NC DEQ contacted the American Society for Testing and Materials (ASTM) about the development of TCLP guidelines for PV modules. DEQ shared with ASTM the issues with using TCLP methodology when applied to PV modules that were observed following the conduct of a literature review and discussions with the stakeholders and another state's environmental agency. As a result of these discussions, ASTM committee members agreed to support the development of a guidance document to reduce the discrepancies that may arise in TCLP PV module testing. One of the ASTM committee members is the director of Arizona State University's Photovoltaic Reliability Laboratory, Dr. Govindasamy Tamizhmani. Dr. Tamizhmani and colleagues have published a standard operating procedure (SOP) for unbiased and repeatable sampling methodology to perform toxicity testing of PV modules. ASTM committee members agreed to support the publication of this procedure as a standard for TCLP sampling methodology for PV modules. Most recently, the Photovoltaic Reliability Laboratory transferred the SOP into the ASTM template, which will be submitted to the ASTM subcommittee ballot for approval. The approximate timeframe for publishing this standard is estimated to be one year.

## **APPENDIX C**

## LIST OF PARTICIPATING STAKEHOLDERS<sup>6</sup>

Duke Energy*	Dynamic Lifecycle Innovations
Dominion Energy*	TT&E Iron and Metal Foils Inc.
NC Electric Membership Cooperatives*	Regional Materials Recovery, Inc.
NC Sustainable Energy Association*	NC Utilities Commission-Public Staff
First Solar*	Advanced Energy*
Cypress Creek Renewables*	EQ Research*
NC Clean Energy Business Alliance	Umicore*
NC Farm Bureau*	Carolina Recycling Association
Energy & Environment Innovation Foundation	ecycleSecure
Ecoplexus	NC Department of Public Safety*
Smith Gardner Inc.	Caldwell County Government
Sierra Club*	Cabarrus County Government
NC Conservation Network*	Chatham County Government
Southern Environmental Law Center*	Cherokee County Government
Recycling Association of NC	Columbus County Government
NC State University Extension	Cumberland County Government
Solar Energy Industries Association*	Currituck County Government
Electronics Recyclers International	Davidson County Government
Law Office of Robert W. Kaylor	Davie County Government
Smith Anderson	Gaston County Government
Capitol Advantage Associates	Granville County Government
Brooks Pierce*	Hoke County Government
NC Association of County Commissioners*	Iredell County Government
Alamance County	Jones County Government
Solterra Partners Invenergy*	Northampton County Government
Minnesota Pollution Control Agency	Onslow County Government
Stevens Lobby and Consulting	Orange County Government
Southern Power Companies	Perquimans County Government
SunnKing*	Randolph County Government
Energy Intelligence Partners*	Rowan County Government
Synergy Recycling	Transylvania County Government
Metech Recycling	Wilson County Government
Powerhouse Recycling Inc.*	Stanly County Government
Institute of Scrap Recycling Industries, Inc	Warren County Government
NC Clean Energy Technology Center*	Yadkin County Government
GEEP Global (Global Electric Electronic Processing)	

<sup>6</sup> Organizations with an asterisk (\*) have participated in the stakeholder meetings either in-person or by remote conference call