

Final 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: January 1, 2021

Receiving Entities:
Environmental Review
Commission General Assembly

Submitting Entities:
Department of Environmental Quality
Environmental Management Commission

Executive Summary

Pursuant to Section 2.(d) of S.L. 2019-132 (HB329/Renewable Energy Amends), the North Carolina Department of Environmental Quality (Department or DEQ) and the Environmental Management Commission (Commission), were directed to submit a joint final report with findings, including stakeholder input, to the Environmental Review Commission and the General Assembly, no later than January 1, 2021. This final report is the culmination of the Department's consideration of the nine matters set out in Section 2(a) of HB329 to inform the development of 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 ("renewable energy equipment"). The information presented herein is also informed by the active participation of more than 100 stakeholders representing the renewable energy industry, investor-owned utilities, local governments, materials recyclers, academia, not-for-profit organizations, and state agencies (Appendix A lists the organizations the participating stakeholders represented throughout the process).

On November 20, 2020, the Draft Final Report was distributed to the stakeholders and members of the Commission via email. The email requested feedback and comment on the Draft report no later than close of business on December 14, 2020, providing 25 days for review. On December 9, 2020, the Commission held a Special Meeting to take up several informational items that were not addressed during the November regular meeting, including an overview of the Draft Final Report, and DEQ staff were available to respond to questions posed by Commissioners. The Commission is scheduled to vote to adopt the Final Report at its meeting in January. A table compiling the substantive comments the Department received is included as Appendix E, and Appendix F includes the comments submitted in full by both Commissioners and stakeholders.

Each of the following nine sections respond in detail to each of the corresponding subsections of the Session Law. Each section begins with an overview of our findings and recommendations (if any) followed by a detailed summary of the research and data that supports the Department's findings.

Key Findings and Recommendations

Section 2(a)(1): Hazard Characterization of EOL Renewable Energy (RE) Equipment

EOL PV modules:

- Only end-of-life (EOL) PV modules – those modules that no longer serve the purpose for which they are intended – are evaluated in this report. Any module, panel, or associated equipment that is in operation and continues to serve the purpose for which it is intended is not considered a waste for purposes of this report.
- For purposes of waste characterization, which indicates waste management requirements, DEQ finds that EOL PV modules will require Toxicity Characteristic Leaching Procedure (TCLP) testing to be considered nonhazardous.
- The Department expects to advance rulemaking efforts to define EOL PV modules as universal waste in 2021.

- The Department has asked the American Society for Testing and Materials (ASTM) to adopt a sample preparation method in TCLP testing of PV module waste for representative and accurate waste characterization. If ASTM adopts such a standard and it is found to be acceptable by the U.S. EPA, the DEQ may initiate rulemaking to 15A NCAC 13A to incorporate this new procedure in North Carolina.

EOL Energy Storage System Batteries:

- The Department finds that some energy storage system batteries exhibit hazardous characteristics and that existing regulations for managing batteries characterized as such indeed apply to energy storage system batteries and further finds that the development of a specific regulatory program for storage batteries is not recommended at this time.

Section 2(a)(2): Preferred Methods to Responsibly Manage RE Equipment

- The Department finds that the waste management hierarchy – waste reduction at the source > recycling and reuse > municipal solid waste (MSW) landfill disposal – applies well to the EOL management of PV modules, energy storage system batteries, and other equipment used in utility-scale solar projects or wind energy facilities.
- Every effort should be made to reduce, reuse, and recycle these materials, to the extent practicable under law, prior to landfill disposal.

Section 2(a)(3): Costs and Benefits of EOL RE Equipment Management Methods

- Reuse/refurbishment and recycling markets for EOL renewable energy equipment in the U.S. are still developing and not fully established due to a limited supply of decommissioned equipment.
- Reuse, refurbishment, and recycling are all environmentally preferable management options.
- Reuse and refurbishment are largely economically advantageous.
- Recycling opportunities are limited and costly, however as more renewable energy equipment reaches EOL and is available for recycling, the recycling process is expected to improve with new technology and operational efficiency which should lead to reduced recycling costs.

As recycling technologies evolve and mature, the Department recommends the creation and maintenance of an on-line list of renewable energy equipment recyclers (both in- and out-of-state), modeled after the registration requirements set out in G.S. 130A-309.142 for facilities recovering or recycling electronics equipment.

Section 2(a)(4): Life-Cycle of RE Equipment Currently in Use in North Carolina

- The Department finds that the economically productive life-cycle for EOL PV modules averages 25 years, energy storage battery systems averages 10 years, and wind energy facilities averages 20 years.

- The Department also finds that the earliest scenario for EOL management appears to apply to those solar facilities installed around 2010, as they approach end of useful life – notwithstanding repowering – beginning in 2031.

Section 2(a)(5): Volume of RE Equipment in Use and Impacts on Landfill Capacity

- DEQ estimates that approximately 500,000 tons of PV modules are currently installed in the state and installations are projected to double in the next 5 years.
 - **Site specific information and annual generation amounts reported to the Energy Information Administration (EIA) through Forms 860 and 923 contain a robust set of static and dynamic generator-specific data. The EIA considers grid-tied facilities with a combined alternating current nameplate capacity rating of 1MW or greater to be a utility-scale operation. DEQ has determined that additional site-specific information may be necessary to evaluate waste management options when existing facilities in North Carolina reach EOL between 2030 and 2045. DEQ recommends the development of minimum notification requirement for facilities 1MW capacity or greater to coincide with federal reporting threshold for utility-scale operation. This recommendation would require amendments to the statutes authorizing the Division of Waste Management to request facility installation information. Furthermore, this recommendation is expected to have a fiscal impact, whether through establishing fee authority in statute or direct appropriations, to provide the Division with the resources necessary for program implementation.**
 - **To ensure adequate landfill capacity is available to dispose of EOL RE equipment, the Department recommends modeling the 10-year waste management planning required for generators of industrial waste pursuant to G.S. 130A-309.09D(c).**
- Conservatively, if all installed EOL PV modules were decommissioned and disposed of at the same time, that volume would account for less than 10% of the total tonnage disposed in North Carolina MSW landfills in FY2018-19.
- According to DWM experts, if every EOL PV module is disposed of in landfills, landfill capacities will not be negatively impacted.
- Fewer than 12MW of energy storage system batteries are installed statewide and because of their relative age, will not reach EOL for at least 10 years.
- Existing laws banning disposal of some batteries in landfills will result in limited landfilling of energy storage system batteries.
- One wind energy generation facility is in operation in North Carolina with an estimated date for decommissioning around 2037.
- Even if technology has not evolved to recycle the fiberglass blades at scale, DEQ predicts no strain on regional landfill capacity if all 4,400 tons of blades must be landfilled at EOL.

Section 2(a)(6): Survey of Other Jurisdictions' Regulatory Requirements

The Department's thorough survey and review of federal, state, and international approaches to management of EOL renewable energy equipment, decommissioning,

and financial assurance reveals many similarities across a patchwork of statutory, regulatory, and voluntary policies. With respect to energy storage system batteries, the Department supports the adoption of a federal regulatory program for EOL management for energy storage system batteries based on information and comments provided by stakeholders and industry experts who expressed concern about the development of a viable reuse and recycling market absent a federal strategy.

Section 2(a)(7): Is Financial Assurance Required to Ensure Proper Decommissioning

- The Department finds that there is a minimum 10-year time horizon for when the first significant tranche of PV modules may reach EOL, repowering efforts notwithstanding.
- The Department finds that existing local government regulatory structures for EOL management and decommissioning are in effect in the majority of the counties where utility-scale solar projects are installed.
 - **At this time, mandated financial assurance requirements are not necessary to ensure proper decommissioning of utility-scale solar projects and DEQ recommends further study on the feasibility and advisability of establishing a statewide standard for financial assurance in five years.**
 - *DEQ recommends the future study involve stakeholders and participation by the North Carolina Utilities Commission to evaluate the feasibility of tying such financial instruments to applications the Commission receives for new projects and methods for capturing financial assurance information for existing projects.*
 - *The future study should assess the historic and projected salvage value of EOL PV modules, incentives to reuse, repower, or recycle EOL PV modules, and the market forces necessary to drive the Department's preferred EOL management options.*

Section 2(a)(8): Infrastructure Needed to Collect and Transport EOL RE Equipment

Given the large volumes of PV modules and other equipment being removed from utility-scale renewable energy sites, transportation will likely be arranged directly to the EOL management facility. A network of collection and consolidation points would not be necessary to manage utility-scale PV modules, energy storage system batteries, and other equipment. The distance that the EOL equipment will need to be transported can vary greatly depending on the destination for EOL management, and the Department recommends that utility-scale renewable energy facilities anticipate and thoroughly evaluate the cost of collection and transportation as part of decommissioning planning.

Section 2(a)(9): Advisability of Establishing a Manufacturer Stewardship Program

- The Department finds that a manufacturer stewardship program for the recycling of EOL PV modules is not advisable at this time due to a variety of considerations including the lack of a strong recycling market, current limited need, and the fact that there is no other state with a mature stewardship program to benchmark.

- Existing rules for the management of solid and hazardous waste provide an adequate framework for proper recycling and disposal of PV modules.
- The Department recommends studying this management option in the future.

Excerpt of Item 2(a)(6)

and usually involves the removal of all solar equipment and restoration of the entire property.

Many counties require that solar facility decommissioning plans include a decommissioning timeline, estimated decommissioning costs, anticipated methods for decommissioning, and plans for updating decommissioning plan in the future. In addition, 24 counties have adopted specific financial assurance requirements for solar facility decommissioning. The majority of these counties require a type of financial guarantee greater than or equal to the estimated decommissioning costs, with the estimated decommissioning costs re-evaluated on a regular basis. The highest financial assurance requirement established by one county is 150% of the estimated decommissioning cost of a solar facility. Some counties allow for the consideration of the potential salvage value in the estimated decommissioning costs for financial assurance. The ordinances authorize several different types of financial assurance instruments, such as a surety bond, certified check, irrevocable letter of credit, and a cash escrow. An additional six counties require decommissioning costs to be considered in the decommissioning plan but do not require a financial guarantee. Several counties' ordinances specify that decommissioning costs must be estimated by a third-party licensed engineer. Beaufort, Hertford, and Warren are the only counties that do not require a financial guarantee, but the ordinances explicitly provide that if the solar facility owner/operator is unable to pay for decommissioning costs, the decommissioning becomes the responsibility of the landowner.

Other States

North Carolina is not alone in its evaluation of the best management methods for EOL PV modules. Minnesota is engaged in a similar stakeholder process to research and develop PV module end-of-life regulations. The Minnesota Department of Commerce and the Minnesota Public Utilities Commission created a working group to review existing laws and decommissioning plans in order to make recommendations on decommissioning. As discussed in Section 2(a)(9), Washington was the first state to enact a PV module EOL management approach utilizing a manufacturer-based stewardship and takeback program. However, Washington recently postponed the effective date for submittals of the manufacturer-based stewardship plans, in part to further research applicability to all solar installed in the state, and to discuss implementation with stakeholders. As described in Section 2(a)(1), California has characterized EOL PV modules that exhibit the characteristic of toxicity as universal waste instead of hazardous waste. Additionally, some states have established best practices without statewide decommissioning mandates. Organizations in Georgia, Massachusetts, New York, and North Carolina, have developed guidance for local governments for solar facility decommissioning in the form of a model ordinance.

The 16 states with decommissioning regulations in place for solar facilities are listed in Table 6-1. The requirements for decommissioning vary from state to state. In Hawaii, the applicability of decommissioning regulations depends on the land classification, while in South Dakota decommissioning requirements apply to facilities greater than or equal to 100MW. Most states do not list specific requirements for inclusion in decommissioning plans, but some specifically require site restoration and an estimated cost of decommissioning. Seven states require financial assurance for future decommissioning of solar facilities. Many states do not specify the amount required; however, the amount must

VII. HB329 Section 2.(a)(7)

Whether or not adequate financial assurance requirements are necessary to ensure proper decommissioning of utility-scale solar projects upon cessation of operations.

As discussed in Section 2(a)(6), more than half of North Carolina’s counties have adopted solar facility decommissioning requirements into county ordinances, nearly a quarter of which include requirements for financial assurance. Figure 7-1 depicts a map created by the Department of the locations of utility-scale solar facilities overlaid in the counties with decommissioning requirements. Table 7-1 lists solar facility information by county including the number of facilities, the sum of the facilities nameplate generating capacity, the sum of the PV modules, the sum metric tonnage of the PV modules and whether the county has adopted requirements for decommissioning and or financial assurance (it is important to note that the county data provided in this section is based on information available at the time this report was submitted).

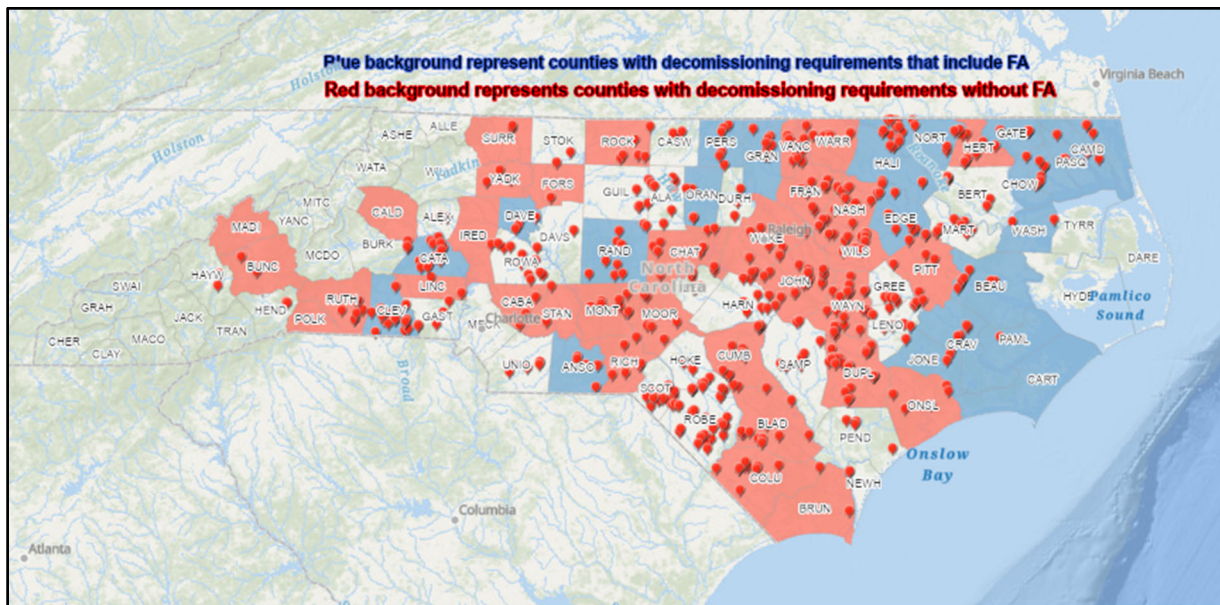


Figure 7-1. Solar Facilities and Counties with Decommissioning Requirements

Financial assurance to ensure proper decommissioning of utility-scale solar projects was the subject of many lengthy discussions and iterative communications among the Department staff and the participating stakeholders. During these discussions, the Department understood better that the contracts executed between private parties – solar developers, landowners, and operators – include financial instruments that ensure proper decommissioning to the extent acceptable to and required by the landowner. The Department was also made aware that like any other infrastructure asset, grid-connected utility-scale solar facilities represent millions of dollars of investments, never mind the value of the interconnection to the transmission grid, that owners, utilities, or third-parties have a financial incentive to maintain the project in good repair and salvage as much value from the equipment at EOL as possible to offset decommissioning costs.

Counties	# of Facilities	Sum of Calc MW	Sum of Number of PV Modules	Sum of Metric Tons Per Facility	Solar Decommissioning Regulation	Financial Assurance
Alamance	8	33	144,969	3,372	No	No
Alexander	2	6	74,224	956	No	No
Anson	7	108	566,574	11,818	Yes	Yes
Beaufort	10	142	616,102	13,794	Yes	Yes
Bertie	5	41	182,727	4,266	No	No
Bladen	13	187	820,511	19,149	Yes	No
Bladen/ Cumberland	1	70	271,510	6,453	-	-
Brunswick	3	11	44,654	1,061	Yes	No
Buncombe	2	5	21,294	492	Yes	No
Burke	3	12	59,380	1,343	No	No
Cabarrus	3	85	423,069	10,056	Yes	No
Camden	3	15	68,619	1,631	Yes	Yes
Caswell	3	15	78,000	1,757	No	No
Catawba	13	105	391,460	9,960	Yes	Yes
Chatham	8	37	251,766	4,484	Yes	No
Chowan	2	10	48,674	1,157	Yes	Yes
Cleveland	21	82	366,646	8,690	Yes	Yes
Columbus	12	54	251,595	5,749	Yes	No
Craven	6	29	208,884	3,608	Yes	Yes
Cumberland	12	116	488,460	11,610	Yes	No
Currituck	3	140	631,752	15,016	Yes	Yes
Davie	4	30	149,921	3,563	Yes	Yes
Duplin	25	150	741,471	17,507	Yes	No
Durham	4	16	80,476	1,864	No	No
Edgecombe	7	105	481,038	11,369	Yes	Yes
Forsyth	2	7	30,329	721	Yes	No
Franklin	10	87	367,697	8,720	Yes	No
Gaston	3	14	67,920	1,566	No	No
Gates	3	15	65,952	1,568	Yes	Yes
Granville	7	33	185,702	3,614	Yes	Yes
Greene	4	14	61,058	1,417	No	No

Guilford	4	18	78,050	1,814	No	No
Halifax	11	136	572,771	13,590	Yes	Yes
Harnett	10	46	236,209	4,931	No	No
Haywood	1	2	6,525	155	No	No
Henderson	2	4	16,676	396	No	No
Hertford	12	150	670,650	15,940	Yes	No
Hoke	3	15	66,806	1,588	No	No
Iredell	1	5	23,000	547	Yes	No
Johnston	23	85	427,786	9,252	Yes	No
Jones	5	25	196,278	3,174	Yes	Yes
Lee	8	39	194,572	3,983	No	No
Lenoir	11	94	430,402	10,162	No	No
Lenoir and Wayne	1	5	23,000	547	-	-
Lincoln	2	10	45,722	1,038	Yes	No
Martin	13	91	480,336	9,338	No	No
Montgomery	7	47	293,101	5,438	Yes	No
Moore	9	39	180,943	4,205	Yes	No
Nash	23	168	998,220	17,974	Yes	No
New Hanover	2	3	13,102	301	No	No
Northampton	15	223	1,531,013	25,769	Yes	Yes
Onslow	5	27	164,500	3,190	Yes	No
Orange	6	18	88,602	2,038	Yes	Yes
Pamlico	1	5	21,257	505	Yes	Yes
Pasquotank	3	43	186,761	4,439	Yes	Yes
Pender	6	125	1,207,848	17,117	No	No
Perquimans	8	51	228,710	5,436	Yes	Yes
Person	6	17	87,608	2,001	Yes	Yes
Pitt	8	84	428,996	9,359	Yes	No
Randolph	12	47	300,788	5,342	Yes	Yes
Richmond	6	70	301,004	7,154	Yes	No
Robeson	38	196	999,410	21,742	No	No
Rockingham	6	30	141,932	3,228	Yes	No

Rowan	11	46	205,386	4,814	No	No
Rutherford	8	97	387,071	9,159	Yes	No
Sampson	10	37	236,744	4,443	No	No
Scotland	14	135	773,796	15,339	No	No
Stanly	2	10	49,000	1,116	Yes	Yes
Stokes	1	4	21,780	477	No	No
Surry	2	5	23,828	566	Yes	No
Union	5	80	397,678	9,404	No	No
Vance	13	108	587,332	12,297	Yes	No
Wake	9	27	125,582	2,840	Yes	No
Warren	7	31	146,804	3,416	Yes	No
Washington	2	19	92,660	2,154	Yes	Yes
Wayne	23	97	501,770	11,082	Yes	No
Wilson	13	128	866,490	20,595	Yes	No
Yadkin	4	14	91,804	1,677	Yes	No

*The existence of 9 facilities were unable to be confirmed by NC DEQ at this time. These facilities were conservatively included in the data.

**Additional facilities may be provided by the NC Department of Agriculture and Consumer Services and added to the data in the future.

Table 7-1. Detailed Solar Facility Information by County

Taking the aforementioned points together with the projected minimum 10-year time horizon for when the first significant tranche of PV modules may reach EOL, repowering efforts notwithstanding (See Sections 2(a)(2) and (4)), and existing local government regulatory structures already in place, the Department finds:

- That mandated financial assurance requirements are not necessary to ensure proper decommissioning of utility-scale projects at this time and recommends further study on the feasibility and advisability of establishing a statewide standard for financial assurance in five years.
 - This focused review should involve stakeholders and participation by the NCUC to evaluate the feasibility of tying such financial instruments to applications to it receives.
- That local government ordinances that require financial assurance for decommissioning are already in effect in the majority of the counties where utility-scale solar projects are installed.
- That further study is needed about the salvage value of EOL PV modules, incentives to reuse, repower, or recycle EOL PV modules, and the market forces necessary to drive the Department’s preferred EOL management options (See Section 2(a)(2)).