Circular Economy Frameworks and Metrics Relevant to Renewable Generation and Lithium Battery Technologies

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Background/Objectives. A circular economy (CE) is one that is regenerative by design, with the intent to improve the efficiency of resource use by re-entering materials with remaining value into the economy rather than discarding them. While recycling is a crucial component, CEs also encompass many more potential actions, such as incorporation of processes and designs that use less virgin material, selection of low emission materials, designing products for increased repurpose or recyclability, specifying sustainable choices and environmental considerations during procurement, life extension of equipment and facilities, and the elimination of waste products. Three broad ways the electric power industry interacts with a CE system are: 1) electric power production and its efficient use across the economy, 2) procurement and use of significant volumes of equipment, materials, fuels, and services, and 3) management of large volumes of materials at the end of their initial lifespan. This research aims to understand the intersectionality of CE with energy industry sustainability priorities, and to inform energy company decision-making around measuring CE progress through CE metrics.

Approach/Activities. The work began by reviewing pre-existing circularity examples in the energy industry and evolving the Anthesis Group Circular Economy Framework to be specific to the energy industry via interviews with industry experts. The resultant CE framework for the energy industry was then applied to four products—coal combustion products (CCPs), photovoltaic (PV) modules, wind turbine blades, and large format lithium-ion batteries. Specific examples of companies that are proactively operationalizing CE principles in their business practices for renewables and batteries were documented as case studies. Sustainability subject matter expertise was utilized to determine the role of CE within current ESG strategies and energy industry activities. The work continues by evaluating frequently cited CE frameworks to assess overlap with sustainability goals, metrics, and priorities and provide guidance to energy companies on tracking CE progress.

Results/Lessons Learned. The energy industry CE framework provides a top-down process to identify opportunities and develop a portfolio of CE strategies. Three fundamental elements include: (1) reduce natural resource use (for example, transition to renewable power, energy efficiency, electrification, equipment design), (2) extend equipment life (improve durability, upgrade, repair), and (3) eliminate resource loss (asset recovery, reuse, recycle). High-level aspirational activities were also identified, such as prioritizing the transition to renewable power, and coordinating across multiple internal and external stakeholders. Identification of key metrics or performance indices that have the capability of measuring outcomes toward CEs remains a need that is being addressed in the current study. By analyzing CE from the sustainability lens, it is possible to leverage EPRI's repository of over 5000 sustainability metrics to begin cataloging CE metrics. The most prevalent CE keyword in the CE Metrics Inventory is "recycl*," revealing that most of the cataloged metrics address material flow with a small subset of these metrics relating to sourcing via recycled materials. Ultimately this research will provide a foundation and growing set of resources for energy companies to apply CE concepts and metrics as they drive toward a more circular energy economy.