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RECOMMENDATIONS FOR THE NEW ADMINISTRATION

Waste Management and the Energy Transition: The Path to Sustainability and a Circular Economy

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This brief is part of a series of policy recommendations for the administration of President Joe Biden. Focusing on a range of important issues facing the country, the briefs are intended to provide decision-makers with relevant and effective ideas for addressing domestic and foreign policy priorities. View the entire series at www.bakerinstitute.org/recommendations-2021.

THE GLOBAL ENERGY & ENVIRONMENTAL CHALLENGE

Global energy and environmental challenges have spurred an increased focus on sustainable sources of energy while global investments in the green energy sector have surged. Low-carbon, "zero" emission technology and scientific advancements required to facilitate the energy transition—such as wind turbines, solar photovoltaic panels, and lithium-ion batteries for electric vehicles and energy storage systems—are pivotal advancements for the energy transition. There are a number of U.S. leadership opportunities that innovative technologies present in the global economic, energy, environment, and geopolitical arenas and in building a stronger, more resilient nation. However, with the Biden administration's focus on a climate plan that prioritizes the clean energy revolution, environmental justice, and sustainability, it is critical to integrate a life-cycle dimension into future policies to identify, quantify, and assess the social, environmental, and economic implications of products and processes across their life cycle and throughout their value chain in order to achieve sustainability and a circular economy. This is important as "zero emissions" and "social assessment" often only apply to one stage of the value chain (e.g., "zero-emission" generation of solar power does not include the global emissions from mineral extraction and refining, the often long-distant transportation of materials and panels, the energy used to manufacture the solar panels, or any end-of-life environmental issues).

SUSTAINABILITY REQUIRES PRIORITIZING LIFE-CYCLE INSIGHTS

Globally there is a growing recognition and commitment within industry and the economy at large, through corporate social responsibility and environmental, social, and governance (ESG) reporting, as well as the United Nations Sustainable Development Goals (UN SDGs), to address responsible consumption and production; affordable and clean energy; sustainable and resilient infrastructure and industrialization; climate change; and waste in the ecosystem. Addressing these issues will require embracing a systems-level and transparent approach to social, environmental, and economic factors throughout a product's

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life cycle and being responsible stewards of valuable resources. In order to measure and have insight around sustainability and the equilibrium of these elements, a comprehensive picture of life-cycle impacts across the supply chain is needed. Appropriate public policy also depends on an accurate assessment of life-cycle ESG issues.

As the Biden administration reprioritizes its strategies and reasserts U.S. leadership on the global stage, it is imperative to address the stressors across the value chain that usher in social, environmental, and economic risk. Life cycle assessments (LCAs) will play a significant role in ensuring the sustainability of energy technologies and in helping the United States remain innovative, competitive, and cognizant of threats to economic prosperity, energy independence, and national security. LCAs are an analysis technique to evaluate the full spectrum of impacts associated with every stage of a product, service, or activity, from cradle to grave (i.e., raw material extraction, materials processing, manufacture, distribution, use, transportation, and disposal).

New energy producing and consuming technologies and innovations must incorporate life-cycle obligations that identify and quantify the environmental, social, and economic impacts from cradle to grave and across the supply chain. These life-cycle insights will help the U.S. government devise strategies to increase our resiliency to system disruptions; manage our reliance on offshore supply chains for critical materials and disposal; and improve domestic energy and waste management infrastructure.

CHALLENGES OF LOW-CARBON, ZERO-EMISSION INNOVATIONS

Energy-related environmental and social concerns are broad and encompass local as well as global issues. Sustainability should not be limited to assessing impacts within U.S. borders; it involves a holistic assessment of all impacts throughout the life cycle of a product, service, or activity. Current net-zero strategies do not account for sustainability metrics outside the United States—they simply shift the risk to other segments of the value chain, leaving those broader impacts unrealized. The innovations and scientific advancements required for the clean energy revolution all come with liabilities that arise throughout a product's life cycle, oftentimes in emerging market supply chains. Most of these impacts are unquantified. For example, import-reliant minerals that are mined, processed, smelted, and traded overseas in countries with opaque or corrupt regimes can create social imbalances due to weak or absent environmental, health, safety, and labor laws in developing economy supply chains. Additional matters that are frequently unaccounted for include obscure trading and waste disposal practices; underdeveloped or nonexistent waste management technologies at a product's end-of-life; and transportation between each segment of this complex global supply chain network that supports renewable and low-carbon energy technologies.

Strategies regarding the energy transition often overlook the environmental and social issues of waste management. With the immediate pressures of climate change and the urgency to incorporate alternative energy resources, there is an overt focus on the benefits of these energy transition technologies, but there is a clear absence of strategy around identifying and quantifying the negative impacts. Currently, wind turbine blades and solar panels are landfilled at the end-of-life, and lithium-ion batteries are stockpiled, landfilled, or incinerated. [1,2,3] This highlights the need to prioritize the safe and sustainable disposal or recycling of renewable technologies before the anticipated influx at the end-of-life. If the goal is to increase the sustainability of these industries, the Biden administration should encourage the development of improved technologies in design, manufacturing, operations, maintenance, and disposal with a focus on upstream research and development for recycling or reuse.

The United States has a glaring blind spot in quantifying and understanding the true cost of the energy transition on sustainability. The Biden administration has an opportunity in the energy transition to take the lead in positively shaping and

implementing social and environmental justice by developing transparent policies that utilize LCAs to capture and quantify the risks, uncertainties, and vulnerabilities of new technologies and to understand the trade-offs that exist not just in the United States, but beyond its borders as well.

RECOMMENDATIONS FOR PRIORITIZING WASTE MANAGEMENT TO ACHIEVE SUSTAINABILITY

Prioritize and integrate life-cycle dimensions into decision-making for a true understanding of sustainability.

Ensuring policies and actions have a life-cycle dimension that captures ESG criteria within and outside U.S. borders allows the United States to prioritize resources and redirect investments, stimulate innovation in enterprises and value chain actors, assist decision-makers in promoting a circular economy, and understand how risks and costs can be lowered to drive investments. Integrating a life-cycle dimension into waste management can objectively inform decisions and accelerate the transition of innovations to higher levels of technology readiness.

Commission a national study of projected renewable energy technology waste quantities and types.

There is a dearth of data that fails to capture the full extent of the evolving waste crisis, detracts from the national vision of sustainability, and leaves the nation vulnerable and unprepared for the demands of a circular economy. Understanding how much waste is generated, what the associated environmental and social impacts are, and what types of renewable energy technology waste are being produced, allows the government to strengthen domestic capabilities and to plan for appropriate management methods and future demand.

The Biden administration should commission a national study that quantifies and analyzes projected energy transition technology waste streams to strategize and support the establishment of suitable regulatory and investment conditions for managing waste at the end-of-life. This data will provide clearer estimates of projected waste products entering their end-of-life over the next 10–20 years. The study should provide recommendations for improving national data collection, data quality, reporting, and tracking. The economic costs of potential strategies would be an important dimension of the study as well.

Adopt sustainable, energy-specific waste policies for renewable systems.

State and federal hazardous waste laws are not adapted to handle renewable and new energy systems. The Biden administration should establish end-of-life management policies specific to energy technologies to secure long-term socioeconomic benefits such as material recovery through recycling and creation of new industries and jobs. This could ultimately include the adoption of a national policy for the proper disposal and recycling of products; the standardization of classification; the development of regulations for collection, disposal, and recycling; the creation of treatment standards; and the implementation of reporting and monitoring requirements. Mandated recycling, coupled with extended producer responsibility, would discourage valuable materials from being landfilled or incinerated and incentivize sustainable designs aligned with circular models.

Require renewable energy and enabling technologies to prepare a recycling and disposal/decommissioning plan.

The Biden administration should encourage renewable energy and enabling technology companies to prepare a recycling and disposal/decommissioning plan, conceptually similar to what oil and gas, nuclear, and hazardous waste industries submit as a part of their upfront planning process for closure and post-closure care requirements of end-of-life operations. This will spur preliminary, end-of-life considerations and encourage collaboration and coordination between the energy sector and the waste industry.

CONCLUSION

Energy and advanced technologies are a necessity for modern human activity and economic and social development. A sustainable approach to renewable energy waste requires the creation and implementation of a circular economy through the use of life cycle assessments. While the current management of renewable energy technologies and other zero-carbon innovations have unveiled weaknesses in existing national systems, it opens the door for opportunities to build more resilient and socially and environmentally conscious policies and business models across the globe. Investments in circular innovations, with a focus on design for recyclability and direct reuse, and the development of appropriate waste management standards can drive U.S. leadership in the clean energy revolution as well as enhance environmental justice, quality, and manufacturing. It is also a proactive step toward attaining global commitments to the UN SDGs and climate goals.

ENDNOTES

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3. Katerin Ramirez-Tejeda, David A. Turcotte, and Sarah Pike, "Unsustainable Wind Turbine Blade Disposal Practices in the United States: A Case for Policy Intervention and Technological Innovation," *New Solutions: A Journal of Environmental and Occupational Health Policy* 26, no. 4 (2016): 581–598, https://doi.org/10.1177/1048291116676098.

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