Smart Prosperity Institute

Executive Summary

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About Smart Prosperity Institute
Smart Prosperity Institute is a national research network and policy think tank based at the University of Ottawa. We deliver world-class research and work with public and private partners – all to advance practical policies and market solutions for a stronger, cleaner economy.
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SOLAR AND WIND ENERGY IN CANADA

VALUE RECOVERY AND END-OF-LIFE CONSIDERATIONS

IMPLICATIONS FOR POLICY-MAKERS

Wind and solar energy will play an ever-growing role, globally and nationally, in meeting future energy needs under mid-century net-zero greenhouse gas emission goals. This transition, enabled by the rapidly declining costs of these technologies, is being accelerated as a mainstay of climate policy.

Fittingly, the policy lens on these renewable energy technologies has focused on their promise in a net-zero future. Only lately has it broadened to include equally critical considerations of the material needs and end-of-life management implications of this transition.

Wind turbines and solar photovoltaic (PV) modules require more material per unit of energy generation (t/MW) relative to fossil-fuel-based counterparts, including critical and strategic minerals and metals subject to potential near-term economic or geopolitical supply constraints. This includes 13 of the 31 minerals designated as critical by Canada based on their necessity for economic growth and national security, plus four rare-earth elements. As early wind and solar installations advance in age and reach end-of-life, rapidly growing volumes of material are being decommissioned and valuable resources are finding their way into waste streams, while policy frameworks have yet to catch up.

To get ahead of this challenge, policies are needed to both encourage the adoption of low carbon renewable energy sources, while also accounting for the material requirements and end-of-life considerations these technologies entail. Circular economy approaches offer the potential to reduce the material intensity of wind turbines and solar PV modules, minimize material loss along their life cycles, recover value at their end-of-life, and reduce future volumes of waste sent to landfills.

This report represents a first effort to explore these issues in the Canadian context. Building on scenarios of projected solar PV and wind turbine adoption to 2050 from the Canada Energy Regulator (CER), it models the potential scale of future end-of-life material volumes stemming from Canadian installed wind and solar energy sources. Drawing on a review of literature, leading global policies, and interviews with selected experts, it outlines pathways to reduce material consumption, extend lifespans and recover value from wind turbines and solar PV modules; lists a menu of policy options to minimize waste generation and encourage circularity of materials; and identifies further research needs.

Key findings include:

- By 2050, even conservative scenarios of renewable energy technology uptake from the CER suggest a 60-fold increase in accumulated end-of-life solar PV modules, and a 30-fold increase in accumulated end-of-life wind turbines (including hard-to-recycle blade waste) from today.

- Bulk recycling of solar PV and wind turbines can be done by existing Canadian recycling facilities for bulk materials with established markets such as glass, iron, steel, and aluminum. Specialized facilities are needed to recover other metals and semi-conductors found in solar PVs, which also have high strategic value; Canada does not yet have facilities for this high-value recycling, nor the volumes to make domestic facilities economically feasible. The rare earths used in wind turbines have established competitive recycling channels, but wind blades lack established economically viable recycling pathways due to their size and composition.

- Voluntary programs currently collect a small share of Canada's thin-film solar PVs for specialized recycling in US facilities. At present, most decommissioned solar PV modules and blade waste from end-of-life wind turbines are now directed to landfills or are being stored pending future recycling options.

- These materials represent a valuable resource, encompassing several critical and strategic minerals which could become subject to potential supply bottlenecks in the near future.

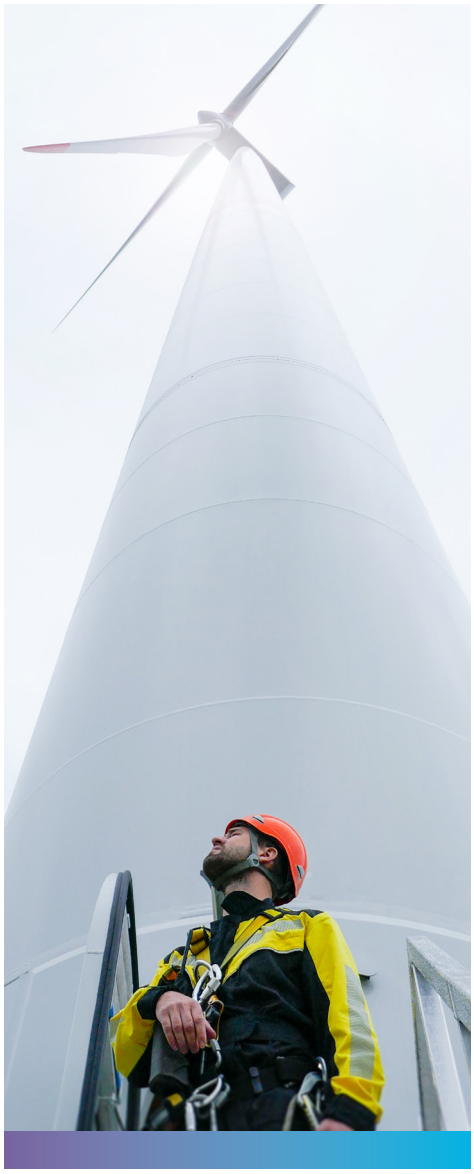
- To date, there has been little policy action in Canada anticipating the volume of end-of-life renewable energy technology material flows, or encouraging greater circularity of materials used in solar PV and wind technologies. This may change with the Government of British Columbia's recently announced intention to include solar panels in its Recycling Regulation and EPR strategy. SPI proposes five policy objectives to guide future action:

1. Divert waste from renewable energy technologies from landfill;
2. Recover critical minerals and metals used in renewable energy technologies and support the creation of markets for the secondary materials;
3. Shift the onus of end-of-life management of renewable energy technologies from the public to the producers of the products;
4. Encourage the consideration of lifecycle impacts in the procurement of renewable energy technologies; and
5. Align with emerging international policies and practices.

- Looking to emerging international policies and practices, potential policy tools include targeted end-of-life regulations such as waste classification and landfill bans; extended producer responsibility; eco-design regulations; labelling and certification; binding and measurable recovery and recycling targets from end-of-life solar PV and wind turbines; and guidelines for testing and certification of second-hand panels.

- More evidence is needed to inform policymaking. There remains a need to address crucial data gaps which limit the modelling of future end-of-life scenarios, conduct more in-depth assessments of recycling options and capacity, and consider stakeholder input on policy options.

While preliminary, these findings clearly identify that evolving strategies to increase the uptake of renewable energy technologies across Canada need to be paralleled with similar attention to policies designed to address equally critical considerations of the material needs and end-of-life management implications of this transition.



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Three working papers with more details on the findings in this Policy Brief are available at **institute.smartprosperity.ca/library**:

Working Paper 1: Solar and Wind Energy in Canada – Value Recovery and End-of life Considerations: Material needs and end-of-life resource flow implications under Canada's climate change objectives, and data gaps.

Working Paper 2: Solar and Wind Energy in Canada – Value Recovery and End-of life Considerations: Pathways to reduce resource consumption, extend the life of products and recover value, and associated Canadian capacity

Working Paper 3: Solar and Wind Energy in Canada – Value Recovery and End-of life Considerations: Policy options to minimize waste generation and encourage value recovery and circularity in materials.

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