

Trade-Related Circular Economy Aspects of Wind and Solar Energy

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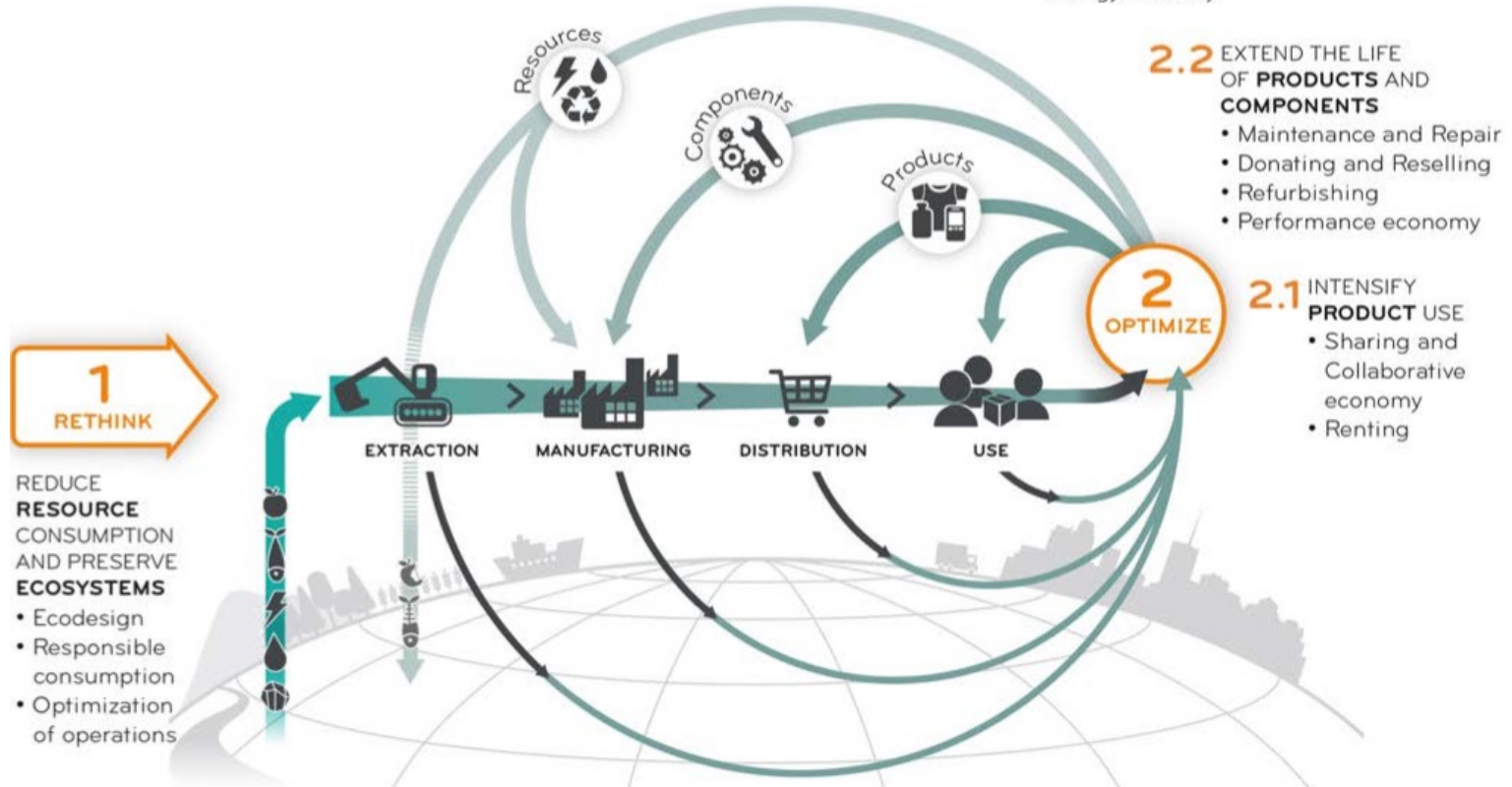
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What does the term 'circular economy' mean to you?

Responses from Mining for Circularity Forum Participants (23 March 2021)



Models of the Circular Economy



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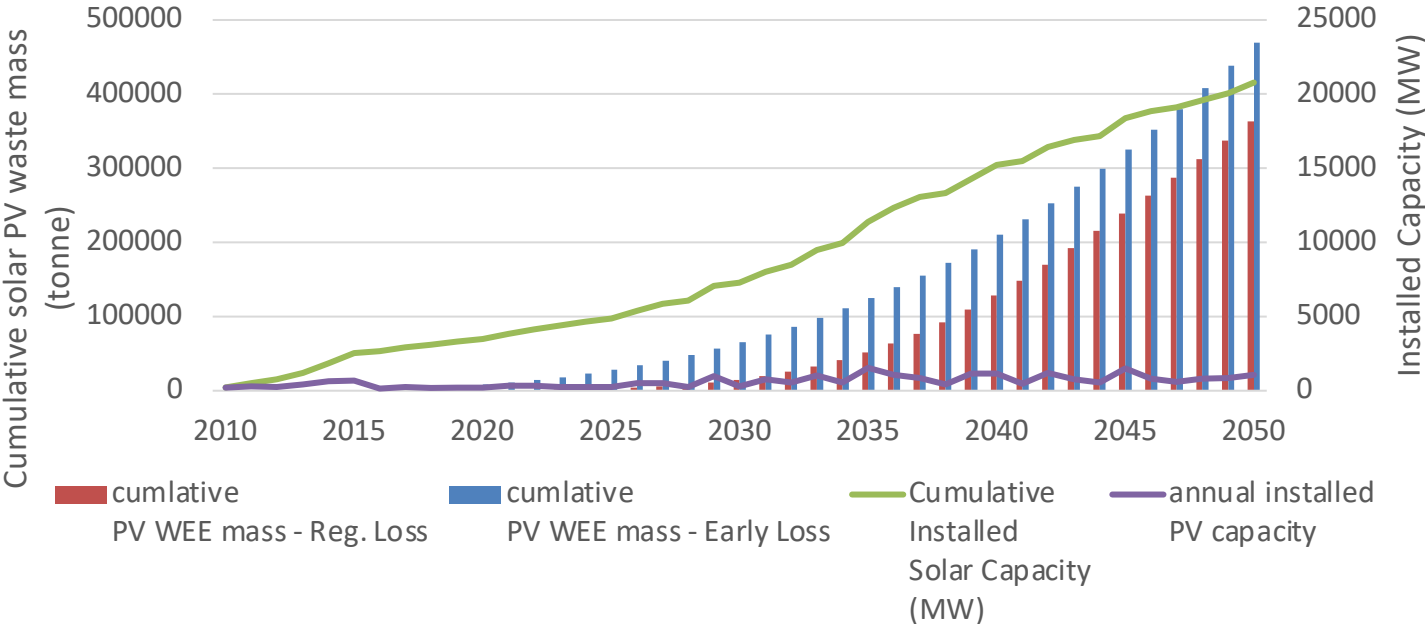


Connecting Circular Economy and a Renewable Energy Transition

In Canada, even conservative scenarios of renewable-energy technology uptake suggest:

- **A 60-fold increase in accumulated end-of-life solar PV modules**

Cumulative Solar PV Waste Evolution

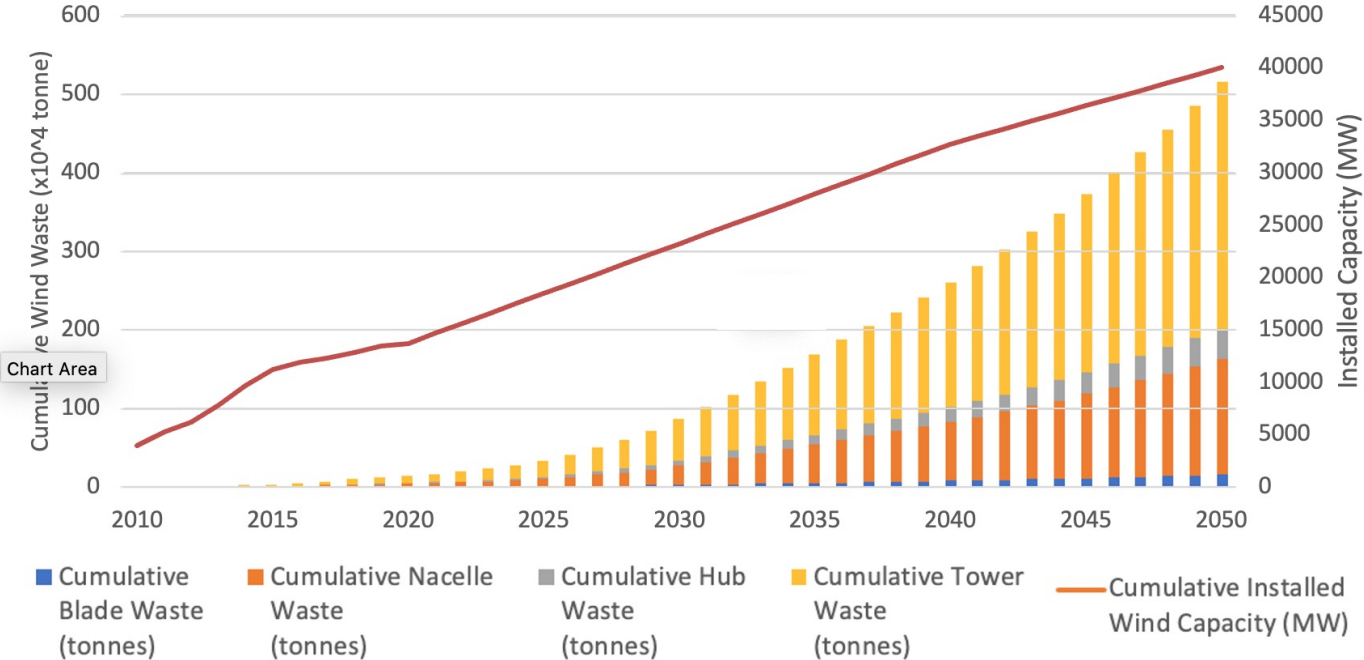


Connecting Circular Economy and a Renewable Energy Transition

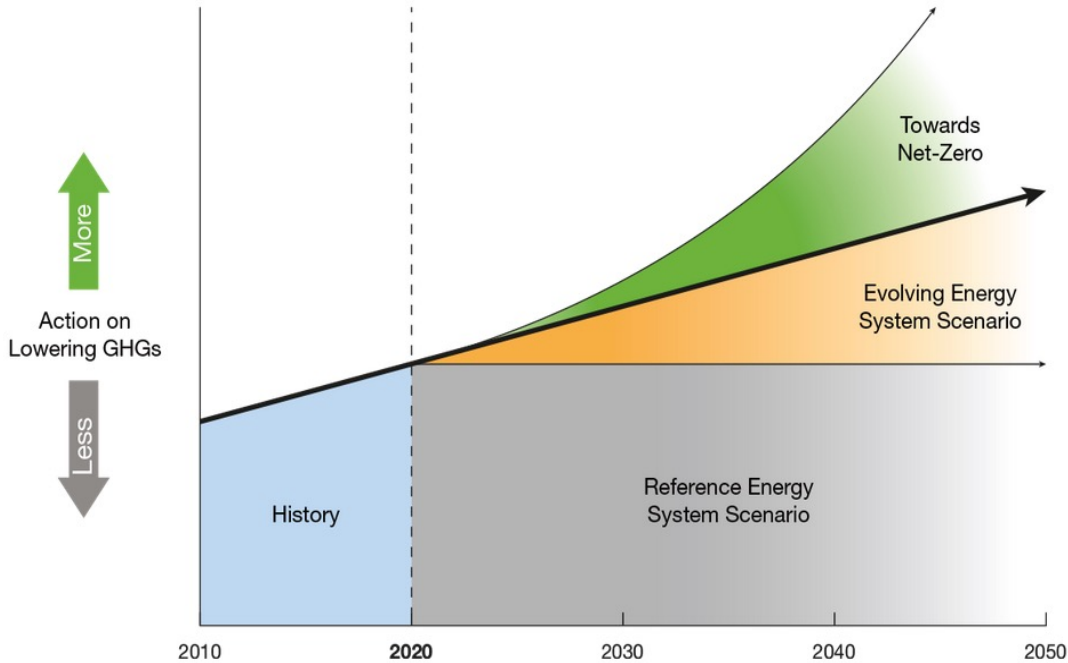
In Canada, even conservative scenarios of renewable-energy technology uptake suggest:

- **A 30-fold increase in accumulated end-of-life wind turbines**

Cumulative Wind Waste Evolution



Conceptual Illustration of EF2020 Scenarios and a Net-Zero Future



Towards Net-Zero

The pace of action on addressing climate change increases from current levels.



Evolving Energy System Scenario

Continues the historical trend of increasing action on climate change throughout the projection. Policies and agreements are strengthened after they sunset. Low carbon technologies continue to be developed.



Reference Energy System Scenario

Climate change actions limited to only the measures that are currently in place. Technological development is modest, and generally limited to those with existing momentum and/or market share.



History

Gradually increasing action on climate change, including policies, regulations, and development of low carbon resources and technologies.



Connecting Circular Economy and a Renewable Energy Transition

In Canada, even conservative scenarios of renewable-energy technology uptake suggest:

- **A 60-fold increase in accumulated end-of-life solar PV modules,**
- **A 30-fold increase in accumulated end-of-life wind turbines.**

These technologies **require more materials** per unit of energy generation compared to fossil-fuel based energy technologies

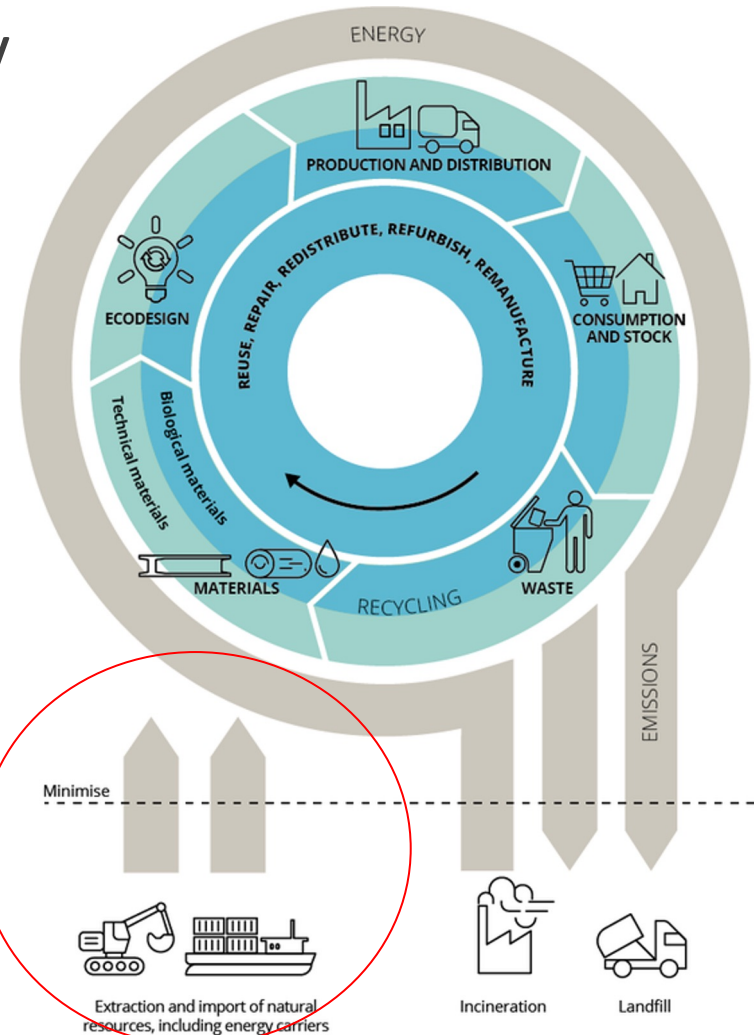
They also use [critical and strategic minerals and metals](#), which are subject to [near-term economic or geopolitical supply constraints](#).

These include 13 of the 31 minerals [designated as critical by Canada](#), because of their importance to economic growth and national security, plus 4 rare-earth elements.



Models of the Circular Economy

Generally, most CE models (e.g. here from the European Env. Agency) place a greater emphasis on downstream production, while aiming to **minimize the role** of primary resource extraction.



"European industries consume more than 20% of the metals that are mined globally, yet European mines produce only 1.5% of iron and aluminium, and 6% of copper." (Vidal, Goffé & Arndt, 2013).



Global Material Demand Projections

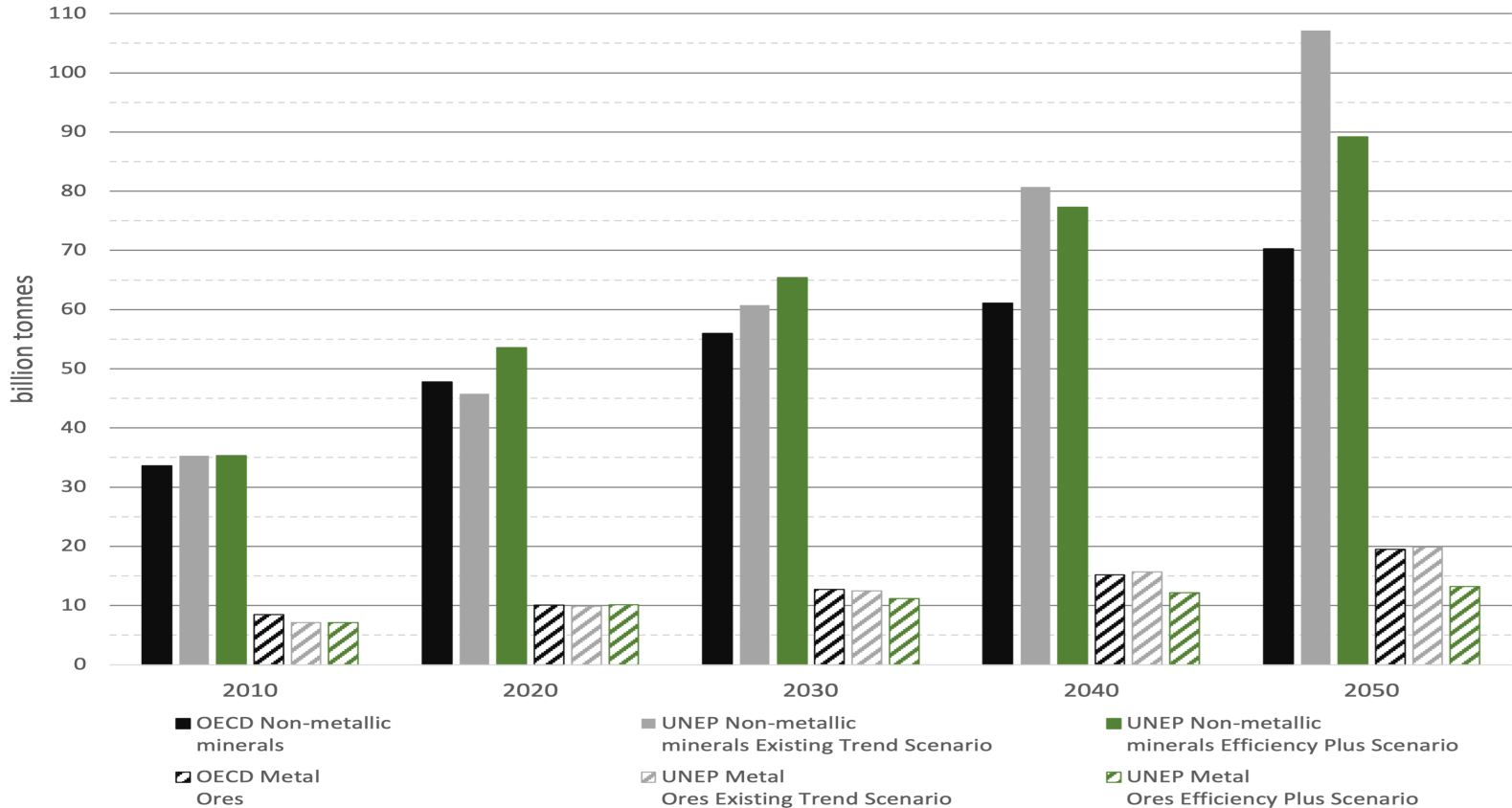
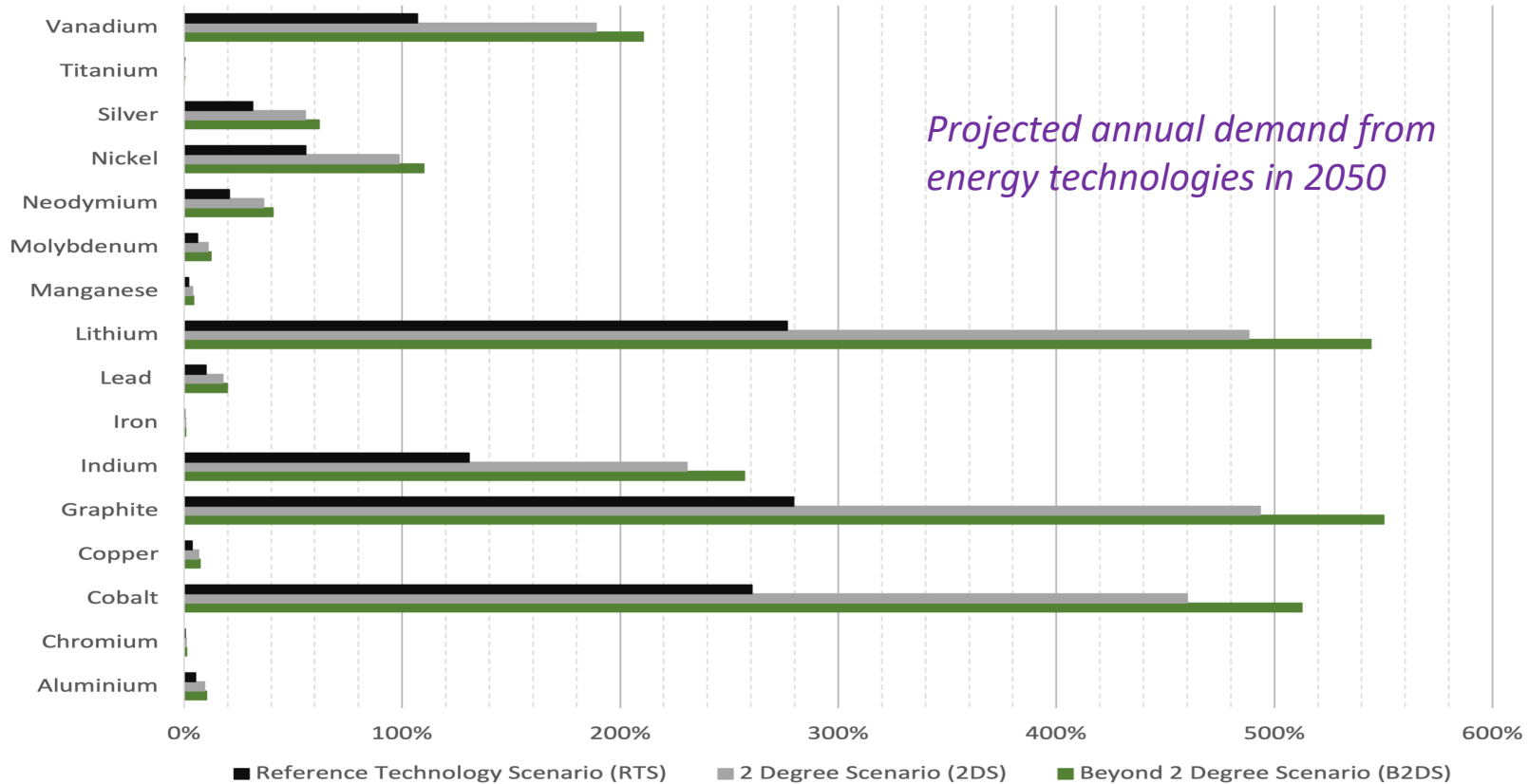


Figure 2: Projected Metal Ore & Non-Metallic Mineral Demand to 2050. Adapted from OECD (2019) and UN Environment Programme, International Resources Panel (IRP 2017)

Global Context: Material needs of rapid decarbonization

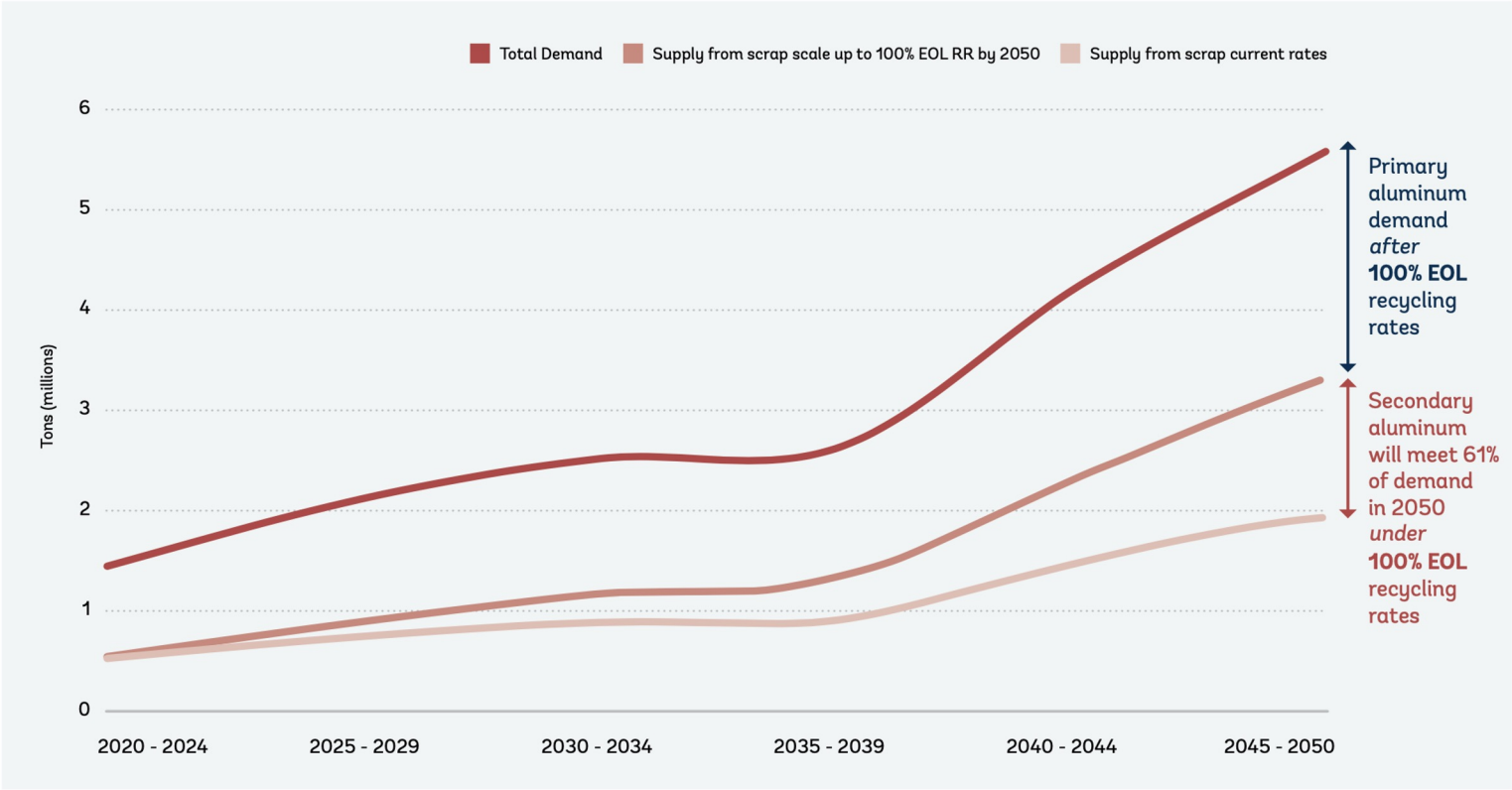
Source: Smart Prosperity Institute. 2021. [Primary Materials in the Emerging Circular Economy](#)



Adapted from World Bank (2020)



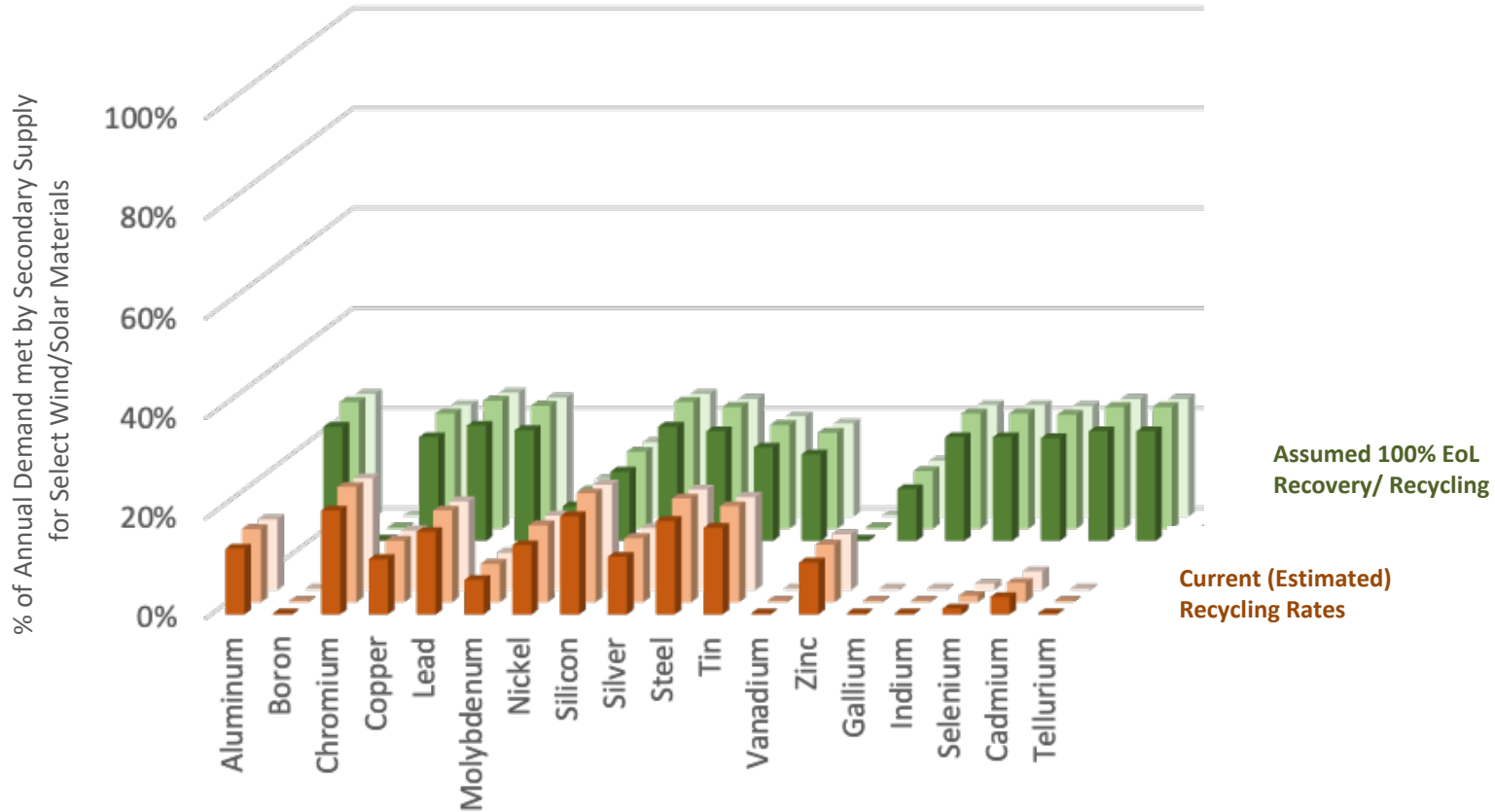
Figure ES.4 Aluminum Recycling Projections Relative to Annual Aluminum Demand Under 2DS Through 2050



Note: EOL recycling rates are assumed to increase annually to meet 100 percent EOL by 2050. This means that secondary aluminum meets an increasing amount of aluminum demand over time. 2DS = 2-degree scenario, EOL = end of life, RR = recycling rates.



Potential of Select Secondary Materials from Projected Renewable Energy Waste Streams in Canada to Satisfy Annual Material Demand



Models of the Circular Economy: Circular 'Core' within a Linear Framework

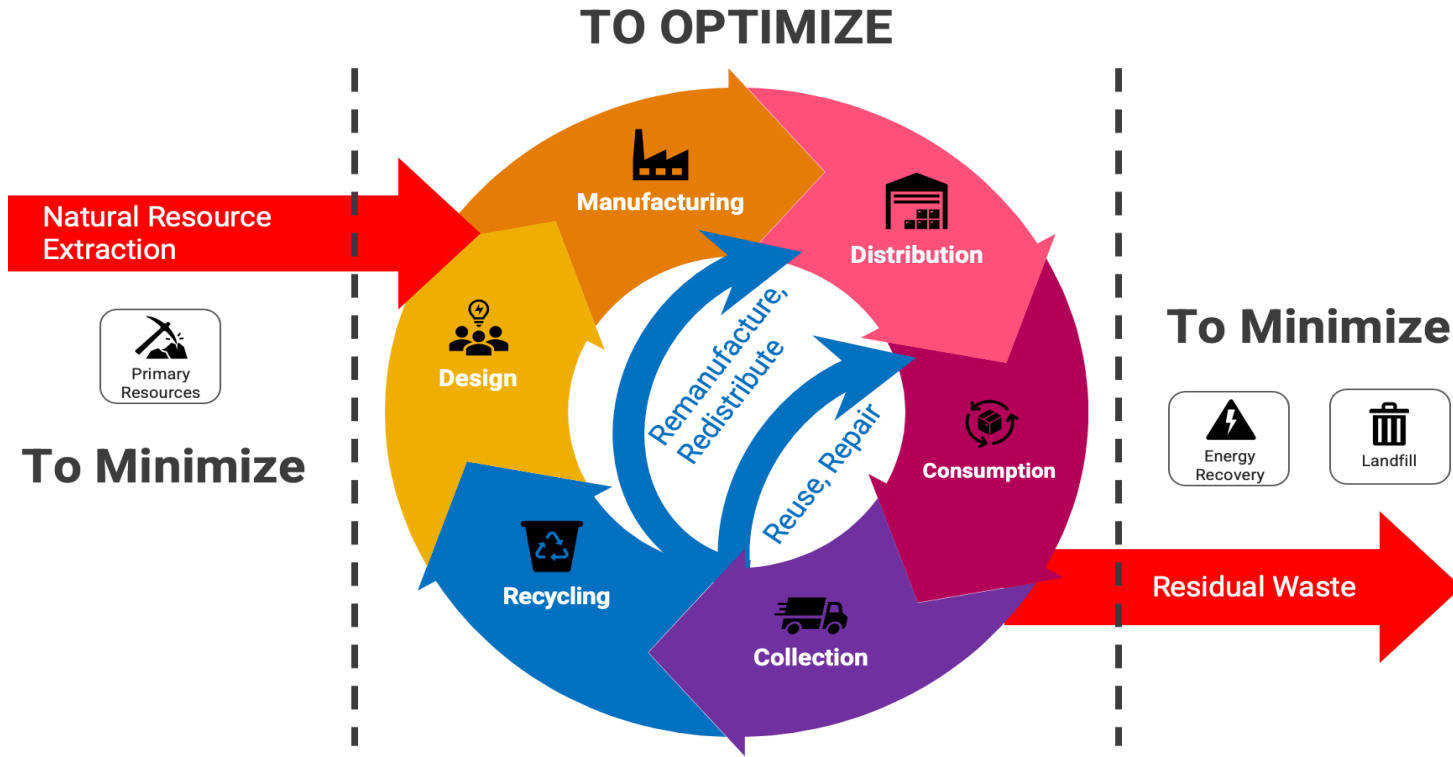


Figure 1: Stylized Version of Characteristic Circular Economy Model Focused on Manufacturing & Consumer Market 'Core' with Resource Producing 'Periphery'.



Extending CE Models for Primary Resource Sectors

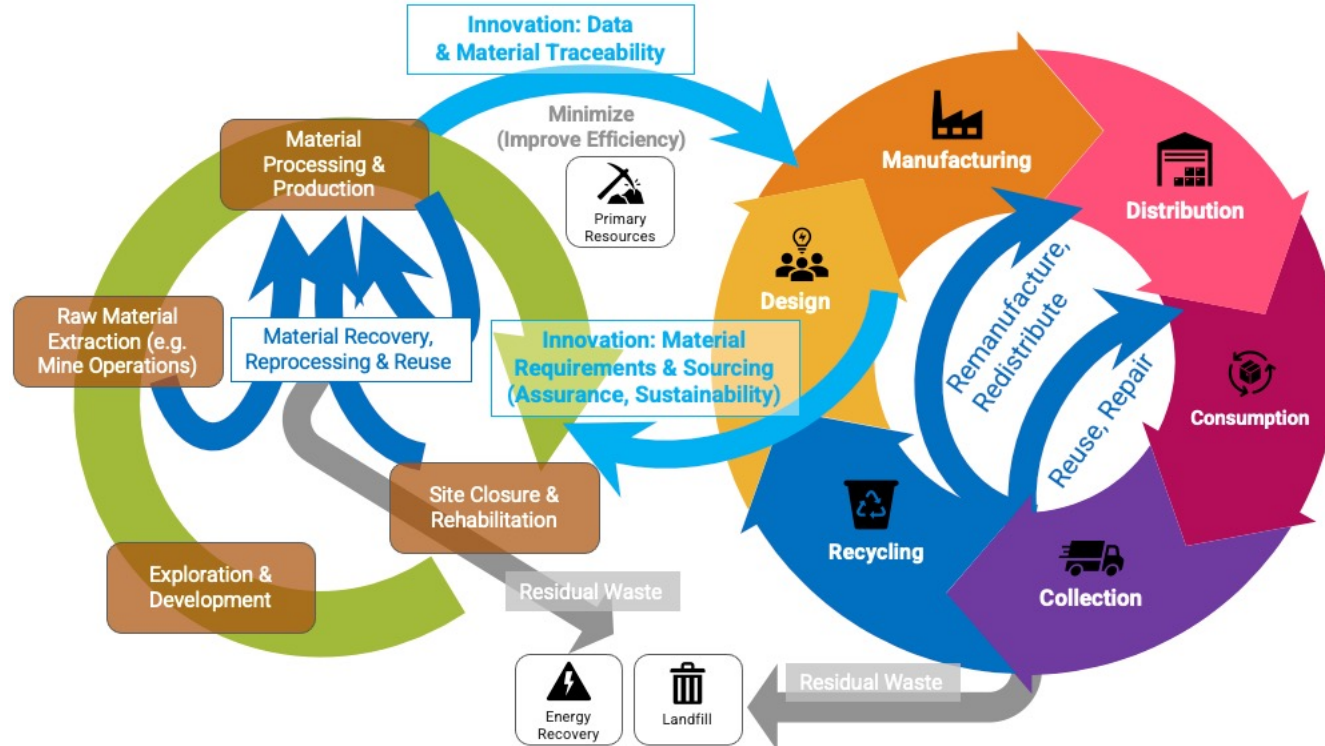
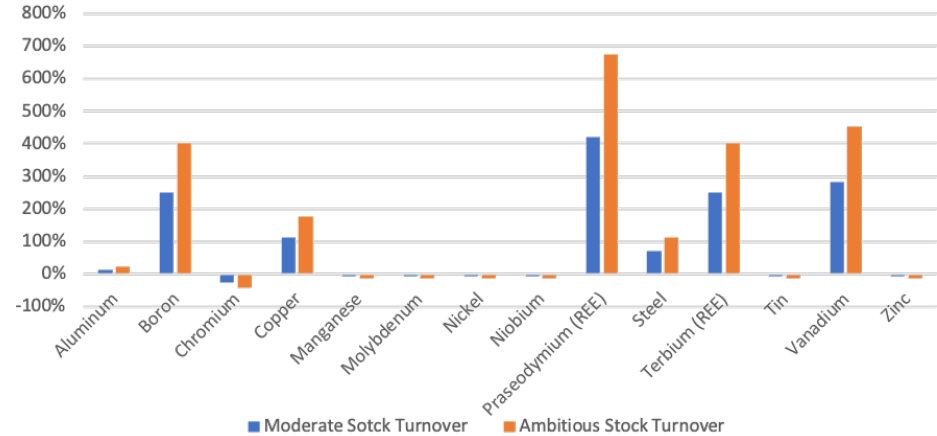
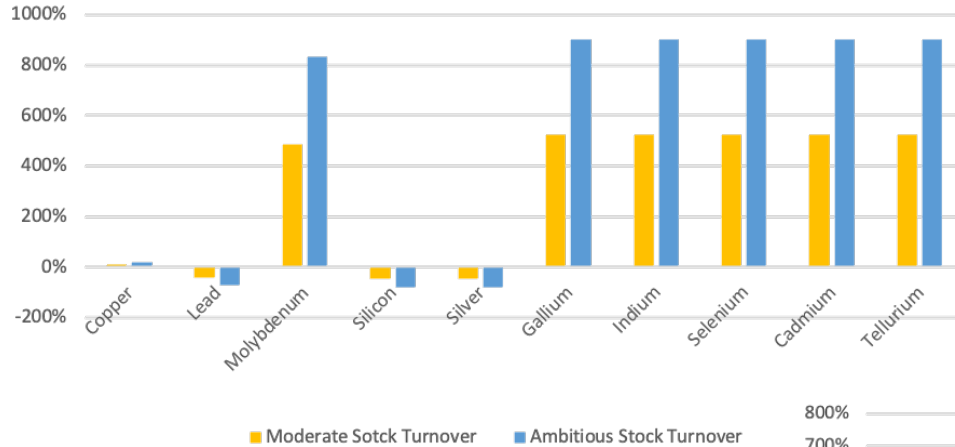


Figure 5: Updated Model of the Circular Economy, with Proposed Upstream/Downstream Linkages & Circular Practices Applied in the Upstream Primary Resource Sector



% Change in Material Demand for Select Solar/Wind Materials

[Moderate vs High Technology Turnover, Relative to Reference Scenario]



Key Circular Economy Considerations that Emerge....

There is a need to strategically consider the investments and policies needed to sustainably and reliably manage the material requirements of this kind of low-carbon transition in the energy sector – with a greater attention to:

- What materials will be required to meet low carbon energy demand?
- Where will those materials be sourced from, and how are they produced?
- What risks exist along key (CSM) supply chains?
- How will we handle material recovery at end of life?

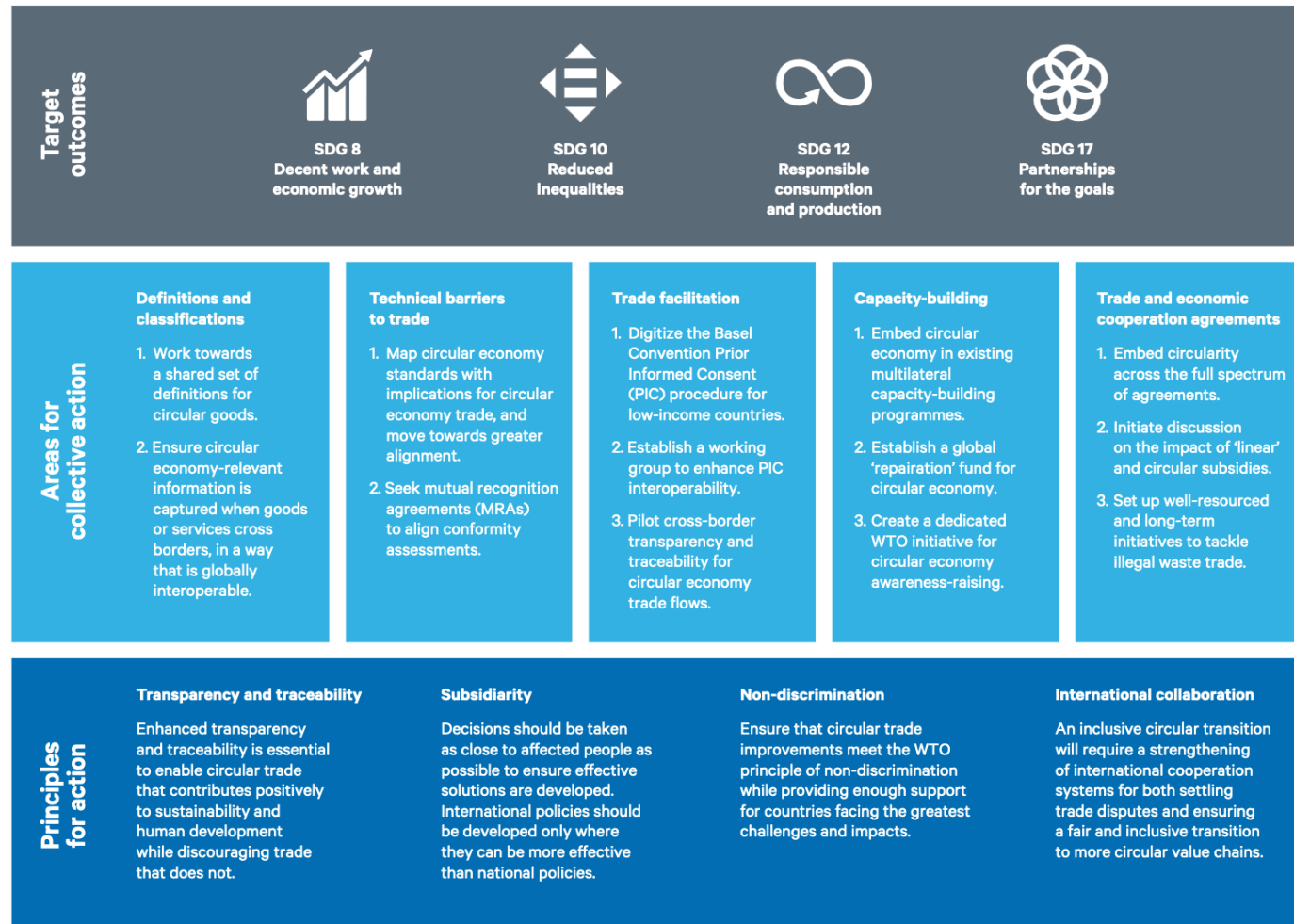


Recommendations for Broadening Circular Trade Opportunities

- **Improve understanding of the emerging demand for trade in circular solutions** by clarifying definitions and classifications for circular trade along key value chains by market / region.
- **Identify regulatory and technical barriers for growing circular trade**, how circularity fits within the environmental or other provisions of existing trade agreements, as well as new policies and programs (such as digital product passports) that can help to overcome these concerns.
- **Build partnerships to facilitate trade while creating supporting regional ecosystems for circular innovation**, to attract investment and grow economies of scale
- **Continue to track nascent clusters of circular business solutions** and ensure alignment and clarity of standards, taxonomies, certifications, and traceability schemes.



Figure 1. A framework for inclusive circular trade



Source: <https://www.chathamhouse.org/sites/default/files/2022-06/2022-06-15-inclusive-circular-trade-barrie-et-al.pdf>



Recent Circular Economy Research

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