PLACES

Plastic Lifecycle Assessment Calculator for the Environment and Society

The climate benefits of plastic waste management in India and Southeast Asia

Investing in waste management and recycling solutions in India and Southeast Asia could reduce GHG emissions by 229 million tonnes by 2030

The Circulate Initiative

thecirculateinitiative.org/ghg-calculator

Plastic waste management has a role in combating climate change.

In the final installment of its Sixth Assessment Report (AR6), the Intergovernmental Panel on Climate Change describes how current efforts globally to mitigate climate change are inadequate for limiting warming to no more than 1.5°C above pre-industrial levels. The world must reduce emissions by roughly half by 2030, and to net zero by no later than 2050 to stay within 1.5°C. Deep emissions cuts across all sectors, including plastics, are urgently needed.[1]

Waste management and recycling have critical roles to play in supporting the transition to a low-carbon economy. Plastics, in particular, contribute to greenhouse gas (GHG) emissions at every step of their lifecycle, making climate change and plastic pollution interconnected stressors on the environment. According to the Organisation for Economic Co-operation and Development (OECD), global plastics production, conversion, and end-of-life (EOL) fates were estimated to produce 1.8 giga tonnes of GHG emissions.[2] Improperly managed plastic waste that ends up in the ocean has been found to release GHG emissions, and microplastics can interfere with the ocean's capacity to absorb and sequester carbon dioxide.[3] Improved plastic waste management and recycling can mitigate the impacts of climate change by reducing the GHG emissions associated with plastics production and plastic waste management.

The Circulate Initiative's PLACES GHG calculator quantifies the relationship between plastic waste management and GHG emissions.

The Circulate Initiative, in collaboration with the Singapore Institute of Manufacturing Technology (SIMTech), a research institute of the Agency for Science, Technology and Research (A*STAR), has developed a first tool of its kind, the Plastic Lifecycle Assessment Calculator for the Environment and Society (PLACES), to provide more clarity around how investments in waste management and recycling solutions could reduce the environmental impact of plastic waste.

Through PLACES, users can quantify:

1. The reduction of GHG emissions based on market-specific waste management systems in India and five countries in Southeast Asia, in terms of plastic types, tonnes of plastic waste, and EOL fates.
2. The environmental impact of the amount of plastic waste (either a specific plastic type or a generic mix) diverted to mechanical recycling from other disposal methods/ EOL fates.
3. The energy and water savings of recycling plastics, compared to diverting to landfills or using other disposal methods, such as incineration, open burning, and open dumping.

PLACES considers the collection and EOL treatments of plastic waste, using a consequential lifecycle assessment (CLCA) model.[4] The results take into account the avoided production of virgin plastic, bitumen, raw materials for cement production, fuel, electricity, and heat as a result of diverting plastic from various EOL fates. PLACES can be customized to the relevant EOL scenarios, such as open dumping, open burning, incineration, sanitary landfilling, and co-processing in cement kilns based on the country context in six countries: India, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam (hereinafter referred to as South and Southeast Asia, or SSEA).

Leveraging the PLACES calculator, this paper highlights four key insights that underscore how investing in proper plastic waste management and recycling can result in significant GHG reductions.

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[1] World Resources Institute. (2023). *10 Big Findings from the 2023 IPCC Report on Climate Change* [online]. Available from: https://www.wri.org/insights/2023-ipcc-ar6-synthesis-report-climate-change-findings

[2] Organisation for Economic Co-operation and Development (OECD). (2022). *Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options* [online]. Available from: https://doi.org/10.1787/de747aef-en

[3] Center for International Environmental Law. (2019). *Plastic & Climate: The Hidden Costs of a Plastic Planet* [online]. Available from: https://www.ciel.org/wp-content/uploads/2019/05/Plastic-and-Climate-FINAL-2019.pdf

[4] A consequential lifecycle assessment (CLCA) model allows users to understand the change in environmental impact as a consequence of the change in technology mix. In the case of an increase in recycling, the model considers the avoided production of virgin plastics.

KEY INSIGHT ONE

Recycling all mismanaged plastic waste in the six markets across South and Southeast Asia can reduce GHG emissions by 229 million tonnes, the equivalent of shutting down 61 coal-fired power plants.

Mismanaged plastic waste refers to the uncollected and improperly disposed of waste (which is not formally managed), such as littered waste and waste disposal in open dumps, unsanitary landfills, and open burning which could leak to the surrounding environment. Across the six countries, the mismanaged plastic waste rates range from about 50% to 75%. By diverting the current mismanaged plastic waste towards recycling, the six countries could reduce their GHG emissions by 38 million tonnes of CO_2-eq. By 2030, cumulatively, the GHG reduction can amount to 229 million tonnes of CO_2-eq emissions, which is equivalent to shutting down 61 coal-fired power plants.[5]

The amount of GHG reduced by ensuring that mismanaged plastic waste is properly handled and diverted to recycling will help narrow the gap between global GHG emissions and the levels associated with limiting warming to 1.5°C.[6]

CO_2

229 million

CO_2-eq emissions reduction by 2030 if 100% of the mismanaged plastic waste in SSEA is recycled

Reduction of greenhouse gasses resulting from the prevention of 100% of mismanaged plastic waste[7]

	Annual mismanaged plastic waste (tonnes)	GHG eliminated per annum based on plastic waste leakage (tonnes CO_2-eq)	GHG eliminated by 2030 (tonnes CO_2-eq)
India	5.3 million	6.0 million	36.0 million
Indonesia	5.8 million	13.7 million	82.3 million
Malaysia	1.2 million	1.5 million	9.0 million
Philippines	1.2 million	2.0 million	12.2 million
Thailand	3.4 million	4.7 million	27.9 million
Vietnam	4.6 million	10.3 million	61.5 million
Total	**21.4 million**	**38.1 million**	**228.9 million**

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[5] United States Environmental Protection Agency (US EPA). (2023). *Greenhouse Gas Equivalencies Calculator* [online]. Available from: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results Note: As the US EPA GHG equivalencies calculator was developed based on US-specific data, this number provides an approximate frame of reference for the reduced GHG emissions.

[6] World Resources Institute. (2022). *6 Takeaways from the 2022 IPCC Climate Change Mitigation Report* [online]. Available from: https://www.wri.org/insights/ipcc-report-2022-mitigation-climate-change

[7] GHG emissions are calculated based on the mismanaged plastic waste amounts. The cumulative GHG amount between 2024 and 2030 is based on a conservative assumption that the amount of mismanaged plastic waste remains unchanged during that period. The GHG emissions are calculated based on diverting the mismanaged plastic waste from the default end-of-life fates for each country (which can include sanitary landfill, co-processing at cement kilns, incineration, open dumps, and open burning) to 100% recycling. The total amounts might not add up due to rounding.

KEY INSIGHT TWO

Diverting one tonne of plastic waste from open burning in any of the six markets towards proper collection and recycling can result in avoiding more than three tonnes of GHG emissions.

Open burning by households is common practice in countries where municipal solid waste (MSW) management systems are inadequate as it provides a cheap and quick way of reducing and disposing of uncollected waste.[8]

Across the six countries studied, open burning contributes significantly to the total carbon footprint of all plastic waste, compared to the other EOL fates. Between 4% and 48% of the total plastic waste across the countries is managed through open burning, which then contributes 24% to 94% of the total carbon footprint of all plastic waste. Indonesia, which has the highest proportion of plastic waste managed through open burning, has 94% of the carbon footprint contributed by open burning. By stopping open burning and diverting plastic waste towards more efficient waste management systems, such as recycling or sanitary landfills, GHG emissions generated by plastic waste can be significantly reduced across SSEA.

Investments in businesses and infrastructure that divert plastic waste from open burning towards proper collection and recycling is a key driver of reducing GHG emissions related to plastic waste management.

75%

or more of the total carbon footprint of all plastic waste is contributed to by open burning in Indonesia, the Philippines, Thailand and Vietnam

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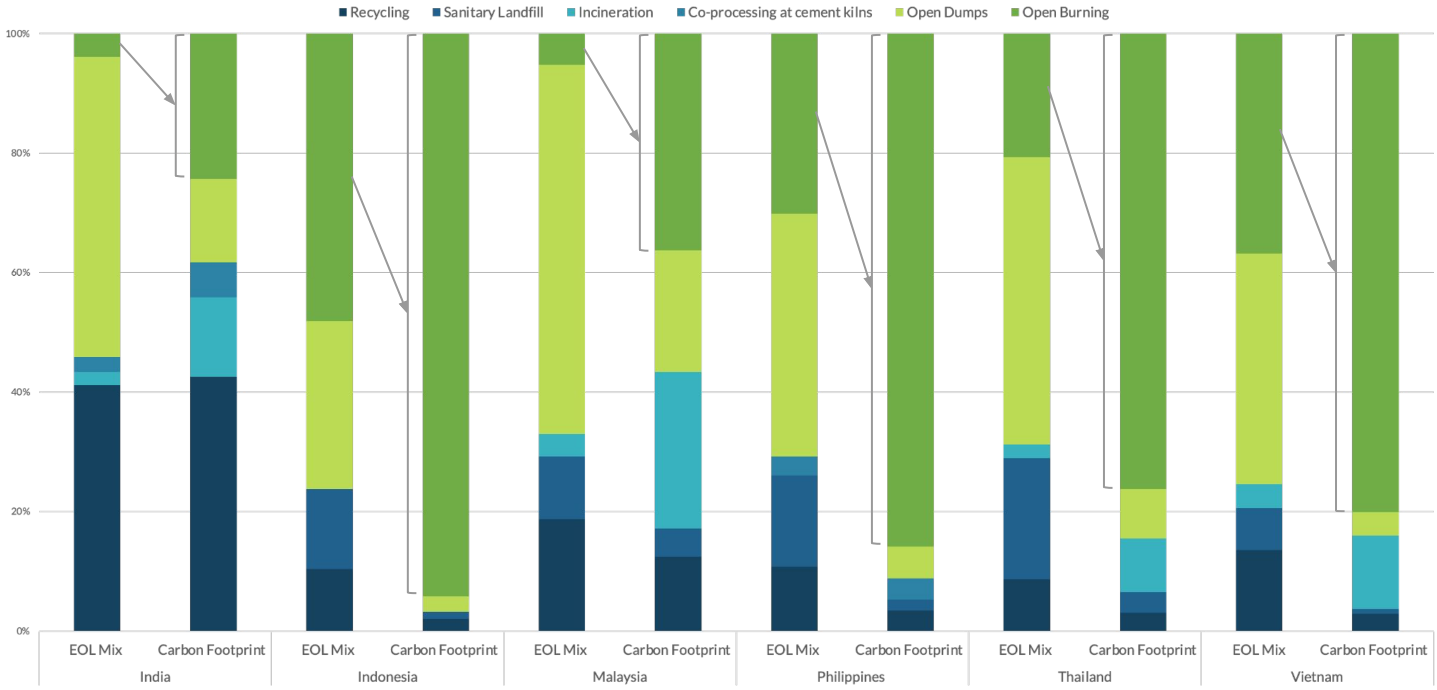
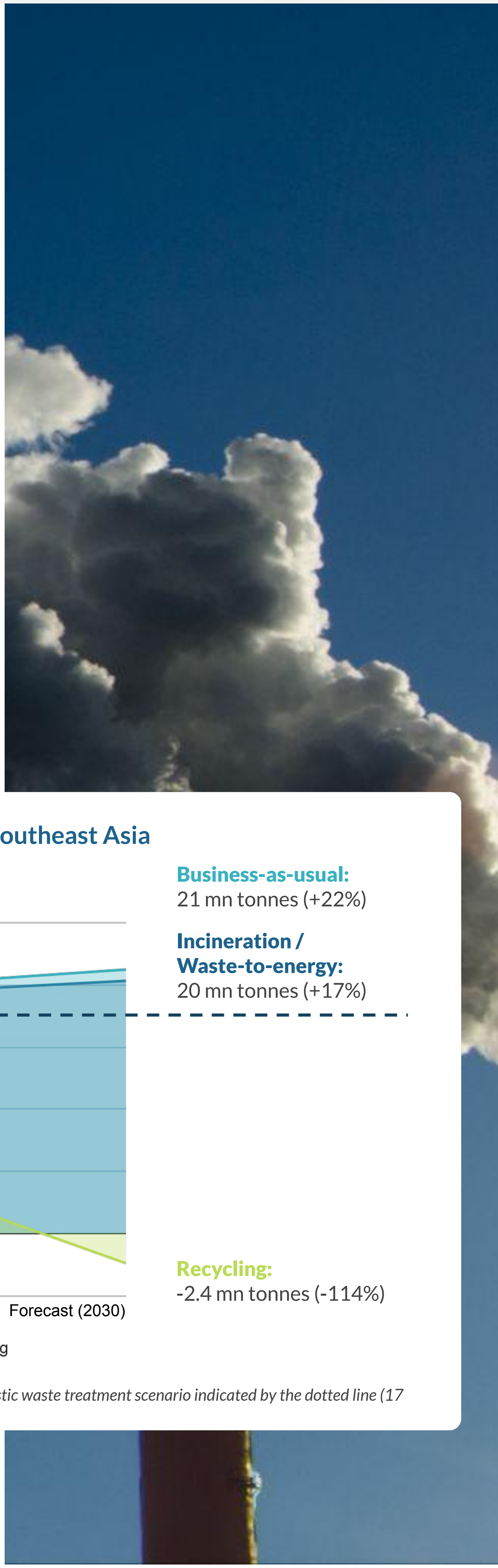
[8] Institute for Global Environmental Strategies. (2022). *Open Waste Burning in Asian Cities: Challenges and Opportunities* [online]. Available from: https://www.iges.or.jp/en/publication_documents/pub/training/en/12314/Summary_Open_Burning_final_16062022.pdf

Contribution of open burning to total carbon footprint of 1 tonne of plastic waste treated



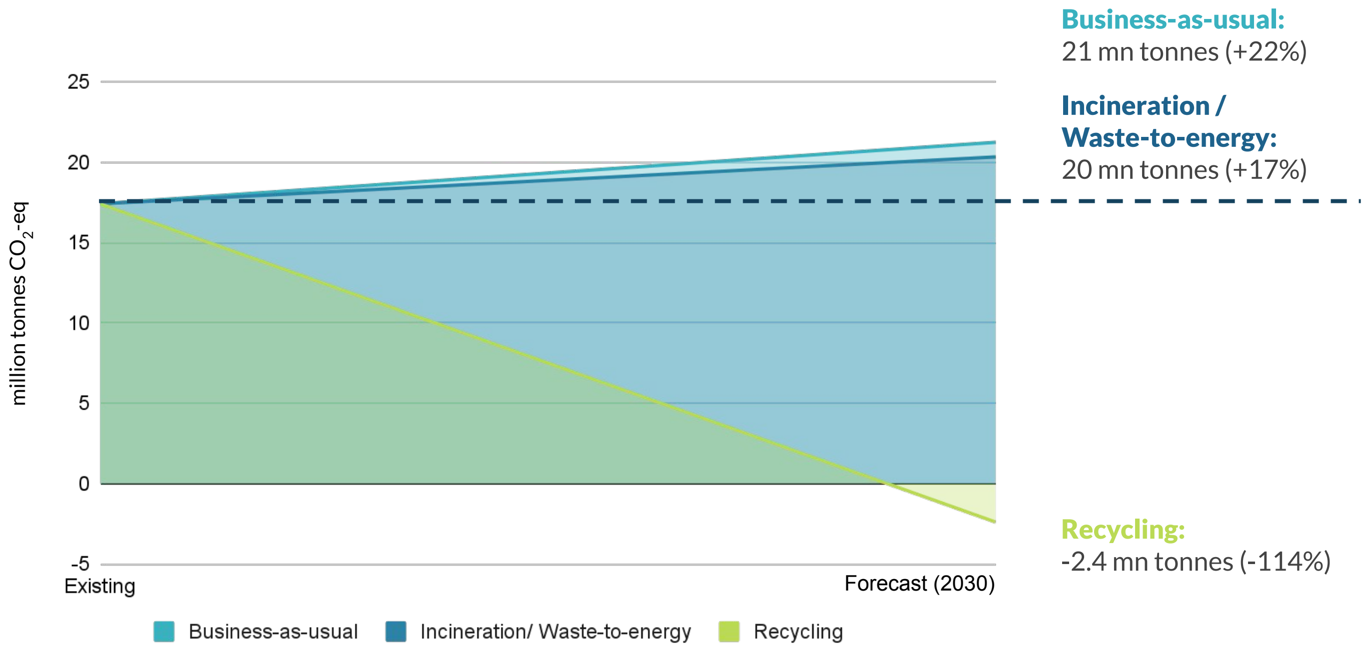


KEY INSIGHT THREE

Incineration and waste-to-energy approaches to plastic waste management in the six countries can result in 20 million tonnes of emissions in 2030; this can be avoided by opting for plastic waste recovery and recycling solutions.

Across SSEA, incineration and waste-to-energy (WtE) are an emerging part of waste management strategies. Approximately 100 plants with a processing capacity of 102,000 tonnes MSW per day are already functioning or expected to come online within the next few years. In most countries, the incineration of plastic waste adds to the overall emissions, even in instances of energy recovery and avoided coal or other fossil fuel-based energy production. Assuming status quo and no further incineration infrastructure is built between now and 2030, a WtE approach to plastic waste management can result in 20 million tonnes of CO_2-eq emissions in 2030. However, a recycling shift based on the recycling targets set by the six governments instead of incineration can result in 2 million tonnes of CO_2-eq emissions being avoided.[9] Implementing policies that promote and enforce household waste segregation, and building material recovery facilities and the required infrastructure for recycling is a much more efficient approach to tackling the climate impact of plastic pollution when compared to installing incineration and WtE facilities.

Carbon footprint of plastic waste treatment in South and Southeast Asia



The percentage figures show the percentage change in the carbon footprint from the existing plastic waste treatment scenario indicated by the dotted line (17 million tonnes CO_2-eq) to the respective projected 2030 scenarios.

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[9] Based on recycling targets set by various governments and projections made by SIMTech A*STAR and The Circulate Initiative for 2030.

KEY INSIGHT FOUR

Meeting the national recycling targets of the six markets in South and Southeast Asia can result in a 10% reduction in global GHG emissions from plastics end-of-life in 2030.

Virgin plastic production is an energy- and water-intensive process as it depletes fossil fuels through the use of crude oil, and high pressure pumping methods that result in high water consumption.[10] Plastics recycling can reduce these negative impacts on energy and water consumption through the avoided production of virgin plastics. Across the six countries, the plastics recycling rate varies, with Indonesia having the lowest plastics recycling rate and India the highest. For every kilogram of plastic waste treated, recycling of plastics results in carbon savings ranging from 0.60 kg to 0.92 kg of CO_2-eq.

India, with the highest recycling rate of 41%, has a carbon footprint in which the emissions benefits from recycling exceed the environmental costs from landfill, open burning, and other EOL fates of the plastic waste generated. Further investments to scale up the system could make a significant and additive climate impact. In the other five countries, a combination of a substantial increase in recycling capacity and diversion away from EOL fates, especially open burning, is required to reduce the carbon footprint, and for water and energy savings.

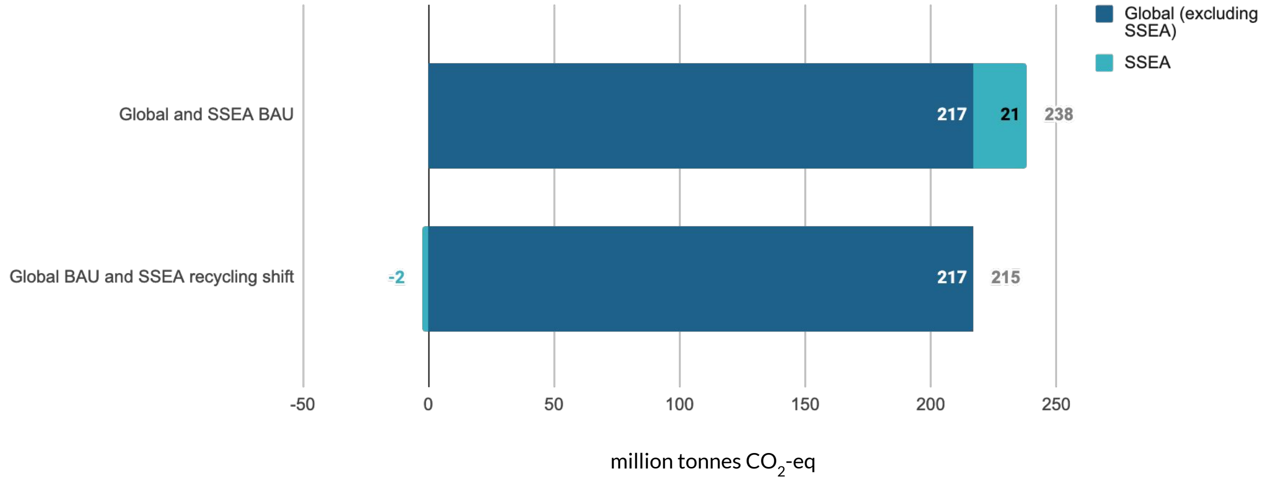
A shift towards greater plastics recycling in the six countries alone can contribute to GHG emissions reduction on a global level. In 2030, assuming business-as-usual with the existing EOL mix in each country, the six countries could contribute 21 of the estimated 238 million tonnes of CO_2-eq emissions globally from plastics EOL.[11] With the projected SSEA recycling shift in 2030, based on government recycling targets, there can be an overall 10% reduction in global GHG emissions from plastics EOL to 215 million tonnes CO_2-eq. Thus, collectively, there is potential for greater carbon benefit with more plastics recycling.

CO_2

10%

reduction in global GHG emissions from plastics end-of-life with a SSEA recycling shift in 2030

GHG emissions from Plastics End-of-Life in 2030: Business-as-usual (BAU) and SSEA Recycling Shift



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[10] Neo, E. R. K., et al. (2021). Life cycle assessment of plastic waste end-of-life for India and Indonesia. *Resources, Conservation and Recycling* [online], 174, 105774. Available from: https://doi.org/10.1016/j.resconrec.2021.105774

[11] Organisation for Economic Co-operation and Development (OECD). (2022). *Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options* [online]. Available from: https://doi.org/10.1787/de747aef-en

The way forward

Investing in effective waste management and recycling of plastics will make substantial contributions to the fight against climate change.

The waste and recycling industry presents a new frontier of opportunities for climate-focused investors, and transforming it into a climate-resilient infrastructure asset class can be impactful for the benefit of the environment, society, and the economy.

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This paper was co-authored by:

Umesh Madhavan
The Circulate Initiative

Nurul Aisyah Suwandi
The Circulate Initiative

Goh Soo Lin (contributing author)
SIMTech, A*STAR

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