PLACES

Plastic Lifecycle Assessment Calculator for the Environment and Society

The Circulate Initiative

Frequently Asked Questions

1. What is PLACES or Plastic Lifecycle Assessment Calculator for the Environment and Society?

PLACES is the first tool of its kind offering users the ability to assess the climate impact of current waste management practices in India and Indonesia, from open burning to recycling.

The open-sourced prototype calculator tracks the greenhouse gas (GHG) emissions reductions, energy and water savings of waste management and recycling solutions that prevent plastic pollution in India and Indonesia. The tool allows users to calculate carbon savings based on various plastic polymers, tonnes of plastic waste and different end-of-life (EOL) fates.

2. Who are the contributors to the development of PLACES?

PLACES has been developed by The Circulate Initiative in partnership with Circulate Capital and Singapore's Agency for Science, Technology and Research (A*STAR).

3. What was the background to developing the tool?

As investors, governments, and other actors make bigger commitments of resources into solving the ocean plastics crisis, they must understand the scale and nature of the problem, as well as the impact of efforts to address it. Critically, decision-makers need tools that help them focus on solutions that not only prevent plastic leakage, but also reduce emissions and align with global climate goals.

Tools, such as the US Environmental Protection Agency's WARM model, have provided useful guidance in developed markets, but none are built on assumptions appropriate to waste management in emerging markets. For investors and project developers in South and Southeast Asia, as well as developing island nations, there is insufficient research and data available at the local levels (i.e., national, jurisdictional or project-specific) on emissions reductions and other environmental benefits of alternative waste management practices. Furthermore, the data and research that do exist are largely inaccessible to cities, private investors, operators, and other interested parties. A credible, accessible, easy-to-use tool is needed to shed light on the impact potential of different interventions in emerging markets.

4. What is the scope of the tool?

The initial study includes downstream waste plastic treatment from collection of plastic waste to final end-of-life (EOL) scenarios, with resulting carbon savings from by-products and avoided production of virgin plastic. The plastic waste flow was mapped based on country specific data.

5. Why is the tool important and for whom?

The tool enables investors, waste management operators, governments, entrepreneurs and other players in the ecosystem to integrate climate science into decision making, set climate objectives, progress towards these, and demonstrate the effectiveness of leveraging recycling to low-carbon investment portfolios.

6. What research methodology was adopted for developing the tool?

The tool was created in partnership with A*STAR using Consequential Life Cycle Assessment modelling developed with ISO 14040/44/67 standards.

Peer review support was provided by members of The Circulate Initiative's Impact Metrics Working Group and the Journal of Resources, Conservation & Recycling's independent editorial board and peer-review process.

7. What can the tool do?

PLACES focuses on quantifying the impact of four plastic types commonly found in single-use packaging (HDPE, LDPE, PP and PET), which together make up the majority of plastic waste in India and Indonesia. In addition, the "generic" category reflects all mixed plastic waste materials based on the status-quo composition for the country.

The tool computes the environmental benefit of recycling compared to different end-of-life (EOL) scenarios - open dumping, open burning, cement kilns and incineration. "Default EOL fate" represents the current end-of-life for plastic waste identified by mapping material flow based on country-specific data.

8. What are the uses of PLACES?

PLACES can be used for scenario modelling to inform plastic waste management and recycling decisions at a system level. For example, mapping the carbon-related impact of a strategic shift towards plastic waste-to-energy (WTE) in Indonesia and India (modelled based on announced projects by the government) indicates this will contribute to higher carbon emissions compared to the current baseline.

9. Can the tool be used to apply for carbon credits for GHG protocol?

PLACES estimates life-cycle GHG emissions associated with material end-of-life (EOL) fates in a systems-based approach; it is not a GHG inventory tool. Carbon Credit Mechanisms adopt an accounting protocol known as the GHG Protocol, which involves the development of a carbon inventory based on a single location over a designated time frame. Emission savings from PLACES are likely outside of these boundaries and refer only to specific quantities rather than quantities over a period of time. In addition carbon credits require accounting for the use-phase of the material (i.e. the product). The use-phase of a material is not currently incorporated into PLACES.

However, the data in PLACES could be used by companies to build their own reporting tool and incorporate a materials inventory to conduct formal carbon footprinting and emissions analysis for both carbon credits and/or Science Based Targets. This would require individual customisation to reconcile the data sets to be specific to a company's Scope 1, Scope 2 and Scope 3 boundaries and remove the generalities in the tool.

10. How can the GHG savings derived from PLACES be used for reporting purposes?

The GHG emissions data derived from PLACES can be used for planning, setting targets and measuring results of anticipated GHG reduction. These should be reported as estimates and provided with the comparison of the baseline scenario. The PLACES emissions data is to help organisations take actions themselves to manage and reduce emissions. It is not a commercial tool.

11. What was the rationale behind selecting India and Indonesia?

PLACES was launched to provide investors data for India and Indonesia; two markets that are at different stages of recycled plastics market development and waste management infrastructure. India and Indonesia also represent two major markets in South and Southeast Asia where plastic waste contributions are significant today and forecast to grow in the coming decades due to the growth in consumer class and higher urbanization rates of medium sized cities.

12. When was the research conducted?

The study was conducted in 2020 with the results based on the best data available at that time.

13. What are the definitions of the key terms used in PLACES?

A glossary of the main terms used in the tool is provided below.

Term	Description
Carbon Footprint	The emission of greenhouse gases associated with a specific material or activity.
Consequential Approach	System modelling approach in which activities in a product system are linked so that activities are included in the product system to the extent that they are expected to change as a consequence of a change in demand for the functional unit.
Default end-of-life (EOL) Fates	Represents the baseline end-of-life pathways for plastic waste identified by mapping material flow based on country specific data.
Energy Consumption	The total amount of energy used in the course of various end-of-life fates, and sourced from different renewable and non-renewable energy sources, including fossil fuels and biomass.
Generic	All mixed plastic materials based on status-quo composition for the country.
HDPE	High-density polyethylene, commonly used in milk bottles, detergent, shampoo bottles, juice bottles.
Investment tonnage	Represents the weight (in metric tonnes) of the different types of polymers diverted from different end-of-life fates due to the current/ proposed recycling intervention.
LDPE	Low-density polyethylene, commonly used in shopping and garbage bags, plastic wrapping, packaging films.
PET	Polyethylene terephthalate, commonly used in clear soft drink bottles, cups, cooking oil bottles.
PP	Polypropylene, commonly used in food containers, straws, automotive parts, bottle caps.
Water Consumption	The amount of water that is evaporated, disposed into water bodies, or incorporated in products.

14. What are some of the key assumptions that have been considered for India?

Following are some of the key assumptions that have been considered for the research for India:

- No imported waste plastic - India has banned the import of waste plastic since August 2019.
- Only source of waste plastics for cement kilns are rejected waste plastics from recycling.
- All dumpsites in India are assumed to be open dumps.
- 10% of waste plastic in open dumps are openly burnt.
- Dumping in water bodies modelled as leakage to water bodies.
- Average transport distance of 5km for informal collection, 15km for formal collection, 50km to recycling facilities, 15km to open dumps and 30km to WTE plants.
- Every kg of recycled plastic leads to an avoided production of 0.5kg of virgin plastic.
- All LDPE products are flexible packaging.
- Recycling rates considered for rigid and flexible plastics to derive recycling rates for HDPE and LDPE:
    - Rigid plastic: 95%
    - Flexible plastic: 40%.
- Breakdown of end-of-life fates for different plastic types:

Plastic	Consumed (MT) (Source: Plastindia Foundation, 2019)	% Consumed that becomes waste (Source: Geyer et al., 2017)	Waste (MT)	% Waste plastic that is recycled (Source: TNN, 2020)	Collected (MT)	Uncollected (MT)
PP	5.17	62%	3.20	60%	1.92	1.28
HDPE	2.77	56%	1.54	75.9%	1.22	0.32
LDPE	2.40	100%	2.40	40%	0.96	1.44
PET	1.66	100%	1.66	90%	1.49	0.17
Others	6.46	10%	0.65	10%	0.06	0.58
Total	**18.45**		**9.45**	**60%**	**5.65**	**3.79**

15. What are some of the key assumptions that have been considered for Indonesia?

Following are some of the key assumptions that have been considered for the research for Indonesia:

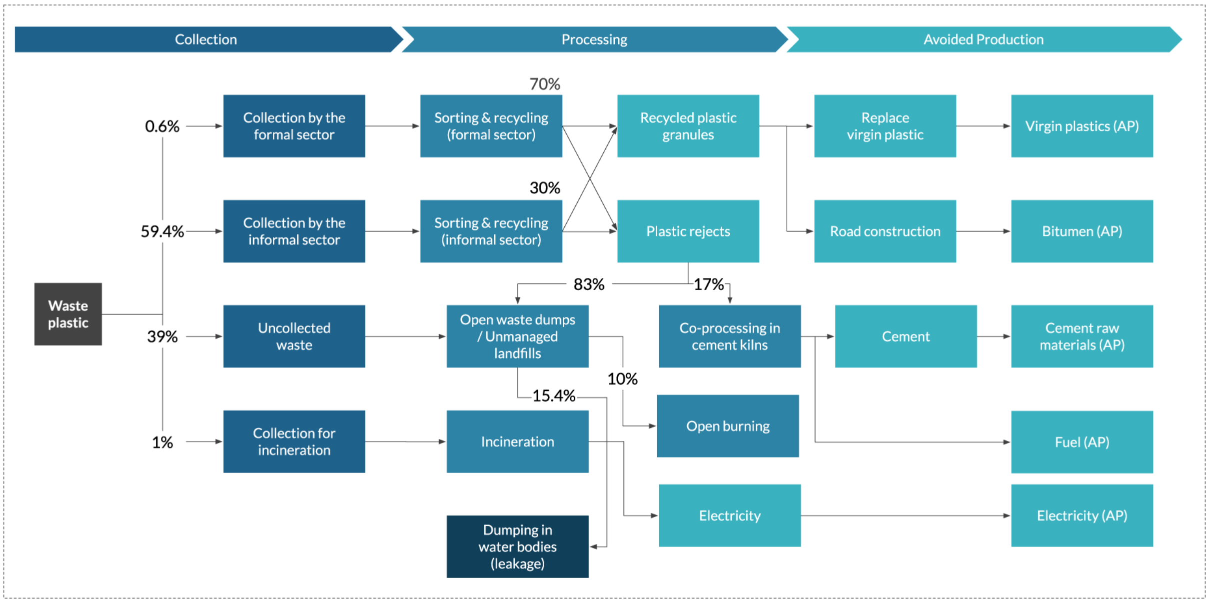
- Average transport distance of 20km between all facilities.

- Average waste plastic import distance modelled as the distance between the UK and Indonesia.
- Share and fate of imported waste plastic is the same as locally generated waste plastic.
- Every kilogram of recycled plastic leads to an avoided production of 0.5kg of virgin plastic.
- Share of plastic received at a junkyard is representative of the national share of recycled plastic.
- Share of plastic consumption is representative of the share of plastic waste generation.
- Breakdown of end-of-life fates for different plastic types:

Plastic	Waste (MT) (Source: Ministry of Environment and Forestry, 2020)	% Waste plastic that is recycled	Collected (MT) (Source: Sustainable Waste Indonesia, 2018)	Uncollected (MT)
PP	1.75	8%	0.14	1.61
HDPE	0.86	29%	0.25	0.61
LDPE	1.06	2%	0.02	1.04
PET	0.68	31%	0.21	0.47
Others	1.29	0%	0.00	1.29
Total	**5.64**	**11%**	**0.62**	**5.02**

16. What is the system boundary for India?

Modelled System Boundary for India: Existing Waste Management (Default EOL fates)

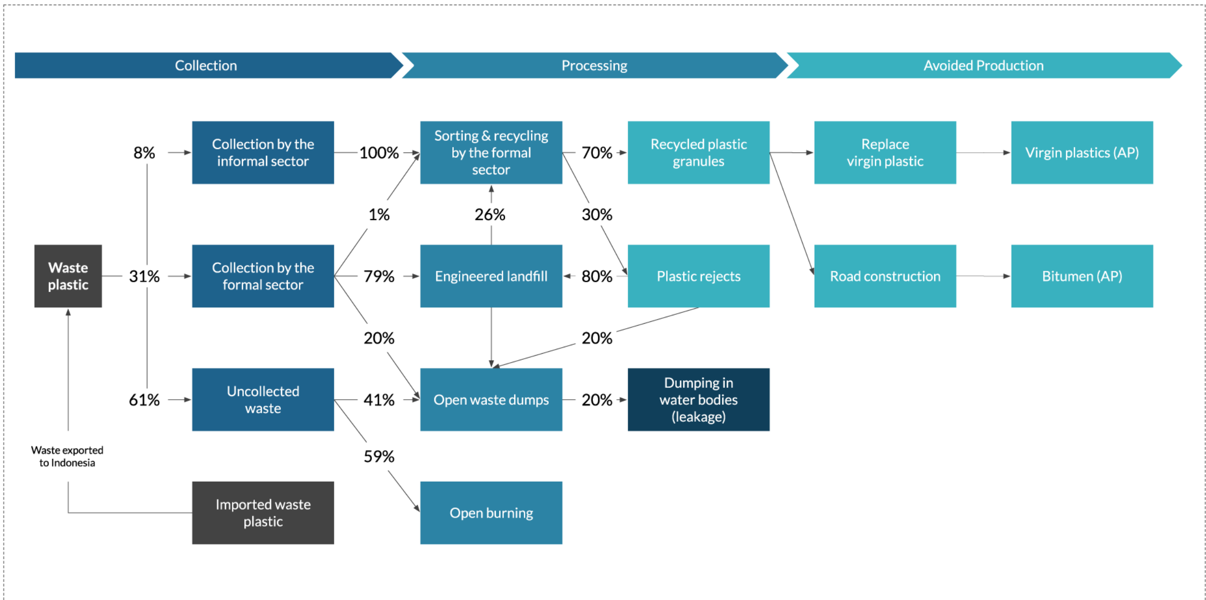


Modified diagram. Original from Singapore Institute of Manufacturing Technology

thecirculateinitiative.org/ghg-calculator

17. What is the system boundary for Indonesia?

Modelled System Boundary for Indonesia: Existing Waste Management (Default EOL fates)



Modified diagram. Original from Singapore Institute of Manufacturing Technology

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18. What is the "carbon footprint" that is included in the results and how should it be interpreted?

Carbon footprint measures the emission of greenhouse gases associated with a specific material or activity. This includes the energy used and transportation during the processing activities. A positive number for carbon footprint represents the carbon dioxide equivalent from all greenhouse gas emissions generated from activities that are harmful to the environment. A negative number means a potential offset of emissions to the environment.

19. What is "energy consumption" included in the results and how should it be interpreted?

Energy consumption indicates the total amount of energy used in the course of various end-of-life fates, and sourced from different renewable and non-renewable energy sources, including fossil fuels and biomass. Depending on the energy sources and consumption, this can be a large contributor to the carbon footprint. A positive number for energy consumption represents the use of energy that depletes these energy sources. A negative number represents potential generation or offsetting the use of energy from the system.

20. What is "water consumption" that is included in the results and how should it be interpreted?

Water consumption measures the amount of water that is evaporated, disposed into water bodies, or incorporated in products. A positive number for water consumption represents the use of water, which reduces water availability. A negative number represents potential generation or offsetting the use of water from the system.

21. What is "initial environmental impact" and how is it calculated?

"Initial environmental impact" is obtained by calculating the emissions generated by the default end-of-life fate, from which plastic waste would be diverted. The tonnes of polymer are multiplied by the relevant emission factors to obtain the result. Users can choose from the following list of end-of-life scenarios to divert their waste from:

India	Indonesia
Default EOL Fates	Default EOL Fates
100% Open Dumping	100% Open Dumping
100% Open Burning	100% Open Burning
100% Incineration	100% Sanitary Landfill
100% Cement Kilns	

22. What is "recycling environmental impact" and how is it calculated?

"Recycling environmental impact" is obtained by accounting for the avoided production of virgin polymers and other products when plastics are recycled and the production of virgin plastic is avoided. The tonnes of polymer recycled will be multiplied by the relevant emission factors to obtain the result.

23. What is "environmental savings" and how should the results be interpreted?

"Environmental Savings" is calculated by subtracting values from "Recycling Environmental Impact" from "Initial Environmental Impact". Calculations will display the resulting (net) greenhouse gas emissions, energy consumption and water consumption for each polymer. A negative result under "carbon footprint," for example, means that the carbon footprint of recycling operations is greater than the greenhouse gas benefit of diverting plastics from the default end-of-life fate.

24. Why is there a negative value for carbon footprint, energy, water consumption in the initial environmental impact and recycling environmental impact?

The calculator accounts for sources of emissions (i.e., burning of plastic waste) and emission sinks (i.e., avoided consumption of electricity or fuel). A negative value indicates that the selected management practice results in the net reduction or avoidance of carbon emissions, energy and water from a lifecycle perspective.

25. Is the environmental impact of virgin plastic production included in the output?

The embodied environmental impact for production of virgin plastics are not included. For this study, the upstream raw material extraction and production of plastics have been excluded, as these processes are common across all plastics, regardless of their EOL fates. This allows the study to focus solely on comparing the impact of waste collection and treatment alone.

26. What are the limitations of the tool?

Note this is a first attempt at assessing whether there is a positive or negative greenhouse gas impact to diverting plastic waste from the environment through recycling interventions. This tool does not inform the sole benefits of recycled plastic over virgin materials nor does it go into other materials.

End-of-life (EOL) scenarios are limited to recycling, open dumping, open burning, cement kilns and incineration. Chemical recycling, waste-to-energy (WTE) and other advanced technologies are not considered, as there is little to no data on operational plants for these technologies in either country.

27. Why are the results for India different from the results for Indonesia?

The results for India and Indonesia differ due to the difference in assumptions, end-of-life states and practices in plastic waste collection and processing in each country. For example, waste plastic collection and processing in Indonesia has a much higher carbon footprint than India on a per kg basis primarily due to the carbon footprint from more prevalent open burning. On the other hand, waste plastic collection and processing in India has higher energy and water consumption compared to Indonesia, due to more active recycling efforts.

28. How easy is this calculator to use? Do you need expertise in an area to be able to use it?

The user interface has been simplified and set up for ease of use by all users. While basic knowledge of the various polymer types and end-of-life states are beneficial, the user does not have to be an expert in Life Cycle Assessment (LCA) methodologies to interpret the results.

29. What are some of the other resources which are available relating to PLACES?

The findings from the research was published in the Journal of Resources, Conservation & Recycling. The article abstract can be accessed through this link. A summary of the findings can also be found here.

30. Are the complete sources that were used for the study available?

Yes, they are available through this link.

31. Can I provide feedback on the tool?

Absolutely! We recognize this is a first attempt at quantifying a complex and difficult concept. We invite stakeholders to share their feedback and perspectives on this work to help us improve for future versions. You can submit your feedback through this link.

32. What are the future plans for PLACES?

We are currently working on expanding PLACES to include more geographies in Southeast Asia. We are also considering how other aspects of the recycled plastics value chain can be incorporated in the tool, so that more users can benefit from the tool. If you would like to suggest ideas to develop PLACES, please connect with us through this link.