Supplementary Information to the Interim Findings of the OECD report

“Towards Eliminating Plastic Pollution by 2040: A Policy Scenario Analysis”

November 2023 ; NOT TO BE CITED OR QUOTED

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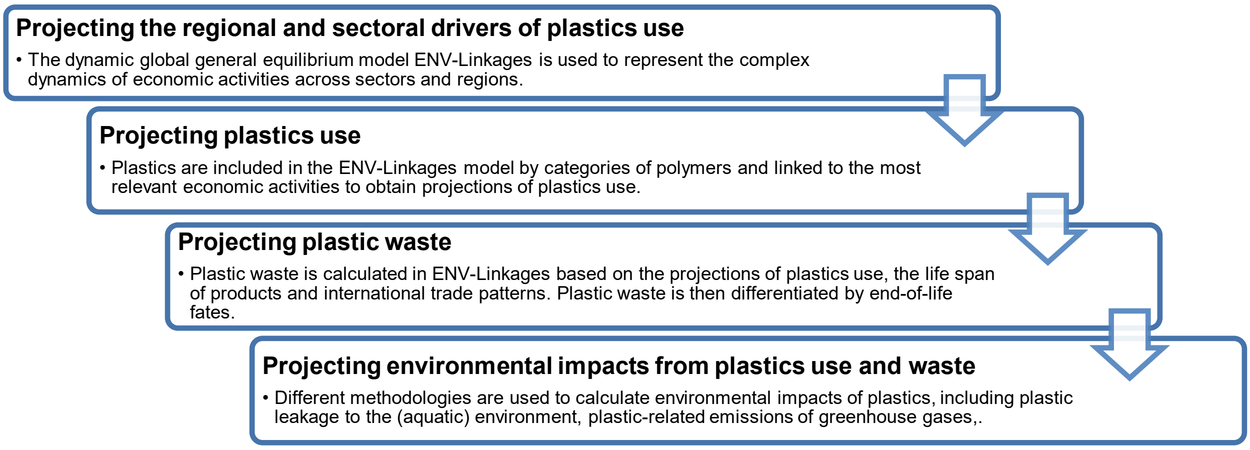
This Supplementary Information document supports the Interim Findings of the OECD report *Towards eliminating plastic pollution by 2040: A policy scenario analysis*. It includes additional information on the modelling framework and the description and quantification of the scenarios presented in the Interim Findings. The Supplementary Information will be integrated in the final report.

Modelling Framework

The modelling of economic flows, plastics use, plastic waste and environmental impacts involves different steps, as illustrated in Figure A.1. Plastics use is linked to sectoral and regional economic projections, which therefore drive the evolution of plastics use over time. Volumes of plastics are then used to calculate generated waste, based on product lifespans of different applications. The waste generated is further broken down by waste treatment, i.e., recycled (collected for recycling), incinerated, landfilled, mismanaged and littered waste, taking into account differences across regions. Finally, projections for a subset of environmental impacts are calculated: leakage of macroplastics to the environment, leakage to aquatic environments, and greenhouse gas (GHG) emissions.

The analysis relies on a suite of modelling tools. More specifically, projections of the economic flows, plastics, plastic waste, and greenhouse gas emissions rely the OECD in-house modelling tools, while projections of aquatic leakage rely on calculations made by L. Lebreton.

Figure A.1. Methodological steps in the modelling framework



The ENV-LINKAGES model

The OECD's in-house dynamic computable general equilibrium (CGE) model ENV-Linkages is used as the basis to project the economic activities that drive plastics use. ENV-Linkages is a multi-sectoral, multi-regional model that links economic activities to energy and environmental issues. A more comprehensive model description is given in Chateau, Dellink and Lanzi (2014[12]).

Production in ENV Linkages is assumed to operate under cost minimisation with perfect markets and constant returns-to-scale technology. The production technology is specified as nested Constant Elasticity of Substitution (CES) production functions in a branching hierarchy. This structure is replicated for each output, while the parameterisation of the CES functions may differ across sectors. The model adopts a putty/semi-putty technology specification, where substitution possibilities among factors are assumed to be higher with new vintage capital than with old vintage capital. In the short run this ensures inertia in the economic system, with limited possibilities to substitute away from more expensive inputs, but in the longer run this implies a relatively smooth adjustment of quantities to price changes. Capital accumulation is modelled as in the traditional Solow/Swan neo classical growth model, where economic growth is assumed to stem from the combination of labour, capital accumulation and technological progress.

Household consumption demand is the result of static maximisation behaviour which is formally implemented as an "Extended Linear Expenditure System". A representative consumer in each region – who takes prices as given – optimally allocates disposal income among the full set of consumption commodities and savings. Saving is considered as a standard good in the utility function and does not rely on forward looking behaviour by the consumer. The government in each region collects various kinds of taxes in order to finance government expenditures. Assuming fixed public savings (or deficits), the government budget is balanced through the adjustment of the income tax on consumer income. In each period, investment net-of-economic depreciation is equal to the sum of government savings, consumer savings and net capital flows from abroad.

International trade is based on a set of regional bilateral flows. The model adopts the Armington specification, assuming that domestic and imported products are not perfectly substitutable. Moreover, total imports are also imperfectly substitutable between regions of origin. Allocation of trade between partners then responds to relative prices at the equilibrium.

Market goods equilibria imply that, on the one side, the total production of any goods or services is equal to the demand addressed to domestic producers plus exports; and, on the other side, the total demand is allocated between the demands (both final and intermediary) by domestic producers and the import demand.

ENV Linkages is fully homogeneous in prices and only relative prices matter. All prices are expressed relative to the numéraire of the price system that is arbitrarily chosen as the index of OECD manufacturing exports prices. Each region runs a current account balance, which is fixed in terms of the numéraire.

As ENV-Linkages is recursive-dynamic and does not incorporate forward-looking behaviour, price-induced changes in innovation patterns are not represented in the model. The model does, however, entail technological progress through an annual adjustment of the various productivity parameters, including e.g. autonomous energy efficiency and labour productivity improvements. Furthermore, as production with new capital has a relatively large degree of flexibility in choice of inputs, existing technologies can diffuse to other firms. Thus, within the CGE framework, firms choose the least-cost combination of inputs, given the existing state of technology. The capital vintage structure also ensures that such flexibilities are larger in the long run than in the short run.

Table A.1. Sectoral aggregation of ENV-Linkages

Agriculture, fisheries and forestry	Manufacturing
Paddy rice	Food products
Wheat and meslin	Textiles
Other grains	Wood products
Vegetables and fruits	Chemicals
Oil seeds	Basic pharmaceuticals
Sugar cane and sugar beet	Primary rubber and plastic products
Fibres plant	Secondary plastic products
Other crops	Pulp, paper and publishing products
Cattle and raw milk	Non-metallic minerals
Other animal products	Fabricated metal products
Fisheries	Electronics
Forestry	Electrical equipment
	Motor vehicles
Non-manufacturing Industries	Other transport equipment
Coal extraction	Other machinery and equipment
Crude oil extraction	Other manufacturing including recycling
Natural gas extraction	Iron and steel
Other mining	Non-ferrous metals
Petroleum and coal products	**Services**
Gas distribution	Land transport
Water collection and distribution	Air transport
Construction	Water transport
Electricity transmission and distribution	Insurance
Electricity generation (8 technologies)	Trade services
Electricity generation: Nuclear electricity; Hydro (and Geothermal); Solar; Wind; Coal-powered electricity; Gas-powered electricity; Oil-powered electricity; Other (combustible renewable, waste, etc.).	Business services n.e.s.
	Real estate activities
	Accommodation and food service activities
	Public administration and defence
	Education
	Human health and social work

Table A.2. Regional aggregation of ENV-Linkages

Macro regions	ENV-Linkages countries and regions	Most important comprising countries and territories
OECD	Canada	Canada
	USA	United States of America
	OECD Latin America (LAC)	Chile, Colombia, Costa Rica, Mexico
	OECD EU	Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden
	Australia & New Zealand	Australia, New Zealand
	Japan & Korea	Japan, Korea
	Rest of OECD	Iceland, Israel,[1] Norway, Switzerland, Türkiye, United Kingdom
Non-OECD	Rest of Latin America (LAC)	Non-OECD Latin American and Caribbean countries
	Non-OECD EU	Bulgaria, Croatia, Cyprus,[2] Malta, Romania
	Eurasia	Non-OECD European and Caspian countries, including Russian Federation
	Middle East and North Africa (MENA)	Algeria, Bahrain, Egypt, Iraq, Islamic Rep. of Iran, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, United Arab Emirates, Syrian Arab Rep., Western Sahara, Yemen
	Sub-Saharan Africa	Sub-Saharan Africa
	China	People's Rep. of China, Hong Kong (China)
	India	India
	Rest of Asia	Other non-OECD Asian and Pacific countries

Notes:

[1] The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

[2] Note by Türkiye: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Türkiye. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

The plastics module

A detailed description of the treatment of plastics in the model is given in (OECD, 2022[6]). Plastics flows are differentiated by polymer and application (Table A.3).

Table A.3. Mapping of plastics use by application to economic sectors

Input sectors	Applications	Output sectors	Polymers*
Plastic products	Building & Construction	Construction	ABS, ASA, SAN; Bioplastics; HDPE; LDPE, LLDPE; PP; PS; PUR; PVC; Other
	Consumer & Institutional products	Accommodation and food service activities; Air transport; Education; Health; Insurance; Lumber; Non-metallic minerals; Business services; Other manufacturing; Public services; Land transport; Pulp, paper and publishing; Real estate; Textile; Water transport	ABS, ASA, SAN; Bioplastics; HDPE; LDPE, LLDPE; PP; PS; PUR; PVC; Other
	Electrical/Electronic	Electrical equipment; electronics	ABS, ASA, SAN; Bioplastics; HDPE; LDPE, LLDPE; PP; PS; PUR; PVC; Other
	Industrial/Machinery	Fabricated metal products; iron and steel; nonferrous metal; Machinery and equipment	HDPE; LDPE, LLDPE; PP; PUR
	Packaging	Food products; Chemical products	Bioplastics; HDPE; LDPE, LLDPE; PET; PP; PS; PUR; PVC; Other
	Personal care products	Chemical products	HDPE; PET
	Transportation - other	Motor vehicles; Public services; Other transport equipment	ABS, ASA, SAN; Bioplastics; Fibres; HDPE; LDPE, LLDPE; PP; PUR; PVC; Other
	Other	Other sectors	Other
Chemicals	Marine coatings	Other manufacturing, other transport equipment	Marine coatings
	Road markings	Construction	Road markings
	Textile sector - clothing	Textiles	Bioplastics; fibres
	Textile sector - other	Textiles	Fibres
	Transportation - tyres	Plastic products	Elastomers (tyres)

Source: OECD ENV-Linkages model.

Regional leakage of macroplastics to the environment is calculated using the methodology described in (OECD, 2022[6]). Specifically, macroplastic leakage stems from three distinct sources: (i) leakage of mismanaged waste; (ii) leakage of littered items, and (iii) leakage from marine activities). The former two thus directly respond to changes in waste management systems, while the latter scales with marine economic activities (and is thus largely the same across scenarios). Finally, note that projections of leakage of microplastics are beyond the scope of the current analysis.

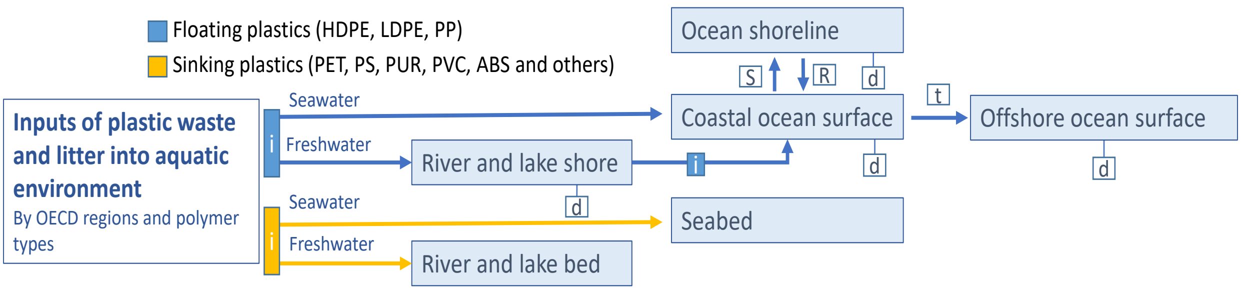
The aquatic leakage model

The projections on the fate of waste plastics in aquatic environments are made by L. Lebreton (2023[7]). The model calculates the amount of leaked plastics ending up in aquatic environments and assesses their mobility as well as degradation in rivers and oceans.

To calculate inputs of plastics by region into aquatic environments, results from a previous study by Borrelle et al. (2020[13]) which estimated leakage of mismanaged plastic waste into rivers, lakes, and the ocean at a global scale were used. The model supporting the results of this study includes global high-resolution distribution of plastic waste generation derived from population density, gross domestic product (GDP) per capita, and country scale municipal waste statistics (Lebreton and Andrady, 2019[14]). The model computes the probability for mismanaged plastic waste to reach an aquatic environment (rivers, lakes, and oceans) as a function of distance and terrain slope direction. By integrating over land, the study reports the national probability of emissions of plastics into aquatic environments, which is independent of the total amount of waste generated but may differ around the world as a function of population location and topography of countries. The probability of emissions by region is computed by weighing country scale emission probability by population size and formulating a regional average including confidence intervals.

The whole-ocean plastic mass budget model presented in (Lebreton and Andrady, 2019[14]) is expanded to a simplified representation of the global aquatic environment. The model differentiates between annual inputs in freshwater and the ocean, allowing floating plastic waste to circulate from one compartment to the other over time. The model also differentiates inputs by polymer types using the OECD ENV-Linkages model estimates and waste projections presented in this report. The likely fate of emitted plastics is determined depending on their density. Additionally, the degradation rates vary between polymers based on laboratory results (Gerritse et al., 2020[15]). The general model framework is presented in Figure A.2. To differentiate between freshwater and marine environment inputs, the model uses the results from Meijer et al. (2021[16]), which provides country-scale probabilities of emissions to the ocean. These results are upscaled to the modelled region by following the same weighted method as for inputs into aquatic environments. The fraction of waste emitted in freshwater and the fraction emitted directly into the ocean for every region and per year is thus estimated. Starting the model in 1951, plastics were emitted into the modelled aquatic environment from every region. Polymers with a density higher than water are assumed to sink on the riverbed, lakebed, or seabed. Floating polymers circulating at the surface could directly reach the coastal ocean surface within the first year or remain in the freshwater system, likely stranded on river and lakeshores. The model also remobilises accumulated waste in river and lakeshores, adding onto inputs from the following year. Floating polymers in the coastal ocean surface follow the same dynamics as in the model presented in Lebreton and Andrady (2019[14]), with recirculation between the shoreline and the sea surface and transfer from coastal to offshore waters. Floating plastics accumulated in river and lake shore or on the ocean surface and shoreline are considered in contact with sunlight, and a fraction of their mass degrades yearly to a sink term representing the mass of microplastics accumulated in freshwater and marine environments.

Figure A.2. Mass balance budget model for plastic in global aquatic environments



Note: Mass inputs by modelled region, characterized by polymer types, are accumulated from 1951 to 2060 into the plastic fate model. Plastics with a density higher than water sink and accumulate in riverbed, lakebed and seabed. Floating plastics (density lower than water) are transported between different aquatic compartments and are allowed to degrade into microplastics over time from contact with sunlight. The region-specific parameter 'i' is the ratio between plastics remaining in freshwater and the plastics entering the marine environment. The parameters 's' and 'r' represent the fraction of stranding and release from the global shoreline. The parameter 't' is the fraction of floating plastic circulating from the coastal to the offshore ocean. Finally, 'd' is the mass fraction degrading into microplastics annually and varies with polymer types.
Source: (OECD, 2022[3]).

Scenario quantification

The quantification of three of the main policy scenarios is provided in the table below; the *Delayed Ambition* scenario implements the same policy package as *Global Ambition*, but by 2060; for a full quantification of the *Delayed Ambition* scenario, please see (OECD, 2022[3]). Note that in addition to the scenarios presented here, two further scenarios are explored in the next section.

Table A.4. Quantification of the main policy scenarios

Pillar	Policy instrument	*Uncoordinated Action*	*Moderate Alignment*	*Global Ambition*
Curb production andl demand	Packaging plastics tax	*EU*: USD 1 000/tonne by 2030, constant thereafter; *Rest of OECD*: USD 1 000/tonne by 2040, constant thereafter; *Non-OECD*: USD 1 000/tonne by 2060	*OECD, EU*: as *Global Ambition* scenario; *Rest of the world*: as *Uncoordinated Action* scenario	*Global*: USD 1 000/tonne by 2030, doubling by 2040, constant thereafter
	Non-packaging plastics tax	*OECD*: USD 750/tonne by 2040, constant thereafter; *Non-OECD*: USD 750/tonne by 2060	*OECD, EU*: as *Global Ambition* scenario; *Rest of the world*: as *Uncoordinated Action* scenario	*Global*: USD 750/tonne by 2030, doubling by 2040, constant thereafter
Design for circularity	Eco-design for durability & repair	*Global*: 10% lifespan increase, 5-10% decrease in demand for durables, increase in demand for repair services such that ex ante total expenditures are unchanged	*Global*: 15% lifespan increase by 2030, constant thereafter; *OECD, EU*: demand changes as *Global Ambition* scenario; *Rest of the world*: demand changes as *Uncoordinated Action* scenario	*Global*: 15% lifespan increase by 2030, constant thereafter; 10-20% decrease in demand for durables by 2030, constant thereafter; increase in demand for repair services such that ex ante total expenditures are unchanged
	Ban selected single-use plastics	None	*OECD, EU*: as *Global Ambition* scenario; *Rest of the world*: as *Uncoordinated Action* scenario	*Global*: phase-out of PP for selected consumer products by 2030
	Substitute away from plastics	Global: reduction of plastics use in production by 8.5% by 2030 with compensating increase in use of other inputs	*OECD, EU*: as *Global Ambition* scenario; *Rest of the world*: as *Uncoordinated Action* scenario	*Global*: reduction of plastics use in production by 17% by 2030 with compensating increase in use of other inputs
Enhance recycling	Recycled content target	*OECD*: 40% recycled content target; *Non-OECD*: 20% recycled content target	*Global*: as *Global Ambition* scenario	*Global*: 30% recycled content target by 2040, 40% by 2060
	EPR for packaging, electronics, automotive and wearable apparel	*OECD + EU*: 30% points increase in recycling, tax on plastics inputs – USD 300/tonne by 2030, constant thereafter, subsidy on waste sector such that the instrument is budget neutral	*OECD, EU*: as *Global Ambition* scenario; *Rest of the world*: as *Uncoordinated Action* scenario	*Global*: tax on plastics inputs USD 300/tonne by 2030, constant thereafter; 30% points increase in recycling by 2040, constant thereafter; subsidy on waste sector such that the instrument is budget neutral
	Enhance recycling through waste management	*EU, Japan & Korea*: 60% recycling rate target by 2030, 70% by 2060; *Rest of OECD, China*: 60% recycling rate target by 2060; *Rest of non-OECD*: 40% recycling rate target by 2060	*Global*: as *Global Ambition* scenario	*EU, Japan & Korea*: 60% recycling rate target by 2030, 80% by 2060; *Rest of OECD, China*: 60% recycling rate target by 2040, 80% by 2060; *Rest of non-OECD*: 45% recycling rate target by 2040, 60% by 2060
Close leakage pathways	Improved plastic waste collection	*OECD*: full reduction of mismanaged waste shares; *Non-OECD*: halving of mismanaged waste shares	*Global*: rate of reduction of mismanaged waste shares by 2040 aligned with *Global Ambition* scenario	Global: full reduction of mismanaged waste shares by 2040
	Improved litter collection	*High income countries* collection rates increase 5%-points; *middle income countries* income-scaled increase	*Global*: as *Global Ambition* scenario	Low-income countries collection rates increase 10%-points by 2040, constant thereafter; high income countries collection rates increase 5%-points by 2040, constant thereafter; middle income countries income-scaled increase