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Plastic Money:

Turning Off the Subsidies Tap

Phase 2 Report

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The Quaker United Nations Office (QUNO) works to promote peace and justice at the international level, focusing on areas such as human rights, peacebuilding, and sustainable development. Through its engagement with rights-holders, United Nations agencies, governments, and non-governmental organizations, QUNO seeks to build collaborative solutions to global challenges. Guided by Quaker principles, QUNO's Sustainable and Just Economic Systems programme addresses the systemic issues driving economic inequality and environmental degradation. QUNO's work on plastic subsidies is part of its broader commitment to fostering economic systems that are both sustainable and just.

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Any errors or omissions remain the sole responsibility of the report's authors.

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1.0 Introduction

Synthetic plastic polymers have become ubiquitous in modern life, thanks to their malleability, lightness, ability to be produced in just about any colour, or transparent, and low cost. Yet each stage of the plastics lifecycle — from hydrocarbon extraction to the refining and polymerization of hydrocarbons, and the disposal of plastic waste — contributes to the triple planetary crises: climate change, pollution, and biodiversity loss.[1] Global production of primary plastics, which are still produced almost entirely from fossil fuels, surpassed 400 million tonnes in 2016. Without serious actions to constrain that growth, that volume will continue expanding by around 3% annually.[2]

The Intergovernmental Negotiating Committee on Plastic Pollution (INC), which is tasked with developing the UN-mandated Global Plastics Treaty to end plastic pollution, including in the marine environment, is expected to produce a final agreed text of an international legally binding instrument by the end of its fifth session (INC-5) at the beginning of December 2024. The negotiators have been tasked with considering what measures — across the entire life cycle of plastics, from production to recycling or ultimate disposal — could or should be pursued to contribute to that goal.

One of those possible measures is ending subsidies for the production of plastics (Box 1.1). Most experts agree that implementing demand-side measures and improving waste management will not alone be sufficient to substantially reduce plastic pollution if annual growth in plastics production continues at its current pace. Like subsidies to any industry, the presumed effect of those subsidies is to reduce the cost of producing primary plastic polymers, driving new investments and the manufacturing of primary plastic polymers, which in turn is likely lowering the final price of plastic products, particularly simple products such as packaging materials. That effect, in turn, helps make plastics compete more easily with alternative materials.

Eliminating subsidies to plastics is an attainable goal and would be consistent with efforts in other international fora, for example, in the Convention on Biological Diversity to phase out environmentally harmful subsidies and in the United Nations Framework Convention on Climate Change to reduce greenhouse gas emissions.

One major barrier to advancing discussion on the issue is a lack of more than impressionistic information on the nature and extent of those subsidies. Good data are available on the size of subsidies provided to fossil fuels, including the refining of crude petroleum, and to the consumption of fossil fuels generally, but not to the production of primary plastic polymers. This is the only initiative that we are aware of that is attempting to quantify and analyse the effects of subsidies on plastics production.

This Phase 2 report remains a work-in-progress and extends the information provided in our Phase 1 Report[3]. In both reports, the focus is on the segment of the industry that is specific to the stages of production that begin with the processing of the raw materials of plastic (steam cracking of naphtha, the isolation of alkanes from raw natural gas, and the gasification of coal) through the production of

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[1] Joachim Peter Tilsted, Fredric Bauer, Carolyn Deere Birkbeck, Jakob Skovgaard, Johan Rootzén (2023), 'Ending fossil-based growth: Confronting the political economy of petrochemical plastics,' *One Earth* 6(6), pp. 607-619, https://doi.org/10.1016/j.oneear.2023.05.018.

[2] United Nations Environment Programme (2021). *From Pollution to Solution: A global assessment of marine litter and plastic pollution.* Nairobi.

[3] Eunomia and QUNO (2024). *Plastic Money: Turning Off the Subsidies Tap*. Phase 1 Report, August 2024

basic resins, and their compounding and extrusion as plastic pellets. This is the segment of the industry that is the most geographically concentrated and dominated by a relatively small number of very large enterprises, some state-owned. Subsidies certainly are provided both upstream and downstream of that segment but are beyond the scope of this study.

We document what information is available and where there are data gaps in respect of government support provided by the top producers, including sub-national governments, in each of five world regions — Asia (eastern); Asia (southern); Western and Central Europe; Middle East and North Africa (MENA), North America, South America — in the form of direct spending (e.g., grants), concessional credit, tax expenditures, and price support for inputs.

Our estimates of government support will form the baseline for the 2nd phase of the work (September–November 2024): projecting future support under a business-as-usual scenario, and modelling the effects of subsidy reform on production, trade, and emissions.

Box 1.1. References to 'subsidies' in the International Negotiating Group's discussions to date

By Dr Alexandra R. Harrington*

A limited number of references to subsidies were included in the draft texts used by the International Negotiating Committee (INC) charged with developing an international legally binding instrument on plastic pollution, including in the marine environment ('the ILBI') during their 3rd session (INC-3, Nairobi, Kenya, November 2023) and 4th session (INC-4, Ottawa, Canada, April 2024), and were included in the Compilation Document to be used as the basis of negotiations for INC-5 (Busan, Republic of South Korea, November 2024). Additionally, during the preparatory meetings for the Ad Hoc Intersessional Open-Ended Expert Group to develop an analysis of potential sources and means that could be mobilised for implementation of the objectives of the instrument, including options for the establishment of a financial mechanism, alignment of financial flows, and catalysing finance, several States raised the issue of subsidies as being potential elements for addressing aspects of the ILBI implementation process.

Thus far, the proposed legal provisions relating to subsidies in the ILBI can be found in binding and non-binding forms. One proposal, newly raised during INC-4, would be to include language 'recognizing that subsidies can play an environmentally harmful role throughout the lifecycle of plastics and in the plastic pollution crisis' in the ILBI preamble. While this would not be a legally binding obligation, it would be important in framing the intent of States to create and implement the ILBI and could serve as support for future decisions and measures of the Conference of the Parties for the ILBI relating to subsidies. There is a proposal to include references to subsidies in the binding, control measures on regulating primary and/or secondary plastic polymers in Part II.1 of the Compilation Document. The proposal would have been for either mandatory or voluntary State Party commitments to either "to not grant or maintain" or "to remove subsidies" for either primary and/or secondary plastics, or both. In Part II.13 on transparency, tracking, monitoring and labelling, a proposal was made that State Parties would be required to include information on subsidies use, phase-outs and related measures in their national monitoring obligations.

Additionally, proposed Annex X to the ILBI, which would contain 'effective measures at each stage of the plastic lifecycle', includes references to States providing information on subsidies and subsidy reform under the heading of the 'distribution/sale/consumption stage' of the full plastic lifecycle.

During the preparatory meetings for the Intersessional Expert Group, subsidies were discussed by some State delegations as a potential tool to use in encouraging the development of plastics alternatives and substitutes (positive or virtuous subsidies) as well as efforts to phase out and eliminate subsidies associated with the production of plastics covered by the ILBI (harmful subsidies). States also raised concerns that subsidies measures stemming from the ILBI be structured in a way that supports existing World Trade Organization (WTO) laws on the topic. These arguments reflect the positions which have consistently been voiced throughout the INC meetings to date. Notably, the Co-Chairs' Synthesis Paper in advance of the Bangkok Intersessional Expert Group meeting includes references to subsidies in potential measures that would allow for the alignment of both public and private financial flows that advance the terms of the ILBI, though they are identified as being geared toward public measures. This Synthesis Paper also highlighted the potential connections between 'elimination, phase out or reform incentives, including subsidies' and existing State commitments under the Kunming Montreal Global Biodiversity Framework to phase out certain forms of subsidies that harm biodiversity.

In late October 2024, the Chair of the INC publicly issued the Chair's Non-Paper in advance of INC5. Building on two earlier iterations which were used to spark conversations with heads of delegations and select intergovernmental bodies following the Bangkok Intersessional Expert Group meetings, this Non-Paper offers the Chair's views on a potential structure for the ILBI based on areas where he found there to be a likelihood of some agreement. It should be noted that, since INC4 authorised the creation of the Compilation Document by the INC Secretariat but not the Non-Paper, procedurally a formal motion to use the Non-Paper as the basis for INC5 negotiations in lieu of the Compilation Document was required from INC5.

In terms of content, it should be noted that the Non-Paper fails to include any references to subsidies and contains far smaller provisions relating to trade, especially import and export requirements, than those proposed in the Compilation Document. Regardless of the document used, it is clear that many States support the use of Annexes, including those listing covered products and providing information on categorizing plastics and plastic components, in a way that will require the merging of scientific knowledge and legal provisions.

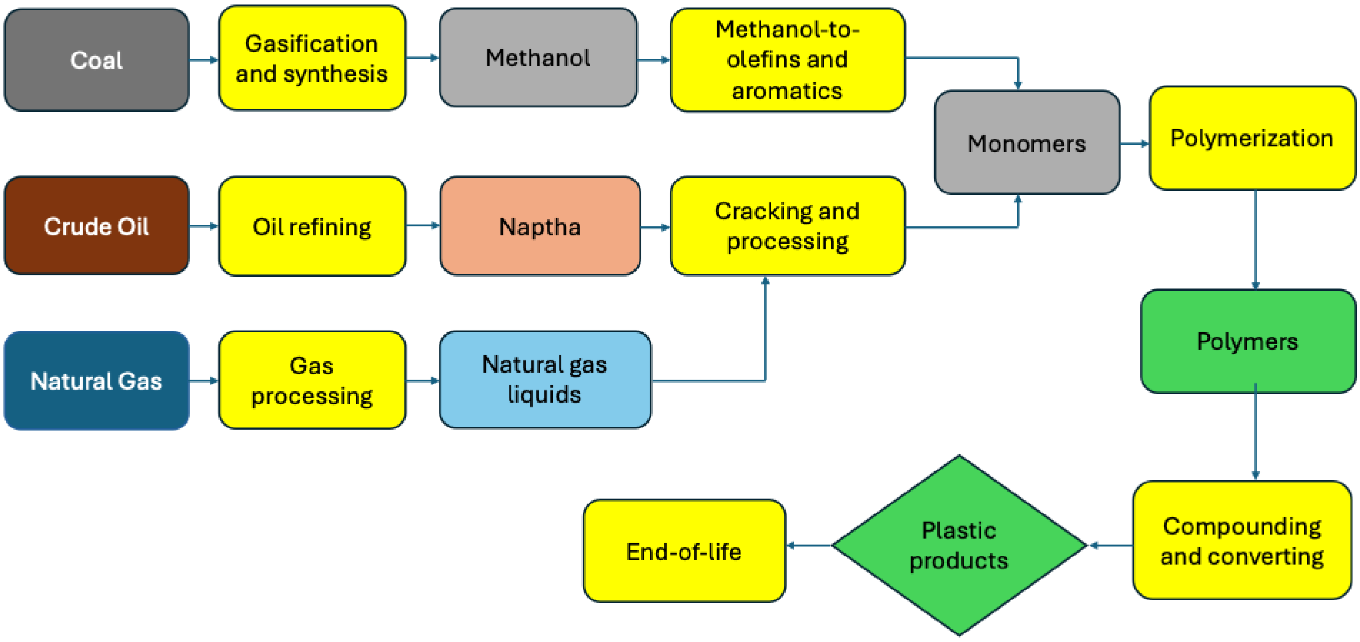
During the Opening Plenary of INC5, it was decided that the Non-Paper would be used as the basis for negotiations, although States retain the right to propose textual edits, including terms from the Compilation Document.

* Chair, IUCN WCEL Plastic Pollution Task Force.

2.0 The Plastics Industry

The raw materials for the production of virgin primary plastic polymers (PPP) are 99% derived from fossil fuels — coal, natural gas, or petroleum. The raw materials — generally hydrocarbons called alkanes, such as ethane, propane, methane, and butane — are extracted from fossil fuels in different ways. Until recently, most PPPs were produced from products of petroleum refining, particularly naphtha (a mixture of C5 to C10 hydrocarbons), but in recent years alkanes separated out from raw natural gas have increased in relative importance. In China, some PPPs are derived from methane (CH_4) obtained from gasifying coal, which in turn is oxidized to form methanol (CH_3OH).

Figure 2-1 Simplified diagram of the inputs and processes involved in producing primary plastic polymers



Source: Adapted from Figure 1 in Joachim Peter Tilsted, Fredric Bauer, Carolyn Deere Birkbeck, Jakob Skovgaard, Johan Rootzén (2023), 'Ending fossil-based growth: Confronting the political economy of petrochemical plastics,' *One Earth* 6(6), pp. 607-619, p. 608.

The process of producing PPPs thus involves breaking down the alkanes into lighter molecules, by means of heat and usually pressure and sometimes catalysts into olefins (chiefly ethylene, propylene and 1,3-butadiene) and other monomers, a process known as 'cracking'. These monomers and then stitched together through a process called polymerization into long chains of repeated molecules, i.e. polymers. The most commonly produced plastic polymers, such as polyethylene and polypropylene, are made from single monomers (Table 2-1). Polymers that are made up of two or more monomer species are called copolymers, common examples of which include acrylonitrile butadiene styrene (ABS), nitrile rubber, and polyethylene-vinyl acetate (PEVA).

Many more polymers are produced than just those thermoplastics (polymers that can be melted and reformed multiple times) listed in rows 1-6 of Table 2-1, often called 'commodity plastics'. Within the broad category of polyethylene, for example are, in addition to HDPE and LDPE, medium-density polyethylene (MDPE), linear low-density polyethylene (LLDPE), and metallocene (mLLDPE), each with properties such as puncture and tear resistance, or balance between toughness and stiffness, that make them better suited for particular applications.

Table 2-1 Leading polymers, their monomers, and examples of applications

Resin I.D. code	Polymer	Abbreviation	Monomer(s)	Examples of common applications	Share of global production in 2022[1]
1	Polyethylene terephthalate[2]	PET	Ethylene glycol $(CH_2OH)_2$, purified terephthalic acid $(C_6H_4(CO_2H)_2$, dimethyl terephthalate $(C_6H_4(COOCH_3)_2$	semi-rigid packaging materials, such as water and soft-drink bottles	6.2%
2	High-density polyethylene	HDPE	Ethylene $(CH_2{=}CH_2)$	semi-rigid packaging materials, such as bottle caps and milk bottles	12.2%
3	Polyvinyl chloride	PVC	Vinyl chloride $(CH_2{=}CH\text{-}Cl)$	water pipes, window frames, films	12.7%
4	Low-density polyethylene	LDPE	Ethylene $(CH_2{=}CH_2)$	light packaging materials, such as plastic wraps	14.1%
5	Polypropylene	PP	Propylene $(CH_3\text{-}CH{=}CH_2)$	rigid food packaging, such as yoghurt pots, carpets	18.9%
6	Polystyrene	PS	Styrene $(C_6H_5CH{=}CH_2)$	rigid food packaging, insulating material	5.2%
7	Other plastics, including thermosets	—	Various monomers, depending on the plastic	baby bottles, plastic compact disks, eyeglasses, car parts, exterior lighting fixtures	15.9%

1. Share of virgin production only. Share for HDPE includes medium-density polyethylene; share for LDPE includes LLDPE.

2. PET can be produced either through the direct esterification of ethylene glycol (EG) and purified terephthalic acid (PTA), or by converting PTA to dimethyl terephthalate (DMT) using methanol and then having DMT react with EG.

Sources: • **Columns 1-4:** Payal Baheti, 'How Is Plastic Made? A Simple Step-By-Step Explanation', no date, https://www.bpf.co.uk/plastipedia/how-is-plastic-made.aspx ; • **Column 6:** Plastics Europe, 'Plastics — the fast facts 2023', https://plasticseurope.org/knowledge-hub/plastics-the-fast-facts-2023/

Within the category of 'other plastics' (row 7 in the table) are various thermosetting polymers (polymers that cannot be melted and reformed), such as polyester resin, polyurethanes, polyurea-polyurethane hybrids, vulcanized rubber, bakelite, and urea-formaldehyde. Another category of polymers are so-called 'engineering plastics'. These are mainly thermoplastic materials with better mechanical or thermal properties than commodity plastics. Examples include polyamides (PA, nylons), polycarbonates (PC), poly(methyl methacrylate) (PMMA), and acrylonitrile butadiene styrene (ABS).

The division — geographically, institutionally, and economically — between the production of alkanes, monomers, and polymers is highly variable. Huge complexes exist at which petroleum is refined yielding, among other products, naphtha. The naphtha is cracked in a separate process, yielding olefin monomers and other products; and then the monomers are polymerized in yet another separate process, yielding polymer resins. All three stages are sometimes under the control of one corporate entity, but often under separate entities or various configurations of joint ventures. The refineries, crackers and polymerization plants also need not be adjacent, though if not they are usually connected by product pipelines.

This variable geometry has implications for the pricing of alkanes and monomers, and in particular transparency into the prices of these chemicals. When the process from refining through polymerization is integrated within one company, those prices are normally proprietary and therefore invisible to observers from outside the company. Some prices from arms-length transactions are collected and reported by governments, while others are available only through firms that collect such data from industry sources and charge customers for limited access.

Top companies and economies

Estimates of the rankings of PPP by economies depend on which polymers are included in the totals — particularly whether synthetic fibres and elastomers (e.g., polymers used in tyres) are included. Whichever definition is used, the world's top producer is China which is estimated to account for over one-third of global capacity of thermoplastics in 2024, followed by the United States, at around 13%, and then a group of economies accounting for around 5% each (India, Saudi Arabia, and South Korea), followed by a group accounting for 2–3% of global production (Brazil, Germany, Iran, Japan, Russian Federation, Chinese Taipei, and Thailand). In total, the top 4 producing economies are estimated to account for around 60% of global capacity to produce commodity plastics, the top 10 producing economies for around 75%, and the top 15 economies (investigated in this study) for 85%.[4]

The economies investigated in this study include: China, United States of America, Kingdom of Saudi Arabia, South Korea, India, Japan, Germany, Thailand, Brazil, Chinese Taipei, Iran, Russia, Belgium, France and Mexico.

Generally, the economies with the longest histories of petrochemical manufacturing and the most expensive feedstocks tend to specialise in producing high-value polymers, whereas those with a shorter history or access to low-cost feedstocks produce commodity polymers, such as polyethylene, poly-vinyl chloride, and polypropylene. China, for example, accounts for 47% of global production of PVC, and 38% or more of the world's output of PET, polypropylene and polystyrene. The United States is the global leader in the production of LLDPE.

In terms of corporate structure, the production of primary plastic polymers and their monomers is led by multinational companies that produce a wide array of chemicals, particularly petrochemicals, and by a few multinational, integrated oil and gas companies (Table 2-2). State-owned companies, such as China's Sinopec and PetroChina, and Saudi Arabia's 70%-owned SABIC, feature among the top five producers, but most of the other significant producers are publicly listed, private-sector corporations. Many companies, both state-owned and privately owned, are subsidiaries of multinational producers or refiners of oil or natural gas. Others, such as LyondellBasell and Dow Chemical, are long-established producers of a wide variety of chemicals.

Corporate integration

Most of the top 10 corporations that produce thermoplastics are also leading producers of the monomers from which the polymers are wholly or partially manufactured — ethylene and propylene — and all of the 10 leading producers of these two monomers also feature among the top 12 producers of

[4] This ranking is based on several sources, some proprietary. The ranking below the top two producers often differs depending on the source and can change with the commissioning of a large facility in any given year.

thermopolymers. They, and many other of the top producers, are members of larger corporate groups with both vertical and horizontal links in the production chain. Joint ventures among monomer and polymer producers are also commonplace, especially in respect of plants built in emerging economies.

Table 2-2 Leading global producers of primary plastic polymers

Company name	Headquarters	Other economies in which it produces PPP or precursors	Controlling ownership	Parent company focus
Sinopec Corp	China		State	oil & gas
ExxonMobil Chemical Company	United States (TX)		private sector (publicly listed)	oil & gas
SABIC	Saudi Arabia	Germany, Netherlands	State	oil & gas
LyondellBasell Industries	United States (TX and the Netherlands	Australia, Belgium, Brazil, China, France, Germany, India, Italy, Spain, UK	private sector (publicly listed)	chemicals
PetroChina (CNPC)	China		State	oil & gas
Dow Chemical Company	United States (MI)	Canada	private sector (publicly listed)	chemicals
INEOS	United Kingdom	Belgium, France, Germany, Italy, Norway, United States	private sector (publicly listed)	chemicals
Braskem	Brazil	Mexico, United States	private sector (publicly listed)	petrochemicals
Formosa Plastics Corporation	Chinese Taipei	China, USA	private sector (publicly listed)	petrochemicals
Chevron Phillips	United States	Saudi Arabia	private sector (publicly listed)	oil & gas
Total Energies S.A.	France	United States	private sector (publicly listed)	oil & gas
Borealis AG	Austria	Belgium, Finland, Germany, Sweden	private sector (publicly listed)	chemicals
Shin-Etsu Polymer Co., Ltd.	Japan	United States, Europe	private sector (publicly listed)	chemicals
Reliance Industries Ltd.	India		private sector (publicly listed)	conglomerate, incl. oil & gas
Westlake Chemicals	United States		private sector (publicly listed)	chemicals

Sources: • **Overall rankings:** Polyglobe, 'Polymer capacities worldwide 2021/2026', 2021, https://www.polyglobe.net/_g/pdf/polyglobe/ePaper/Poster_2021/, based on mid-point values between 2021 and 2026;
• **Headquarters and other economies of operation:** corporate web sites, Wikipedia entries.

3.0 Subsidies to PPP Producers

The WTO definition of a subsidy

The most common definition of a subsidy used internationally is that of the World Trade Organization (WTO), as set out in Article 1.1 of its 1994 Agreement on Subsidies and Countervailing Measures (SCM Agreement). That definition deems a subsidy to exist if:

> '(a)(1) there is a financial contribution by a government or any public body within the territory of a Member (referred to in this Agreement as "government"), i.e. where:
>
> > (i) a government practice involves a direct transfer of funds (e.g. grants, loans, and equity infusion), potential direct transfers of funds or liabilities (e.g. loan guarantees);
> >
> > (ii) government revenue that is otherwise due is foregone or not collected (e.g. fiscal incentives such as tax credits);
> >
> > (iii) a government provides goods or services other than general infrastructure, or purchases goods;
> >
> > (iv) a government makes payments to a funding mechanism, or entrusts or directs a private body to carry out one or more of the type of functions illustrated in (i) to (iii) above which would normally be vested in the government and the practice, in no real sense, differs from practices normally followed by governments.
>
> or
>
> (a)(2) there is any form of income or price support in the sense of Article XVI of GATT 1994;
>
> and
>
> (b) a benefit is thereby conferred.'[5]

A key part of this definition is 'a benefit [to one or more recipients] is thereby conferred'. Hence, when a government makes an equity infusion (i.e., invests its own funds) in, say, a state-owned firm; provides goods or services (other than general infrastructure); or purchases goods from a company; no subsidy is conferred if these transactions take place on the same terms as a private entity participating in the market that invests in a project with a similar profile, or sells the same goods or services, or purchases the same goods or services. Or, to put it another way, when a government accepts a return on investment lower than a private-market actor would require, or provides goods (including access to land or mineral resources) or services either for free or at a discounted price, or buys goods or services from a firm at above-market price, a benefit is considered to be conferred.

Price support under this definition excludes that which is provided by tariffs or other import barriers, because those barriers are set (and disputed) under a different WTO process. The Organisation for Economic Co-operation and Development (OECD) does consider that the effects of such barriers, which raise producer (and consumer) prices above what they would be in the absence of those barriers, constitute a form of government support. But to avoid confusion with WTO terminology, when it discusses such a transfer ('market price support to producers', or simply 'market price support') it tends

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[5] WTO, 'Agreement on Subsidies and Countervailing Measures', no date, https://www.wto.org/english/docs_e/legal_e/24-scm_01_e.htm

to use the term 'support' rather than subsidy. The types of price support from which many producers of PPPs benefit, however, more commonly relate to the prices of chemical feedstocks or process energy.

The main purpose of the SCM Agreement is to establish rules for governing disputes among WTO members over alleged adverse trade effects caused by one of its members' subsidies. It defines three categories: prohibited, actionable, and non-actionable. One test to determine within which category a subsidy falls is whether it is considered to be 'specific'. Article 2 of the SCM Agreement sets out criteria for making such a determination. Prohibited subsidies — i.e., subsidies that are contingent upon export performance or upon the use of domestic over imported goods — are deemed specific. Other types of subsidies can be determined to be specific based on such factors as:

> 'use of a subsidy programme by a limited number of certain enterprises, predominant use by certain enterprises, the granting of disproportionately large amounts of subsidy to certain enterprises, and the manner in which discretion has been exercised by the granting authority in the decision to grant a subsidy.'[6]

The issue of specificity has a bearing on how or whether price-related subsidies to industrial inputs (i.e., consumer price support) are considered actional subsidies under current SCM Agreement rules.

The main types of subsidies to PPP producers

This section describes the principal forms of government support to producers of primary plastic polymers. The WTO definition of a subsidy characterizes subsidies in terms of the transfer mechanism — e.g., grants, tax concessions, or price support. For economic analysis, the initial (or statuary) incidence of government support — i.e., to what factor of production is the subsidy directed — is also of importance. Thus this section is framed with both dimensions in mind.

Capital-related support

Government support for investments in plants that produce primary plastic polymers or their chemical inputs is provided typically through grants, loans below-market rate, loan guarantees, or the acquisition of equity.

Grants tied to investments in plants are the most transparent forms of capital-related support, and on occasion can be significant. But they are provided less commonly than the other forms.

Concessional loans and loan guarantees from public finance institutions are another mechanism by which governments support new investments. The types of institutions involved include national development banks (which often support both domestic and international projects), multilateral development banks (MDBs), and export credit agencies. Oil Change International (OCI), an NGO, maintains the 'Public Finance for Energy Database' of public finance provided from G20 members' bilateral finance institutions and the major MDBs. By OCI's definition, such a body qualifies as a 'public finance institution' if 'national government(s) hold more than 50% of the ownership stakes and where there is a clear policy mandate that drives decisions beyond solely commercial performance.'[7]

Unlike a grant, an equity infusion by a government implies that the State has taken an ownership position in a company and that its return on that investment thus is dependent on the company's economic performance. Wholly state-owned enterprises are common in the energy sector, including

[6] *Ibid*, Article 2.1(c).

[7] Oil Change International, 'Public Finance for Energy Database: About', accessed 16 Aug. 2024, energyfinance.org.

petroleum refining and electricity production, but exist also in the petrochemical industry, including that part of it involved in the production of monomers and polymers. It is certainly conceivable that when a government invests public funds in such a state-owned enterprise (SOE) the enterprise behaves in the market similarly as its peers. Historically, however, SOEs have long attracted particular attention from other governments and non-state actors.[8] For example, in the founding document of the WTO's predecessor, the General Agreement on Tariffs and Trade (GATT), the contracting parties to the Agreement devoted a section of the document (Article XVII) specifically to state trading enterprises, requiring that such enterprises:

> … in accordance with commercial considerations, including price, quality, availability, marketability, transportation and other conditions of purchase or sale, and shall afford the enterprises of the other [GATT] contracting parties adequate opportunity, in accordance with customary business practice, to compete for participation in such purchases or sales.[9]

Support to feedstocks

Some 99% of virgin polymer production is derived from fossil fuels. When petroleum is the starting point, the main feedstock hydrocarbons are products of refining crude oil: naphtha (a mixture of C5 to C10 hydrocarbons) and refinery olefins.[10] In the case of natural gas, they are natural gas liquids, which are removed from the raw natural gas stream by cryogenic expansion or condensation. Monomers and polymers made from coal involve first gasifying the coal to produce methane, and then converting the methane to methanol.

Simply put, government support to chemical feedstocks is typically provided via one of three mechanisms: (1) government intervention in the setting of prices for those feedstocks; (2) government policies, such as tax credits or rebates, that reduce the effective price paid by purchasers of those feedstocks; and (3) policies that reduce or exempt the feedstock chemicals from taxes normally applied to similar products.

Support for process energy

The production of monomers and primary plastic polymers is energy-intensive. Steam cracking, which decomposes alkanes such as ethane in furnaces at a temperature of around 850 °C, requires high-temperature heat, typically generated by the combustion of fossil fuels such as natural gas or liquefied petroleum gas (LPG), though hydrogen and electricity can also be used.[11]

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[8] See for example, Teresa Ter-Minassian (2017), 'Identifying and Mitigating Fiscal Risks from State-Owned Enterprises (SOEs)', Discussion Paper No. IDB-DP-546, Inter-American Development Bank.

[9] GATT, 'The General Agreement on Tariffs and Trade (GATT 1947)', 30 Oct 1947, https://www.wto.org/english/docs_e/legal_e/gatt47_01_e.htm#articleXVII

[10] U.S. Energy Information Administration, 'How much oil is used to make plastic?', 10 Jul. 2024, https://www.eia.gov/tools/faqs/faq.php?id=34&t=6

[11] Jiwon Gu, Heehyang Kim, Hankwon Lim, 'Electrified steam cracking for a carbon neutral ethylene production process: Techno-economic analysis, life cycle assessment, and analytic hierarchy process,' *Energy Conversion and Management*, Vol. 270 (2022), 116256, https://doi.org/10.1016/j.enconman.2022.116256.

The polymerisation of the monomers that emerge from the cracking process is also energy-intensive. It requires both process heat — typically provided by fossil fuels or electricity — and electricity to power machinery.[12]

As with feedstocks, government support for energy used in the processes for producing monomers and polymers is typically provided via one of three mechanisms: (1) government intervention in the setting of prices charged for fuels or electricity; (2) government policies, such as tax credits or rebates, that reduce the effective price paid by purchasers of fuels or electricity; and (3) policies that reduce or exempt the fuels or electricity from taxes normally paid by other consumers of the same fuels or electricity.

Other support

Other forms of support provided to the upstream segment of the plastics industry could include subsidies for inputs other than chemicals or energy, such as water consumed in the production process[13] or land on which facilities are built, but also to value-adding factors, such as labour, or new knowledge (via government-funded research and development, for example). So far, we have not been able yet to investigate systematically whether producers of monomers or primary plastic polymers have benefitted from such subsidies. Examples of subsidies for training, however, have often formed a (modest) part of larger incentive packages to attract corporations to invest in primary-plastic-manufacturing facilities in the United States.[14]

Price support is also provided to some producers through import protection, normally in the form of import tariffs on competing products. While the effects of these tariffs are usually to increase domestic prices, they also encourage investments in the industry in the economy applying the tariffs, especially if there is a large and growing market for polymer resins and there is an opportunity for import substitution.

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[12] Marczak, H. (2022). Energy Inputs on the Production of Plastic Products. *Journal of Ecological Engineering*, 23(9), pp.146-156. https://doi.org/10.12911/22998993/151815

[13] Significant public resources are spent on desalinizing water in the Gulf Cooperation Council (GCC) region, for example. See Mohsen Sherif, Muhammad Usman Liaqat, Faisal Baig, and Mohammad Al-Rashed (2023), 'Water resources availability, sustainability and challenges in the GCC countries: An overview,' *Heliyon*, 9(10), pp. e20543, https://doi.org/10.1016/j.heliyon.2023.e20543

[14] Search for 'training reimbursement' for the chemical industry at Good Jobs First's 'Subsidy Tracker', https://subsidytracker.goodjobsfirst.org/?company_op=starts&major_industry%5B%5D=chemicals&subsidy_op=%3E&face_loan_op=%3E&subsidy_type%5B%5D=training+reimbursement&order=company&sort=&page=3

4.0 Results and Discussion

This section presents the results of the two modelled scenarios. Section 4.1 focuses on the results from the baseline scenario and Section 4.2 shows the results from the full subsidy removal scenario.

4.1 Baseline Scenario

4.1.1 Polymer Production

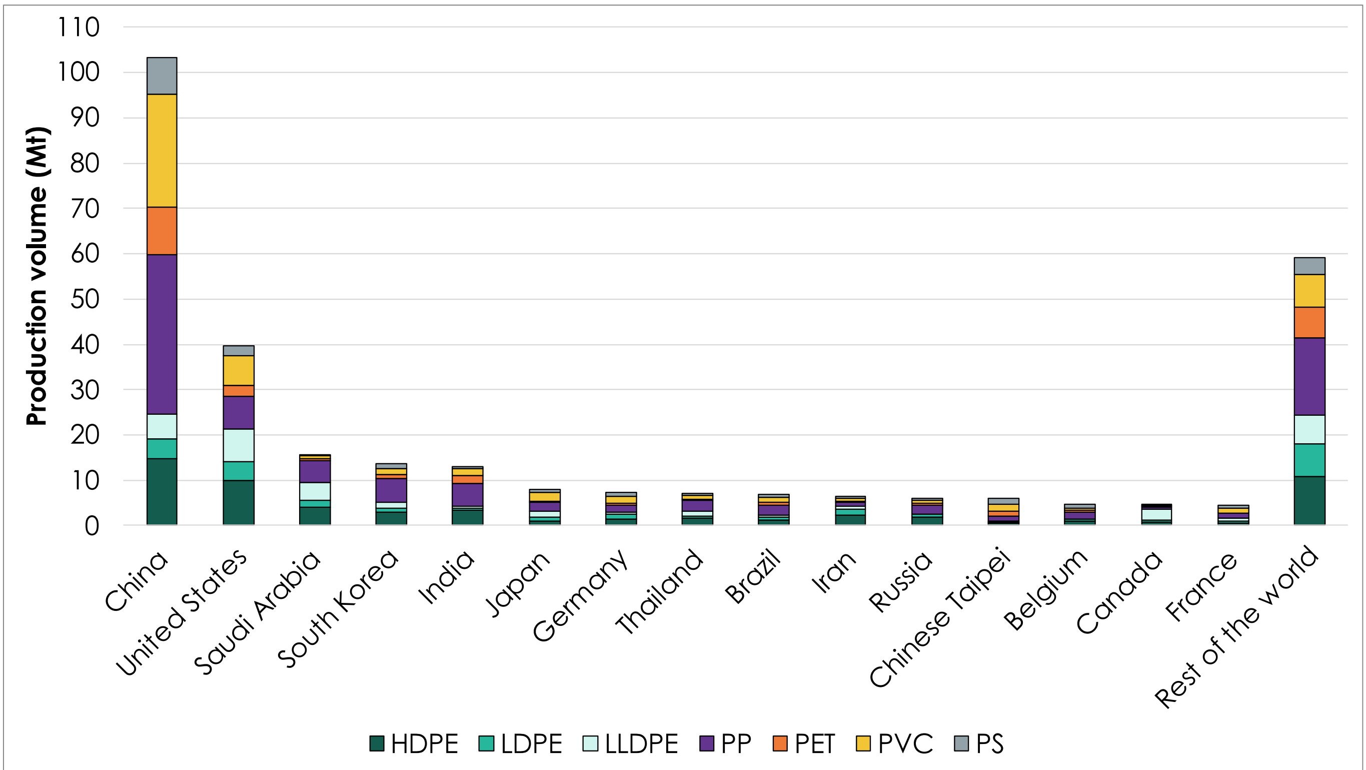
Results are presented for the top 15 ranked economies according to total polymer production volume in 2024, and the rest of the world combined.

In the baseline scenario, total polymer production is estimated at 305.8 million tonnes in 2024, rising to 590.4 million tonnes in 2050.

In 2024 and 2050, China is the largest polymer producer with estimated total polymer production of 103 million tonnes in 2024 (Figure 4-1), rising to 206 million tonnes in 2050 (Figure 4-2). China produces all seven of the main primary polymers (HDPE, LDPE, LLDPE, PP, PET, PVC and PS).

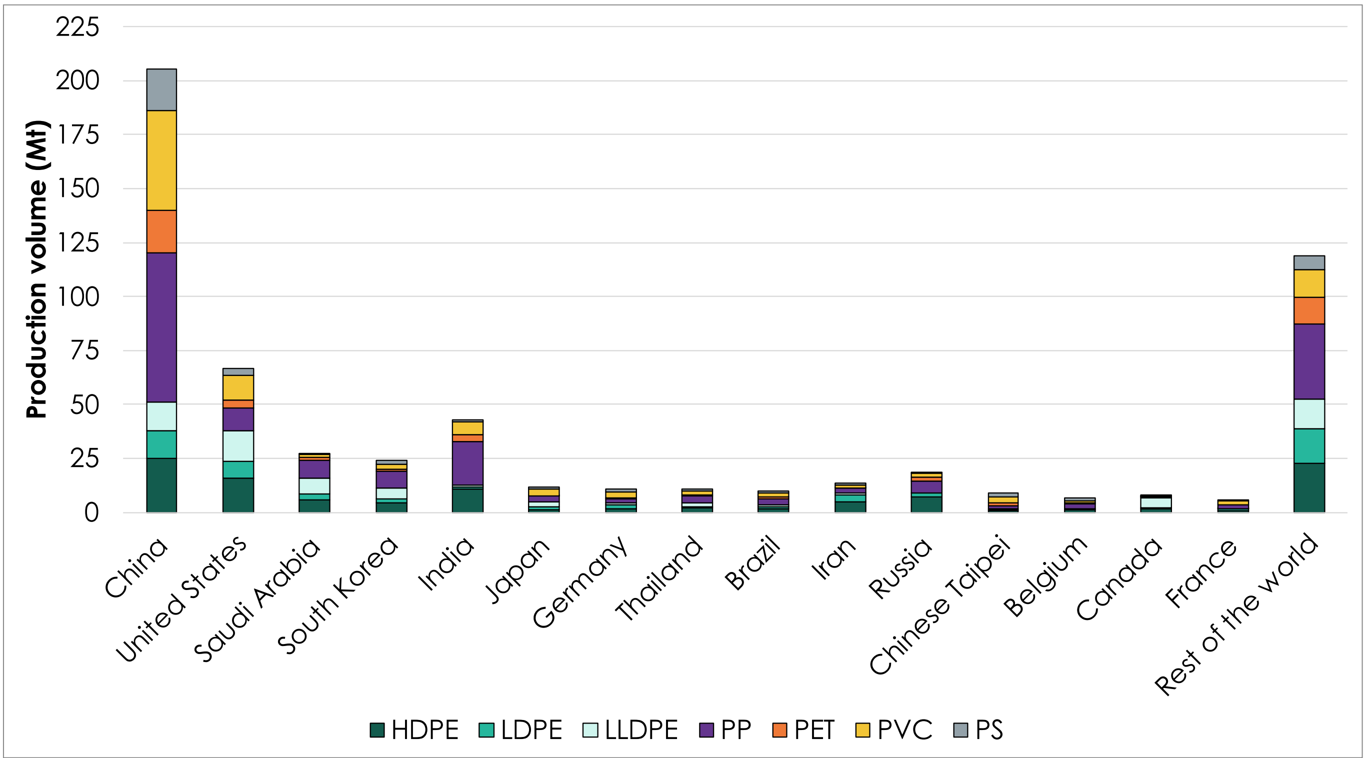
The United States is the second largest polymer producer in 2024 and 2050, accounting for 40 million tonnes of production in 2024 and 67 million tonnes of production in 2050. The majority of US production is PE; 21.3 million tonnes in 2024 and 37.7 million tonnes in 2050, respectively (Figure 4-1 & Figure 4-2).

Figure 4-1: Polymer production volumes, baseline scenario, 2024



Source: Eunomia Analysis

Figure 4-2: Polymer production volumes, baseline scenario, 2050



Source: Eunomia Analysis

4.1.2 Level of Subsidies

This Section shows the level of feedstock subsidies and the level of process energy subsidies to monomer and polymer production, in the baseline scenario.

4.1.2.1 Feedstock subsidies

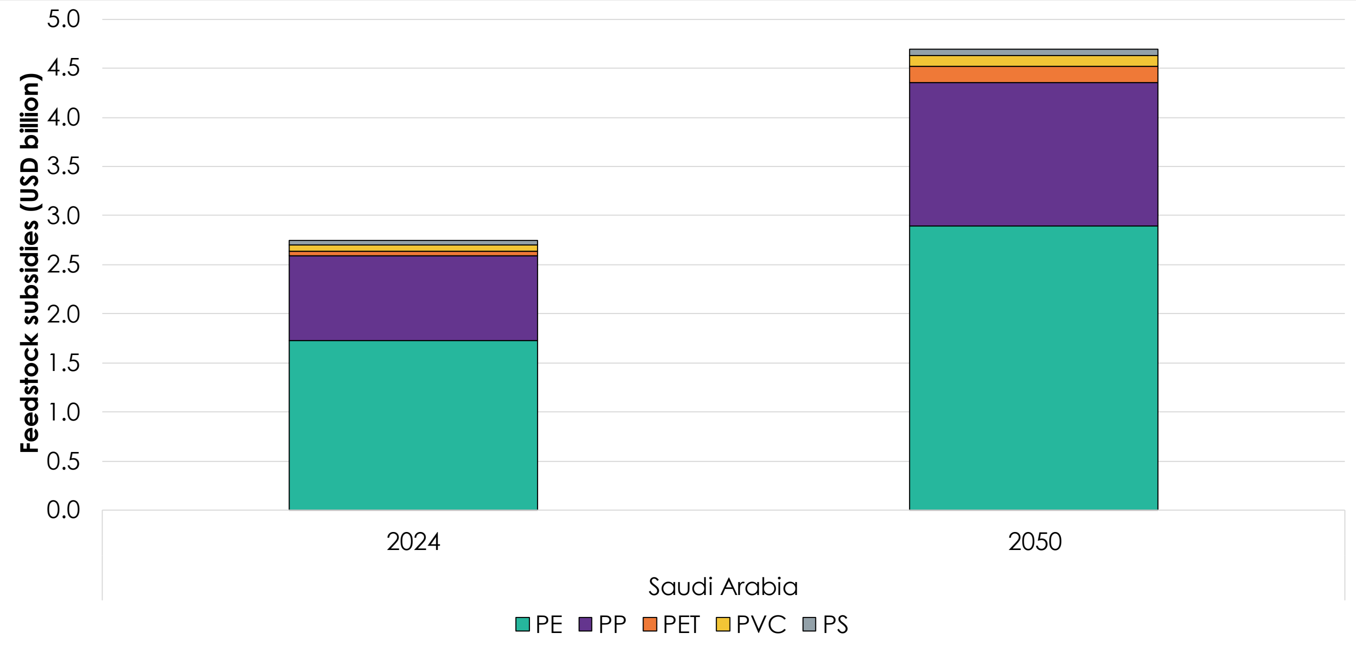
Results are presented for any of the top 15 ranked economies according to total polymer production volume in 2024 with positive subsidy levels, plus Indonesia and Qatar which have the second and fourth highest total feedstock subsidy levels in 2024. Results for Saudi Arabia are presented separately because the values are large relative to other economies. Other forms of government support relating to top producers are discussed in Section 4.1.2.4.

Globally, total feedstock subsidies are estimated at USD 3.3 billion in 2024 and USD 6.7 billion in 2050.

The level of feedstock subsidies is highest, in both 2024 and 2050, in Saudi Arabia (Figure 4-3). In 2024, total feedstock subsidies in Saudi Arabia are estimated at USD 2.75 billion, while in 2050 they are estimated to reach USD 4.7 billion. The majority of feedstock subsidies in Saudi Arabia are to the production of PE; USD 1.7 billion in 2024 and USD 2.9 billion in 2050, respectively.

Feedstock subsidies are also significant in Iran, Indonesia and Qatar (Figure 4-4). For Indonesia, the largest amount of feedstock subsidies in 2024 and in 2050 are to the production of PP; USD 60 million in 2024 and USD 260 million in 2050, respectively. Though smaller in value, Indonesia also has feedstock subsidies for the production of PE, PET, PVC and PS, in 2024 and in 2050. For Iran and Qatar, the largest amount of feedstock subsidies in 2024 and 2050 are to the production of PE; USD 80 million in 2024 and USD 180 million in 2050, for Iran, and USD 90 million in 2024 and USD 220 million in 2050, for Qatar.

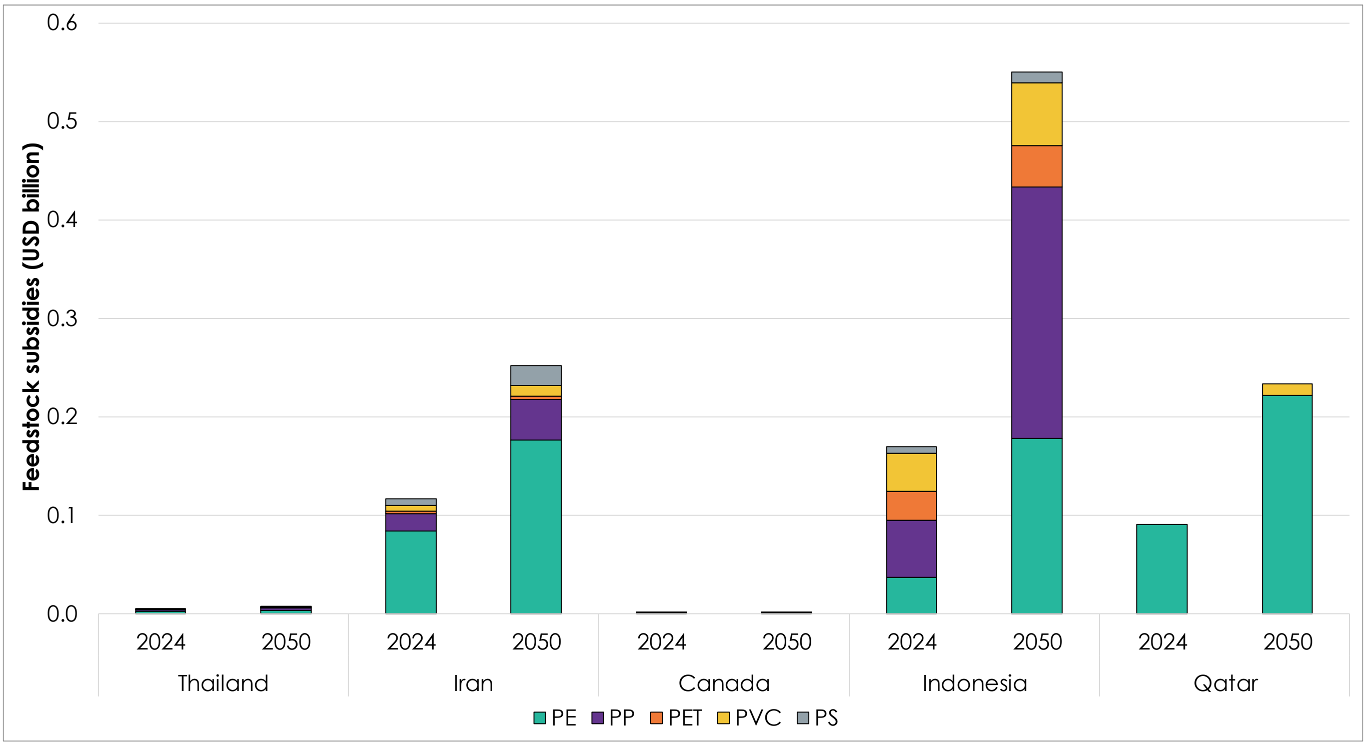
Figure 4-3: Feedstock subsidies, baseline scenario, 2024 & 2050



Source: Eunomia Analysis

Of the remaining top-15 ranked economies according to total polymer production volume in 2024, only Thailand and Canada have any feedstock subsidies in 2024 or 2050, although the amounts of these subsidies are smaller; USD 4 million in 2024 and USD 7 million in 2050, for Thailand, and USD 0.4 million in 2024 and USD 1 million in 2050, for Canada (Figure 4-4).

Figure 4-4: Feedstock subsidies, baseline scenario, 2024 & 2050



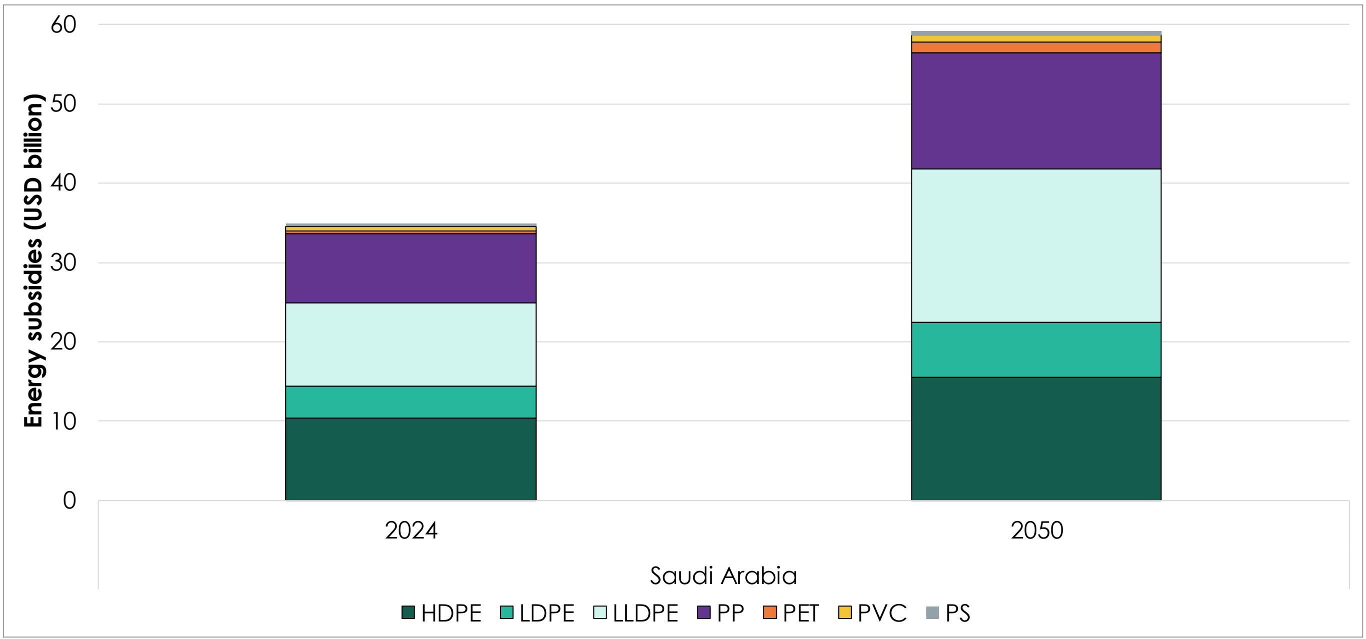
Source: Eunomia Analysis

4.1.2.2 Process energy subsidies to monomer production

Results are presented for any of the top 15 ranked economies according to total polymer production volume in 2024 with positive subsidy levels, plus Indonesia and Kuwait which have the third and fourth highest total process energy subsidy to monomer production level in 2024. Results for Saudi Arabia are presented separately because the values are large relative to other economies. Other forms of government support relating to top producers are discussed in Section 4.1.2.4.

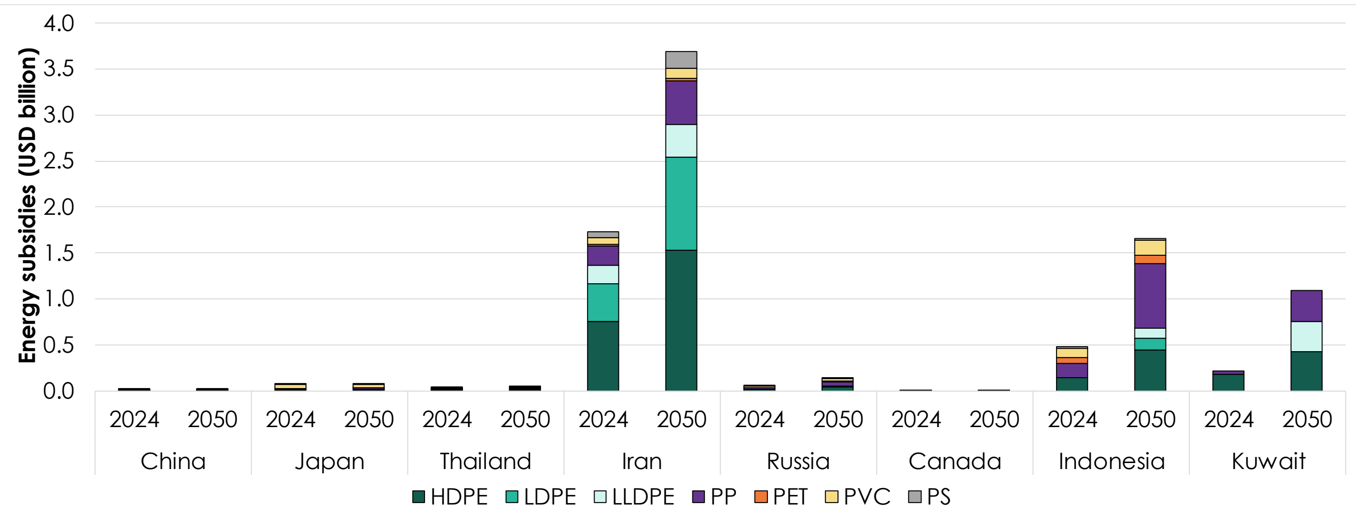
Globally, total process energy subsidies to monomer production are estimated at USD 37.8 billion in 2024 and USD 66.8 billion in 2050.

Figure 4-5: Process energy subsidies to monomer production by associated polymer, baseline scenario, 2024 & 2050



Source: Eunomia Analysis

Figure 4-6: Process energy subsidies to monomer production by associated polymer, baseline scenario, 2024 & 2050

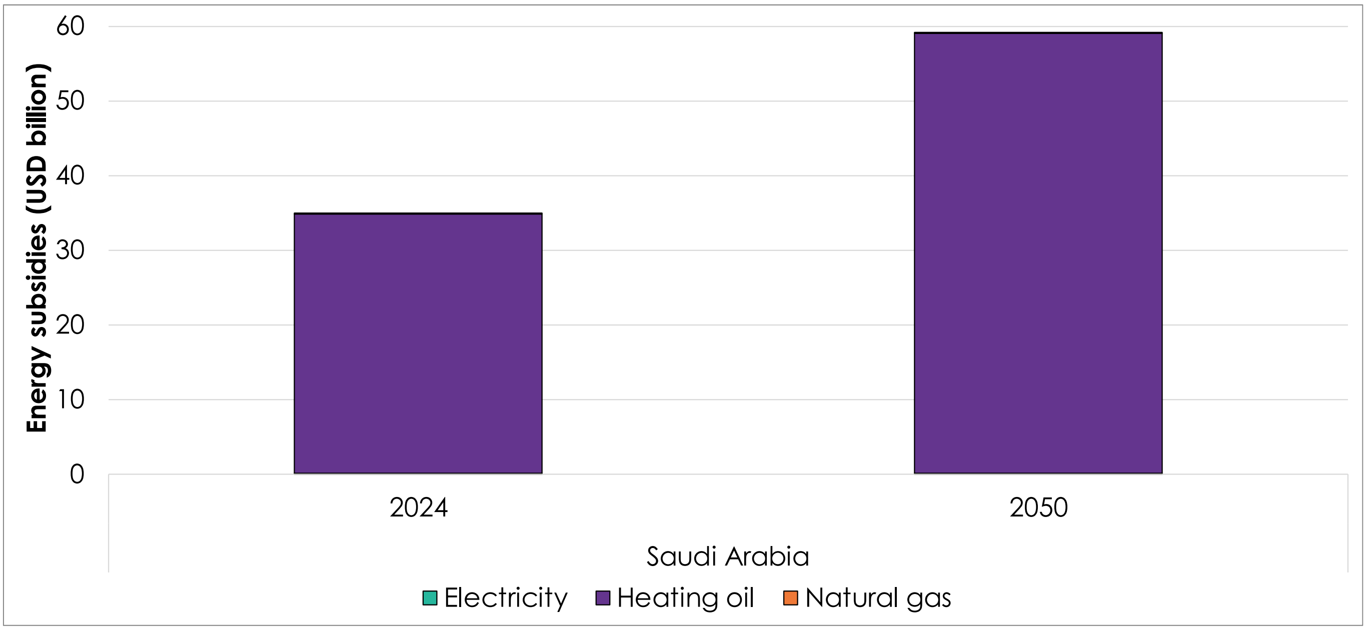


Source: Eunomia Analysis

The values of subsidies to process energy for monomer production in Saudi Arabia, in 2024 and 2050, are significantly higher than for any other economy (Figure 4-5 and Figure 4-6). These subsidies are estimated to total USD 35 billion in 2024, rising to USD 59 billion in 2050.

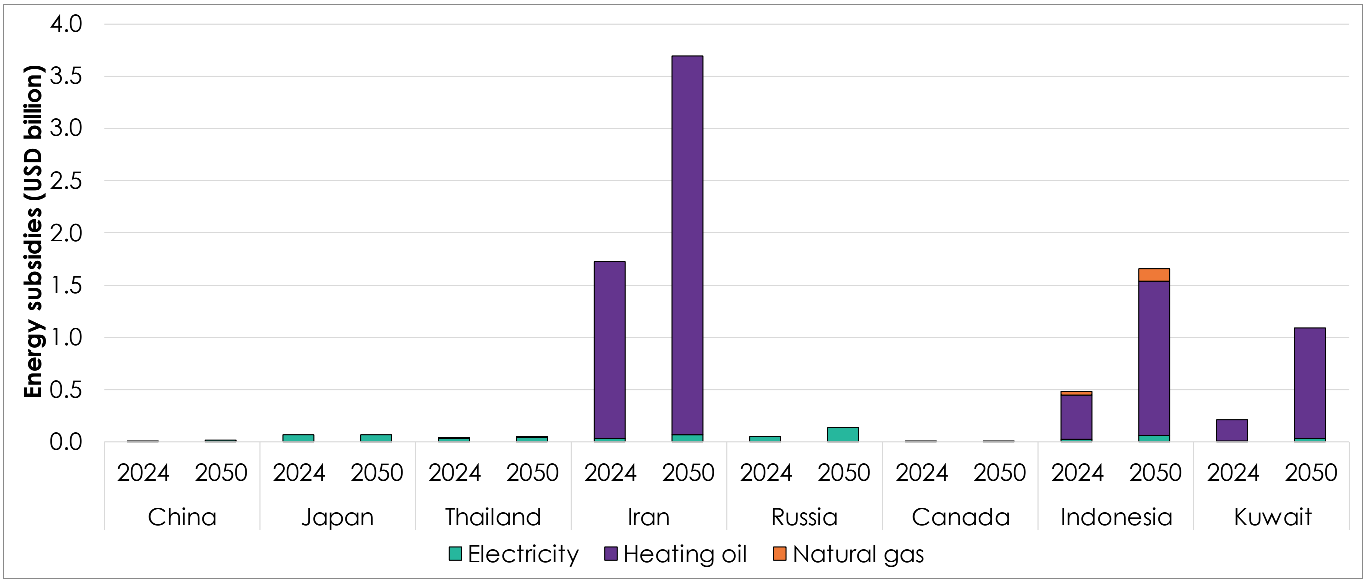
In Saudi Arabia, process energy subsidies are distributed across the production of the precursors of all seven primary polymer types (HDPE, LDPE, LLDPE, PP, PET, PVC and PS). However, the majority of these subsidies are accounted for by production of the precursors to HDPE, LDPE, LLDPE and PP. Further, the vast majority of Saudi Arabia's process energy subsidies for monomer production are for energy sourced from heating oil; USD 34.7 billion in 2024 and USD 59 billion in 2050, respectively (Figure 4-7).

Figure 4-7: Process energy subsidies to monomer production by energy source, baseline scenario, 2024 & 2050



Source: Eunomia Analysis

Figure 4-8: Process energy subsidies to monomer production by energy source, baseline scenario, 2024 & 2050



Source: Eunomia Analysis

Iran also has significant process energy subsidies for monomer production, the majority of which are for energy sourced from heating oil (Figure 4-8). Total process energy subsidies for monomer production are estimated at USD 1.73 billion in 2024, rising to USD 3.7 billion in 2050 (Figure 4-6). USD 1.69 billion and USD 3.63 billion of these, respectively, are subsidies to process energy for monomer production sourced from heating oil.

4.1.2.3 Process energy subsidies to polymerisation

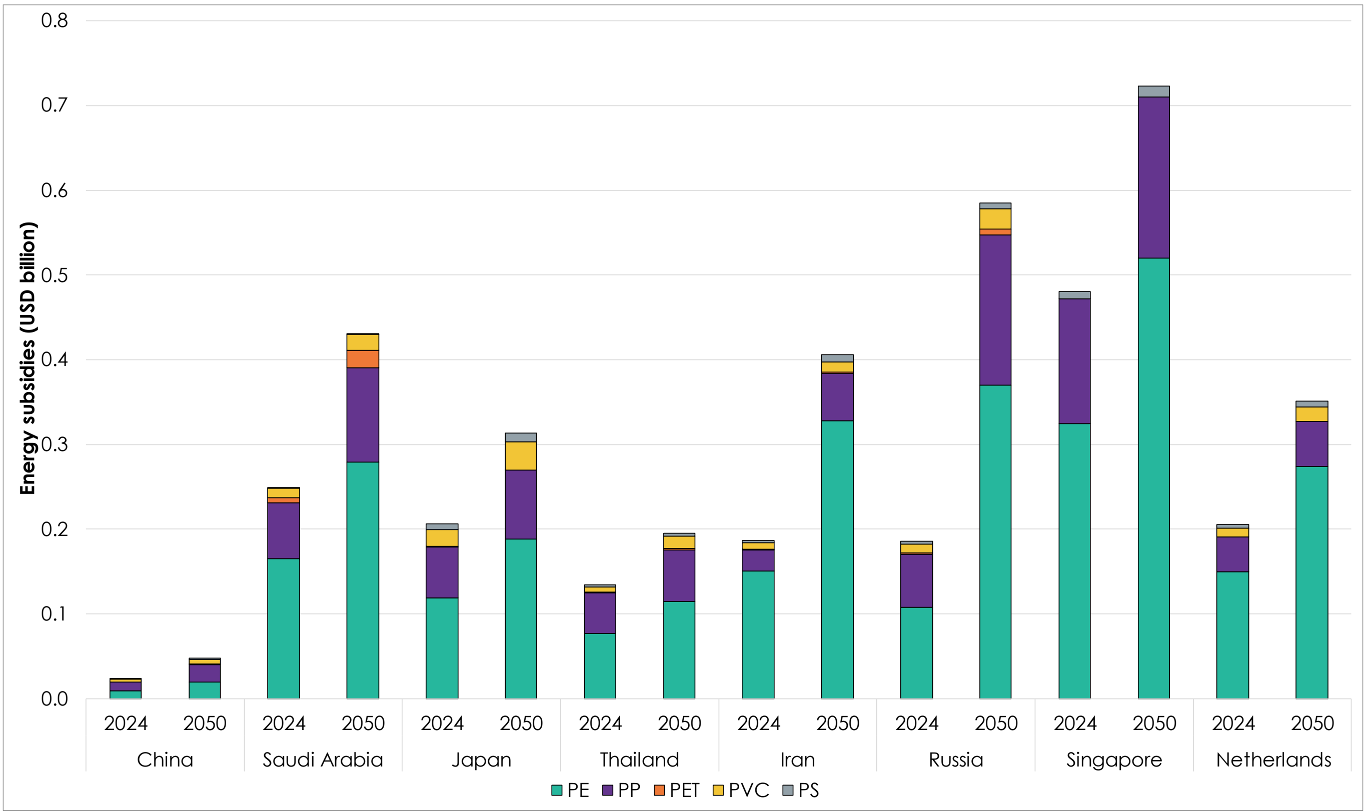
Results are presented for any of the top 15 ranked economies according to total polymer production volume in 2024 with positive subsidy levels, plus Singapore and the Netherlands which have the first and fourth highest total process energy subsidy to polymerisation levels in 2024. Other forms of government support relating to top producers are discussed in Section 4.1.2.4.

Globally, total process energy subsidies to polymerisation are estimated at USD 2.2 billion in 2024 and USD 4.5 billion in 2050.

The values of subsidies to process energy for polymerisation are highest in 2024 and 2050 for Singapore; USD 480 million in 2024 and USD 720 million in 2050 (Figure 4-9). All of these subsidies are to process energy sourced from electricity (Figure 4-10).

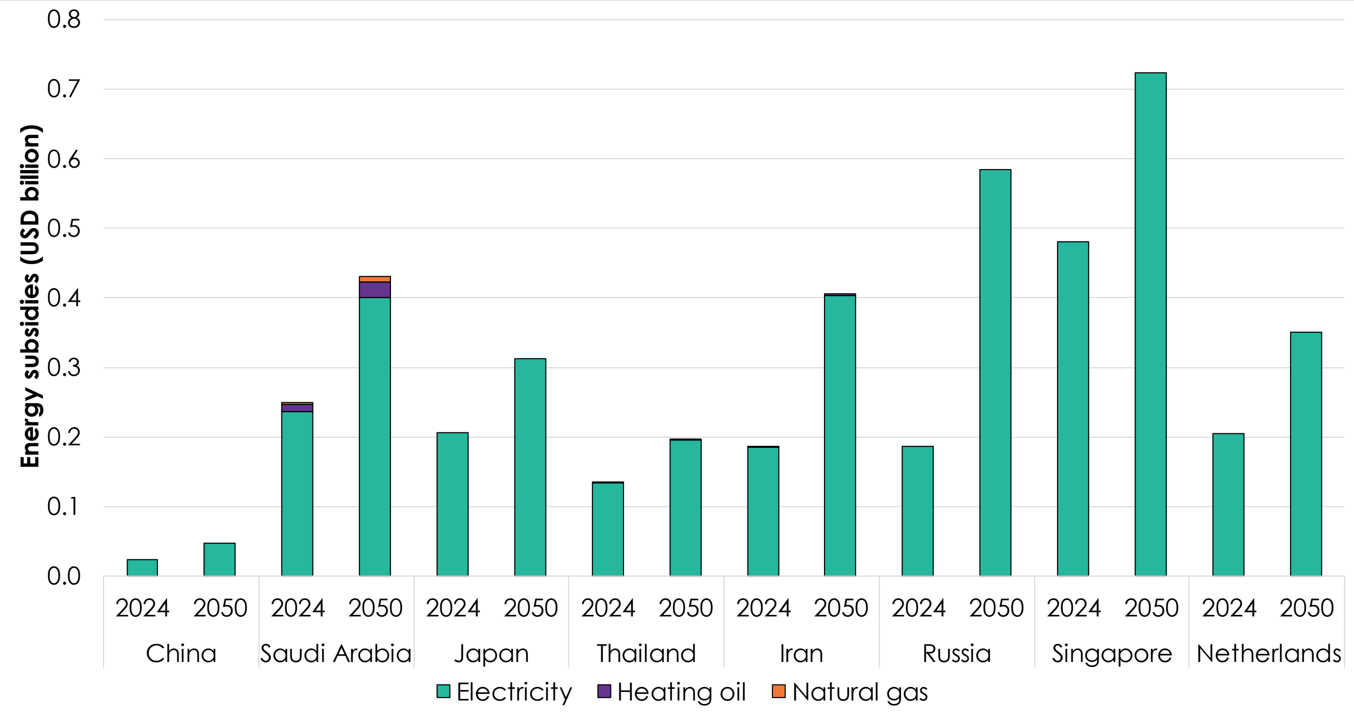
Process energy subsidies for polymerisation are also significant across Saudi Arabia, Japan, Thailand, Iran, Russia and the Netherlands in 2024 and 2050 (Figure 4-9). The vast majority of all process energy subsidies to polymerisation are for energy sourced from electricity (Figure 4-10).

Figure 4-9: Process energy subsidies to polymerisation by polymer, baseline scenario, 2024 & 2050



Source: Eunomia Analysis

Figure 4-10: Process energy subsidies to polymerisation by energy source, baseline scenario, 2024 & 2050



Source: Eunomia Analysis

4.1.2.4 Other Forms of Government Support

During this Phase 1 of the research project[15], the limited time available did not allow for a systematic search for grants provided by governments, or subnational units thereof, in which production of primary plastic polymers takes place. However, it did identify several notable examples. The Government of the Province of Alberta, Canada, under its Alberta Petrochemicals Incentive Program (APIP), offers grants of up to 12% of a project's eligible capital costs.[16] These grants have ranged from several tens of millions to several hundreds of millions of U.S. dollars, and for one plant expansion under consideration could exceed USD 1 billion.

Similarly, in recent years, Hungary's government has provided investment aids to facilities involved in the plastics polymer value chain. In 2018, for example, it approved a EUR 45 million investment aid to BorsodChem Zri, in connection with a EUR 142 million new facility for the production of aniline, an organic compound used in the production of rubber and urethane foams.[17] More recently, the Hungarian government provided a EUR 37.9 million (USD 42 million) investment grant for a EUR 1,300 million facility to produce polyol (a chemical widely used in the production of polyurethane), along with a EUR 93.6 million (USD 104 million) corporate tax credit, which can be claimed once the investment is

[15] Eunomia and QUNO (2024). *Plastic Money: Turning Off the Subsidies Tap*. Phase 1 Report, August 2024

[16] Government of Alberta, 'Alberta Petrochemicals Incentive Program', accessed at https://www.alberta.ca/alberta-petrochemicals-incentive-program. Prior to this programme, the Province provided a succession of support policies, starting in 2006, to incentivise the transformation of ethane, methane or propane feedstocks into higher-value petrochemical products.

[17] European Commission, 'State aid: Commission approves Hungary's €45 million investment aid to BorsodChem', 28 Sept. 2018, https://ec.europa.eu/commission/presscorner/detail/en/IP_18_5941

operational.[18] In the United States, both the federal and state governments have provided grants for facilities that manufacture polymers or their precursors, though tax concessions are more commonly used, especially by sub-national governments.[19] These typically take the form of property-tax abatements, or measures that reduce corporate income tax. Although the latter are strictly speaking related to income and not investments, they are usually offered as a specific incentive to invest.

Identifying all instances of public funds used to help finance new or expansions of PPP plants would require considerable additional research. However, an analysis of the 'Public Finance for Energy Database'[20] shows that the principal value of the loans and loan guarantees provided by the included G20 governments and multilateral development banks in connection with facilities intended for the production of monomers or polymers totalled over USD 28.3 billion over the years 2013–22, or an average of USD 2.8 billion a year. To the extent that these loans or guarantees were provided on more favourable terms than the companies could have obtained through private financial institutions — which is likely — a benefit was conferred. To estimate the subsidy-equivalent value of these transactions one would have to compare the net present value of the cost of financing the borrowed amount with the value had the debt been procured from a private-sector bank. However, performing such a calculation would require more information than this study was able to obtain so far.

Finally, it is clear that subsidies conferred through tax abatements, reductions, and exemptions are significant in some economies. In the United States alone, support provided to the plastics industry by state and local governments, mainly in the form of tax benefits, have averaged over USD 800 million in some years.

4.1.2.5 Total subsidies

In the baseline scenario, total price-related subsidies to polymer production are calculated as the sum of process energy subsidies to monomer production, process energy subsidies to polymer production and feedstock subsidies. Results are presented for any of the top 15 ranked economies according to total polymer production volume in 2024 with positive subsidy levels, plus the rest of the world combined. Results for Saudi Arabia are presented separately because the values are large relative to other economies.

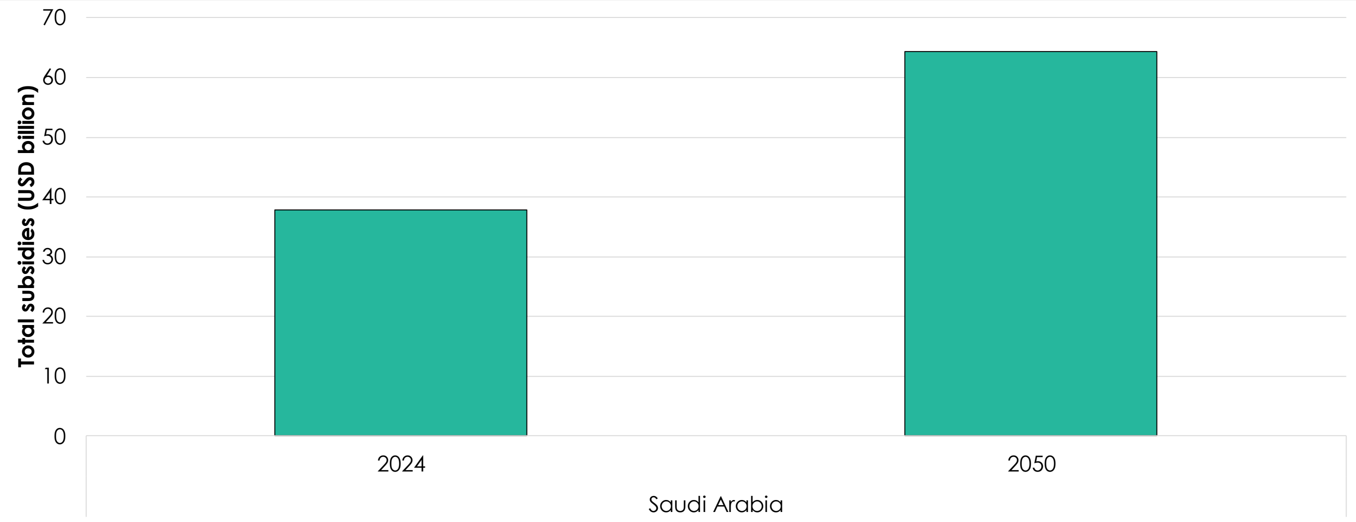
Total price-related subsidies to polymer production are estimated at USD 43 billion in 2024 and USD 78 billion in 2050 (Figure 4-11 & Figure 4-12). Saudi Arabia accounts for the majority of these subsidies; USD 38 billion in 2024 and USD 64 billion in 2050 (Figure 4-11).

[18] Mary Bailey, 'MOL Group inaugurates major investment project to boost polyol production', *Chemical Engineering*, 16 May 2024, https://www.chemengonline.com/mol-group-inaugurates-major-investment-project-to-boost-polyol-production/

[19] See Good Jobs First, 'Subsidy Tracker, no date, https://subsidytracker.goodjobsfirst.org

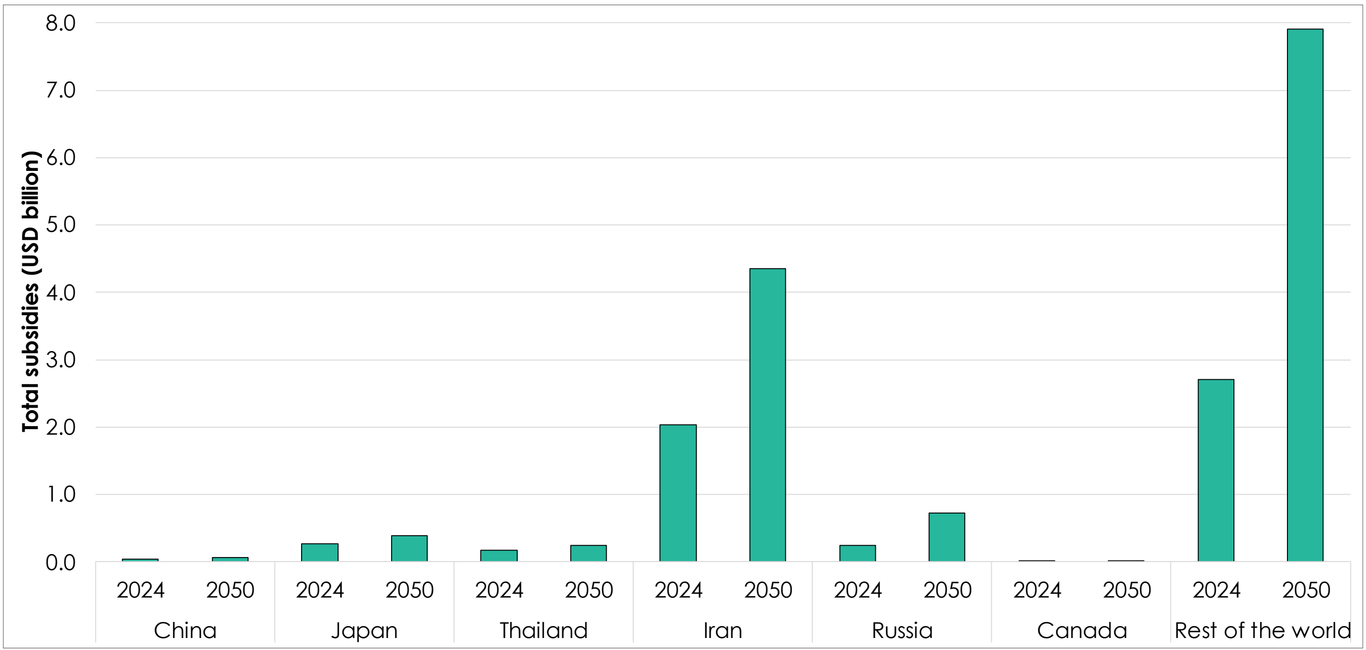
[20] Oil Change International, 'Public Finance for Energy Database: About', accessed 16 Aug. 2024, energyfinance.org.

Figure 4-11: Total price-related subsidies to polymer production, baseline scenario, 2024 & 2050



Source: Eunomia Analysis

Figure 4-12: Total price-related subsidies to polymer production, baseline scenario, 2024 & 2050



Source: Eunomia Analysis

Adding in other forms of government support that are not captured by the price-gap calculations, such as grants for investing in steam crackers and polymerization plants, tax expenditures, and rebates on fossil fuel inputs (see Phase 1 report[21]) would raise the total to at least USD 45 billion a year in 2024. That value puts it in the range of subsidies to several other economic activities with major environmental significance identified recently by Koplow and Steenblik (2024), such as non-energy mining (USD 40 billion a year) and marine capture fisheries (USD 55 billion), though they are of a different order of magnitude from government support to agriculture (over USD 600) and fossil fuels

[21] Eunomia and QUNO (2024). *Plastic Money: Turning Off the Subsidies Tap*. Phase 1 Report, August 2024

(over USD 1000) (Table 4-1).[22] When total subsidies to polymer production are combined with other environmentally harmful subsidies (EHS), the total EHS reaches an estimated USD 2.6 trillion.

Table 4-1: Estimated scale of environmentally harmful subsidies

Sector	Scale of subsidy (billions of 2023 USD per year, rounded)
Fossil fuels	1,050
Non-energy mining	40
Agriculture	610
Fisheries	55
Forestry	175
Transport	180
Water	390
Construction	150

Source: Koplow & Steenblik, 2024.[23]

4.2 Impacts of Removing Subsidies

This Section presents the results from the modelling of the full subsidy removal scenario. Impacts are presented as changes relative to the baseline scenario in 2024 and 2050.

4.2.1 Impacts on Polymer Production

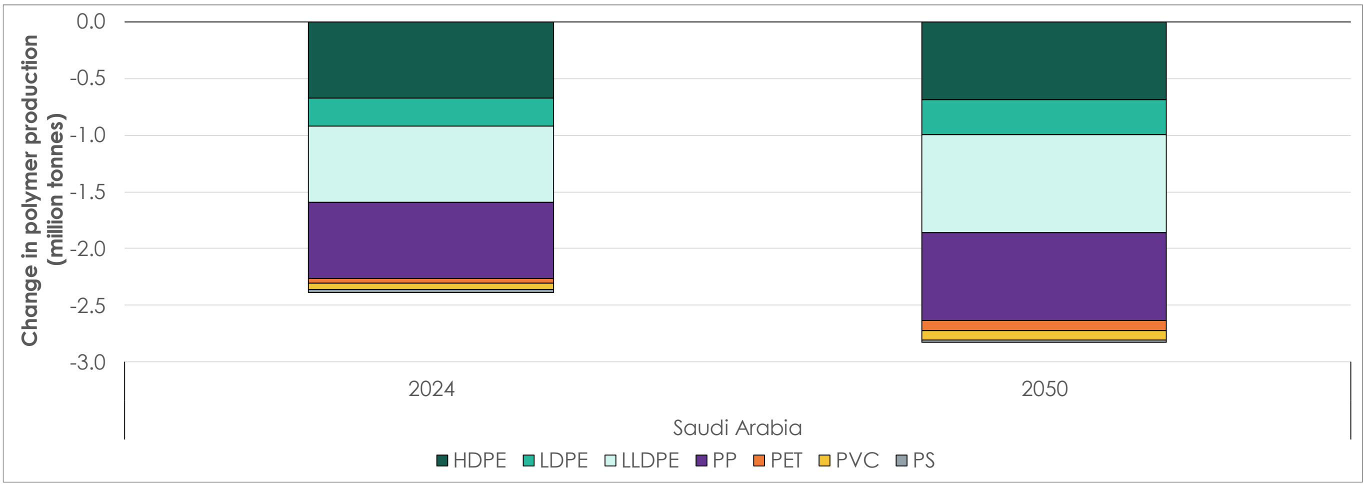
Results are presented for any of the top 15 ranked economies according to total polymer production volume in 2024 with changes in production volumes, plus Indonesia, Singapore, Kuwait and the Netherlands which have the third, fourth, seventh and eighth largest change in polymer production volume in 2024, respectively. Results for Saudi Arabia are presented separately because the values are large relative to other economies.

Under the full subsidy removal scenario, polymer production decreases by the largest amount, relative to the baseline scenario, in Saudi Arabia (Figure 4-13). It is estimated that removal of subsidies to plastic production decreases Saudi Arabia's polymer production by 2.38 million tonnes in 2024 and 2.83 million tonnes in 2050. The largest decreases in production are for HDPE, LLDPE and PP, which each decrease by 0.67 million tonnes from the baseline scenario in 2024 and 0.69, 0.86 and 0.78 million tonnes, respectively, in 2050.

[22] Doug Koplow and Ronald Steenblik (2024), *Protecting Nature by Reforming Environmentally Harmful Subsidies: An Update*, Earth Track. https://www.earthtrack.net/sites/default/files/documents/ehs_report_september-2024-update_final.pdf

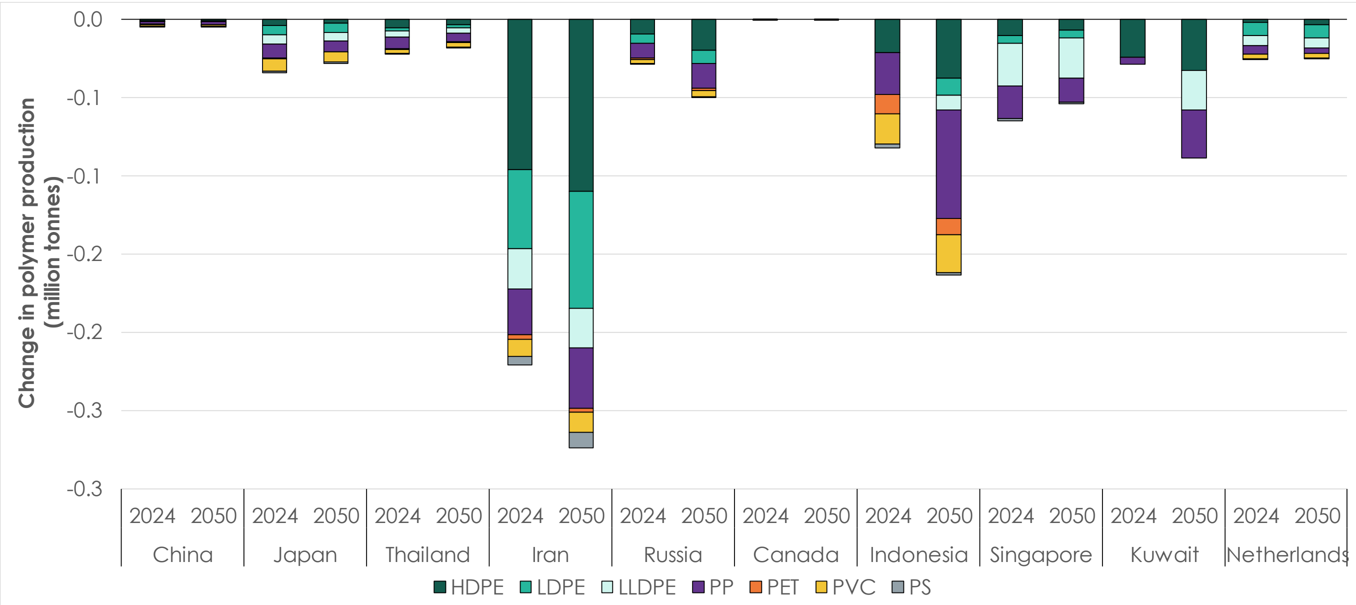
[23] *ibid*

Figure 4-13: Change in polymer production volumes, subsidy removal scenario, 2024 & 2050



Source: Eunomia Analysis

Figure 4-14: Change in polymer production volumes, subsidy removal scenario, 2024 & 2050

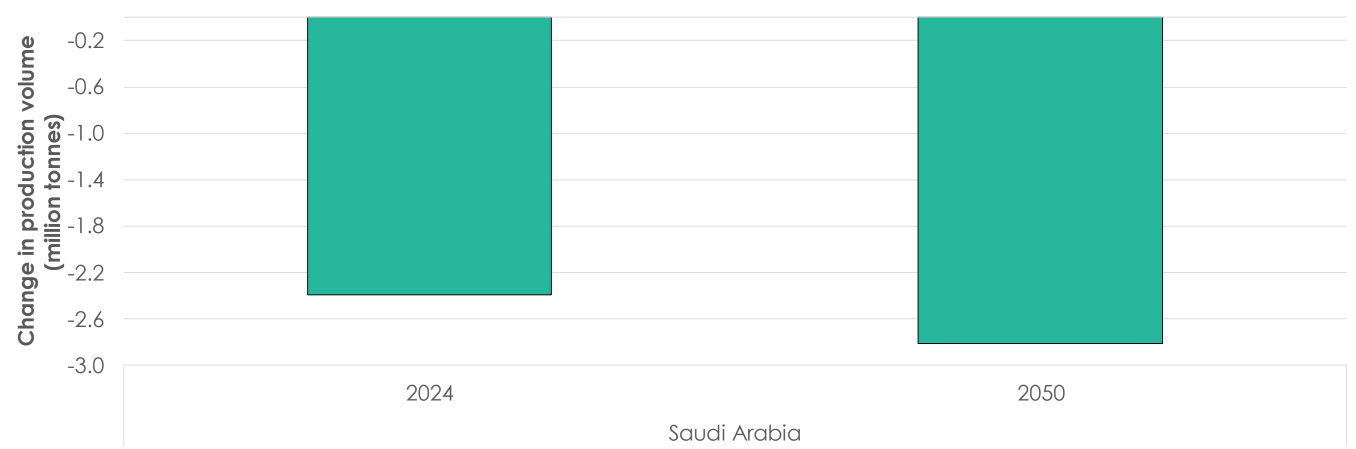


Source: Eunomia Analysis

Changes in polymer production volumes are much smaller for other economies (Figure 4-14). The second largest decrease in production is for Iran, where polymer production decreases from the baseline scenario by 0.22 million tonnes in 2024 and 0.27 million tonnes in 2050. The majority of the decreases in Iran's production are accounted for by HDPE, LDPE, LLDPE and PP.

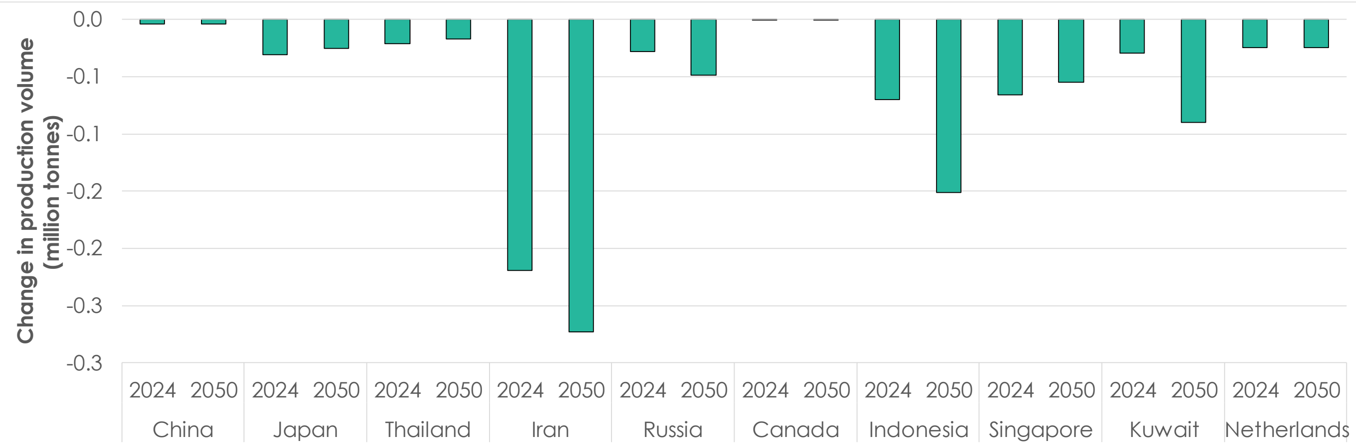
Monomer consumption volumes move in line with polymer production volumes and so the changes in monomer production under the full subsidy removal scenario, mirror the changes in polymer production. Therefore, the largest decreases in monomer production in 2024 and 2050 are for Saudi Arabia (Figure 4-15), followed by Iran (Figure 4-16).

Figure 4-15: Change in monomer production volumes, subsidy removal scenario, 2024 & 2050



Source: Eunomia Analysis

Figure 4-16: Change in monomer production volumes, subsidy removal scenario, 2024 & 2050



Source: Eunomia Analysis

4.2.2 Impacts on Consumers

Table 4-2 presents the impact of the removal of subsidies to plastic production, on product prices for a selection of consumer products.

In the case of fast-moving consumer goods such as a bottle of mineral water, a bottle of Coca-Cola, or a juice box, the plastic content of the product is contained in the packaging, and accounts for a small share of the overall product weight (estimated at 2.13%, 3.8% and 0.81%, respectively). For these products, the average price increase resulting from the removal of subsidies to polymer production is less than 1%. Across the 17 economies[24] for which retail price data was gathered for a 1.5L bottle of mineral water, full subsidy removal was estimated to increase the overall product price from USD 0.662 to USD 0.664, equivalent to a 0.75% price increase. Across the 15 economies[25] for which retail price data was gathered for a 0.5L bottle of Coca-Cola, a 10% increase in polymer prices was estimated to increase the overall product price from USD 0.915 to USD 0.916, equivalent to a 0.17% price increase.

[24] Belgium, Brazil, Canada, China, Germany, India, Indonesia, Iran, Japan, KSA, Kuwait, Mexico, Oman, South Korea, Chinese Taipei, Thailand, USA.

[25] Belgium, Brazil, Canada, China, Germany, India, Indonesia, Japan, KSA, Kuwait, Mexico, Oman, South Korea, Thailand, USA.

Across the 17 economies[26] for which retail price data was gathered for a juice box, full subsidy removal was estimated to increase the overall product price from USD 2.411 to USD 2.413, equivalent to a 0.09% price increase.

Table 4-2: Impact on consumer product prices from removing subsidies to plastic production

Product sector	Product label	No. of economies covered	Average product price - original (US$)	Average product price - new (US$)	Average price increase (US$)	Average price increase (%)
Packaging	Bottle of water	17	0.662	0.664	0.0024	0.75%
Packaging	Bottle of soft drink	15	0.915	0.916	0.0015	0.17%
Packaging	Juice box	17	2.411	2.413	0.0017	0.09%
Clothing	Dress	17	38.56	38.60	0.0371	0.08%
Flooring	Vinyl flooring (per kg)	17	5.12	5.19	0.07	1.53%
Agriculture	Agricultural mulch film (per kg)	17	52.05	52.29	0.24	3.16%

Source: Eunomia analysis.

In the case of fast-moving consumer goods such as a bottle of mineral water, a bottle of Coca-Cola, or a juice box, the plastic content of the product is contained in the packaging, and accounts for a small share of the overall product weight (estimated at 2.13%, 3.8% and 0.81%, respectively). For these products, the average price increase resulting from the removal of subsidies to polymer production is less than 1%. Across the 17 economies[27] for which retail price data was gathered for a 1.5L bottle of mineral water, full subsidy removal was estimated to increase the overall product price from USD 0.662

[26] Belgium, Brazil, Canada, China, Germany, India, Indonesia, Iran, Japan, KSA, Kuwait, Mexico, Oman, South Korea, Chinese Taipei, Thailand, USA.

[27] Belgium, Brazil, Canada, China, Germany, India, Indonesia, Iran, Japan, KSA, Kuwait, Mexico, Oman, South Korea, Chinese Taipei, Thailand, USA.

to USD 0.664, equivalent to a 0.75% price increase. Across the 15 economies[28] for which retail price data was gathered for a 0.5L bottle of Coca-Cola, a 10% increase in polymer prices was estimated to increase the overall product price from USD 0.915 to USD 0.916, equivalent to a 0.17% price increase. Across the 17 economies[29] for which retail price data was gathered for a juice box, full subsidy removal was estimated to increase the overall product price from USD 2.411 to USD 2.413, equivalent to a 0.09% price increase.

In the case of a higher-value consumer good such as a dress, the plastic content of the overall product weight is higher, but the share of the plastic price in the overall product price is still small (estimated in the range 1.0% - 2.2%). Therefore, an increase in polymer prices resulting from the removal of subsidies has minimal impact on the retail price of the final product. Across the 17 economies[30] for which retail price data was gathered for a polyester summer dress from a chain store, full subsidy removal was estimated to increase the overall product price from USD 38.56 to USD 38.60, equivalent to a 0.08% price increase.

In contrast, for products such as plastic mulch film used in agriculture, the entire product is plastic and the share of the plastic price in the overall product price can be larger. Therefore, an increase in polymer prices resulting from the removal of subsidies has a relatively larger impact on the retail price of the final product. Across the 17 economies[31] for which retail price data was gathered for plastic mulch film (per kg), full subsidy removal was estimated to increase the overall product price from USD 52.05 per kg to USD 52.29 per kg, equivalent to a 3.16% price increase.

Similarly, for a construction product such as vinyl flooring, the share of the plastic price in the overall product price is relatively large (estimated average 37%). Across the 17 economies[32] for which retail price data was gathered for vinyl flooring (per kg), full subsidy removal was estimated to increase the overall product price from USD 5.12 per kg to USD 5.19 per kg, equivalent to a 1.53% price increase.

Overall, these results show that the impact of full subsidy removal on the prices of plastic-containing consumer products is minimal, including on products that consist primarily of plastic.

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[28] Belgium, Brazil, Canada, China, Germany, India, Indonesia, Japan, KSA, Kuwait, Mexico, Oman, South Korea, Thailand, USA.

[29] Belgium, Brazil, Canada, China, Germany, India, Indonesia, Iran, Japan, KSA, Kuwait, Mexico, Oman, South Korea, Chinese Taipei, Thailand, USA.

[30] *ibid*

[31] *ibid*

[32] *ibid*

5.0 Conclusion

This study attempts to estimate the current level and future projection of primary polymer production subsidies globally and model the impacts of removing these subsidies on polymer production as well as on consumers of final products.

The findings of the study reveal that the PPP industry potentially receives substantial subsidy support in a number of economies across the world. The level of PPP subsidies could be potentially in magnitude similar to non-energy mining subsidies and marine capture fisheries subsidies, and if the demand for plastic products that contain these primary polymers continues to increase over time, the level of PPP subsidies will continue to rise as well.

The results of the modelling exercise show complete removal of the PPP subsidies will lead to a significant reduction in primary polymer production, with a larger reduction observed in economies with higher levels of subsidies. In terms of the impact on prices of plastic products, the overall impacts across the majority of the plastic product groups seem to be very low, implying a negligible impact on the consumers of final products.

This study is produced to facilitate informed discussions during the INC-5 meeting in Busan. It is intended to serve as a reference point for INC delegates and stakeholders, providing evidence to support and guide discussions.

The continued investigation and analysis will help to further elucidate the complex dynamics of government support within the PPP industry, ultimately contributing to more informed policy decisions and international agreements aimed at addressing plastic pollution and its impacts

5.1 Next Steps

Further research and analysis are due to be undertaken in the next stages of this study to enrich the findings of the modelling exercise presented in this report. More specifically, the study will, in the next stage, aim to:

- Model additional scenarios of partial removal of subsidies as well as the potential for some exemptions for specific processes or energy sources (e.g. renewable energy sources).
- Model a few key environmental impacts of these scenarios, such as reduction in GHG emissions and reduction in plastic pollution.
- Examine possible relationships between the level of PPP subsidies and polymer prices at global and/or regional levels.
- Update the country profiles included in the Phase 1 report[33] of this research and produce additional country profiles.

[33] Eunomia and QUNO (2024). *Plastic Money: Turning Off the Subsidies Tap*. Phase 1 Report, August 2024

Appendix

A.1.0 Methodology

A.1.1 Estimation of Current Level Subsidies

A.1.1.1 Feedstock Subsidies

Fossil fuel derived feedstock subsidy rates (in USD per tonne of feedstock) were estimated by using data from the IMF's Fossil Fuel Subsidies Data: 2023 Update database[34]. The database contains economy-level electricity and fuel pricing data disaggregated by fuel type and end-user. Subsidy rates were calculated by subtracting the price paid by the consumer for a product from the cost of supply of that product. Where the number obtained was positive (i.e., the consumer price was lower than the cost of supply), it was assumed that a subsidy was provided. The following three streams (as disaggregated in the IMF database) were used to estimate the rate of potential polymer feedstock subsidies for the different sources of feedstock:

- 'Oil products – other', which includes streams such as naphtha, heating oil and other oil-derived products. This category therefore excludes common fuels such as gasoline, diesel, kerosene and LPG.
- 'Natural gas – other', which includes products obtained from natural gas that are not used for energy applications such as fertilizers, polymer feedstocks and other chemicals.
- 'Coal – other', which includes coal tar, fertilisers (e.g., ammonia) and polymer precursors among other chemicals.

As the proportion of polymers that are derived from either oil, natural gas or coal is not well documented, particularly for individual economies, the split among the polymer feedstock sources used to produce a polymer was based in this analysis on data from the IEA World Energy Balances database.[35] This data provides annual consumption in TJ of 'crude, NGL and feedstocks and oil products, 'natural gas' and 'coal and coal products' used for chemical feedstocks and non–energy products in the petrochemical industry, for each economy. The relative consumption rates of these different streams were used to estimate the split among polymer feedstock sources for each economy for the years 2015 to 2022, the latest available year of data.

In addition, the level of subsidy support presented in this report assumes that all products that are derived from the above three fossil fuel sources benefit equally from subsidies. In other words, the estimated subsidy rates were assumed to apply equally to all products derived from each stream. Although it is acknowledged that different products may benefit from varying levels of subsidisation in each economy, the available data at this stage of the project are not granular enough to allow further disaggregation of subsidy rates by product.

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[34] IMF Fossil Fuel Subsidies Data: 2023 Update, https://www.imf.org/-/media/Files/Topics/energy-subsidies/EXTERNALfuelsubsidiestemplate2023new.ashx

[35] IEA World Energy Balances Data, https://www.iea.org/data-and-statistics/data-product/world-energy-balances#

Economy and polymer specific production volumes were then obtained using data from the OECD on primary polymer demand volumes by polymer type[36]. These data were broken down to the economy level using Polyglobe data[37] on polymer production capacity by economy. Polyglobe data were used to estimate the proportion of polymer production by economy for the years 2015-2029, based on known projects in development that are available in the Polyglobe database. Thereafter, this distribution of production by economy was kept constant, to produce estimates of polymer production volume by polymer and economy to 2050.

Monomer consumption rates were also estimated using data from literature (i.e., tonnes of monomer consumed per tonne of polymer produced). However, the conversion efficiencies of any precursors used to produce monomers were not established due to the complexity of the supply chain and of the precursor production processes. This is likely to underestimate the real level of subsidisation to a degree because any unaccounted for inefficiencies or losses in the production process of monomers would increase the consumption of potentially subsidised precursors.

The estimated subsidy rates by economy and feedstock source, production volume by economy and polymer, and monomer consumption rates by polymer were combined to obtain an estimate of the level of subsidisation by economy and polymer.

The focus of this study is on feedstocks derived from fossil fuels. For example, PVC is produced from the polymerisation of vinyl chloride (VCM), which, when produced via the ethylene-based production route, stoichiometrically comprises circa 45% ethylene. Therefore, the consumption of fossil-based feedstock to produce PVC was assumed to be 45% multiplied by a monomer consumption factor obtained from the literature. Although this approach is likely to understate the full level of subsidisation for the production of polymers that require non-fossil-based feedstocks, the bulk of polymer production is derived from fossil fuels so it is likely that the impact on the subsidy levels estimated here will be low.

A.1.1.2 Process Energy Subsidies

A.1.1.2.1 Polymerisation

The type of energy consumed (e.g., electricity, natural gas, oil, etc.) and the rate of consumption can vary widely by polymerisation process. For the purposes of this work, the type, split and consumption rate of the electricity or fuel used to supply energy to different polymerisation processes was largely based on the work of Karali, N., Khanna, N., & Shah, N. (2024)[38]. The data and assumptions from this work were used to obtain energy consumption rates by fuel type and polymer in GJ consumed per tonne of polymer produced.

These consumption rates were then combined with the polymer production volumes, estimated from OECD and Polyglobe data as described above (see Appendix A.1.1.1), to obtain total energy consumption by energy source, polymer and economy.

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[36] OECD Global Plastics Outlook: Policy Scenarios to 2060, https://www.oecd-ilibrary.org/sites/aa1edf33-en/1/3/2/2/index.html?itemId=/content/publication/aa1edf33-en&_csp_=ca738cf5d4f327be3b6fec4af9ce5d12&itemIGO=oecd&itemContentType=book

[37] https://www.polyglobe.net/login.asp

[38] Karali, N., Khanna, N., & Shah, N. (2024). Climate Impact of Primary Plastic Production. Lawrence Berkeley National Laboratory. Report #: LBNL-2001585. Retrieved from https://escholarship.org/uc/item/12s624vf

Similar to feedstock, the estimation of the subsidy rates for process energy used in polymerisation plants was based on IMF's Fossil Fuel Subsidies Data: 2023 Update database. Subsidy rates were calculated by subtracting the price paid by industrial consumers for an energy source from the cost of supply of that energy source. Where the number obtained was positive, it was assumed that a subsidy was provided. The following three energy sources were used to estimate the rate of potential energy subsidies for the different polymerisation processes and economies:

- 'Electricity – industrial' includes the prices of electricity consumed by industry.
- 'Natural gas – industrial' includes the prices of natural gas consumed by industry.
- 'Oil products – other' as already discussed, this category includes a range of products, including heating oil consumed by industry.

The IMF dataset provides energy subsidy rates for industry in general. In the modelling exercise, it was assumed that these rates would apply to different industrial sectors equally (including for polymerisation plants); however, this may not be true in practice as it is likely that different industrial sectors may benefit disproportionately from energy subsidies. Therefore, it is possible that polymerisation plants receive a higher or a lower subsidy rate compared to other industries which would impact the estimates presented here. However, there is a substantial lack of data on the energy prices paid by different industrial sectors, therefore a more accurate estimation of subsidies to the polymer industry is not possible without more granular data.

Subsidy estimates were finally obtained by combining the data on total energy consumption by energy source, polymer and economy with the IMF energy subsidy rate data.

A.1.1.2.2 Monomer production

Total monomer consumption volumes were calculated from the OECD data on polymer production volumes as described above (see Appendix A.1.1.1). The split among the feedstock sources used in monomer production was based on data from the IEA World Energy Balances database. This data provides annual consumption in TJ of 'crude, NGL and feedstocks and oil products, 'natural gas' and 'coal and coal products' used for chemical feedstocks and non–energy products in the petrochemical industry, for each economy. The relative consumption rates of these different streams were used to estimate the split among feedstock sources of monomer production for each economy for the years 2015 to 2022, the latest available year of data.

Monomer production methods vary across the different feedstock types. Further, the type of energy consumed (e.g., electricity, natural gas, oil, etc.) and the rate of consumption can vary widely by monomer production process. For the purposes of this work, the type, split and consumption rate of the electricity or fuel used to supply energy to different monomer production processes was largely based on the work of Karali, N., Khanna, N., & Shah, N. (2024)[39]. The data and assumptions from this work were used to obtain energy consumption rates by fuel type and polymer in GJ consumed per tonne of monomer produced. Global shares of monomer production by the various production methods, according to feedstock type, were also estimated based on data and assumptions from Karali, N.,

[39] Karali, N., Khanna, N., & Shah, N. (2024). Climate Impact of Primary Plastic Production. Lawrence Berkeley National Laboratory. Report #: LBNL-2001585. Retrieved from https://escholarship.org/uc/item/12s624vf

Khanna, N., & Shah, N. (2024)[40]. These assumptions were applied together to obtain estimates of the amount of process energy consumed (in GJ) by each production process, broken down by energy source, for each economy and associated polymer, for the years 2015 to 2024.

Subsidy rates for the process energy used in monomer production processes were calculated in the same way as for the process energy used in polymerisation processes (see Appendix A.1.1.2.1).

A.1.2 Scenario Modelling

The following two scenarios were modelled:

1) A **baseline scenario** in which it was assumed that feedstock subsidies and process energy subsidies for monomer production and polymerisation continue at the average rate from the period 2015-2020. The baseline scenario was projected to the years 2024 and 2050.
2) A **full subsidy removal scenario** in which it was assumed that all feedstock subsidies and process energy subsidies for monomer production and polymerisation are removed. The impact of full subsidy removal on monomer and polymer production volumes was assessed relative to the baseline scenario, for the years 2024 and 2050.

These two scenarios were modelled for 71 economies and 7 primary polymers (HDPE, LDPE, LLDPE, PP, PET, PVC and PS).

A.1.2.1 Modelling Baseline Future Projections

The baseline scenario projected forward the estimation of the current level of subsidies to the year 2050.

In the baseline scenario, future economy and polymer specific production volumes were projected to 2050, in line with projections of polymer demand in the OECD's Global Plastics Outlook: Policy Scenarios to 2060.[41] Monomer consumption volumes associated with these projected polymer production volumes were estimated using data on monomer consumption rates from literature, as above (see Appendix A.1.1.1).

To project the split among the polymer feedstock sources used to produce a polymer in each economy to 2050, the split was assumed to remain constant from the latest available year of data, 2022.

Fossil fuel derived feedstock subsidy rates and process energy subsidy rates for monomer production and polymerisation were projected to 2050 as the average subsidy rate across the years 2015-2020, estimated as described above (see Appendix A.1.1). The years 2021 and 2022 were excluded to take into account that, in some economies, feedstock and energy subsidy rates were distorted during the COVID-19 pandemic while governments prioritised economic relief for industries and consumers.

Using these projections, feedstock subsidies and process energy subsidies for monomer production and polymerisation were calculated in the same way as for the current level of subsidies (Appendix A.1.1).

[40] Karali, N., Khanna, N., & Shah, N. (2024). Climate Impact of Primary Plastic Production. Lawrence Berkeley National Laboratory. Report #: LBNL-2001585. Retrieved from https://escholarship.org/uc/item/12s624vf

[41] OECD Global Plastics Outlook: Policy Scenarios to 2060, https://www.oecd-ilibrary.org/sites/aa1edf33-en/1/3/2/2/index.html?itemId=/content/publication/aa1edf33-en&_csp_=ca738cf5d4f327be3b6fec4af9ce5d12&itemIGO=oecd&itemContentType=book

A total subsidy rate (USD per tonne of polymer) by polymer and economy, for 2024 and 2050, was calculated by summing the annual value of feedstock subsidies and process energy subsidies to monomer production and polymerisation, and dividing the total by the annual polymer production volume. Polymer prices (USD per tonne of polymer) - by polymer, economy and year - were estimated based on regional polymer price data from Wood Mackenzie.[42] This data gives polymer prices by polymer and region for the years 2015-2040. Prices were projected forward to 2050, based on a linear trend. Prices were then mapped to the economy level based on each economy's region.

A.1.2.2 Modelling Impacts of Removing Subsidies

The full subsidy removal scenario assessed the impacts of removing all estimated subsidies on monomer and polymer production volumes, relative to the baseline scenario, for the years 2024 and 2050.

First, the impact of removing feedstock subsidies and process energy subsidies for monomer production and polymerisation on polymer prices were estimated. It was assumed that when subsidies are removed the polymer price increases by the total subsidy amount. Polymer prices – by polymer and economy – in the full subsidy removal scenario were, therefore, estimated by adding the baseline total subsidy rate to the baseline polymer price.

Given the new polymer price, the associated change in polymer production in the full subsidy removal scenario was estimated for the years 2024 and 2050. It was assumed that the demand function for primary plastic takes the form of the Cobb-Douglas function, which implies that the price elasticity of demand is constant along the demand function. This is a very standard assumption in empirical modelling of demand functions and price elasticity for products and services, and there is no contrary evidence that the demand function for primary plastics would take an alternative form.

The price elasticity of demand for primary plastic was estimated using a panel data regression model with time-series data for six polymers in seven different regions, across the years 2015-2022.[43] The estimated elasticity was -0.15, implying that for a 1% change in price the resulting change in quantity demanded will be 0.15%.

Polymer production volumes under the full subsidy removal scenario – by polymer and economy – were then estimated by the function:

$$q_1 = q_0 \left(\frac{p_1}{p_0}\right)^{-0.15}$$

Where q_0 denotes polymer production volume in the baseline scenario, p_0 denotes the polymer price in the baseline scenario and p_1 denotes polymer price in the subsidy removal scenario.

Monomer consumption volumes associated with the new polymer production volumes estimated under the full subsidy removal scenario were then estimated using data on monomer consumption rates from literature, as above (see Appendix A.1.1.2.2).

The change in monomer consumption and polymer production volumes, by polymer and economy, for the years 2024 and 2050 could then be obtained as the difference between the volume in the full subsidy removal scenario and the volume in the baseline scenario.

[42] Data provided by Wood Mackenzie.

[43] Data provided by Wood Mackenzie.

A.1.2.3 Estimating Impacts on Consumers

This analysis assessed the impact of the full subsidy removal scenario on the price of selected consumer goods across different economies.

A.1.2.3.1 Selecting product categories

This analysis focusses on selected product categories to enable a comparison of the impact of subsidy removal across economies and across different types of plastic-containing consumer goods. The following product types were selected for the analysis:

- a bottle of water
- a bottle of soft drink
- a juice box
- a dress
- vinyl flooring
- agricultural mulch film

These product categories were chosen because price data for comparable versions of the product was readily available across economies. In addition, these product categories give coverage across fast-moving consumer goods and consumer durables, as well as across products with different shares of plastic content.

A.1.2.3.2 Data collection

Data were collected from the following sources to perform the analysis:

- **Retail prices**: Retail prices of consumer goods were gathered from the websites of major retailers in the selected economies, via direct email requests to product retailers, or from cross-economy retail price tracking websites, e.g., GlobalProductPrices.com.
- **Product weight, main polymer in the product and share of polymer in the overall product weight:** Where available, information on the weight and composition of products was obtained from the technical specifications given in product listings on retailer websites. Where this information was not given, product weights and composition were estimated using alternative sources, e.g. the manufacturer's technical specifications, or other technical reports.
- **Polymer prices:** Average polymer prices, 2015-2022, in 7 world regions[44] were obtained from previous research carried out by Eunomia.

A.1.2.3.3 Data analysis

The collected data were used to estimate:

- The cost of plastic in the product, based on the product's weight, the share of polymer in the overall product weight and the price of the polymer.

[44] North America, Africa, Latin America and the Caribbean, Greater Europe, Middle East, APAC, Russia and the Caspian.

- The share of the overall product retail price accounted for by the cost of the plastic in the product.

Then, an illustrative analysis was performed to demonstrate the impact of removing subsidies to plastic production on the price of the different types of consumer goods.

- It was assumed that the removal of subsidies to plastic production would increase polymer prices by the amount of the subsidy.
- The increase in the price of plastic in consumer goods, due to the assumed increase in polymer prices, was estimated.

Then, the increase in the overall product price of consumer goods was estimated.

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