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Insight Report

Radically Reducing Plastic Pollution in Indonesia: A Multistakeholder Action Plan

National Plastic Action Partnership

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Global Plastic Action Partnership in
collaboration with the Indonesia National
Plastic Action Partnership

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Content

Foreword

Luhut Binsar Pandjaitan, Coordinating Minister for Maritime Affairs and Investment, Republic of Indonesia

How Indonesia plans to tackle its plastic pollution challenge[1]

What will it take to end plastic pollution within a generation? For Indonesia, it all began with a radical vision.

Our beautiful nation is grappling with a serious plastic pollution challenge. We are home to the world's largest archipelago – more than 17,000 islands, 81,000 kilometres of coastlines and a rich abundance of biodiverse marine ecosystems. Our pristine natural environment is a gift that we have treasured for thousands of years and one that we must pass down to future generations.

At the same time, the amount of plastic waste generated in Indonesia each year is growing at unsustainable levels. In our cities, our waterways and our coastlines, the accumulation of toxic plastic waste is harming our food systems and the health of our people. Our booming fishing industry, the second largest in the world, is under threat from rising levels of marine plastic debris. By 2025, the plastic waste leaking into our oceans could increase to 780,000 tonnes per year – if no action is taken.

I'm proud to announce that Indonesia will be choosing not what is easy, but what is right. Rather than staying with a "business as usual" approach, we will be embracing a sweeping, full-system-change approach to combatting plastic waste and pollution, one that we hope will spark greater collaboration and commitment from others on the global stage.

At the World Economic Forum's Annual Meeting in Davos earlier this year, we presented to the world a first look at Indonesia's new plan for tackling plastic pollution, which aims to cut marine plastic leakage by 70% within the next five years. This report, developed for the National Plastic Action Partnership, forms the basis of that plan.

The vision goes even further: by 2040, we aim to achieve a plastic pollution-free Indonesia – one that embodies the principle of the circular economy, in which plastics will no longer end up in our oceans, waterways and landfills, but will go on to have a new life.

Indonesia's unprecedented national effort to take on plastic pollution is crossing a new frontier in what is possible. Working from the basis of a radical idea, we have created a platform – the Indonesia National Plastic Action Partnership – to mobilize willpower from all sectors and identify a clear path towards our goal to show that plastic pollution is not too complex or too enormous a challenge to overcome.

As we move from incubation to implementation in the months to come, I invite all to join us on this journey. As Indonesia puts this plan into action, we look forward to sharing our knowledge and to learning from others on bringing solutions and successes to scale. Together, we will demonstrate how we can work together to end plastic pollution and build a healthier, more sustainable future for our children and grandchildren.

Executive Summary

Indonesia faces a mounting plastic pollution crisis. Plastics are valued materials with a key role in the economy, and the nation generates around 6.8 million tonnes of plastic waste per year, a figure that is growing by 5% annually. Despite major commitments from government, industry and civil society, the flow of plastic waste into the country's water bodies is projected to grow by 30% between 2017 and 2025, from 620,000 tonnes per year to an estimated 780,000 tonnes per year.[2]

National Plastic Action Partnership

Recognizing the urgent need to take bold, unprecedented action on plastic pollution, the Government of Indonesia collaborated with the Global Plastic Action Partnership – a multistakeholder initiative set up by the World Economic Forum – to launch the Indonesia National Plastic Action Partnership (NPAP) in early 2019. This initiative complements many actions and initiatives currently underway in Indonesia to reduce plastic pollution, led by national and sub-national governments, businesses, academia, non-governmental organizations, community and religious groups – outlined further in Chapter 2. The NPAP supports Indonesia's National Action Plan on Marine Debris, the Indonesian National Waste Management Policy and Strategy (Jakstranas and its subnational equivalent Jakstrada) and other efforts towards achieving a 70% reduction in the nation's marine plastic debris by 2025.[3]

Near-zero plastic pollution by 2040

This report presents an ambitious set of actions for Indonesia to deliver on this ambitious goal and ultimately achieve near-zero plastic pollution by 2040. It envisions a sweeping System Change Scenario that encompasses priority actions needed across the plastics ecosystem, including reduction in avoidable plastic use, materials innovation, waste recovery, recycling and disposal.

The actions presented are deeply rooted in Indonesia's first comprehensive and fully costed analysis of the topic. This analysis is adapted from global research by the Pew Charitable Trusts and SYSTEMIQ[4] and was carried out with the NPAP Indonesia Expert Panel, NPAP Indonesia Steering Board, Indonesian Government and other stakeholders.

Key insights

Urgent action is needed to turn the tide of plastic waste and pollution in Indonesia

Seventy percent of Indonesia's plastic waste, an estimated 4.8 million tonnes per year, is considered mismanaged in ways such as being openly burned (48%), dumped on land or in poorly managed official dumpsites (13%), or leaking into waterways and the ocean (9%, or 620,000 tonnes of plastic waste).

Despite a sharp growth in foreign waste imports in 2018, more than 95% of plastic pollution comes from waste generated within Indonesia.[5] Mismanaged plastic waste pollutes the ecosystems and harms tourism and fisheries.[6] Open burning of plastic waste releases harmful substances to the air. It is even in the food we eat: plastic debris was found in 55% of sampled fish species in the market of the city of Makassar.[7]

The situation is expected to worsen in the next years.

> **This report includes a business-as-usual scenario that estimates plastic pollution will increase by one-third to 6.1 million tonnes in 2025 and will more than double in 2040 – even if plastic waste collection rates keep pace with growing waste generation.**

Solutions must be differentiated by geography and type of plastic

Around 72% of plastic pollution originates in rural regions and small- to medium-sized cities. The mismanagement of plastic waste is a domestic challenge – one that requires substantial action and policy change from the local level to fuel momentum nationally. There is also a notable difference among different types of plastic. Rigid plastics, such as polyethylene terephthalate (PET) bottles, have a higher value for recyclers and cause less pollution, particularly in more urban areas. However, some flexible plastics, particularly those made of multiple layers of different materials, cannot be recycled economically; they form about three-quarters of the plastic waste leaking into nature.

Action and investments are needed across the entire plastic system

The System Change Scenario (SCS) combines five system changes that would together reduce ocean leakage in Indonesia by 70% by 2025.

- **Reduce or substitute plastic usage** to prevent the consumption of more than a million tonnes of plastics per year by 2025 by switching to reuse and new delivery models, changing behaviours and replacing plastics with alternative materials that yield improved environmental outcomes.

- **Redesign plastic products and packaging for reuse or high-value recycling** with the ultimate goal of making all plastic waste a valuable commodity for reuse or recycling.

- **Double plastic waste collection** from 39% to more than 80% by 2025 by boosting state-funded and informal or private sector collection systems. This implies expanding plastic waste collection to four million new households each year until 2025.[8] Give priority to medium and small cities as these represent three quarters of plastic pollution.

- **Double current recycling capacity** by building or expanding plastic sorting and recycling facilities to process an additional 975,000 tonnes per year of plastics by 2025. To achieve this, large-scale recycling hubs need to be strengthened in Java and developed in urban centres outside Java.

- **Build or expand controlled waste-disposal facilities** to safely manage an additional 3.3 million tonnes of plastic waste per year by 2025[9] for the disposal of non-recyclable plastics, and plastic waste generated in locations without recycling facilities. A step up in enforcement of illegal waste burning and dumping is required to limit pollution in areas that have collection.

Delivering this 70% ocean leakage reduction scenario from 2017 to 2025 requires a total capital investment of $5.1 billion and an operational funding budget of $1.1 billion/year in 2025, in order to run an effective waste-management and recycling system.[10]

A circular and pollution-free plastics system by 2040 can lower waste-system costs and maximize environmental and social benefits

For **2017 to 2025**, the SCS includes a projected acceleration of recycling, more than doubling current capacity. In this scenario, collection rates grow even faster than recycling and there is a large growth in controlled disposal of plastic waste, a so-called “linear economy” solution.

The **2025 to 2040** period sees the acceleration of a second ambitious programme of action – achieving “near-zero” pollution of plastics into nature and transitioning from a linear to a **circular economy**. This transformation will decouple economic growth from plastic use through reduction and substitution and spur a radical increase in plastic-recycling rates through better product design and system changes (from around a 10% recycling rate today to more than 40% in 2040, measured as the share of plastics actually recycled into new materials).

In addition to preventing an additional 16 million tonnes of plastic leakage into waterways and the ocean by 2040, the SCS presented in this report is also expected to accelerate progress towards a number of targets set out in the UN Sustainable Development Goals (SDGs), including:

- Curbing 20 million tonnes of greenhouse-gas emissions per year (27% less than 2017 emissions) through reduced waste burning and increased recycling
- Creating more than 150,000 direct jobs
- Improving public health outcomes by reducing air pollution, improving solid waste management and mitigating the risk of flooding due to blocked drains
- Advancing gender equality and social justice for women, migrants and poor communities who are at higher risk for harm and exploitation
- Yielding economic benefits for local communities that derive livelihoods from fisheries or tourism

Delivering this scenario that eliminates ocean leakage within a generation requires a total capital investment of $13.3 billion between 2025 and 2040 and an operational funding budget reaching $1.8 billion/year in 2040.

Critical system changes can be unlocked and enabled through a combination of policy changes, financial investments, industry leadership and public engagement

Indonesia is increasingly recognized globally for its leadership in addressing plastic pollution. Chapter 4 provides a ten-point action plan for the ambitious and coordinated multistakeholder effort that is urgently needed to enable system change, end plastic pollution and establish a best-in-class model for other countries to follow.

Chapter 1
From concern to crisis – plastics in Indonesia now and in the future

This report covers plastics found in municipal solid waste (MSW), which represents around 50-70% of total plastics consumption in Indonesia.[11] Plastic packaging, carrier bags, cigarette butts, diapers, toys and durable household goods are examples of products containing plastics that become MSW after use.[12] Plastic MSW makes up the bulk of plastic waste generation and is over-represented in plastic pollution. The remaining 30-50% of plastics has a longer use period and consists of plastics used in cars and motorcycles, tyres, electronic appliances, textiles, industrial processes, agriculture, fishing and aquaculture and construction. For convenience of communication, we will refer to plastic MSW as "plastic waste" from now on.

Around 6.8 million tonnes of plastics became plastic waste (MSW) in 2017. The NPAP has calculated this using a so-called system model, an analytical tool that estimates all the plastic flows in Indonesia, mostly using mass estimates based on measurements in the waste system, reported by local governments.[13] In contrast, the plastics industry reports a figure of 5.8 million tonnes of plastics as produced or imported into Indonesia.[14] Unfortunately, statistical discrepancies are still common and can only be solved by improving reporting and monitoring waste statistics.

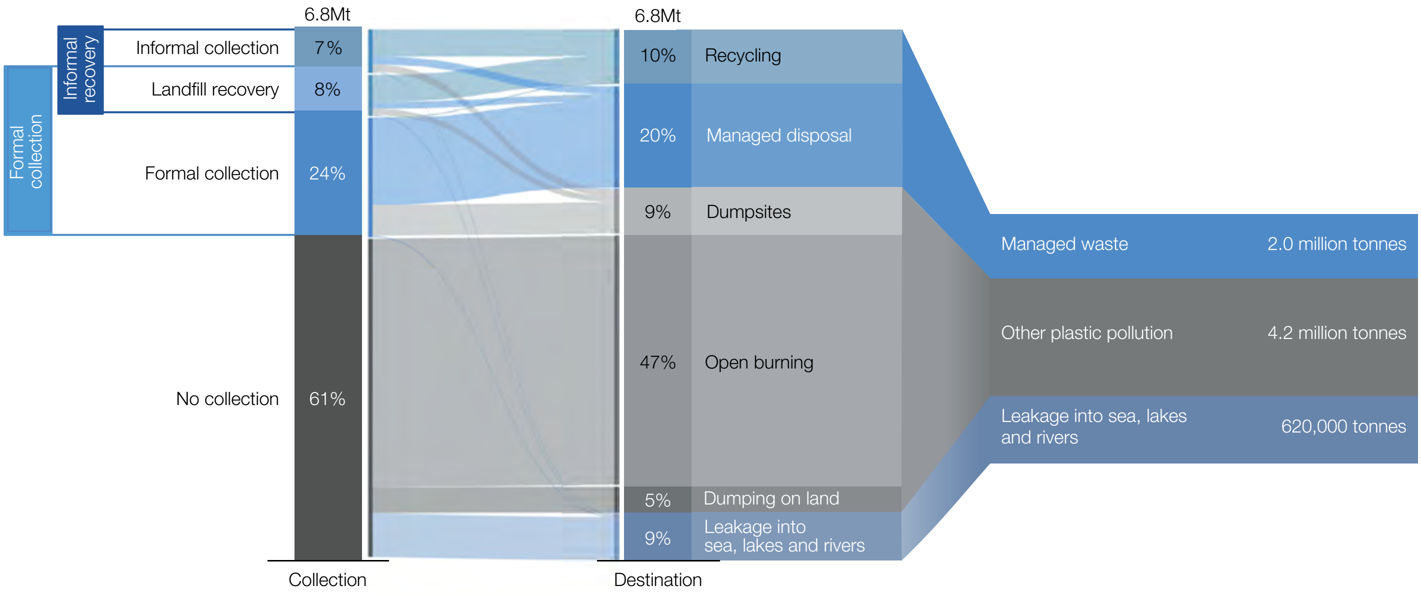
Plastic consumption grew by 5% per year between 2012-2016, at a rate similar to Indonesia's gross domestic product (GDP) growth.[15] Since 2018, Indonesia has also become a net importer of plastic waste, which adds some 220,000 tonnes from abroad (3%) to plastic waste.[16]

Not included in the above definitions is plastic waste generated at sea, such as discarded fishing nets and waste from ships. Maritime sources of waste contribute significantly to ocean plastics (estimated at 10-30% worldwide).[17] Due to data limitations, the NPAP was not able to model maritime waste for Indonesia. This was also the case for plastic particles that are generated by abrasion of tyres, washing of synthetic textiles or discharge of micro-beads in personal care products (known as primary microplastics). When this report addresses these topics, it does so based on research done elsewhere.

What is the baseline situation for plastic pollution in Indonesia?

The NPAP system model estimates that 620,000 tonnes of plastic entered Indonesia's waters in 2017.[18] Most plastics are not collected into a managed waste system after use (4.2 million tonnes, or 61% of plastic waste). This leaves households and small businesses with no other option than to dispose of them in an environmentally harmful way: 78% of uncollected plastic waste is burned by households, often close to homes, 12% of it is discarded into bodies of water and 10% is dumped on land or buried and can then end up in bodies of water through rainwater runoffs. Much larger volumes are burned by households, often close to homes (about 78% of uncollected plastic waste).

Figure 1: Where Indonesia's plastic waste ends up today (percentage of total plastic waste generated)



Source: NPAP analysis

Of the plastic waste that is collected, most is handled by local governments (2.1 million tonnes, or 32% of total plastic waste). Nearly all of this waste is combined with other household waste streams and goes directly to landfills or official dumpsites[19] without sorting of waste at households or in the collection system. We estimate that government-run sorting centres (TPS3R) process around 1% of waste collected. Approximately 8% of plastic waste that is collected by local governments is brought to uncontrolled official dumpsites from where it can leak into the environment, including into water bodies. As of early 2020, Indonesia does not have commercial-scale incineration or waste-to-energy facilities, but several are planned.

The informal sector (including waste pickers, junk shops and aggregators) plays a critical role in collection. This sector collects around 500,000 tonnes of plastic waste (7% of total plastic waste) directly from residential areas and 560,000 tonnes of plastics (8% of the total) from collected waste that is in transit to landfill and from landfills themselves.[20] Nearly all waste collected by the informal sector ends up at a recycling facility.

The huge contribution of the informal sector to preventing plastic pollution has largely gone unrecognized and waste pickers often work for low pay in unsafe conditions.

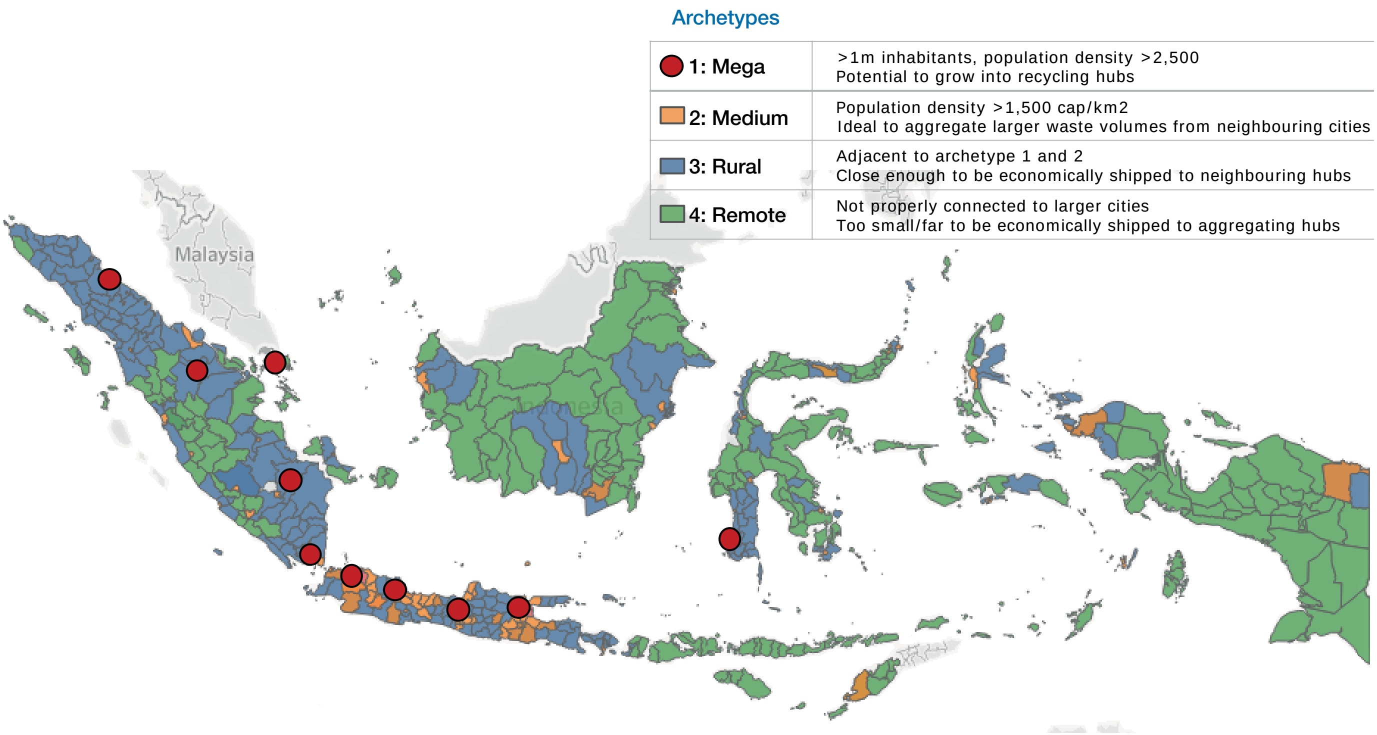
Of the 1 million tonnes of plastic waste that the informal sector collects for recycling, around 700,000 tonnes are transformed into recycled plastic; the remaining 300,000 tonnes are eventually disposed of due to yield losses in the sorting and recycling process, such as after contamination with organic material.

This puts Indonesia's plastic recycling rate at around 10% of the total 6.8 million tonnes of plastic waste generated (measured as a percentage of plastic waste that is actually recycled into new plastic). Of recycled plastics, around 85% are processed in a way that makes it difficult to recycle the product again. An example of this are PET bottles recycled into textiles, or mixed plastics.

Box A: Regional diversity and analysis of sources of mismanaged waste in Indonesia

With 17,000 islands spread over more than 5,000km, Indonesia's regional diversity is among the highest in the world. To capture some of this diversity, the NPAP system model splits Indonesia's regencies and cities into four groups or *archetypes* and runs all analyses separately for each archetype.

Figure 2: Geographic archetypes used in the NPAP system model and System Change Scenario

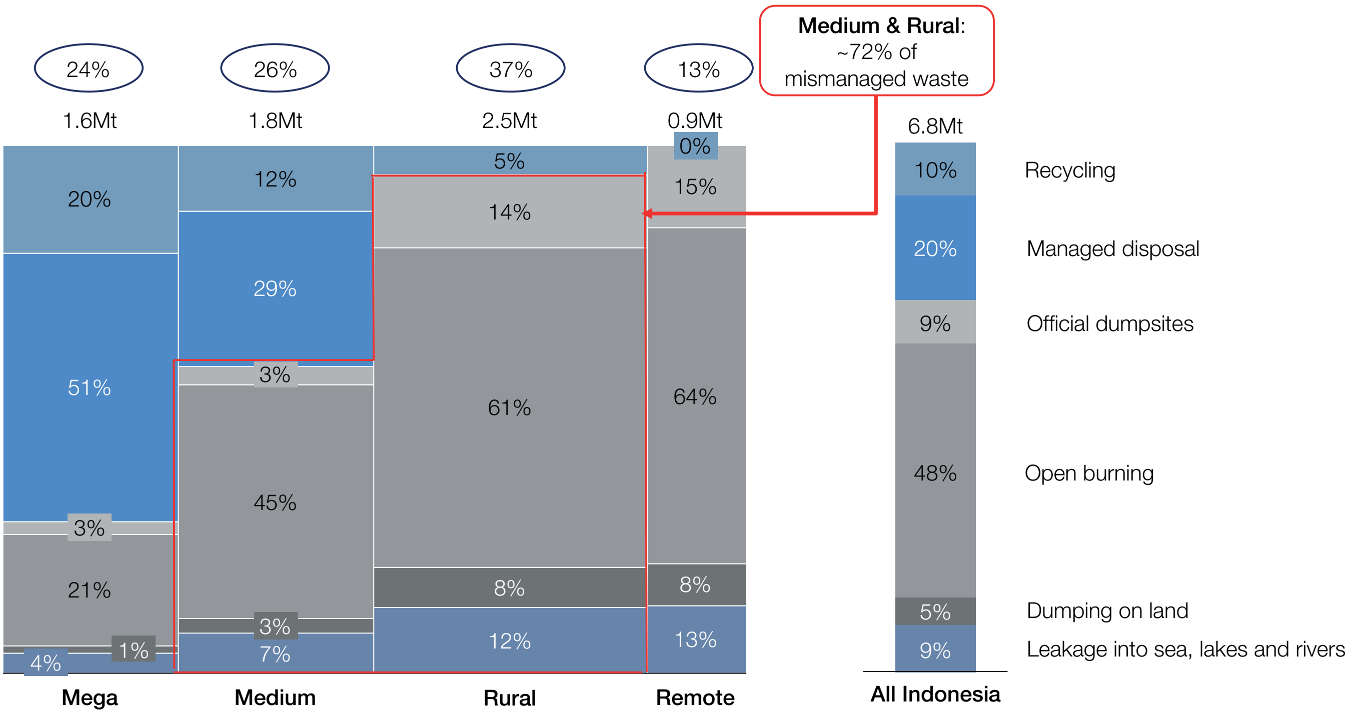


Source: NPAP analysis

The archetypes have large differences among them. We highlight three main differences:

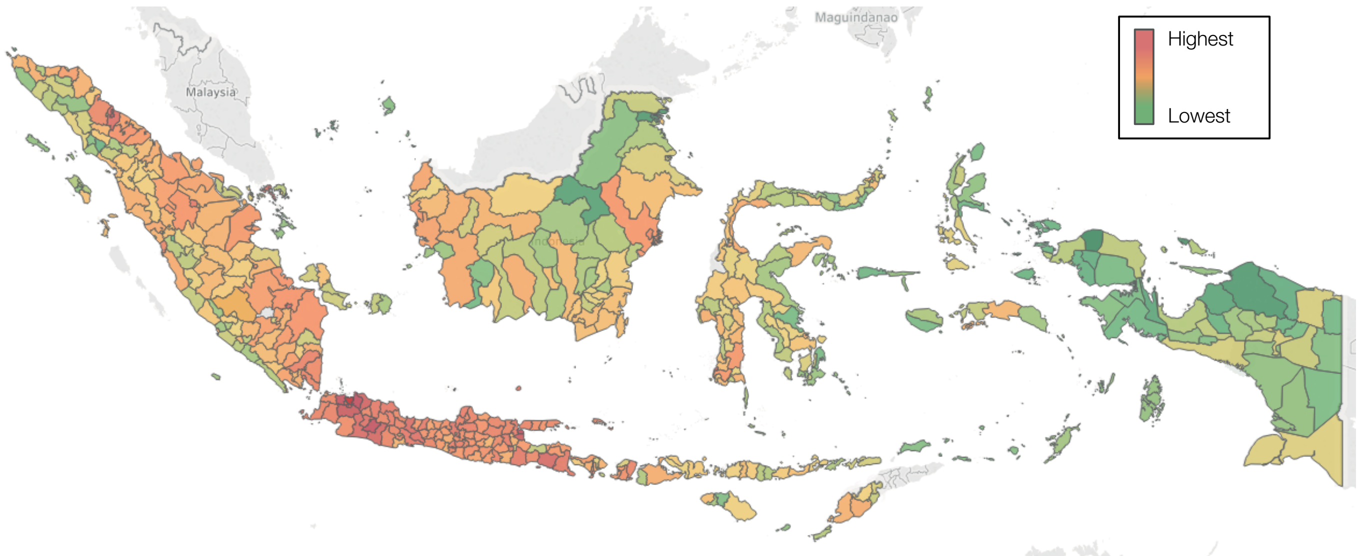
1. Waste-generation **volumes per person** are highest in wealthier archetypes, particularly *Mega*-cities such as Jakarta, where consumption is 1.5 times higher than in *Rural* and *Remote* areas.[21]
2. Average plastic waste-**collection rates** are dramatically higher in *Mega*-cities: 74% compared to 20% and 16% in *Rural* and *Remote* areas respectively.
3. **Informal sector** workers (waste pickers and aggregators) are most active in and around large cities, as this is where recycling plants are concentrated and population density is highest. In contrast, in *Remote* areas of Indonesia, they play a very limited role in waste management.
4. Overall, this combination of factors means that an estimated 72% of mismanaged plastic waste comes from *Medium* and *Rural* archetypes in Indonesia (Figure 3). 64% of mismanaged plastic waste comes from Java, which is the most populous island (56% of Indonesians live in Java).

Figure 3: The fate of all Indonesia's plastic waste, in each archetype (million tonnes per year, 2017)



Source: NPAP analysis

Figure 4: Total plastic waste generation in each City or Regency of Indonesia[22]



Source: NPAP Indonesia analysis

The System Change Scenario (SCS) that is presented in Chapter 3 models different plastic flows for each of the four archetypes. One insight is that improving waste management only in the two urban archetypes, *Mega* and *Medium*, is not enough to achieve the targeted 70% reduction in ocean plastic leakage by 2025. Solutions must also be extended to *Rural* and *Remote* parts of Indonesia.

What are the effects of mismanaged plastic waste on Indonesia's people and environment?

Ocean leakage affects more than 800 animal species in marine ecosystems around the world.[23] A study in Makassar, the largest city in Eastern Indonesia, found that 55% of fish species in the market are contaminated with microplastics.[24] Through ingestion or entanglement, macroplastics can cause mortality,[25] injury and sub-lethal impacts[26] and degrade into microplastics that are easily ingested by species throughout the food chain. At high concentrations (above current environmental levels), microplastics can cause negative impacts on growth, health, fertility, survival and feeding in a range of invertebrate and fish species.[27]

Marine plastic pollution has a direct negative impact on the 3.7 million Indonesians who depend on wild fisheries for their livelihoods, as well as more than a hundred million who depend on them for protein.[28] Plastics in coastal waters and on beaches are a major concern for the tourism industry, which employs 13 million Indonesians.[29] On land, poor management of plastic waste exacerbates flooding in big cities by clogging drainage systems[30] and may have contributed to major floods that struck the capital Jakarta in January 2020.[31]

Waste burning releases harmful substances into the atmosphere. Around 5,600 tonnes of particulates were emitted from burning plastics in 2017[32] and are often emitted close to where people live. Plastic burning also emits several tonnes of heavy metals (like lead, nickel, chromium and zinc) each year from the inks and additives. These substances are carcinogenic and prolonged exposure increases the risk of cardiovascular diseases.[33]

Burning of polyvinylchloride (PVC) in particular is problematic because it releases dioxin emissions, to which long-term exposure increases the risk of hormonal disruptions, reproductive issues and immunotoxicity.[34] Open burning of plastic waste is a source of greenhouse emissions that generated around 9.4 million tonnes of CO_2-equivalent emissions in 2017 – the same as 2 million cars driven over a period of one year.[35]

Box B: Plastics, gender and marginalized groups

A **gender perspective** is critical for understanding the plastic pollution challenge in Indonesia, and for designing effective solutions. Indonesian women play a greater role in making household purchasing decisions and in day-to-day management of waste in most households.[36] They are also more exposed to the negative effects of plastic pollution, such as through direct exposure to emissions from waste burning or dumping. Safe exposure levels to chemicals are often lower, since women have a higher proportion of body fat, which provides a greater reservoir for materials that can accumulate in the body.[37]

Jobs in government-run waste management are predominantly held by men, even though waste sorting is often handled by women workers.[38] Female workers in the informal sector waste system are exposed to health and safety risks, workplace violence and discrimination.[39]

The critical role of women in designing and implementing solutions is increasingly being recognized by society. Women are playing a larger role as volunteers in community waste banks, and mobilization campaigns activated through women's associations and networks serve as examples for effective community engagement. Women also self-report adhering more frequently to proper disposal behaviour, whereas men confess to littering more.[40]

Gender perspectives on solid waste management and informal-sector waste systems are the subject of numerous studies and initiatives, for example:

- Ocean Conservancy and GA Circular (2019), *The Role of Gender in Waste Management: Gender Perspectives on Waste in India, Indonesia, The Philippines and Vietnam*
- WIEGO Gender and Waste Toolkit[41]
- USAID Women's Economic Empowerment and Equality (WE3) Technical Assistance Project[42]

Marginalized groups are more exposed to plastic pollution

The negative impact of plastic pollution also falls disproportionately on the shoulders of marginalized communities. For example, Indonesians living without an official land title are less likely to be served by government-run collection and thus more exposed to the effects of waste burning. They are also more likely to suffer from flooding caused by waste blocking drains. In 2018, an average year, floods affected over 1.5 million Indonesians.[43]

Source: Kartini International and the sources referenced

What are the root causes of plastic pollution in Indonesia?

Plastic pollution in Indonesia has three interconnected root causes:

1. **Underdeveloped and underfunded solid waste-management systems** with low waste-collection rates, resulting in open burning or dumping of plastic waste. Where plastic waste is collected, waste systems very rarely have segregation of recyclables. This leads to high contamination rates, lower value for recycling and higher chance of post-collection leakage.

2. **Avoidable and problematic uses of plastics**, such as the use of excess plastics in packaging of goods or unnecessary use of problematic materials that yield negative environmental impacts.

3. **Low or no after-use value** for many types of waste plastics relative to other recyclable materials, such as aluminium cans, and relative to the time taken for collection of many plastic waste items, which limits the amount of plastic waste that the informal/ private sector is able to economically collect and recycle.

1. Under-developed and under-funded solid waste-management systems

Only 39% percent of waste is collected in Indonesia. This is equivalent to 160 million Indonesians,[44] about the population of Bangladesh, having no or only partial access to plastic-waste collection in their communities. They often have no choice but to dispose of their plastic waste in an environmentally harmful way.

Translating national policies for solid waste management into improved practices at the city level is challenging due to several interconnected factors, including:

- **Decentralized and fragmented governance and accountability** for waste management across multiple levels of local government. In some areas, accountability is delegated to the village level or even lower, with challenges of sub-scale economics and a shortage of technical knowledge and implementation capacity.

- **Low investment** from local government, due to multiple competing demands on annual budgets (e.g. road construction, education, healthcare and irrigation infrastructure). This is compounded by the absence of a common system that would enable households to efficiently and consistently pay for waste-management services, such as through their electricity bills, a practice that has been implemented in several other countries.

- **Institutional and technical capacity gaps** and under-developed monitoring and information systems, which make it challenging to enforce policy and incentivise good practices.

- **Shortage of suitable land** for waste facilities.

- Limited options to **valorize organic waste** in the Indonesian context, where chemical fertilisers are subsidized. Organic waste represents more than 60% of total weight in the municipal waste stream and is a major driver of the costs of running a full waste-management system.

2. Avoidable and problematic uses of plastics

Plastics are lightweight, affordable, easy-to-use, strong and flexible materials with many valuable applications. Plastics play an important role in keeping food safe, medical equipment sterile and fuel consumption low, due to their light weight compared to alternative materials. However, some of the current uses of plastics are avoidable or problematic, leading to unnecessary waste and pollution.

Avoidable plastics can be illustrated by overpackaging in e-commerce electronic products whose primary packaging is designed for transport, that are repackaged with a secondary layer of packaging with the same function. Other examples of avoidable plastics use include the practice of selling drinks in plastic cups even when durable mugs are available, as well as serving guests individual polypropylene (PP) cups of water, even when the same water is available from a refill tank.

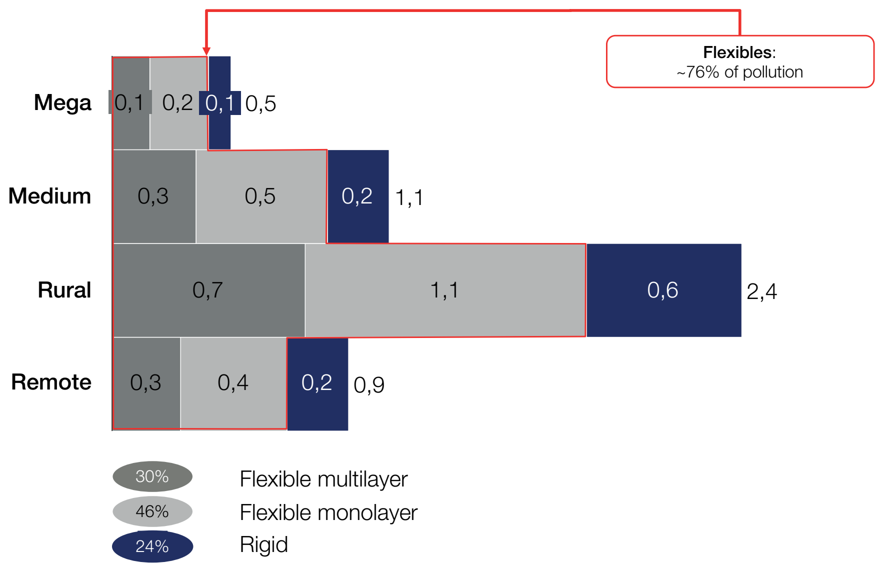
Problematic plastics include those that impose proven negative effects on human health when burned, such as PVC in packaging. It also includes so-called oxo-degradable plastics that have been marketed as a solution for plastic waste but disintegrate quickly into microplastic particles and are considered to have a worse impact on ecosystems and recycling systems than standard plastics.[45]

3. Low or no after-use value

High value packaging materials such as aluminium cans (around $800 per tonne in East Java in 2019) are rarely found polluting the environment even when there is not an effective solid waste-management system in place; they are viewed as too valuable for disposal.

However, many forms of plastic waste have low or zero value in the recycling market and are time-consuming to collect. For example, small sachets or wrappers made from multilayer plastics have very low market price for recyclers (less than $50 per tonne in the few locations where there is demand (East Java, 2019)), and it takes many days to collect 1 tonne. As a consequence, the informal/private collection system and the recycling industry focus on the highest-value materials in the most high-density areas (e.g. clean plastic waste from commercial and industrial sources, and post-consumer bottles and containers made from PET and rigid HDPE), and other plastics seen as less valuable are more likely to leak into the environment (Figure 5).

Figure 5: Mismanaged plastic waste by plastic type: flexibles represent ~76% of plastic pollution (million tonnes per year in 2017)



Source: NPAP analysis

After-use value starts with the design process. International eco-design guidelines have been developed to improve the after-use value of plastic products and packaging. To give one example, colour pigments used in plastic packaging contaminate the recycling process and lead to a lower value output, compared to clear or natural-coloured packaging. Overall, it has been estimated that packaging design improvements could increase average after-use value by $90-140 per tonne of mixed plastics collected for recycling.[46]

Limited access to plastic recycling facilities also limits after-use value in many parts of Indonesia. Today, recycling hubs are concentrated in only a limited number of geographies and one-third of plastic waste is generated in so-called “recycling deserts”, areas in which no recycling plant is available within a reasonable commercial range[47] (Box C).

What future scenario is projected for plastic waste in Indonesia, without ambitious action on solutions?

Plastic waste generation is projected to grow from 6.8 million tonnes in 2017 to 8.7 million tonnes in 2025. **If current rates of plastic waste collection and treatment are simply maintained in line with increasing waste generation, leakage of plastics into Indonesia’s water bodies is projected to increase from 620,000 to 780,000 tonnes per year from 2017 to 2025 (+30%) and more than double to 1.2 million tonnes per year by 2040.**[48]

This increase is driven by two factors:

- Population growth, from 260 million people in 2019 to 310 million people in 2040
- Economic growth, which is projected to increase waste per person by 38% in 2040 versus today as well as the proportion of plastics compared to other types of waste such as organics, because consumers tend to buy more goods packaged in plastic when their income increases

Figure 6: Handling of plastic waste if collection rates stay at 39% (million tonnes)

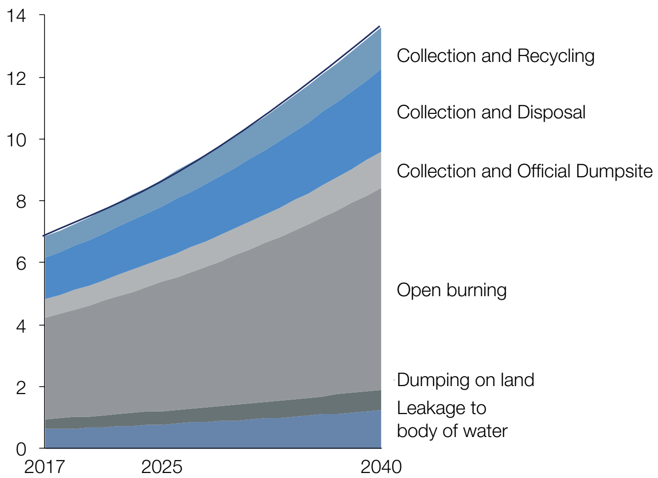
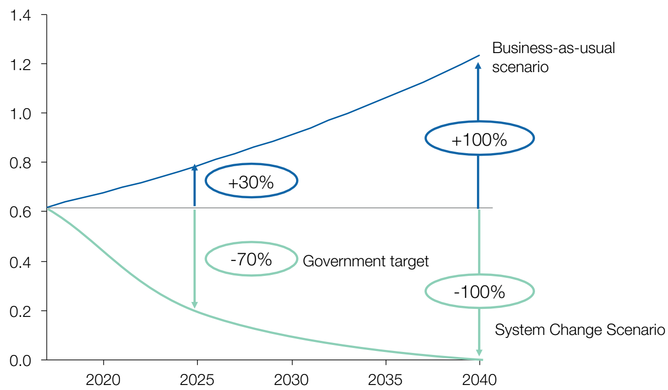


Figure 7: Business-as-usual projection vs. System Change Scenario



Chapter 2

Waking up to the challenge – case studies and examples of emergent action in Indonesia

Single-use plastic reduction

1 Banjarmasin is the first city in Indonesia to successfully restrict plastic bags, following an extensive communication period to gain buy-in from businesses and the community. Government promotes the use of a locally produced traditional basket

2 MAP Group, a leading retail company with more than 2,000 outlets across the country (e.g. Starbucks, Burger King) commits single-use to replace plastics cups and cutlery, and charge a fee for plastic bags

3 BlueBird Group, a company that operates 25,000+ taxis, works together with WWF to eliminate the cups and bottles used daily by its drivers by providing tumblers and refill stations in taxi pools

4 Nazava, the provider of a technology to filter rainwater and surface water into drinking water have sold over 150,000 products thus reducing the consumption of single-use water bottles, Nazava was originally founded to solve water shortage in Aceh post-tsunami

New business model

5 MUUSE in Bali operates a deposit-based platform where restaurants and consumers can rent reusable food containers and cups for take-away orders

6 Bulk stores are emerging across Indonesia, especially in cities such as Jakarta, Bandung, Yogyakarta, and Denpasar, offering packaging free shopping to support zero-waste lifestyle

7 Starting in 2015, Kecipir.com operates an online platform in Jakarta that connects farmers and consumers, allowing sales and delivery of in-season organic vegetables with minimal packaging

Material Innovation

8 Evoware, has developed edible seaweed-based food wrapping

Redesign for recycling

9 Nestlé switches to paper straws for its drinks cartons

10 In 2019, Aqua launched Indonesia's first plastic bottle made of 100% recycled material in Bali and Jakarta. By eliminating pigments and replacing labels by embossed text, the bottles are fully recyclable

Innovation & informal sector integration

11 Gringgo, founded in 2015 in Bali, developed a digital platform to connect waste workers with households using route analysis to increase collection efficiency

12 Waste4Change and EcoBali privatize waste collection and employ former waste pickers as collection and sorting workers in an improved working environment. Monthly reports are provided to increase customer awareness

13 Smash, MallSampah, Obabas, and other start-ups are helping digitize waste bank operations and connect them with the community

14 Plastic Bank pays a premium price for collected plastics using a "plastic offset" scheme funded by corporate clients

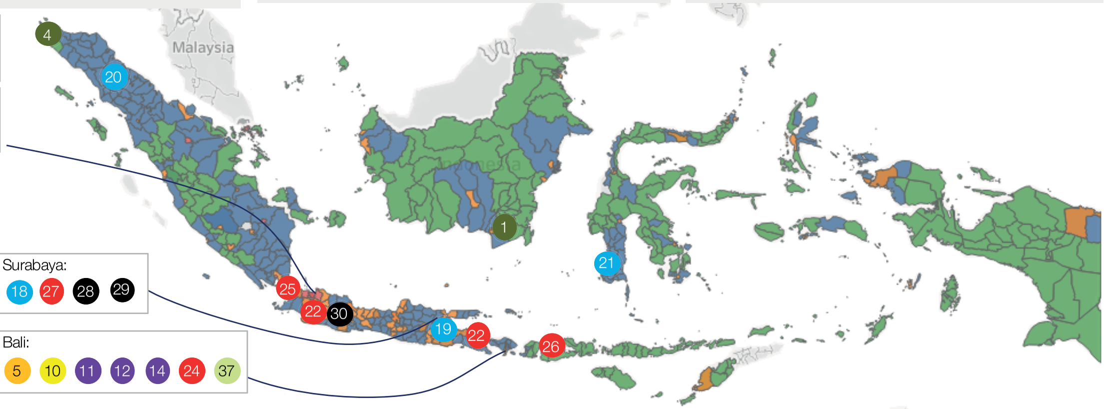
15 In September 2018, SecondMuse launched an incubator network in Surabaya to accelerate solutions to ocean plastics

Nation-wide initiatives: 2 6 8 9 13 15 31 32 33 34 35 36 38

Jakarta: 3 7 10 16 17

Surabaya: 18 27 28 29

Bali: 5 10 11 12 14 24 37



Waste management & recycling

16 In 2016, Jakarta increased the salary of its waste workers, known as the orange army, resulting in increased performance. The government monitors the system by requiring each worker to send a daily report via mobile phone pictures

17 The Jakarta Environmental Agency in collaboration with Waste4Change, GBCI, and MVB Indonesia launched waste reduction initiatives for buildings and restaurants in which best practices will receive awards

18 The Surabaya city government has improved the city waste management strategy by building sorting facilities, expanding waste banks, and implementing the first plastic-for-bus tickets initiative. In early 2019, the city was awarded Adipura Kencana, the highest clean city award

19 TPST Bakti Bumi in Sidoarjo has been equipped with a sorting conveyor and plastic crusher to meet the 14% waste reduction target set by the local government

20 A waste reduction strategy is scheduled to be piloted in Lake Toba, North Sumatera, following partnership built between Indonesia and IGES-Japan

21 Makassar has received the Adipura award three times for its improvement in managing waste throughout the city. It is driven by the community with support from the government

Community and city level partnership

22 Project STOP in Muncar has implemented a zero-leakage collection system that covers ~50,000 residents for the the first time. STOP has expanded to Pasuruan, East Java and Jembrana, Bali

23 In 2018, Bandung adopted The Zero Waste Cities programme, community-based waste management aiming to divert more waste from landfill through community engagement

24 In Bali, Merah Putih Hijau is implementing a community partnership to improve solid waste management. PRAISE and McKinsey.org recently launched the Desa Kedas programme to upgrade waste sorting facilities and stimulate household waste segregation

25 Masaro, implemented in e.g. Cilegon, Banten, aims to create zero waste communities with waste segregation and waste processing into compost and plastic-to-fuel products

26 Koperasi Serba Usaha, a local cooperative in Labuan Bajo, employs a trash bank model to attract people to participate in the system

27 Common Seas and PC Muslimat Surabaya, a women's charity, have agreed to collaborate to tackle diaper waste by piloting re-usable diaper and introduce new waste management service in the Brantas river

Recycling technology

28 Unilever CreaSolv® facility close to Surabaya recycles flexible and multi-material plastics

29 Greater Surabaya will also be home to a bottle-to-bottle recycling facility built by Danone in partnership with Veolia

30 Plastic Energy™ has signed an MoU to build five plants in West Java targeting to convert 100,000 tons of plastic into fuel annually

31 Plastic-to-roads is being trialled in several places, in a Chandra Asri and PUPR collaboration in Bali, Banten, and other areas

Enabling activity and research

32 The Coordinating Ministry for Maritime Affairs and Investment, World Bank, and GA Circular are developing best practices and strategies into effective behaviour-change campaigns

33 Nahdlatul Ulama, one of the largest religious organisations in the world, has issued a detailed 76-page Islamic guidance on proper plastic waste management

34 Indonesia Waste Platform, founded in 2015, connects over 1000 organizations and individuals to coordinate solutions for waste management challenges

35 IPI, a waste picker association established in 1991, advocates better livelihood for waste pickers through access to national healthcare (BPJS). They introduced waste recycling zones (KPPS) in Greater Jakarta to better integrate the formal and informal sectors.

36 IP2WM, PRAISE, ADUPI are associations of plastics manufacturers, consumer packaged goods, and recycling industry with growing concern on plastic pollution that have been promoting and developing recycling technologies

37 Bali Partnership has carried out extensive research to build a baseline data of plastic waste in Bali

38 LIPI and universities, such as ITB, Udayana, ITS, UI, Unhas, are pioneering research on plastic pollution data

The social enterprise Nazava builds affordable filters for drinking water, providing a reusable alternative to plastic water bottles.

At the Jakarta headquarters of Nahdlatul Ulama, the largest Islamic organization in Indonesia, workers turn plastic waste into art and household products, such as stools.

A young campaigner with the NGO Indonesia Diet Kantong Plastik (Plastic Bag Diet) persuades a shopper at Tebet Market in Jakarta to exchange her plastic shopping bag for a reusable one.

Workers prepare collected plastic waste for recycling at a flaking and washing plant in Denpasar, Bali, supported by Danone-AQUA.

Chapter 3

Fast and purposeful – a System Change Scenario

2020-2025: Reducing marine plastic leakage by 70% through short-term interventions

In this chapter we present a "System Change Scenario" (SCS) with a costed package of system changes that could collectively reduce ocean plastic leakage in Indonesia by 70% from 2017 to 25. This scenario is based on an economic model for plastic flows in Indonesia under different scenarios, adapted from global research by the Pew Charitable Trusts and SYSTEMIQ.[49]

The scenario was developed based on three key criteria: the impact and relative cost of different system changes; the risk of unwanted consequences for people and the environment; and expert opinions on the feasibility, technology readiness and speed of implementation of different solutions.

The analysis indicates how a combination of system changes could achieve the 70% target but does not judge the overall feasibility of delivering the scenario in the allotted time period.

The SCS consists of five system changes:

1. **Reduce or substitute plastic usage** to prevent the consumption of more than a million tonnes of plastics per year by 2025.

2. **Redesign plastic products and packaging** for reuse or high-value recycling.

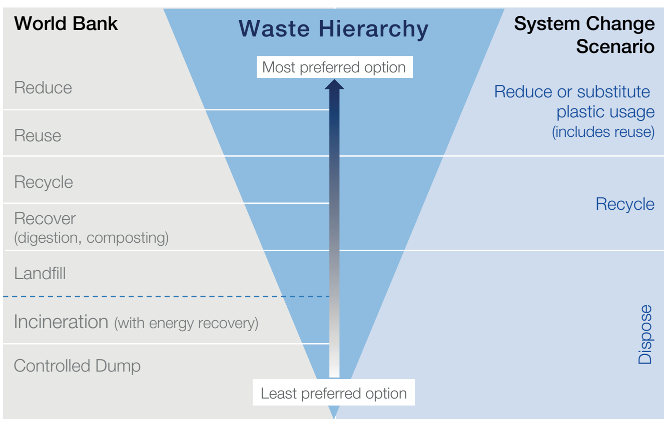
3. **Double plastic waste collection** from 39% to 84% by 2025 by boosting state-funded and informal or private-sector collection systems.

4. **Double current recycling capacity** to process an additional 975,000 tonnes per year of recycled plastic by 2025.

5. **Build or expand controlled waste disposal facilities** to manage an additional 3.3 million tonnes of plastic waste per year by 2025.[50]

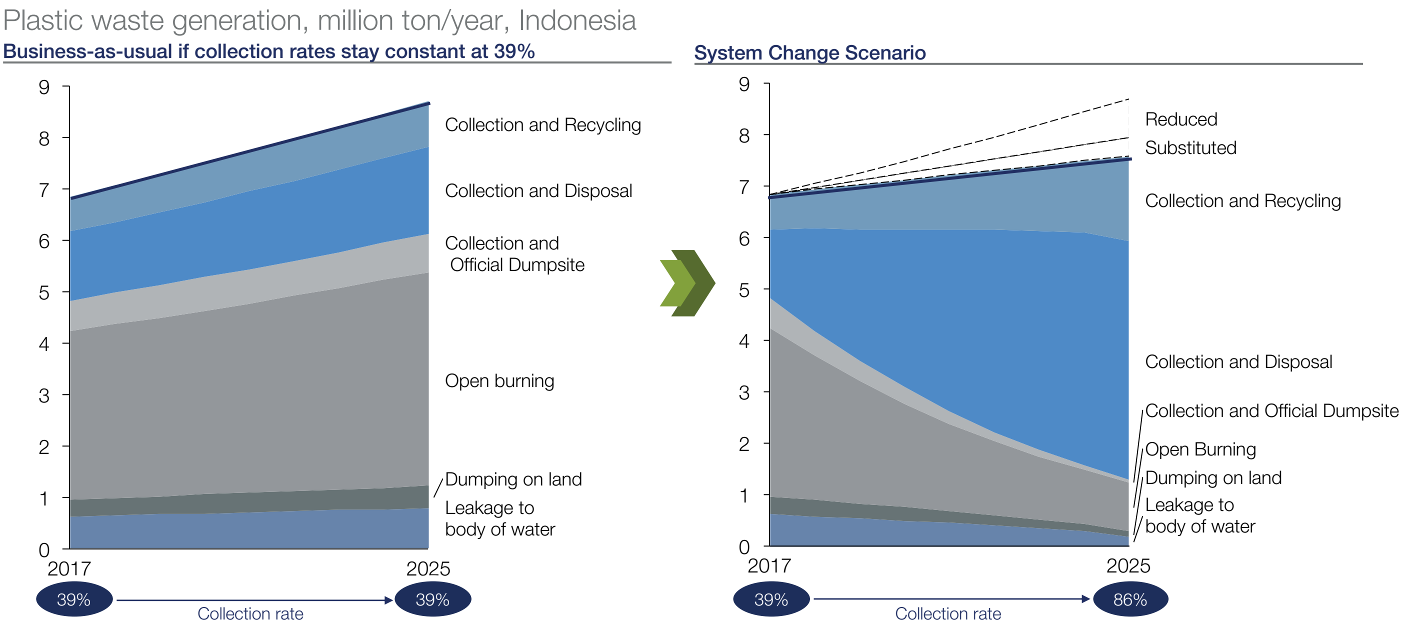
The order of the system changes outlined above reflects the "waste hierarchy" used by global policy-makers and investors such as the World Bank (Figure 8).[51]

Figure 8: Alignment of System Change Scenario with the Waste Hierarchy



Source: World Bank

Figure 9: Fate of MSW plastic waste in "business as usual" scenario and SCS (million tonnes per year)



Source: NPAP Analysis based on >50 public, private and academic publications, nearly all Indonesian (e.g. Jakstrada, BPS, PUPR)

1. Reduce or substitute more than a million tonnes per year of avoidable plastic use by 2025

The SCS quantifies how much reduction and substitution (R&S) is possible by 2025 through an analysis of 15 types of plastic applications. Four R&S options are considered:

- Avoidance of use, such as plastic straws, stirrers, fresh fruit trays and tubs
- Reuse, such as water bottles, shopping bags, and durable cutlery
- New delivery models, such as packaging-free deliveries, refill from dispensers, and take-back services
- Substitution with non-plastic materials that have a better environmental impact, such as internationally certified compostable materials or paper-based materials used for certain applications

The SCS estimates the R&S potential based on three factors (see details in the methodological appendix):

1. Evidence of R&S potential
2. Risk of unintended consequences for performance, health and food safety, convenience or affordability
3. Implementation time

Using this methodology, the SCS estimates that 1.1 million tonnes per year of plastic consumption (13% of projected plastic waste generation in 2025) can be reduced or substituted by 2025 without compromising on performance, health and food safety, convenience or affordability.

1.1 Reduction potential: 740,000 tonnes of plastic use avoided in 2025

Out of 15 screened product applications, five represent around 80% of the estimated reduction potential:

1. **Carrier bags** (8% of plastic waste) that are not used just for groceries, but often also for direct food-contact applications in traditional markets. The SCS points towards savings of up to 40-50% (320,000 tonnes per year) of plastic bag waste by further encouraging reusable and durable bags in the place of unnecessary single-use bags.

2. **Sachets and multi-material flexible packaging** (16% of plastic waste), which is often used in small format goods (e.g. shampoo, seasoning packs) to provide a single-dose product for lower-income consumers. The SCS estimates that new delivery models that replace sachets and multi-material flexible packaging with re-fills and packaging reuse systems can avoid 140,000 tonnes of plastic waste per year by 2025 (around a 10% reduction from 2017 volumes).

3. **Business-to-Business packaging** (rigid and flexible, 9% of plastic waste) is typically large-format packaging designed for bulk delivery (e.g. shrink wrap and cooking oil containers for restaurants). Businesses can reconfigure operating and business models to encourage reuse and build a collective returnable packaging network to prevent an estimated 120,000 tonnes per year (around 10-20%) of this type of waste.

4. **Bottles** (food and non-food, around 8% of plastic waste). Using reusable water bottles coupled with refill models and concentrated non-food goods point towards prevention of around 70,000 tonnes per year of bottle waste (a reduction of 10 to 20%).

1.2 Substitution potential: 370,000 tonnes of plastic use avoided in 2025

Three substitutes for plastic are modelled to the gauge substitution potential: paper, coated paper and compostable materials. Specifically, this means:

- **Paper** or cardboard materials, generally as a replacement for plastic films
- **"Coated paper"** with a coating that meets the criteria for technical recyclability[52]
- Internationally certified **compostable** materials used in locations that have suitable after-use systems, such as certified home-compostable materials where food-waste collection or home composting is supported and materials could be segregated from mechanical recycling

Paper and coated paper are only considered acceptable under strict conditions for land use and energy use. Metal and glass were not considered as substitute materials because of concerns about the life-cycle climate impact of these materials compared to plastics. The SCS estimates that **370,000 tonnes per year of plastic consumption (4% of projected plastic-waste generation) can be avoided in 2025 without compromising on performance, health and food safety, environmental impact, convenience or affordability.**

2. Redesign plastic products and packaging

Plastics with low or zero value for recycling are less likely to be picked up by waste pickers and more likely to pollute the environment. **Design-for-recycling** (D4R) specifically takes the after-use value of plastic products and packaging into account in the design process.

To simulate the effect of design for recycling in the NPAP Indonesia system model, the SCS assumes that 20% of non-recyclable (multi-material) plastics are switched to recyclable formats by 2025. Doing so increases the volume of recyclable materials by 470,000 tonnes per year and is estimated to reduce loss rates in the recycling industry. The combination of these measures leads to an improvement in recycling rates and reduced plastic pollution.

3. More than double the plastic-waste collection rate from 39% to over 80% (2.7 to 6.2 million tonnes per year) by 2025

A rapid increase in the plastic-waste collection rate is central to the SCS. After all, households without waste-collection services have no choice but to burn, bury or dump their plastic waste.

The SCS projects that plastic-waste collection rates would need to more than double to 84% to achieve the 70% ocean-leakage reduction target by 2025. This could be achieved through an accelerated rollout of government-run waste-management systems (70% of the new collection in the SCS) and through incentives for the recovery of more plastic waste by private/informal collectors (30% of the new collection in the SCS).

This incentive programme is incorporated in the SCS because it could integrate informal-sector workers and enable a faster rollout of plastic-waste recovery, compared to reliance on local government agencies. An incentive programme of this nature would rely on proactive approaches to improve working conditions in the informal sector, support legal and environmental compliance and enable mutually beneficial cooperation or integration between private/informal and government-run waste systems.

Lessons from existing schemes in South Asia, Africa and Latin America can be referenced for good practices in this field.[53]

4. Double recycling rate by 2025

Increased waste collection and improved design of plastic products and packaging would provide more suitable feedstock for the recycling industry. Construction or expansion of recycling facilities will be needed to process these materials and to provide the incentives for collection of plastic waste. The SCS incorporates a doubling of recycling rate from 10% to 22%, adding 975,000 tonnes so that 1.7 million tonnes are recycled in 2025.

The SCS assumes that all recycling will take place in the form of mechanical recycling until 2025 (cleaning and remoulding of plastics into new products). Advanced (chemical) recycling technologies could play a bigger role after 2025, assuming that technological readiness, safety and speed of deployment progress is managed. These advanced recycling technologies could include pyrolysis, gasification, purification or depolymerization of plastic waste back into feedstocks that can be used to manufacture recycled plastics. Plastic-to-fuel solutions are classified in the NPAP Indonesia model as "disposal" options.

Box C: Analysis of recycling catchments in Indonesia

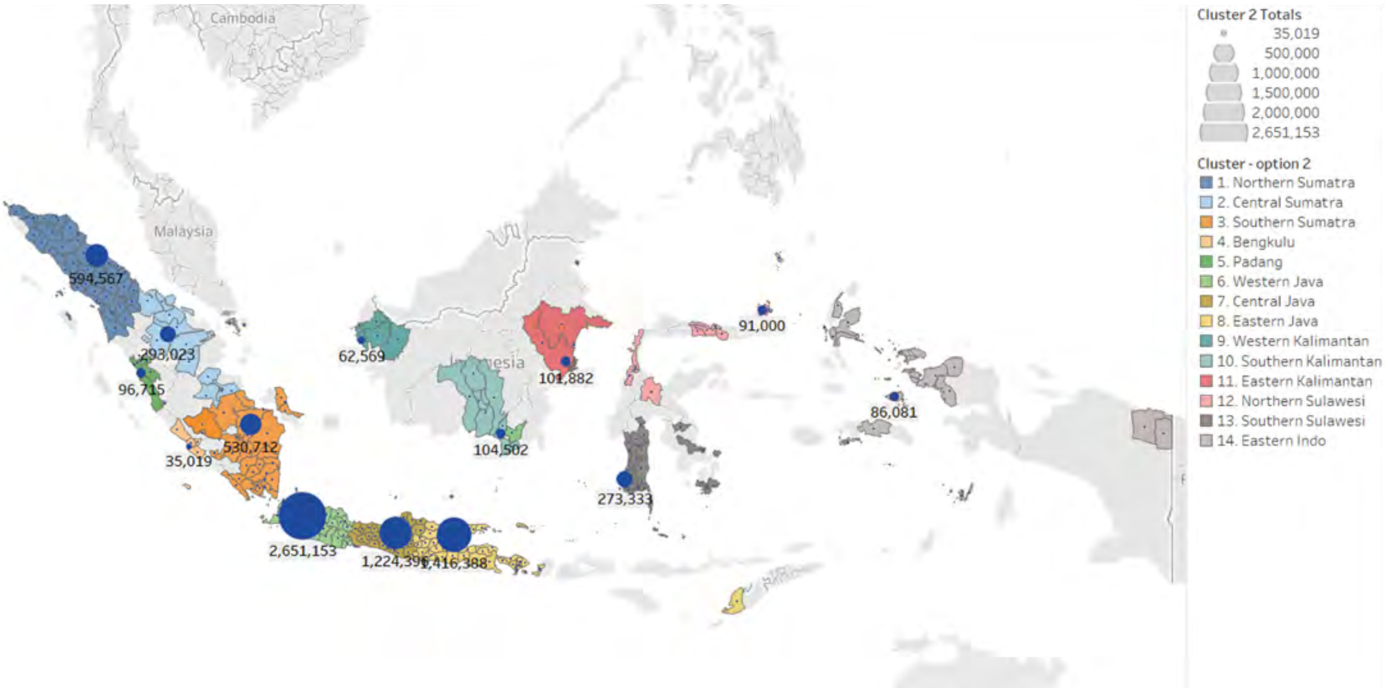
Today, between 80% and 90% of recycling companies are concentrated on the island of Java,[54] with a much smaller concentration in Northern Sumatra. This leaves most of Indonesia's land area (though not its population) too far from a recycling plant to supply recyclable material under commercial conditions.

To understand the geographic challenges for plastic recycling in Indonesia, we defined 12-14 potential "recycling catchments" in Indonesia centred on a major city, each able to cover a hinterland of around 400 km in distance without obvious topographic barriers, from where we assume waste can be economically shipped to the hub.[55]

Viable economics for recycling depend on economics of scale and consistent feedstock supply. 300,000 tonnes per year of total plastic-waste generation in a catchment was estimated as a minimum size for a viable plastic-waste recycling hub, since a 50% recovery rate for recyclable plastics (one third of the total plastic waste) would generate approximately 50,000 tonnes of recyclable plastics per year – suitable for one mid-sized recycling plant processing PET and one plant processing polyolefin plastics (PE/PP).

This calculation could change if advanced recycling technologies are proven to accept a wider range of plastics, such as flexible polyolefin plastics.

Figure 10: Potential recycling catchments analysed (BAU plastic-waste generation, tonnes in 2025)



The recycling catchments clearly divide into three groups based on plastic-waste generation and logistics costs:

1. Catchments in Western, Central and Eastern Java, Northern and Southern Sumatra have volumes of over 500,000 tonnes of waste generation per recycling catchment (74% of national plastic waste by volume).
2. Marginal catchments in Central Sumatra and South Sulawesi[56] have volumes of around 300,000 tonnes, which is borderline for an economically viable recycling hub (7% of national plastic waste by volume).
3. Catchments in the rest of Indonesia have volumes of less than 220,000 tonnes (20% of national plastic waste by volume).

This analysis suggests that catchments in Western, Central and Eastern Java, Northern and Southern Sumatra are commercially viable recycling hubs if the right enabling conditions are met. Central Sumatra and South Sulawesi would require more support. Catchments in other parts of Indonesia are not likely to support commercially viable recycling hubs and will require a different strategy for plastic-waste management, for example by supporting pre-processing and shipping of plastic waste for recycling in other parts of Indonesia or elsewhere in the region. A prototype for this model could be Labuan Bajo in East Nusa Tenggara, where this approach is being piloted by the government of Indonesia and local government authorities together with industry and NGO partners.

5. Build or expand controlled waste disposal facilities

Despite the ambitious projection for growth in recycling in the SCS, a substantial increase in controlled disposal capacity is needed to accommodate the extra volumes of additional plastic collected. To handle this, controlled disposal capacity must be expanded to accommodate 3.3 million additional tonnes of plastic waste per year in 2025.[57]

We define controlled disposal as any option for post-collection management of plastic waste that does not recycle the material into a new material or product, and operates within internationally accepted limits for health, environmental and social impacts. The word “controlled” is not intended to mean that these options are harmless to people or the environment. Landfills are the only disposal option that operates at scale in Indonesia today. For that reason, sanitary landfills are assumed as the controlled disposal option and used to estimate disposal costs in the SCS (for new landfill construction and operation). It should be noted that most landfills currently in operation in Indonesia require a substantial improvement in sanitary practices; however, retrofitting of existing landfill facilities to meet international standards is not included in the SCS cost analysis.[58]

2025 to 2040: Transition from a mostly linear "disposable" economy to a circular plastics economy

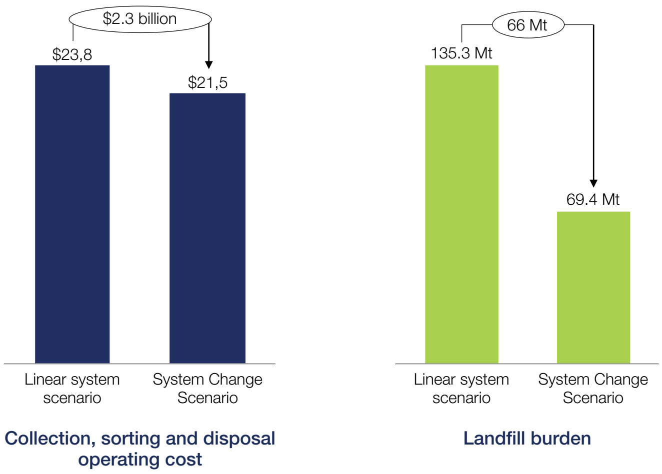
From 2017 to 2025, the SCS includes an ambitious scaling up of recycling capacity in Indonesia: more than doubling the amount of plastics that are currently recycled. Yet as collection rates need to grow even faster to bring down plastic pollution, the SCS only meets the 70% ocean-leakage reduction target if it relies on so-called "linear-economy" solutions – plastic-waste collection and disposal – to meet the 70% ocean-leakage reduction target.

The 2025 to 2040 SCS sees the acceleration of a second programme of action: achieving a "near-zero" level of leakage of plastics into nature, and transitioning the nation from a linear to a **circular economy**. This transformation will decouple economic growth from plastic use through reduction and substitution, as well as lead to a radical increase in plastic recycling rates through better product design and system changes.

> **The SCS projects that 2.8 million tonnes of plastic recycling could be recycled in 2040, compared to an estimated 680,000 tonnes in 2017.**

Compared to reliance on "linear economy" solutions to reach near-zero leakage, this circular economy scenario saves $2.3 billion in waste-management costs and avoids the disposal of 66 million tonnes of plastic into over-burdened landfill facilities from 2025 to 2040 (see Figure 11).

Figure 11: Comparison of circular vs linear scenarios to reach near-zero leakage from 2025 to 2040



Source: NPAP analysis

The **2025 to 2040 SCS** includes the following system changes, summarized in Figure 12:

1. Reduce or substitute (R&S) around 6.5 million tonnes per year of avoidable plastic use by 2040:

   Reduction
   The consumption of 4.3 million tonnes per year of plastics could be avoided in 2040, compared to projected growth in plastic-waste generation (31% of projected plastic-waste generation in 2040). This could be achieved through avoidance of use or reuse, without compromising on performance, environmental impact, health and food safety, convenience or affordability.

   Substitution
   2.2 million tonnes per year of plastics could be substituted with known alternatives in 2040, compared to projected growth in plastic-waste generation (16% of projected plastic-waste generation in 2040). This could be achieved through substitution from plastics to internationally-certified compostable materials or materials based on paper or cardboard, without compromising on performance, health and food safety, convenience or affordability.

2. Redesign plastic products and packaging

The SCS models a further shift towards standardization and design for recycling, with almost half of all non-recyclable (multi-material) plastics switched to recyclable formats by 2040 (up from 20% in 2025). Doing so increases the volume of recyclable plastic materials by 1.1 million tonnes per year.

3. Extend plastic-waste collection to almost all communities in Indonesia

To achieve near-zero leakage of plastics to the ocean, almost all communities in Indonesia must be served by government-run or private/informal sector collection of plastic waste by 2040. In the SCS, 7.1 million tonnes per year of plastic waste would require collection in 2040.

Since the SCS incorporates a rapid expansion of waste collection from 2017 to 2025 (and significant R&S), the remaining rollout from 2025 to 2040 is more modest in comparison (990,000 tonnes of additional government-run and informal collection in *Rural* and *Remote* areas in 2040 compared to 2025, equivalent to about 20% of Indonesia's population). This expansion poses particular challenges and involves higher costs because it requires plastic-waste collection from remote and rural communities in the country.

The 2025-40 SCS increases plastic-waste sorting and recycling in government-run collection streams, through increases in segregation of recyclable waste in households and by sorting an additional 1.1 million tonnes per year through TPS3R or other waste sorting facilities (on top of the 330,000 tonnes per year processed in 2025).

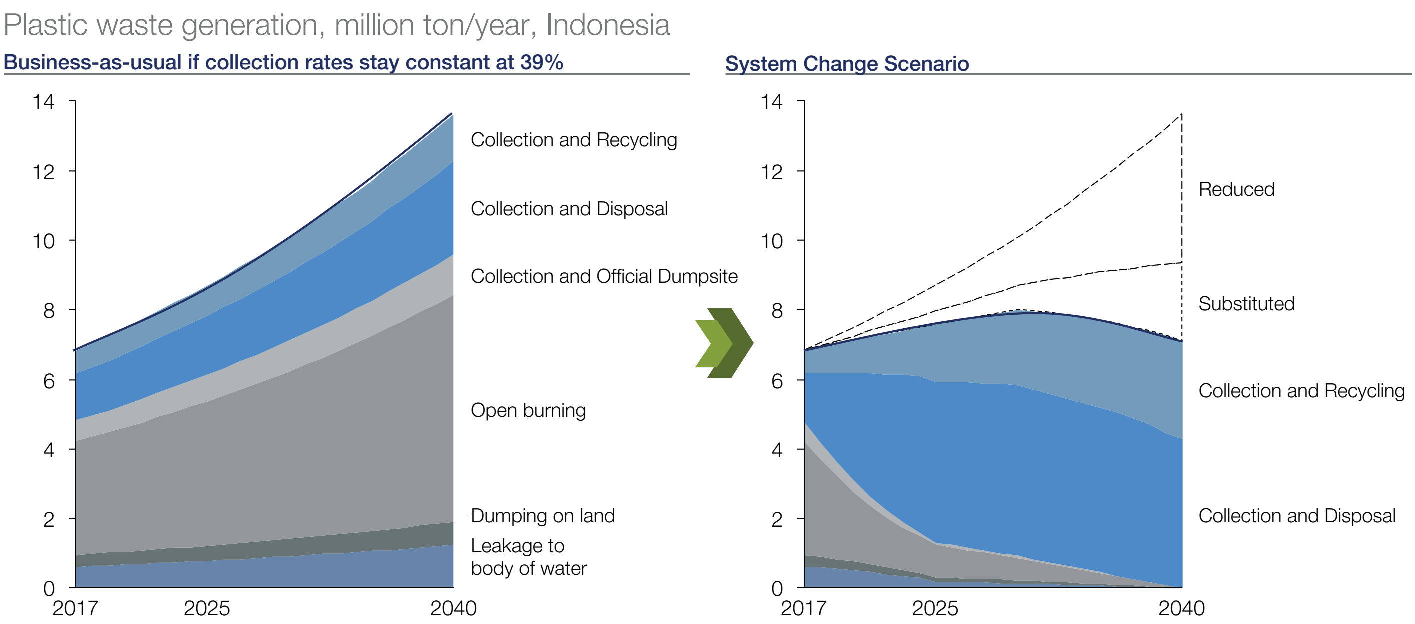
4. Quadruple the plastic recycling rate by 2040

The SCS projects that 2.8 million tonnes of plastic recycling could be recycled in 2040, compared to an estimated 680,000 tonnes in 2017. The 2040 figure includes 150,000 tonnes of plastics-to-plastics chemical recycling that could process low-value plastics that are unsuitable for mechanical recycling today. The overall plastics recycling rate would increase from 10% in 2017 to 40% in 2040.

5. Build or expand controlled disposal facilities by 2040

Under the SCS, significant steps to reduce, substitute and recycle more plastics by 2040 would slow down the growth in disposal volumes after 2025. However, even taking this into account, the SCS projects a need for controlled disposal facilities that can handle 4.3 million tonnes per year of plastic waste in 2040 (and beyond). Plastics-to-fuel processing is estimated to grow to 150,000 tonnes in 2040, on the assumptions that this technology is economically viable compared to other disposal options, and that it can be operated safely and in accordance with international standards for air emissions. This must be proven in the Indonesian context.[59]

Figure 12: Where plastics end up, BAU vs SCS, 2017 to 2040 (million tonnes per year)



Source: NPAP Analysis

Costs and benefits of the System Change Scenario

Financial costs

– **Total capital investments** of $5.1 billion are required to realize the SCS from 2017 to 2025 (for all waste, including non-plastics). Of this, $4 billion is required for state-managed waste collection and disposal infrastructure, and $1.1 billion is required to develop the necessary capacity in the (private) plastic recycling sector.[60]

  From 2025 to 2040, additional capital investments of $13.3 billion are required: $11.7 billion for state-managed waste collection and disposal infrastructure, and $1.5 billion for plastic recycling.[61]

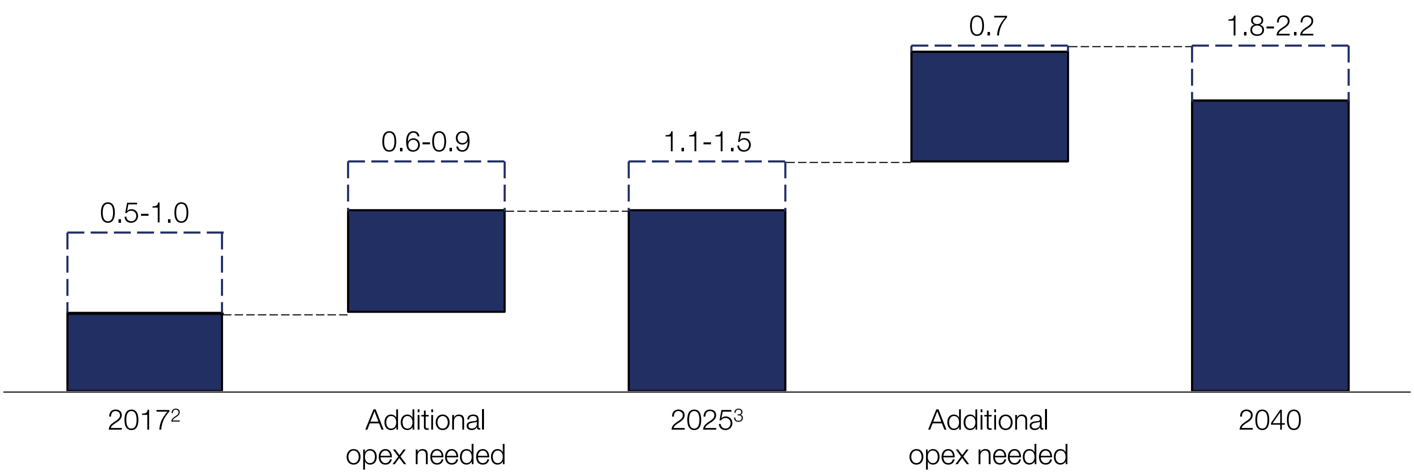
– **Annual operating expenditures** on solid-waste management need to rise from $0.5-1.0 billion[62] in 2017 to $1.1-1.5 billion in 2025. These figures represent the costs to run government-run collection, sorting and disposal of both plastics and non-plastics. They include incentives to the informal/private sector to supplement the value of post-use plastics and increase collection rates.

Not included are the revenues and costs of the profitable parts of the industry, including informal/private collection, sorting and recycling, beyond the incentive. Costs of reducing, substituting or re-designing plastics are not included in these totals as they are considered costs and benefits to private enterprise that would not be covered by the government. In the SCS, Indonesia's government saves $700 million in waste-management costs from reducing and substituting avoidable plastics from 2017 to 2025.

Operating expenditure will rise to $1.8-2.2 billion per year in 2040, driven by higher collection rates in rural and remote areas, higher operating costs of segregated collection, and expansion of sorting facilities.

Capital expenditure to realise the System Change Scenario					
Years	Collection and controlled disposal systems for all waste	Collection and disposal – allocated to plastic waste	Collection equipment attributed to plastic waste	Plastic recycling facilities	Safe disposal facilities attributed to plastic waste
2017-2025	$4.0 billion	$1.2 billion	$0.4 billion	$1.1 billion	$0.8 billion
2025-2040	$11.8 billion	$4.2 billion	$2.0 billion	$1.5 billion	$2.2 billion

Figure 13: Waste-management operational cost excluding recycling (USD billion per year)



Source: NPAP Analysis

Social and environmental benefits

The System Change Scenario has a sweeping positive impact on Indonesia's society and environment. Firstly, by design, it would meet the government target of 70% reduction of **ocean plastics leakage by 2025 and reach near-zero leakage by 2040**. Between 2017 and 2040, this adds up to 16 million tonnes of avoided ocean plastic.[63] In parallel, it would also bring other types of mismanaged waste down by the same rate and avoid a total of 128 million tonnes of plastic pollution into the environment. A second environmental effect is the curbing of **greenhouse gas (GHG) emissions** and **air pollution**. Under the SCS, Indonesia would avoid emissions of 10 million tonnes of GHG (CO_2-equivalent) per year in 2025 and 20 million tonnes per year in 2040.

These figures are for plastics only; an even more positive contribution to climate change mitigation can be expected from the proper management of organic waste, which would be enabled through implementation of some elements of the SCS, but not quantified here.

A social co-benefit of realising the SCS is the net creation of more than **150,000 direct jobs** in the plastic waste and recycling sectors, most of them in waste collection systems.[64] This also highlights a major anticipated challenge: the need to mobilise and train such a large workforce in a short space of time.

The SCS is also expected to contribute to the improvement of **public health**. A decrease in waste burning will reduce air pollution, limit the spread of contagious diseases, and lessen the likelihood of flooding caused by mismanaged waste blocking rivers and drainage systems.

Finally, the System Change Scenario offers the opportunity to advance **gender equality** and **social justice**, as women, migrants, marginalized communities and low-income populations are more likely to be negatively affected by plastic pollution and inadequate solid-waste management (see Box B).

Beyond the System Change Scenario

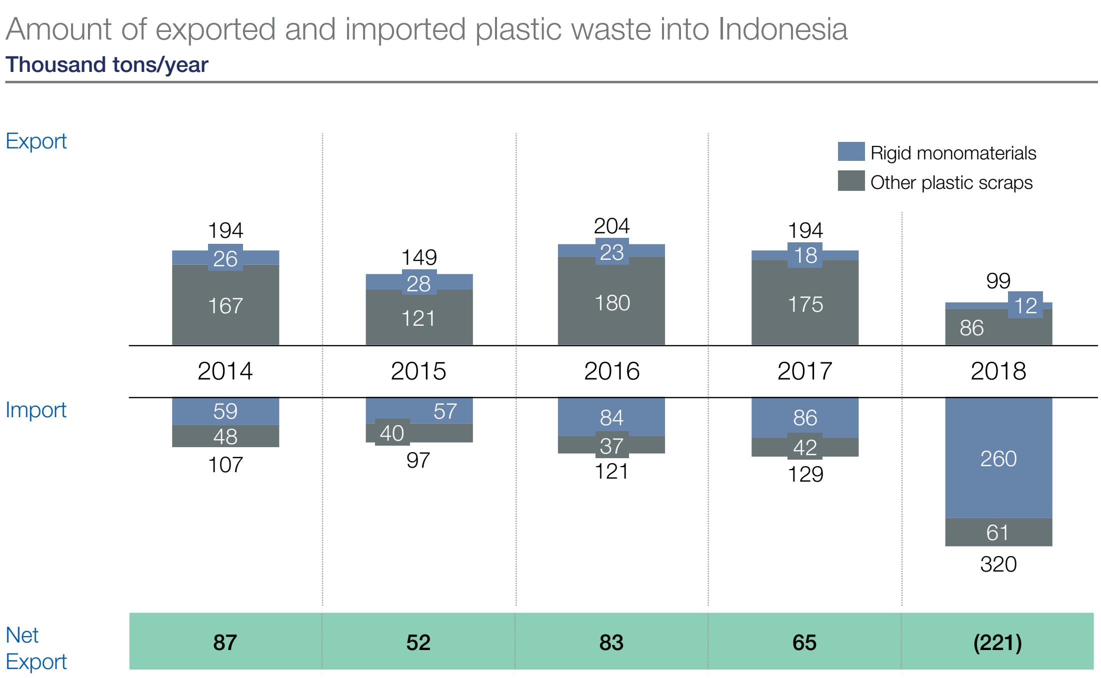
Due to data limitations, three important topics could not be addressed by the NPAP system model: plastic-waste imports, microplastics and maritime sources of waste. For these topics, we rely on research carried out elsewhere.

Plastic-waste imports

Indonesia switched from being a net exporter to a net importer of plastic waste in January 2018, after China effectively closed its market. One study estimates that 5-20% of plastics imported into the Global South is low-value and may lead to burning or dumping (data for Indonesia is not available).[65]

Reports in the Indonesian media also suggest that we should look beyond plastic imports alone into plastic contamination in paper imports.[66] On this basis, a preliminary estimate of potential leakage from plastic-waste imports today is less than 5% of total leakage in Indonesia.[67] Although plastic-waste imports may be small in comparison to total plastic-waste generation (about 3%), they are much larger as a share of recycling feedstock: in 2018, imports accounted for 30% of recycling feedstock in Indonesia. Reducing imports could free up recycling capacity that can be used for the substantial extra volumes of Indonesian waste that must be collected to meet the country's targets for preventing plastic pollution.

Figure 14: Exports and imports of plastic waste (thousand tonnes, Indonesia)



Source: NPAP Analysis

Primary microplastic sources

The NPAP had insufficient sources for Indonesia to analyse pollution from primary microplastics.[68] Global analysis indicates that around 13% of total ocean plastics leakage is estimated to come from four sources of microplastics: tyre dust (77% by mass), pellets (17%), textile microfibers and microplastics in personal care products (both contribute less than 6%). International research indicates that middle- and lower-income countries will become a growing source of primary microplastics in the next years, with primary microplastic pollution projected to grow from 148 to 419 grams per capita between 2016 and 2040.[69]

Broadly, microplastics can be addressed by three types of interventions:

1. Material and product redesign to eliminate some sources of microplastics. This could mean developing low-abrasion tyres, using natural fibers and improving fabric cuts and weaving style in textiles, or eliminating microbeads in personal care products.

2. Bans on avoidable sources of microplastics. The European Union has banned the use of microplastics in most products, such as in cosmetics, detergents, paints, polish and coatings.[70]

3. Construction or upgrading of wastewater treatment facilities equipped with microplastic filtering systems. In Indonesia, as of 2017, only 13 cities have wastewater treatment facilities at scale.[71] Many recycling plants operate with minimal wastewater treatment or without these facilities altogether.

Maritime sources of leakage

Abandoned, lost, and discarded fishing gear, as well as litter from ships (35% of maritime waste in the European Union and possibly higher in Indonesia) are understood to be major maritime sources of leakage. Maritime sources of leakage in Indonesian waters are also not covered by the NPAP analysis due to a lack of data. This knowledge gap is a worldwide issue; estimates of the contribution of maritime sources of leakage range between 10 and 30% of ocean leakage, but there is much uncertainty.

Guidelines have been published[72] and pilot projects have been run to recover and recycle fishing gears, also in Indonesia.[73]

Reliable data is also scarce for marine littering from ships. Given its geographic position on the Malacca Strait, Indonesia sits on one of the world's busiest shipping routes. In addition, Indonesia's island geography means that ships play a larger role in the nation's domestic transport system than in comparable countries. Combatting marine littering requires measures similar to managing land-based waste: reduce problematic plastics as much as possible, provide waste management facilities in ports, and create incentives or enforcement measures to ensure that vessels use these facilities.

Chapter 4
Five points of action – a comprehensive policy and industry action roadmap for Indonesia

Despite an impressive and growing ecosystem of Indonesian initiatives to tackle the mismanaged plastic waste challenge (Chapter 2), achieving the 70% ocean leakage reduction target in Indonesia will require a step-change in efforts. **An action plan of practical recommendations for government, industry and civil society is proposed below**, co-developed and tested with the NPAP Expert Panel and Steering Board. It outlines a combination of actions and critical accelerators that would achieve a radical and sustained reduction in mismanaged plastic waste in Indonesia, in line with the President's vision, the National Action Plan on Marine Plastic Debris and the Roadmap for Waste Reduction by Producers.[74]

Delivery of this plan will require a coordinated multistakeholder effort between government, industry and civil society – with a combined focus on policy reform, industry leadership and voluntary action, public and private investment, civil society and community mobilization and innovation.

Five points of action	Ten critical accelerators to enable system change
1. **Reduce or substitute plastic usage** to prevent the consumption of more than 1 million tonnes of plastics per year by 2025 2. **Redesign 500,000 tonnes of plastic products and packaging** for reuse or high-value recycling 3. **Double plastic-waste collection** from 39% to 84% by 2025 by boosting state-funded and informal or private sector collection systems 4. **Double current recycling capacity** to process an additional 975,000 tonnes per year of recycled plastic by 2025 5. **Build or expand controlled waste-disposal facilities** to manage an additional 3.3 million tonnes of plastic waste per year by 2025.[75]	a. **Reduce or substitute avoidable uses of plastic through policies, targets and incentives.**[76] **Phase out the most problematic plastic uses** through voluntary industry action and regulation. This includes PVC and expanded polystyrene in packaging, unsafe degradable materials such as plastics with oxo-degradable additives, and microplastics in personal care products.[77] Stimulate **plastic reduction, plastic-free alternatives and reuse models** through innovation and fiscal incentives, such as reuse models that can replace single-use shopping bags, straws, tableware and food-service containers, multilayer sachets, food and beverage packaging and business-to-business packaging. Test reduction and substitution measures with a gender-conscious approach to ensure successful adoption and make sure the risks are assessed to avoid impact to environment and society, especially to women and marginalized groups. **"Walk the talk"** by reducing avoidable uses of plastics on premises for companies and civil society organizations, government agencies and state-owned enterprises, schools and universities and incorporating R&S principles in procurement guidelines for national government bodies and state-owned enterprises.[78] b. **Transition to 100% recyclable, reusable or compostable plastics and increase the use of recycled plastics, through policies, targets and incentives** Implement policies, industry initiatives and incentives that will enable the transition of all packaging in Indonesia to be 100% recyclable, reusable or compostable, in alignment with the Ellen MacArthur Foundation's Global Commitment to a New Plastics Economy. Provide incentives and support for eco-design and use of recycled plastics, for example through modulated fees in an Extended Producer Responsibility scheme and by streamlining the process for certifying recycled content for food-contact packaging applications.[79] Set up a dialogue between businesses and government regarding the implementation and funding of the Roadmap for Waste Reduction by Producers, issued by the Minister of the Environment and Forestry in 2019 Develop a world leading packaging design programme or institute in Indonesia, which would bring together companies, government and academia to ensure that design is tailored to the particular needs of emerging-market waste collection and recycling systems.[80] c. **Boost solid-waste management master plans, implementation initiatives and monitoring across Indonesia**: Strengthen the Jakstrada policy by developing Solid Waste Management and Recycling Master Plans for each province and update those of regencies and cities, with cross-government support and the involvement of stakeholders and experts, and ensure that solid waste management responsibilities are articulated at the appropriate level of government for effective implementation. Ensure policies and practices support equality and non-discrimination principles, particularly in creating equal-opportunity employment for women and men across the plastics value chain, as well as strengthening safety and protection measures for women working in waste management. Expand solid-waste management through a city-by-city or regency-by-regency programme that combines capacity building, infrastructure development, behaviour change, a workable long-term funding plan and local regulations. Identify priority locations for new recycling factories and provide incentives or special regulatory regimes,[81] based on assessments of recycling potential and installed capacity in provincial Solid Waste Management and Recycling Master Plans.

Incorporate strategies for valorizing organic waste, such as by equalizing the subsidies that chemical fertilizers receive with new subsidies for waste-based fertilizers or through carbon-credit mechanisms.
Strengthen national and sub-national monitoring of waste collection rates, leakage rates, recycling rates, sanitary landfill management practices and incentivize high performance among local governments, potentially through an extended and strengthened application of the Adipura "clean city" initiative.

d. Integrate and support **informal-sector workers and companies** in the waste and recycling system.
Recognize the important role of workers in the informal waste recovery sector in Indonesia, strengthen representative associations such as Ikatan Pemulung Indonesia (IPI) and consult this sector as key stakeholders for national and sub-national decisions on waste management and recycling.

Ensure safe and dignified working conditions and living wages in a way that is equitable for women and marginalized groups. Provide training, protective equipment and tools, simplified access to government identity cards *(KTP)*, uniforms, access to healthcare, social security and pension through inclusion in Indonesia's social security programme *(BPJS)*.[82]

Design waste systems to incorporate safe informal/private sector collection and sorting activities away from landfills or dumpsites and provide opportunities in government-funded waste management and recycling systems for informal-sector workers and companies.

e. **Enable industry co-funding of plastic-waste collection and recycling systems**, such as through an Extended Producer Responsibility (EPR) scheme that draws from international best practices, yet is tailored to the Indonesian context and is developed collaboratively between industry and government to be fair, cost-effective, and fit-for-purpose in scaling up packaging recovery and recycling.

f. Mobilize capital investment for **equipment and infrastructure** and budgets for **waste-system operations**
Ramp up operational spending on solid-waste management through national budgets *(APBN)*, local budgets *(APBD)* and co-funding from industry, waste-generating companies (such as through disposal fees) and households (such as through retribution fees from households receiving waste-management services, paid through local taxes or electricity payments).

Mobilize funds for solid waste-management equipment and infrastructure, for example through a blended finance approach with concessionary capital from governments, industry, philanthropy and multilateral agencies that can "crowd in" large-scale investment from mainstream financial investors for large infrastructure investments, such as through the SDG Indonesia One platform.

Enable investment into plastics recycling facilities by increasing the reliability of feedstock supply (for example, innovative approaches working with informal sector supply chains), improving transparency, environmental and quality standards in the recycling sector, securing offtake demand (through long-term contracts for recycled plastics), and providing fiscal incentives such as lowering value-added tax for recycled materials. These should target upgrades of existing facilities as well as greenfield investments.

g. Provide **capacity building, training and skills development** to enable a rapid growth of the solid-waste management and recycling sector in Indonesia in line with international best practices for safety, efficiency, cost-effectiveness and transparent financial management, environmental standards and gender equality.

h. Conduct ambitious **public engagement and behaviour-change** campaigns in partnership with government, industry, civil society and religious organizations designed to encourage positive consumer choices, waste behaviours and participation in reduction, reuse and innovative waste-management and recycling programmes.

j. Enable **innovation and incubation of new and emerging solutions**, through support and incentives from government and industry, such as advanced recycling technologies like plastics-to-plastics chemical recycling, new plastic-free product delivery models or reuse systems, and digital technologies and traceability mechanisms for socially responsible waste collection through informal/private supply chains.

k. Continue and expand efforts to **convene, coordinate and collaborate on solutions** between stakeholders and decision-makers across government, industry, civil society and academia, using the NPAP Indonesia platform and others to ensure a convergent approach to changing the plastic system and meeting national targets.

Relation between the five points of action and 10 critical accelerators

✓✓ Direct effect
✓ Indirect effect

	1. Reduce or substitute plastic usage	2. Redesign plastic products and packaging	3. Double plastic waste collection	4. Double current recycling capacity	5. Build or expand safe waste disposal facilities
A Reduce or substitute avoidable uses of plastic through policies, targets and incentives	✓✓		✓		✓
B Transition to 100% recyclable, reusable or compostable plastics and increase the use of recycled plastics		✓✓		✓	
C Boost solid-waste management master plans, implementation initiatives and monitoring			✓✓	✓✓	✓✓
D Integrate and support informal sector workers and companies in the waste and recycling system		✓	✓✓	✓✓	✓
E Enable industry co-funding of plastic-waste collection and recycling systems	✓	✓	✓✓	✓✓	✓
F Mobilize capital investment for equipment and infrastructure, and budgets for waste-system operations			✓✓	✓✓	✓✓
G Provide capacity building, training and skills development	✓	✓	✓✓	✓✓	✓✓
H Conduct ambitious public engagement and behaviour-change activities	✓✓	✓✓	✓✓		
I Enable innovation and incubation of new and emerging solutions	✓✓	✓✓	✓✓	✓✓	✓✓
J Continue and expand efforts to convene, coordinate and collaborate on solutions between stakeholders	✓✓	✓✓	✓✓	✓✓	✓✓

Appendix

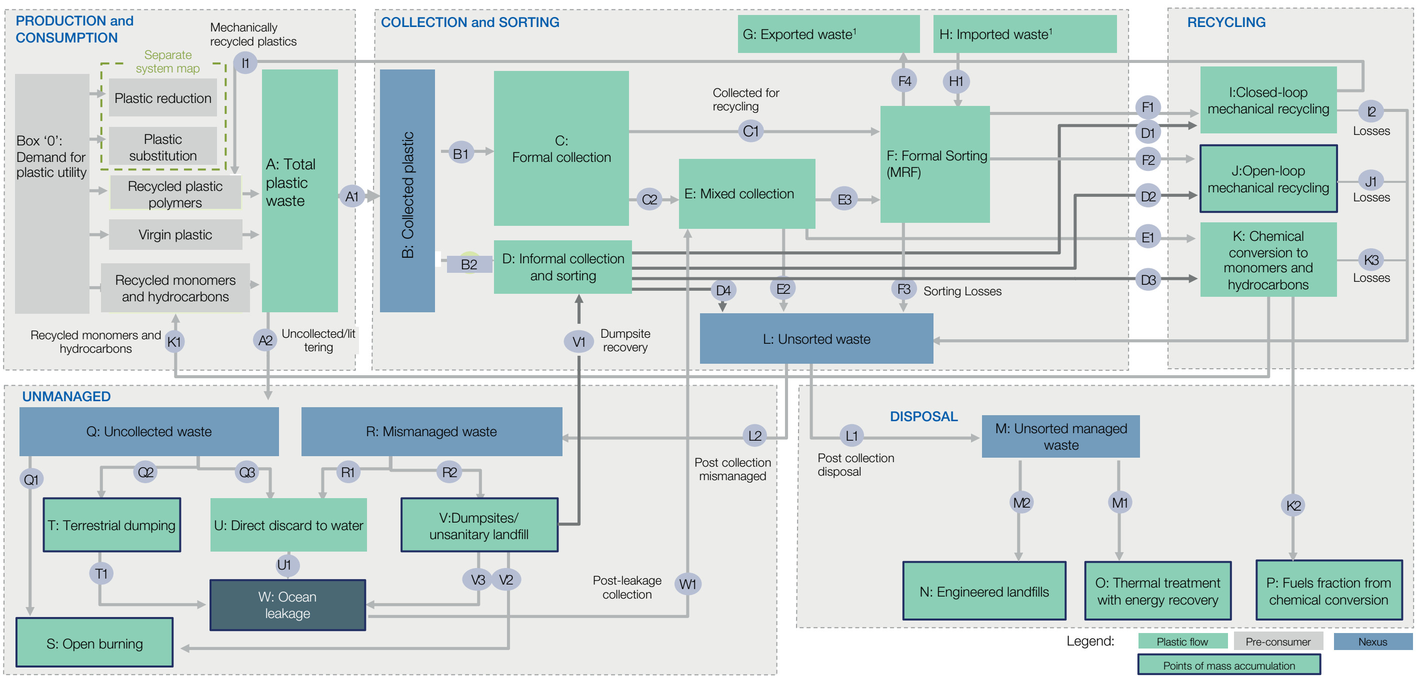
Methodology for scenario analysis

With support from the Indonesia expert panel, the NPAP team has striven to use the most recent and accurate data in compiling this report. It should be pointed out, however, that quality of waste data is often a challenge in Indonesia. To make the report easier to read for a general public, we have chosen to give point estimates, rather than ranges throughout the report. This should not be taken as an indication that the data reported is precise - much work remains to improve waste data accuracy in Indonesia. The NPAP Indonesia scenario analysis methodology is adapted from global research by the Pew Charitable Trusts and SYSTEMIQ and the system model outlined in Figure 15.[83] It was carried out with input from the NPAP Indonesia Expert Panel, the NPAP Indonesia Steering Board, the Indonesian Government and other key stakeholders. Field data from Indonesia was used as much as possible, mostly data reported by local governments, the national government and shared in academic papers. This covered nearly all input. In rare cases where data was not available, assumptions were made based on other sources, such as global data. The analysis result was then verified with the NPAP expert panel.

Secondary data

Population data was obtained from *Biro Pusat Statistik* combined with tonnage and composition data from *Jakstranas* (2017-2018) and *Adipura* (2015). To estimate waste-generation growth, the World Bank *What a Waste 2.0* (2018) formula was used, which uses GDP and population projections.

Figure 15: System map on which the analytical model used in GPAP is based



Source: NPAP Analysis

Growth projection for plastic waste was derived from *Breaking the Plastic Wave* analysis.

The formal (government-run) collection rate was estimated based on the amount of waste transported to landfill or sorted in TPS 3R from *Jakstranas* data (2017-2018). Informal collection was estimated according to several academic papers (such as Putri et al, 2018 and Sasaki et al, 2014) and industry reports for Jakarta and Surabaya. Step-down assumptions for the *Medium* and *Rural* archetypes (i.e. assuming 50% lower than *Mega*) were made as no archetype-specific data on the informal sector was available to us. *Remote* is assumed to not have significant informal-sector activity.

Plastic waste collected by the informal sector and plastic waste sorted by TPS 3R are assumed to go to recycling facilities. The loss rate between plastic collected for recycling and plastic recycled is based on Putri et al (2018). The split between open loop and closed loop mechanical recycling is taken from *Breaking the Plastic Wave* (forthcoming) for lower- and middle-income countries.

The fate (final destination) of plastics that are uncollected was calculated based on the percentage from *Riset Kesehatan Dasar* (2018). The transfer rate for post-collection mismanaged waste to the end destination of plastic waste and the transfer rate for mismanaged plastic waste to different end-of-life destinations is based on *Breaking the Plastic Wave* and the ISWA Plastic Pollution Calculator. Transfer rates are an area in which current data quality is especially poor; we suggest this as an area for further research.

While the study used data at the regency or city level to derive estimates for waste generation and plastic leakage (drawing on population data and national averages), it is important to note that the analysis *cannot* be used to estimate the waste situation in specific regencies or cities. The team was unable to verify data for more than 300 districts and expected data inconsistencies within each individual regency or city. However, the archetype analysis was used to average-out inconsistencies within each archetype and nationally.

Scenario assumptions

The System Change Scenario was modelled on plastic leakage into bodies of water, which is a proxy of plastic into the sea, to achieve a 70% reduction of ocean leakage in 2025 (compared to 2017) and near-zero leakage in 2040. The Reduce and Substitute levers were modelled based on *Breaking the Plastic Wave* (forthcoming) adapted to Indonesia.

The SCS estimates the reduction and substitution percentages for 15 different plastic applications based on three factors:

1. **Evidence for the R&S potential**: Proven examples of reductions in avoidable plastic use from across the world, through voluntary industry action or regulation, checked for applicability in lower- and middle-income countries.

2. **Risk of unintended consequences**: Screening of potential negative impacts on the environment, health and food safety, and society at large; as well as performance, convenience or affordability using a methodology established by a global panel of experts convened for *Breaking the Plastic Wave*. The screening is tested for the Indonesian context using high-volume applications relevant to Indonesia (beverage bottles made from PET, water cups made from polypropylene, single-use plastic carrier bags – typically low-density polyethylene or LDPE – and multilayer sachets for food or cosmetic products). Where risks of negative impacts exceed a threshold level, they are not considered viable opportunities to reduce avoidable plastic use.

3. **Implementation time**: most R&S efforts cannot be implemented overnight, as they require policy change and changes to products and supply chains. The SCS takes this into account by assuming a certain implementation timeframe that depends on the assessments for technological maturity, performance, convenience, and affordability.

The SCS recognizes that the urban archetypes can execute waste management at a lower price per inhabitant than *Rural* and *Remote*, due to scale, population density and the presence of an informal sector. For that reason, the SCS targets full collection rate for *Mega* and *Medium* in 2025.

For *Rural* areas, the SCS targets a 70% collection rate in 2025. The SCS assumes that collection operations cost 10 to 30% more than in *Mega* cities. In the SCS, it is assumed that residents in lower-density areas compost their organic waste locally; waste collection covers inorganic waste only to reduce cost.

Collection costs in *Remote* regencies are assumed to be 40% higher than *Mega* on average. *Remote* is the most diverse of the archetypes, both geographically and culturally. It includes very low-income communities as well as towns centred on oil and gas production or tourism that generate more waste per person than *Mega* cities. Here too the SCS assumes that only inorganics are collected, targeting a 60% collection rate in 2025.

NPAP Expert Panel

The NPAP expert panel has guided the analysis and provided detailed feedback on assumptions used where data is not available. Our stakeholders were drawn from a broad group:

- Government, in particular the Coordinating Ministry of Maritime Affairs and Investment, the Ministry of Environment and Forestry, and the Ministry of Public Works
- Industry, including plastic raw material producers, plastic recyclers, and the consumer goods sector
- Academics
- Non-profits and waste-management practitioners
- The investment community, including development banks

Consultation was done on a continuous basis with individual experts and through convenings of the panel. The panel was convened at three stages of the analysis: (1) Business-as-Usual, (2) System Change Scenario, and (3) after the first draft of action recommendations. Adjustments were made after each panel session based on feedback received. In total, we received more than 200 comments from over 15 parties on this report and held one-on-one meetings with more than 30 organizations.

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Endnotes

1. An early version of this foreword was shared on 20 January 2020 at the Annual Meeting of the World Economic Forum in Davos-Klosters. See: https://www.weforum.org/agenda/2020/01/here-s-how-indonesia-plans-to-tackle-its-plastic-pollution-challenge/.
2. The estimated total plastic-waste generation of 6.8 million tonnes per year requires further research to reconcile with industry production and importation estimates. Further research and action are also required to assess and then reduce plastic pollution from primary microplastics (small plastic particles from sources including textiles, tyre dust and personal care products) and maritime waste (plastic pollution at sea, primarily from shipping and fishing industries).
3. Other major targets are a 30% reduction of waste at source (including recycling) and increasing the volume of managed plastic waste to 70% (Presidential Decree 97/2017). This target builds on existing policy programmes to improve waste management and reduce pollution, such as Jakstranas and Jakstrada, initiated in 2017. In this report, we take "marine plastic debris" to hold the same meaning as "ocean plastic leakage". "Ocean plastic leakage" is part of a broader category we call "mismanaged waste", which includes open burning, dumping on land, official dumpsites and dumping into other bodies of water. Generally speaking, measures that address the root causes of ocean leakage also reduce ocean leakage. The methodology used in this report does not allow us to quantify leakage into oceans specifically, but only "leakage into bodies of water". Deltares and the World Bank are working on a follow-up study (forthcoming), based on NPAP data, that quantifies ocean leakage specifically using hydrological modelling.
4. This research will be published in 2020 as *Breaking the Plastic Wave*. We refer to it in this document as *Breaking the Plastic Wave* (forthcoming).
5. Net plastic scrap imports are equivalent to 3.1% of domestic waste generation; these are generally imports specifically aimed at the recycling industry, which can be expected to have lower leakage rates than domestic plastic waste in general (which is 61% uncollected). We have no data on illegal waste imports, plastic hidden in paper waste imports, which may increase the total import numbers and therefore their environmental leakage. The figure of >95% takes a prudential margin into account. The team estimates that the actual figure is higher.
6. Marine Debris: Understanding, Preventing and Mitigating the Significant Adverse Impacts on Marine and Coastal Biodiversity. *Technical Series No.83*. Secretariat of the Convention on Biological Diversity, Montreal.
7. Rochman, Chelsea M et al. "Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption." *Scientific Reports* vol. 5 14340. 24 September 2015, doi:10.1038/srep14340.
8. An annual average from 2017 to 2025 of total additional households that would need to be served by collection services by 2025 to meet an 84% collection rate, assuming four persons per household.
9. In addition to 18.3 million tonnes of non-plastics, mostly organic material.
10. Figures refer to total municipal solid waste, including non-plastics.
11. Calculated based on INAPLAS & Ministry of Industry, *Plastic flow*, 2019; *Breaking the Plastic Wave* (forthcoming) reports that plastic MSW makes up 64% of total plastic waste worldwide.

12. This report follows the World Bank's definition of municipal solid waste.

13. Based on population data from BPS (*Badan Pusat Statistik*, Indonesia's central statistics agency), aggregated total waste-generation data from Ministry of Environment and Forestry (*Sistem Informasi Pengelolaan Sampah Nasional/SIPSN*), Adipura waste-generation data, and waste composition data from SIPSN.

14. One explanation for the discrepancy between these figures is contamination: the volume that is counted as "plastic MSW" contains more than plastic molecules alone; inevitably, it includes humidity and traces of former use.

15. Euromap; GDP growth was 5% over the same period.

16. This report uses 2017 as the base year. Because the switch from net-exporter to net-importer of plastic waste took place in 2018, we do not include imports in our analytical model. Instead, we treat the subject separately.

17. *Breaking the Plastic Wave* (forthcoming).

18. LIPI (Indonesian Institute of Science) released a baseline number of 0.27-0.59 million tonnes of ocean plastic per year based on early field results in 18 locations collected using stranded beach data collection over a year. This figure was adopted by the National Taskforce on Marine Plastic Debris as a preliminary national baseline in December 2019.

19. Lacking more precise data, the system model assumes that all waste disposal in archetypes *Mega* and *Medium* are landfills and all disposal in archetypes *Rural* and *Remote* are official dumpsites. We assume higher runoffs from dumpsites than from landfills. There is no incineration at scale in Indonesia today. In this report, we assume that official dumpsites are semi-formal disposal facilities; this makes them different from smaller-scale dumping on land by households.

20. For example as waste pickers who work at waste-transfer stations or on landfills to recover plastics that were originally collected by the government.

21. By definition; regencies and cities are allocated to the archetypes *Mega*, *Medium* and the pair *Rural/ Remote* based on population density. The distinction between *Rural* and *Remote* is made based on distance from an urban centre, e.g. a potential recycling hub.

22. This map is based on per-archetype averages for the collection rate and for waste generation per capita; it does not accurately reflect local circumstances.

23. *Marine Debris: Understanding, Preventing and Mitigating the Significant Adverse Impacts on Marine and Coastal Biodiversity*. Technical Series No. 83. Secretariat of the Convention on Biological Diversity, Montreal.

24. Rochman, Chelsea M et al. "Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption." *Scientific Reports* vol. 5 14340. 24 September 2015, doi:10.1038/srep14340.

25. Barreiros, João P., and Violin S. Raykov. "Lethal lesions and amputation caused by plastic debris and fishing gear on the loggerhead turtle Caretta caretta (Linnaeus, 1758). Three case reports from Terceira Island, Azores (NE Atlantic)." *Marine Pollution bulletin* 86, no. 1-2 (2014): 518-522; De Stephanis, R., Giménez, J., Carpinelli, E., Gutierrez-Exposito, C. and Cañadas, A. "As main meal for sperm whales: Plastics debris." *Marine pollution bulletin*, 69(1-2), (2013) pp.206-214.

26. Lavers, J.L., Hutton, I. and Bond, A. "Clinical pathology of plastic ingestion in marine birds and relationships with blood chemistry." *Environmental Science & Technology 53*, 2019: 9224-9231.

27. GESAMP. "*Sources, fate and effects of microplastics in the marine environment: part two of a global assessment*" (Kershaw, P.J., and Rochman, C.M., eds). (IMO/FAO/UNESCO-IOC/UNIDO/WMO/ IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 93, 220 p. (2016).

28. Number for wild fisheries, aquaculture is not included https://globalmarinecommodities.org/en/indonesia-2/.

29. https://www.wttc.org/about/media-centre/press-releases/press-releases/2019/indonesian-travel-and-tourism-growing-twice-as-fast-as-global-average/; BPS data points to a similar number: of 124.5 million employed workers in Indonesia, 11.17% works in tourism sector, which calculates to 14 million.

30. Ratih Indri Hapsari and Mohammad Zenurianto. “View of Flood Disaster Management in Indonesia and the Key Solutions”, *American Journal of Engineering Research*, 5 (3), 140-151. April 2016 http://dibi.bnpb.go.id/.

31. President Joko Widodo commented on the December 2019 / January 2020 Jakarta flood: “Some of the flooding is caused by damage to the ecosystem but it is also a result of our mistakes in disposing of waste everywhere”, “At least 21 dead in Jakarta floods as thousands are evacuated”, *Asian Financial Review*, 2 January 2020

32. This number was calculated using an emission factor from laboratory experiments. Park, Young Koo, Wooram Kim and Young Min Jo. “Release of Harmful Air Pollutants from Open Burning of Domestic Municipal Solid Wastes in a Metropolitan Area of Korea.” Aerosol and Air Quality Research, 2013: 1369.

33. Cogut, A. “Open Burning of Waste: A Global Health Disaster.” R20 Regions of Climate Action, 2016.

34. Exposure to Dioxins and Dioxin-Like Substances: A Major Public Health Concern, who.int; Julvez & Grandjean, 2009.

35. Calculated using an EPA conversion number and *Breaking the Plastic Wave* (forthcoming).

36. GA Circular, *The Role of Gender in Waste Management: Gender Perspectives on Waste in India, Indonesia, The Philippines and Vietnam*, Ocean Conservancy/GA Circular, 2019, 31.

37. Julvez, J. & Grandjean, P. “Neurodevelopmental toxicity risks due to occupational exposure to industrial chemicals during pregnancy.” *Industrial health*, 47 (5), pp.459–468, 2009. Cited in: WECF, Women Engage for a Common Future, Plastics, Gender and the Environment, Utrecht: WECF, 2017; SEA Circular, *Marine plastic litter in East Asian Seas: Gender, human rights and economic dimensions*, UNEP, Cobsea, SEI, 2019.

38. GA Circular, 2019, 36; in addition, Government data for West Jakarta confirm this statement.

39. WIEGO, Violence and Informal Work, Briefing Note, May 2018.

40. GA Circular, 2019, 36.

41. https://www.wiego.org/gender-waste-project.

42. US AID, *Women’s Economic Empowerment and Equality (WE3) Technical Assistance – Municipal Waste Management And Recycling WE3 Gender Analysis Report*, April 2019.

43. Ratih Indri Hapsari and Mohammad Zenurianto, 2016, 30.

44. Direct data about access to waste collection is not available. This number was calculated based on the tonnage of uncollected waste and waste generation per capita in the various regions of Indonesia.

45. https://www.newplasticseconomy.org/assets/doc/Oxo-statement-May2019.pdf and http://standardisasi.menlhk.go.id/index.php/barangjasateknologi-ramah-lingkungan/barang-berlabel-lingkungan/ekolabel-yang-berbasis-sni/. For an overview of the environmental effects of oxo and other materials: Napper, I.E. and Thompson, R.C., 2019. Environmental deterioration of biodegradable, oxo-biodegradable, compostable, and conventional plastic carrier bags in the sea, soil, and open-air over a 3-year period. Environmental science & technology.

46. Ellen MacArthur Foundation, *The New Plastics Economy - Catalysing Action*, 2017, p 36.

47. Calculated as all of Indonesia minus Java and North Sumatra.

48. This projection assumes that Indonesia's waste-management capacity increases to maintain the collection rate and recycling rate at 39% and 10% respectively (as in 2017). We have also calculated an alternative scenario where waste management does not expand (remains at today's size despite growth in waste volumes). In this case waste generation increases from 620 thousand to 870 thousand tonnes per year by 2025 (+41%) and more than doubles to 1.5 million tonnes per year by 2040.
49. This research will be published in 2020 as *Breaking the Plastic Wave*. We refer to it in this document as *Breaking the Plastic Wave* (forthcoming).
50. In addition to 18.3 million tonnes of non-plastics, mostly organic material.
51. The World Bank. 2012. *What a Waste: A Global Review of Solid Waste Management*. Washington, DC 20433 USA.
52. Acceptable coated paper is defined as paper with plastic coating less than 5% weight, or other compostable/water-soluble solutions. This material needs to be acceptable by the current recycling industry, certified in line with international standards.
53. Examples of cooperation and integration between formal and informal could be drawn from the city of Pune, India and various cities in Latin America.
54. Various sources from Adupi.
55. Both road and sea transport are considered viable transport alternatives.
56. The clusters centred on Medan, Pekanbaru, Palembang and Makassar.
57. In addition to 18.3 million tonnes of non-plastics, mostly organic material
58. Dian Andriani, "A Glance at the World: Current Status of Waste Management in Indonesia", *LIPI Working Paper*, January 2015.
59. In the SCS, plastics-to-fuel processing focuses on plastics that are hard to recycle economically (e.g. flexible or multilayer plastics). Plastics-to-fuel recycling is often seen as a stepping stone to plastics-to-plastics chemical recycling since the process to convert plastic waste back to synthetic oil is similar in both cases.
60. Does not include capital investments for informal-sector collection and sorting.
61. Indonesia has updated its solid waste-management funding programme with World Bank support in 2019. At the time of writing, it was too early to assess the results.
62. First method is using the model estimates of collection rate, disposal activities, and the estimated operational cost per tonne; this bottom-up method gave us $0.5 billion per year. The second method looks into government budget items that could be used for waste management and assigned estimated proportion for waste-management activities, such as local (Dana Desa, Dinas Lingkungan Hidup) budgets, and national (PUPR) budgets, etc.; this top-down method gave us the $1 billion per year estimate. It is not possible for the NPAP to provide accurate top-down depiction as departmental responsibilities may overlap between waste management and other sanitation responsibilities. Therefore, we present both numbers as a range while using the modelling exercise consistently for System Change Scenario.
63. The NPAP team was unable to calculate ocean plastics directly and used "leakage into bodies of water" as a proxy.
64. Job creation by improved waste management outweighs potential job losses through reduced waste volumes. The total job creation under the SCS is higher than the direct job creation reported because a number of factors are not included in this number: direct jobs in organic waste management; direct

job creation caused by the "reduce and substitute" transformation (whereas job losses due to lower production are taken into account in the above numbers); indirect jobs that result from the SCS, for example food stalls, which sell more because collection workers have more disposable income, or suppliers of waste bins; sustained employment in fisheries and tourism.

65. *Breaking the Plastic wave* (forthcoming).

66. https://www.thejakartapost.com/news/2019/07/09/after-plastic-indonesia-now-also-returns-contaminated-paper-waste-to-australia.html.

67. Based on 320,000 tonnes of imports in 2018 compared to a little over 1 million tonnes of plastic available for recycling (pre-loss rate) in 2018.

68. Primary microplastics are any plastic fragments or particles that are already 5.0 mm in size or less before entering the environment. These include particles from tyres, clothing, microbeads, and plastic pellets (also known as nurdles).

69. Preliminary findings based on research on four major modelled sources; it does not reflect total microplastic leakage, *Breaking the Plastic Wave* (forthcoming).

70. https://www.theguardian.com/environment/2019/jan/30/eu-european-union-proposes-microplastics-ban-plastic-pollution.

71. https://news.detik.com/berita/d-3442862/baru-13-kota-di-indonesia-yang-miliki-sistem-ipal-berskala-besar.

72. Gilman, E., Chopin, F., Suuronen, P. & Kuemlagen, B. *Abandoned, lost or otherwise discarded fishing gear: Methods to estimate ghost fishing mortality, and the status of regional monitoring and management*. (2016); Huntington, T. *Development of a best practice framework for the management of fishing gear. Part 1: Overview and current status. Global Ghost Gear Initiative*, 2016.

73. https://www.ghostgear.org/projects/2018/10/10/gear-marking-in-indonesian-small-scale-fisheries.

74. Decree 75/2019 of October 2019 by the Minister of the Environment and Forestry

75. In addition to 18.3 million tonnes of non-plastics, mostly organic material.

76. Achieve these reduction targets without lowering the value of plastic waste, such as without changing design to the point where it is no longer a valuable commodity for recycling, e.g. through light-weighting.

77. Review the current green certification of oxo, for instance, to bring Indonesian certification in line with international standards.

78. The Coordinating Ministry of Maritime Affairs and Investment and the Ministries of the Environment and Forestry and of Marine Affairs and Fisheries are examples of ministries that have implemented such guidelines.

79. For example, eco-design incentives could encourage a shift in rigid plastic packaging to transparent (pigment-free) mono-material formats that are more easily recycled into high value products.

80. Currently many packaging designs come from Japan, Europe or North America.

81. Example: Plastic Parks in India.

82. KTP stands for *Kartu Tanda Penduduk*, "Resident Identity Card"; *BPJS* stands for *Badan Penyelenggara Jaminan Sosial*, "Social Security Management Agency", shorthand for the state-run health and old age insurance scheme.

83. This research will be published in 2020 as *Breaking the Plastic Wave*. We refer to it in this document as *Breaking the Plastic Wave* (forthcoming).

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