Asia-Pacific Economic Cooperation

USAID FROM THE AMERICAN PEOPLE

PROMOTING RECYCLABLE MATERIALS POLICIES IN THE ASIA-PACIFIC REGION

A Study of the Policy Landscape in the Asia Pacific Region

ABBREVIATIONS

AI	Artificial Intelligence
AMSD	APEC Marine Sustainable Development
APEC	Asia-Pacific Economic Cooperation
ARCAM	APEC Regulatory Cooperation Advancement Mechanism
ASEAN	Association of Southeast Asian Nations
ASTM	American Society for Testing and Materials
C	Celsius
CAPEX	Capital Expenditure
CDC	Centers for Disease Control and Prevention
CEO	Chief Executive Officer
COVID-19	Coronavirus Disease 2019
CTI	Committee on Trade and Investment
DBS	Development Bank of Singapore
DENR	Department of Environment and Natural Resources
DVD	Digital Versatile Disc
EN	European Standard
EPA	Environmental Protection Administration (Chinese Taipei)
EPR	Extended Producer Responsibility
EPZ	Export Processing Zone
F	Fahrenheit
GIS	Geographic Information System
GNI	Gross National Income
GtCO2e	Gigaton of Equivalent Carbon Dioxide
HDPE	High-Density Polyethylene
HS	Harmonized System
ICT	Information and Communications Technology
ISWM	Integrated Solid Waste Management
kg/m³	Kilogram Per Cubic Meter
kWh	Kilowatt-hour
LDPE	Low-Density Polyethylene
MDVWG	Marine Debris Virtual Working Group
ml/g	Milliliters Per Gram
mm	Millimeter
MRF	Materials Recovery Facility
MW	Megawatt
Mwh	Megawatt-hour
NGO	Nongovernmental Organization
NIMBY	Not In My Backyard
OFWG	Oceans and Fisheries Working Group
OSHA	Occupational Safety and Health Administration
P	Peso (Philippines)
PA	Polyamide
PET	Polyethylene Terephthalate
PNG	Papua New Guinea

PP	Polypropylene
ppm	Parts Per Million
PPP	Public-Private Partnership
PS	Polystyrene
PVC	Polyvinyl Chloride
rHDPE	Recycled High Density Polyethylene
RM	Malaysian Ringgit
RMPP	Recyclable Materials Policy Program
Rp	Rupiah (Indonesia)
rPET	Recycled Polyethylene Terephthalate
SEZ	Special Economic Zone
SME	Small and Medium Enterprise
SMM	Sustainable Material Management
SOM	Senior Officials' Meeting (APEC)
THB	Thai Baht
UN	United Nations
US$	United States Dollar
USAID	United States Agency for International Development
VWG	Virtual Working Group
WMR	Waste Management and Recycling
WtE	Waste-to-Energy

CONTENTS

EXECUTIVE SUMMARY

Solid waste pollution, including marine litter and ocean plastic, is an escalating global problem and members of the Asia-Pacific Economic Cooperation (APEC) have acknowledged that there is a clear need for a coordinated vision and long-term strategy to manage and mitigate this problem. Using APEC's convening power to drive regional actions and policy responses, APEC members endorsed the Roadmap on Marine Debris in 2019,[1] providing a sound framework to support collective efforts on marine litter and ocean plastics under several APEC fora.

Plastic waste accounts for 80 percent of all marine litter[2]. The World Bank Group estimates that 80 percent of marine litter originates from land-based sources, and are caused by inadequate waste disposal and management systems, sewage overflows, industrial activities, construction and urban and storm-water run-off[3]. The sudden increase in single-use plastics during COVID-19 has also contributed greatly to the stress on the region to tackle marine plastic litter. A recent study[4] estimates that 129 billion face masks and 65 billion plastic gloves are used and disposed of each month since the pandemic began.

Ocean plastic pollution and marine litter need sustainable regional solutions. APEC members' enhanced efforts at finding sustainable solutions to address the increased challenge of managing marine litter and ocean plastic pollution, is appropriately timed. Indeed, the cost of inaction far outweighs the benefits of tailored investments in the waste management, recycling, and treatment industries. Such investments offer opportunities for APEC members to coordinate and align efforts with other regional organizations including the Association of Southeast Asian Nations (ASEAN); multilateral agencies including the World Bank Group; various United Nations (UN) agencies as well as other nongovernmental and industry associations.

This study is a key deliverable under the United States led APEC Recyclable Materials Policy Program (RMPP) and its aim is to map out key waste management and recycling trends and opportunities in APEC economies across a range of areas: policy aspects, private investment, and innovative solutions for recycling infrastructure. The study also presents a selection of case studies from APEC economies which are categorized under four areas (1) policies and regulation, (2) private sector engagement, (3) attracting investment, and (4) enforcement. Of particular relevance for APEC members are examples of effective legislative and regulatory reforms undertaken and innovative practices adopted by economies.

The survey findings indicate that APEC economies have implemented a range of measures, including policy, regulatory and non-regulatory instruments, to manage solid waste pollution. These include policy white papers, frameworks and master plans including new Integrated Solid Waste Management plans and Extended Producer Responsibility (EPR) mechanisms. This study also showcases practical and tailored fiscal instruments that can be used effectively to support new recycling and waste treatment processes.

---

[1] Asia-Pacific Economic Cooperation, "APEC Roadmap on Marine Debris: Third Senior Officials' Meeting," August 29-30, 2019, available online.
[2] Olha Krushelnytska, *Solving Marine Pollution: Successful Models to Reduce Wastewater, Agricultural Runoff, and Marine Litter*, Washington, DC: World Bank Group, September 2018, available online.
[3] Ibid.
[4] Tadele Assefa Aragaw and Bassazin Ayalew Mekonnen, "Current Plastics Pollution Threats Due to COVID-19 and Its Possible Mitigation Techniques: A Waste-to-Energy Conversion via Pyrolysis," *Environmental Systems Research* 10, no. 8 (2021): pp.1-11, available online.

This information is useful for economies to develop appropriate programs and policy directions for attracting prospective investors in the waste management and recycling value chains. This can also support efforts to create viable and effective enabling policy environments which can guide public utilities in developing robust burden-sharing arrangements with the private sector.

The case studies included in this report underscore how the future of waste management and recycling value chains is in innovative digital solutions that can efficiently guide service provision and technology application. For example, assisting a public authority and investor to find common ground on the definition and classification of a proposed WMR business or increasing transparency in the trade of waste and scrap commodities using blockchain, e-payments, and geographic information system (GIS) instruments, are such approaches.

As a premier regional multilateral organization which covers 21 economies in the Asia Pacific region, APEC member economies have the ability to harness the entrepreneurial potential in waste management and recycling (WMR) value chains and promote innovation through stronger definitions and materials quality standards in the recycling industry. Inaction or business-as-usual approaches will carry substantial political and economic consequences. The report places emphasis on supporting more dynamic regulatory and legislative frameworks that can help incentivize private sector engagement, attract investment, and ensure effective enforcement to guide recycling efforts. The analysis can also be used to identify areas for future collaboration.

The report's recommendations detailed below are aimed at supporting practical, tangible and actionable solutions to facilitate the adoption of sustainable WMR approaches which harness the entrepreneurship and innovation that resides in the region.

RECOMMENDATIONS:

1. **Based on the information contained in this report and leveraging existing knowledge and practices, develop a list of practices and technologies that can drive robust policy responses to support cutting-edge, innovative recycling and recovery practices in WMR value chains in the Asia Pacific region[5].**

The limited application of existing knowledge, best practices and financing efforts to support cutting-edge and innovative WMR practices, risks undermining the entrepreneurial potential of APEC members. To address this, increasing members' awareness through knowledge sharing of emerging innovative recycling and recovery policies and practices can drive appropriate policy and investment decisions in the Asia Pacific region.

A dynamic and discretionary approach may be employed by economies to adopt emerging and innovative waste management, recycling and treatment applications being pioneered in some contexts. For example, advanced forms of food contact grade / bottle-to-bottle recycling processes to produce recycled polyethylene terephthalate (rPET) and recycled high density polyethylene (rHDPE), could be solutions that

[5] The information contained in this report focuses on basic, long-standing WMR practices and technologies which can inform practices in the various APEC economies and be adopted based on context specific needs.

can provide economies with potentially viable opportunities to further invest in sustainable non-virgin petrochemical manufacturing. However, this nascent approach has not yet been considered widely across APEC member economies by food-grade certification authorities due to a host of reasons - including the lack of technical knowledge of emerging technologies and limited policy direction to support such practices. An enhanced understanding of risks, cutting edge, innovative recycling and recovery solutions such as this, could enable APEC economies to take further steps to increase non-virgin polymer usage across fast moving consumer goods value chains and food contract packaging.

The adoption of such practices should be underpinned by appropriate public policy and robust governance arrangements. For example, a coordinated approach to the development and implementation of government policy responses that recognize recyclers who are operating clean and safe technologies in the WMR value chain, is needed. In addition, further recognition and support for new innovations through targeted information sharing, branding and marketing campaigns will also help to manage the misplaced "not in my back yard" (NIMBY) sentiments from the public.

2. Promote clearer materials quality standards for plastics, paper, and organics.

One of the key recommendations of this report is for APEC members to promote the establishment of transparent, consistent and comprehensive recycled material standards by driving a suite of legislative, voluntary and industry led policy initiatives which leverage best practice examples from existing regional and global frameworks.

While acknowledging voluntary and other standards that are already out there, and also considering challenges involving plastic standardization (such as the use of various plasticizers and other proprietary inclusions) exploring ways of developing approaches to support a practical, informed, and dynamic set of quality standards for recyclable commodities is essential to foster industries' efforts in this space. Transferring these quality standards to all plastics—most notably, opaque plastics and plastics that have been manufactured using fillers like calcium carbonate—is also an approach that can be adopted to enhance waste recycling rates in APEC economies.

3. Improve the financial sustainability of WMR investments by improving ways of securing public expenditure.

Waste management efforts suffer from chronic underinvestment in infrastructure and underfunding for collection services in developing economies. This is mainly at the municipal level. There are also capital expenditure needs of waste management and recycling infrastructure in developing economies which are twin challenges to be addressed to improve sustainable WMR practices.

The challenges with securing ongoing recurrent and operating expenditures at the municipal level to ensure the long-term sustainability of new WMR infrastructure investments supported under public-private partnerships is a critical challenge facing developing economies. As this capital expenditures / operating expenditures (CAPEX/OPEX) [6] disconnect often occurs at the municipal level, broader coordination between domestic, regional, and local authorities on both pipeline and active public-private partnerships could help mitigate funding shortfalls for key infrastructural assets.

---

[6] CAPEX (Capital Expenditure); OPEX (Operational Expenses)

A popular mechanism to help local authorities sustain the costs of domestically financed infrastructural development is to grant them the authority to 'ring-fence[7]' revenue collected locally (e.g., property rates, local taxes, environmental fees, and levies) for expenditure on relevant environmental planning expenses. Ring fencing is particularly important where standard recycling business models cannot support sustainable solid waste collection or recycling services based on user fees alone. For example, in island economies, remote tourist destinations, or smaller economies where the economies of scale do not lend themselves to strong private sector engagement and investment, the absence of public subsidies for operational expenses can often lead to a significant dearth of effective recycling services. Because properties and activities frequented by tourists generally tend to produce large amounts of single-use plastics and nonrecyclable waste, and these tourist locations are normally far away from industrial cities or commercial centers, the costs of extracting the recyclables and forwarding them to relevant markets can become prohibitive. Further, this type of initiative could be implemented alongside EPR schemes to provide a regulatory clarity on the responsibility within waste producers and WMR actors on solution design, development and implementation.

4. **Develop one-stop-shop agencies in economies to coordinate investments and public-private partnerships to support WMR.**

Explore the potential benefits of establishing "one-stop shops" to facilitate a practical approach to implement more conducive definitions, materials quality standards, and tailored subsidy instruments. The importance of a solution of this nature for the Asia Pacific region cannot be understated. By aggregating relevant governmental standards and enforcement authorities under the same roof to facilitate effective and timely intragovernmental coordination and to streamline approval processes for prospective and active public-private partnerships, the one-stop-shop investment model can be perceived as the so-called silver bullet of investment incentives. For example, in the Philippines, a Public-Private Partnerships Center, which serves as a central coordinating and monitoring agency for all public-private partnership projects, has facilitated 17 waste management public-private partnership projects as of 2017.

5. **Explore the potential of digital solutions to support effective waste management services, enforcement mechanisms, and quality control.**

The research undertaken as part of this study indicates that the future of effective waste management services, enforcement and quality control lies in innovative digital solutions.

The study highlights several examples of cutting-edge solutions that can be adopted and replicated in APEC economies. There is considerable potential in promoting initiatives that can help the integration of appropriate digital solutions to improve WMR. Supporting economies to integrate digital solutions into WMR service provision, compliance, enforcement, and quality control can lead to substantial transparency and efficiency gains in public and privately derived services. Whether through the integration of basic GIS tracking services for transport and route planning or the indexing of commodity prices on a public, digital, mobile app to realize greater inclusivity in WMR value chains, the benefits of digital integration in the WMR supply chain are clear.

---

[7] Ring-fence is referring to formal guarantee that funds allocated for a particular purpose will not be spent on anything else.

6. Support new policy, legislative and regulatory developments

Over half a dozen respondents noted they are currently or imminently planning to launch substantial legislative and regulatory updates or reviews related to waste management and recycling approaches. APEC members should invest in knowledge sharing initiatives between developed and developing economies and the provision of targeted technical assistance.

INTRODUCTION

Solid waste pollution, including marine litter and ocean plastic, is an escalating problem globally with the volume of plastics entering the ocean expected to triple by 2040. The Asia-Pacific region has been identified as a region of concern for marine litter due to significant volumes of mismanaged solid waste and an extensive coastline supporting large populations that depend on the marine ecosystem for livelihood generation[8]. The scale and speed of the urban industrial transformation of the Asia Pacific region as well as population growth in the region have contributed to high levels of solid waste generation. Recent studies indicate that, should marine litter continue at the current rates, the damage to the marine economy in the APEC region by the year 2050 will be US$216 billion[9].

Marine litter can have significant adverse social, health and environmental impacts. In contexts where solid waste is inefficiently managed, spillover effects on many other sectors of the economy are observed. Such impacts can result in the degradation of natural marine environments which threaten marine mammals, fish and seabirds as it can break down into microplastics and nano plastic particles which contain harmful chemicals that can lodge inside tissues of marine organisms consumed by humans[10,11]. Marine litter can also impact economic growth and livelihoods as a result of damages caused to tourism potential, fishing, shipping and other environmentally dependent industries.

Solid waste is typically generated and managed locally. Successful WMR systems are underpinned by robust policy frameworks that facilitate the implementation of environmentally sound practices and technologies, define waste and recyclable materials, provide for dynamic and functional secondary materials markets, and encourage WMR infrastructure development through investment facilitation including public-private partnerships. Such policy environments enable more recyclable materials across the Asia-Pacific region to be effectively recovered, recycled and reused. Unfortunately, supporting sustainable WMR is a challenge - particularly in developing economies. This is due to the increasing generation of waste, the high costs associated with waste management, municipal operational budgetary constraints, capacity limitations, as well as public policy coordination and governance issues which have led to problems of solid waste management services across the world.

Building on the work of the Sustainable Material Management Program (SMMP) supported under the APEC Regulatory Cooperation Advancement Mechanism (ARCAM)[12] , the Recyclable Materials Policy Program (RMPP) led by the United States, aims to strengthen the capacity of economies to identify and

---

[8] United Nations Environment Program, "From Pollution to Solution: A Global Assessment of Marine Litter and Plastic Pollution," 2021, available online.
[9] A. McIlgorm, K. Raubenheimer, and D. E. McIlgorm, *Update of 2009 APEC report on Economic Costs of Marine Debris to APEC Economies*, A report to the APEC Ocean and Fisheries Working Group by the Australian National Centre for Ocean Resources and Security (ANCORS), University of Wollongong, Australia, December 2020, available online.
[10] Philip J. Landrigan et al., "Human Health and Ocean Pollution," *Annals of Global Health* 86, no. 1 (2020): pp. 151, available online.
[11] Some studies indicate that the impact of marine litter and, in particular, microplastics and nanoplastics, on human health is still largely debated and much more focused research needs to be undertaken to address this issue. Refer to Luisa Galgani et al., "Editorial: Impacts of Marine Litter," *Frontiers in Marine Science* 6 (2019), available online.
[12] ARCAM was designed as a mechanism to develop an understanding of emerging regulatory issues to promote robust regulatory objectives and trade and investment flows in APEC economies.

develop domestic policies that foster WMR infrastructure, address barriers to trade and expand markets for recyclable materials while respecting respective economies' domestic laws and regulations. RMPP focuses on four policy areas (1) support for environmental regulation; (2) survey of existing practice in identifying and processing of waste and recyclable materials; (3) international materials quality and processing health and safety standards; and (4) enabling policies for recycling infrastructure investments (including public-private partnerships). Key deliverables under this program include this analytical study as well as policy resource guides based on case studies focusing on solutions from across the Asia-Pacific region.

The analysis was conducted by an independent waste management technical expert. The report presents primary and secondary data on existing policy and regulatory environments and best practices that are appropriate for the scale, scope, and context of member economies, and reflective of appropriate ways to address economies' domestic waste management and recycling challenges. This includes various standards of best practice and prospective investments that are viable and attainable across the region. The report also helps to shed light on the emerging practices of environmental regulation; definitions for standard and cutting-edge waste recovery practices; occupational health and safety standards across the waste management and recycling sector; and enabling policies to support recycling infrastructure investment including public-private partnerships.

This report aims to facilitate discussions among members on domestic strategies and relevant policies that enable sustainable investments in WMR infrastructure, and develop appropriate policy responses to support these strategies. APEC economies should also be able to effectively leverage the information and lessons contained in this report to improve existing policy frameworks and practices and examine potential areas for collaboration.

APPROACH AND METHODOLOGY

The study employed an in-depth survey distributed to all APEC members via email to collect up to date information on policy frameworks and processes in APEC economies. The survey focused on gathering primary data and context specific information relating to the following four core policy areas of RMPP.

- *The regulatory, legislative, and policy framework of each economy*, including white papers, masterplans, integrated solid waste management planning, Extended Producer Responsibility (EPR) initiatives, and planned/prospective "pipeline" legislative efforts that were underway. The economy-level information gathered was limited to the central government levels.
- *Private sector engagement*, including through: the recognition of the informal sector including waste pickers; investment facilitation; grant financing and tax incentives for investments in recycling services; licensing, training, and quality monitoring requirements for private companies engaging in the recycling or recovery of electronic waste, including by updating and harmonizing the classification of electronic waste products to enable consolidation and recovery of critical materials therein;
- *Attracting and promoting investment*, including through: large infrastructural and/or public-private partnerships, investments (including materials recovery facilities, chemical recycling facilities, waste-to-energy, composting, carbon trading); trade facilitative policies (including foreign ownership, tax waivers, export or special economic zones); and public subsidies and investments (including through cross-subsidization and tariff ring-fencing).

- *Enforcement*, including through: licensing and certification requirements (for general and hazardous waste types); fines, fees, and penalties for improper waste disposal (for general and hazardous waste types); and specific understanding of the management, disposal, and enforcement of investors or operators, who handle electrical and electronic waste.

In addition to information collated via the survey, the research also drew heavily on APEC's past work along with desktop research of "real world" examples and case studies of business and industry activity in various economies. The original survey is included in Appendix A. It is expected that qualitative data from stakeholder consultations—both in terms of the content of case studies used in this research and issues raised by stakeholders- could provide a sound basis for future research.

APEC CONTEXT

Acknowledging the extent of the challenge posed by ineffective and inefficient solid waste management infrastructure and the great socio-economic and environmental costs associated with marine litter and pollution, APEC members have focused on increasing cooperation and collective efforts to address this problem at the regional level. In 2010 APEC members committed via the Paracas Action Agenda to "reduce both sea and land-based sources of marine pollution and marine litter, both domestically and regionally" and also "support greater efforts towards regional cooperation to prevent and combat marine pollution in cases of emergency"[13]. The 2014 APEC Ocean-related Ministerial Meeting in Xiamen (the Xiamen Ministerial Declaration) was also instrumental in providing a framework for members to "promote cooperation on the reduction and mitigation of marine pollution, including from land-based sources"[14]. More recently, in 2019, APEC members endorsed the APEC Roadmap on Marine Debris to encourage a "consolidated approach by driving policy development and coordination at every level" to foster research and innovation, share best practices and lessons learned, and increase access to finance and facilitating private sector engagement to promote investment, trade and market creation in industries and activities that enable marine litter management and prevention"[15].

Addressing key challenges and opportunities regarding marine litter has been an area of focus for APEC members for a number of years and supported under a range of APEC fora. For example, the APEC members' Virtual Working Group (VWG) on Marine Debris[16], formed in 2014 by the Chemical Dialogue (CD) in collaboration with the Oceans and Fisheries Working Group (OFWG), works widely to develop market innovative solutions to address the issue of marine litter with a specific focus on innovations in land-based solid waste management to prevent litter from entering the ocean.

As mentioned earlier, research conducted as part of this study covers a range of documents, programs, and initiatives that APEC members have launched in recent years that recognize the marine litter challenge. Several programs have been delivered under the APEC Committee on Trade and Investment (CTI) and the OFWG**.** These are summarized below.

---

[13] Asia-Pacific Economic Cooperation, "APEC Paracas Declaration and Paracas Action Agenda," October 10-11, 2010, available online.
[14] Asia-Pacific Economic Cooperation, "Fourth APEC Ocean-Related Ministerial Meeting (AOMM4): Towards New Partnership through Ocean Cooperation in the Asia Pacific Region," August 28, 2014, available online.
[15] Asia-Pacific Economic Cooperation, "APEC Roadmap on Marine Debris.
[16] Asia-Pacific Economic Cooperation, "The Virtual Working Group on Marine Debris," available online.

The Committee on Trade and Investment

In APEC, the Committee on Trade and Investment (CTI) is mandated to reduce impediments to business activity in the areas outlined by the Osaka Action Agenda, with the objective of promoting free and open trade and investment, including for recyclables and other commodities that have been recovered from waste streams. Efforts to facilitate trade and investment in sustainable material management (SMM) solutions have been supported under CTI's APEC Regulatory Cooperation Advancement Mechanism (ARCAM) initiative. CTI and its sub-fora including the Chemical Dialog and the Sub-Committee on Standards and Conformance (SCSC) are mandated to support issues around standards and harmonization.

Oceans and Fisheries Working Group

The APEC Oceans and Fisheries Working Group (OFWG) supports APEC's work to foster sustainable economic growth, development, and prosperity in the Asia-Pacific region. The forum works to facilitate free and open trade in the region and promotes the sustainable use of fisheries, aquaculture, and marine ecosystem resources and related goods and services, and is actively working in relevant areas on marine litter management. Notable initiatives supported under the OFWG include:

- The 2019 APEC members endorsed the Republic of Korea-sponsored 'Workshop's Recommendation for a Draft on APEC Marine Debris Management Guideline,' which informed the development of a Roadmap on Marine Debris.[17] The OFWG also developed an Implementation Plan for the Roadmap on Marine Debris that is updated annually to guide and track implementation of the Roadmap.
- The Global Marine Debris Monitoring and Modeling in Indonesia.[18]
- The APEC workshop on marine debris and microplastics and the workshop on sustainable development of marine resources in Puerto Varas in 2019.[19] This project proposed a Blue Citizenship Initiative to raise the awareness of various stakeholders to translate ideas into practical actions, thus contributing to reversing the marine environment degradation.
- The OFWG is also currently supporting two initiatives led by Japan and Viet Nam. These are: the Good Practice and Innovative Workshop for Marine Debris Prevention and Management in the APEC Region (led by Japan)[20] and Promoting APEC Innovative Models in Reducing and Managing Land-based Debris into Oceans for Sustainable Development (led by Viet Nam).[21]

A list of relevant APEC initiatives is included in Appendix F.

---

[17] Asia-Pacific Economic Cooperation, "APEC Roadmap on Marine Debris."
[18] APEC Oceans and Fisheries Working Group, "Capacity Building on Global Marine Debris Monitoring and Modeling: Supports Protection of the Marine Environment," February 18–20, 2020, available online.
[19] APEC Oceans and Fisheries Working Group, "APEC Workshop on Marine Debris and Microplastics: Blue Citizenship," APEC Projects Database, 2019, available online.
[20] APEC Oceans and Fisheries Working Group, "Good Practice and Innovative Workshop for Marine Debris Prevention and Management in the APEC Region," OFWG 02 2019A Project Update, October 20, 2019, available online.
[21] APEC Oceans and Fisheries Working Group, "Promoting APEC Innovative Models in Reducing and Managing Land-based Debris into Oceans for Sustainable Development," APEC Project Database, 2019, available online.

REGIONAL AND MULTILATERAL CONTEXT

APEC members' policy directions on waste management and recycling of solid waste, complement efforts progressed by other regional and global organizations including ASEAN, the Pacific Regional Environmental Program (SPREP), as well as UN and other multilateral agencies such as UNEPs Global Partnership on Marine Litter (GPML) and the Global Recycled Standard (GRS).

1. The Association of Southeast Asian Nations (ASEAN)

ASEAN members (Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam) have taken notable action to promote economic, political, and environmental efforts to address the marine litter challenge. Underpinned by the ASEAN Framework of Action on Marine Debris, the regional group developed recommendations from the ASEAN Conference on Reducing Marine Debris in the ASEAN Region in Phuket in November 2017, considering the East Asia Summit (EAS) Conference on Combating Marine Plastic Debris in Bali in September 2017[22].

More recently, ASEAN launched the Bangkok Declaration on Combating Marine Plastic Debris in the ASEAN Region, adopted by members in June 2019, during Thailand's chairing of ASEAN. This was followed by members endorsing the ASEAN Regional Action Plan for Combating Marine Debris, which seeks to promote an integrated approach to address marine plastic pollution in the ASEAN region over the next five years (2021–2025). The implementation of the action plan will be managed through 14 regional actions at three key stages of the value chain: (1) reduce inputs into the system; (2) enhance collection and minimize leakage; and (3) create value for waste reuse[23].

2. The Pacific Regional Environment Program (PREP)

The Secretariat of the Pacific Regional Environment Program (SPREP) is responsible for regional coordination and the delivery of waste management and pollution control action in line with the organization's strategic framework "Cleaner Pacific 2025" that guides regional cooperation and collaboration. The framework is based on the four goals of preventing waste and pollution, recovering resources from wastes and pollutants, improving management of recyclable items and improving monitoring of the impact of poor waste and pollution management on local environments[24].

3. The Global Partnership on Marine Litter (GPML)

The Global Partnership on Marine Litter (GPML) is a multi-stakeholder partnership that aims to brings together all actors working to address marine litter and plastic pollution, including government, scientific and technology community and academia, private sector, NGO's, private citizens and more. The GPML aims to reduce the leakage of plastics into the ocean through improved design, application of the '3Rs'

---

[22] Association of Southeast Asian Nations, "ASEAN Framework of Action on Marine Debris," June 22, 2019, available online.
[23] Association of Southeast Asian Nations, "Launch of the ASEAN Regional Action Plan for Combating Marine Debris in the ASEAN Member States (2021-2025)," May 28, 2021, available online.
[24] Secretariat of the Pacific Regional Environment Program, "Historic First Steps Towards A Cleaner Pacific," July 16, 2015, available online.

principle (reduce, re-use, recycle), encouraging 'closed-loop' systems and circular production cycles; maximization of resource efficiency and minimization of waste generation[25].

4. Global Recycled Standard (GRS)

The Global Recycled Standard (GRS) is a voluntary product standard for tracking and verifying the content of recycled materials in a final product. The standard applies to full supply chain and addresses traceability, environmental principles, social requirements, chemical content and labeling[26].

In addition to the programs mentioned above legal efforts have been pursued at international levels to address marine pollution. A summary of notable examples includes the following: 1972 Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter (or the London Convention), the 1996 Protocol to the London Convention (the London Protocol), and the 1978 Protocol to the International Convention for the Prevention of Pollution from Ships (MARPOL). However, compliance with these legal frameworks can be improved[27].

[25] Global Partnership on Marine Litter (GPML), available online,

[27] International Union for the Conservation of Nature (IUCN), "Issues Brief: Marine Plastic Pollution," published May 2018, updated November 2021, available online.

THE PROBLEM

THE ENVIRONMENTAL, HEALTH AND SOCIO-ECONOMIC IMPACTS

The overall utility of plastics is clear in terms of reducing food waste, improving the durability of food related products, and enabling affordable access to a wide array of everyday products. However, the negative impacts caused by the excessive and unnecessary use of plastic, improper disposal, and leakage into the environment, could outweigh the positive benefits. If we are to protect our rivers, oceans, and ecosystems for future generations, the leakage into our environment and oceans need to be managed. It is estimated that the amount of plastic pollution in our oceans could already be as high as 150 million metric tons. More than 800 marine species are known to be negatively affected by plastic pollution.[28]

In addition to growing concern about the impacts of pollution caused by plastic waste on the oceans, ecosystems, and human health, its contribution to global greenhouse gas emissions and climate change is also of growing concern. Plastic refining is among the most greenhouse gas intensive industries in the manufacturing sector and it is growing fast. The manufacturing of plastic is both energy intense and emissions intensive, producing significant emissions through the cracking of gases and oil-based raw material. Today, annual greenhouse gas emissions from plastic manufacturing are the equivalent to the emissions of 189 coal plants. This figure is growing and is expected to reach the equivalent of 615 coal plants by 2050.[29] Improving the uptake and quality of recycled content in plastic manufacturing not only reduces the need for virgin plastic input; but also reduces emissions and waste from virgin plastic production. In addition to this, at the other end of the lifecycle, the uncontrolled burning of waste, including plastics, is also a major contributor to greenhouse gas emissions, with some sources reporting that this accounts for up to 10 percent of global emissions. This is estimated as being equivalent to an estimated 1 gigaton of equivalent carbon dioxide (GtCO2e) of greenhouse gases, a figure expected to grow to 2.1 GtCO2e under a business-as-usual scenario.[30] Burning plastic waste also creates particulate and persistent organic pollutant (POPs) emissions that are highly polluting[31]. Incineration without emissions control can lead to extremely high GHG emissions, which strengthens the case for promoting effective recycling policies and initiatives.

Plastic pollution also burdens fragile systems of urban drainage in developing economies contributing to flooding that have other negative impacts. Flows of plastic waste, including microplastic, and microbeads, into oceans, and the risk of ingestion by living organisms, including human beings, has received global attention.

---

[28] The Pew Charitable Trusts and SYSTEMIQ, "Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution," July 23, 2020, available online.
[29] Sandra Laville, "Single-Use Plastics A Serious Climate Change Hazard, Study Warns," *The Guardian*, 2019, available online.
[30] The Pew Charitable Trusts and SYSTEMIQ, "Breaking the Plastic Wave."
[31] POPs are a set of toxic chemicals that are persistent in the environment and able to last for several years before breaking down. POPs are highly toxic and can negatively affect humans, plant and animal species and natural ecosystems both in close proximity and at significant distances away from the original source of discharge. (ENP, more can be found online).

Poorly managed waste has been shown to impact tourism potential and lost workdays resulting from poor health outcomes.[32] The impact of discarded product packaging washing up on beaches around the world is likely to be increasingly damaging to economies that rely on coastal tourism, and there is an important role for businesses to spearhead cutting edge and sustainable initiatives to reduce plastic use or to maximize the uptake of recycled plastics in their manufacturing processes.

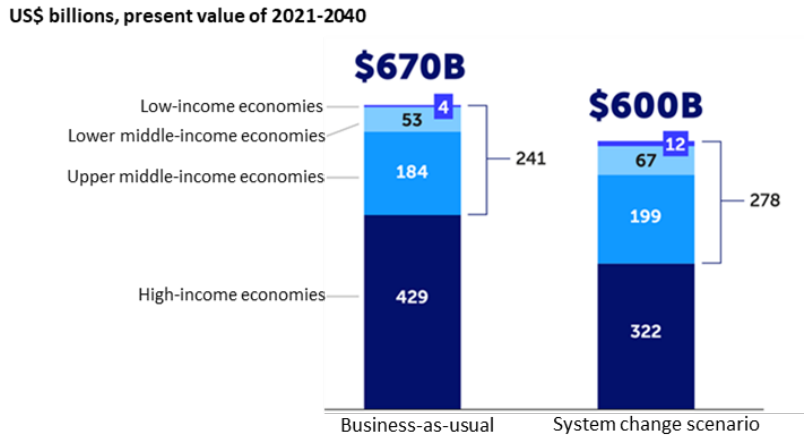
In APEC economies, the plastic waste management challenge is directly related to marine plastic litter, which has proven to have devastating impacts on economic activities related to the marine environment such as fishing and tourism.[33] It is also closely linked with limitations involving existing solid waste infrastructure. The World Bank Group estimates that 80 percent of marine litter originates from land-based sources such as mismanaged dumps and landfills, stormwater discharge, sewage, industrial facilities, and coastal tourism. Notably, solid waste pollution may also be transported from inland rivers.[34] And, while the litter washed up or strewn on beaches and trapped in ocean gyres captures the public's attention, it represents only 5 percent of annual ocean plastic pollution inflows. The vast majority of plastic pollution in the marine environment lies beneath the surface, making it challenging to locate and access and, as a result, much more expensive to clean up.[35]

It is crucial to address plastics as a specific category within the broader solid waste pollution spectrum. This is due to the significant impact of plastic pollution on the environment and potentially on human health[36], and also because the solution to reducing plastic waste lies in the implementation of circular economy models. One study estimates that the costs associated with a business-as-usual approach to ocean-based plastic consumer waste pollution will lead to losses of US$70 billion between 2021 and 2040, including revenue losses to fisheries, aquaculture, and marine tourism industries—in addition to the cost of cleaning up litter on beaches.[37] A separate study puts the economic damage at US$13 billion annually.[38]

---

[32] Navarro Ferronato and Vincenzo Torretta, "Waste Mismanagement in Developing Countries: A Review of Global Issues," *International Journal of Environmental Research and Public Health* 16, no. 6 (2019): pp. 1060, available online.
[33] A. McIlgorm et al., *Update of 2009 APEC report*.
[34] Olha Krushelnytska, *Solving Marine Pollution*.
[35] Musau Zipporah, "Plastics Pose Biggest Threat to Oceans," *Africa Renewal* (United Nations), May-July, 2017, available online.
[36] Studies have linked human consumption of marine animals that have ingested plastics and microplastics with toxin absorption, however, the impact of marine litter and, in particular, microplastics and nanoplastics, on human health is still largely debated and much more focused research needs to be undertaken to address this issue. Refer to - Luisa Galgani et al., "Editorial: Impacts of Marine Litter," *Frontiers in Marine Science* 6 (April 26, 2019), available online.
[37] Krushelnytska, *Solving Marine Pollution*.
[38] United Nations Environmental Program, "Plastic Waste Causes Financial Damage of US$13 Billion to Marine Ecosystems Each Year as Concern Grows over Microplastics," June 23, 2014, available online.

Figure 1: Difference between a Business-as-Usual and System Change Scenario



Source: The Pew Charitable Trusts and SYSTEMIQ (2020).

Note: Economic data may differ with APEC members.

Regionally, the annual economic impacts caused by plastic waste pollution costs the tourism, fishing, and shipping sectors of the Asia-Pacific region US$10.8 billion[39], while the costs of cleanup and lost revenue from plastic pollution that ends up on beaches, coasts and marine environments in Europe is estimated at 630 million Euros per year.[40] Plastics are a particularly ubiquitous and persistent form of marine pollution with contamination levels rising drastically on beaches, the seafloor, and in coastal and oceanic waters. While research on ocean plastics and marine litter is far from complete and the understanding of the process involved in the transformation of macro plastics to microplastics is limited; it has been assumed that the ratio of the mass of polymer waste in the oceans to the mass of its fish stocks will reach 1:3 by 2025. If this trend continues, the polymer waste to fish stock ratio will increase to 1:1 by 2050[41]. Such examples indicate the urgent need for further research and analysis in this area. Waste management practitioners and governments will be limited in their ability to implement effective initiatives to address the problem of waste plastics without sound data and clear measurement, but some actions can be undertaken while research continues.

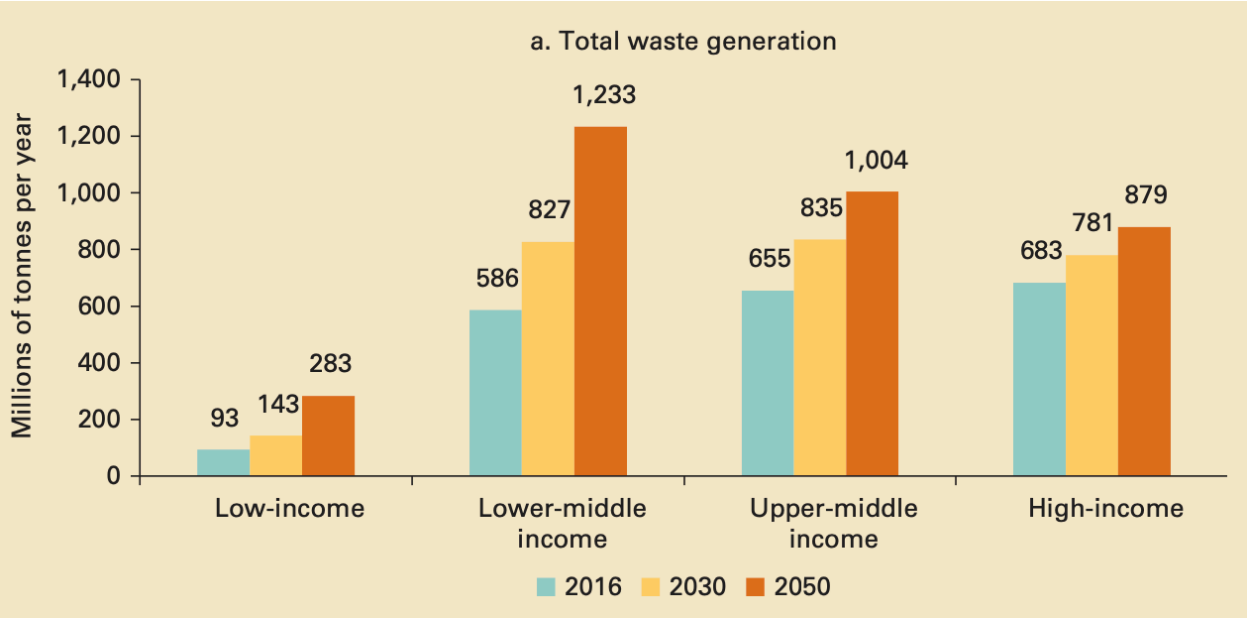
As populations grow and economies further industrialize and urbanize, waste generation rates per capita will increase, as will the challenges of identifying and procuring land for end disposal infrastructure, such as landfills and the challenges associated with financing, operating, and maintaining new WMR infrastructure. Municipal solid waste (MSW) generation globally is expected to increase to 2.2 billion tons per year by 2025[42] and to 3.4 billion tons by 2050[43] - more than double the population growth over the same period. Service provision will become more expensive, adding further pressure to already

---

[39] A. McIlgorm et al., *Update of 2009 APEC report*.
[40] United Nations Environmental Program, "Single Use Plastics: A Roadmap for Sustainability," revised edition, June 5, 2018, available online.
[41] Beachapedia, "Plastic Pollution Facts and Figures," updated April 2, 2021, available online.
[42] Mansoor Ali and Veronica Di Bella, *Topic Guide: Solid Waste Management*, Evidence on Demand, UK, April 2016, available online.
[43] World Bank, "Solid Waste Management," September 23, 2019, available online.

constrained services and the ability of local authorities, to keep up. The impacts will be greater in developing economies, where solid waste management services often represent the single highest budget item, accounting for up to 20 percent of municipal budgets.[44]

Figure 2: Total Waste Generation Estimates per Region



Source: Kaza et al., What a Waste 2.0 (2018).[45]

Note: Per World Bank definitions of "low income" economies may differ from the APEC categorization of developing economies.

Financing and infrastructure related challenges present the importance and value of promoting waste reduction, reuse, recycling, and recovery applications. Although considered a service industry delivering a public good, solid waste management can also be viewed as a dynamic market system that is based on the efficient management of materials and waste as a resource. When viewed through the lens of a market system, waste management becomes a value-added process in which waste becomes a tradable input/commodity—with numerous opportunities for adding value, reducing social and environmental costs, and promoting economic development through, for example, the creation of employment at each stage of the value chain or the trade of recyclable commodities.

Nowhere is the need for more dynamic and market-led solutions in the WMR value chain more apparent than in plastic waste typologies[46]. Plastic waste quantities within the waste streams vary depending on a complex interplay of income levels, local regulatory frameworks, local consumer demand for plastic products, and more but typically makes up an estimated 7–12 percent by weight, of

[44] Silpa Kaza et al., *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*, Urban Development, Washington, DC: World Bank Group, 2018, available online.
[45] Ibid.
[46] Typologies refer to different types of plastics.

over two billion tons of municipal solid waste generated globally per annum.[47] It is estimated that around 140 to 240 million tons of plastic waste are produced each year and the amount is growing rapidly.[48]

THE EXTENT OF THE PLASTIC WASTE CHALLENGE

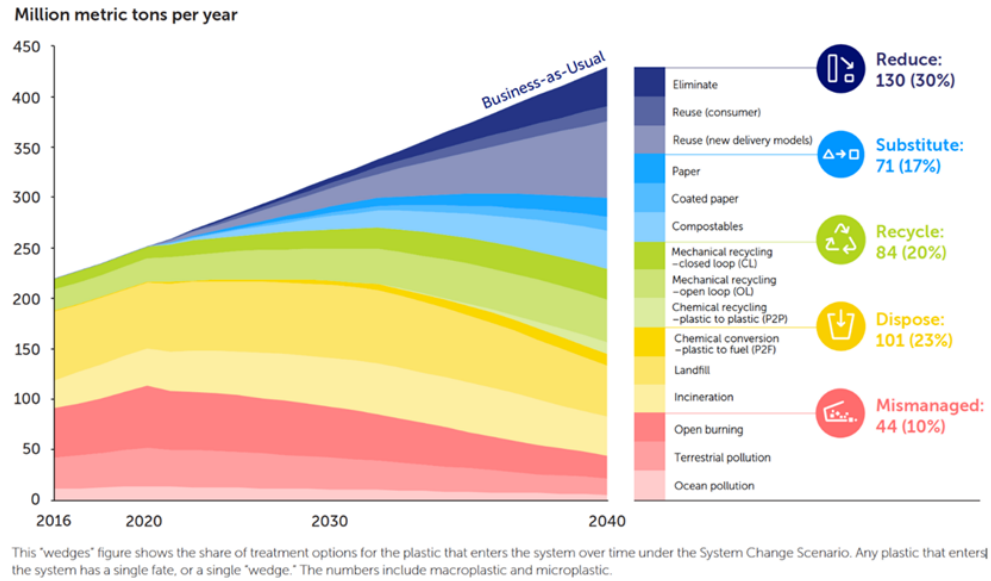
Global production of new plastic products is currently estimated at approximately 350 million tons per year. Single use plastics make up 50 percent of this figure. Under a business-as-usual scenario, it has been estimated that the production of new plastic products will double globally by 2040 to around 700 million tons per year, driven by increasing demand for the convenient properties that plastic offers such as being low cost, light weight, and durable, and the fact that it is easily produced in different colors and shapes.[49] Despite the global scale and awareness of the problem, plastic waste continues to rapidly grow. Under business as usual, "peak plastic" (the point at which global plastic production is expected to peak) is not expected until 2100 by some estimates,[50] particularly because many petrochemical firms intend to offset losses from a weak crude oil market, by increasing production of single-use plastics.[51] It is anticipated that by 2040, the amount of plastic waste pollution that flows into the oceans every year will nearly triple to 29 million metric tons. In addition, if no action is taken to address the plastic pollution issue, the accumulation in the ocean will reach an estimated 600 million metric tons by 2040.[52]

A recent study by the Pew Charitable Trusts and SYSTEMIQ[53] advocates that the solution for avoiding such an overwhelming surge in the scale of the plastic waste problem involves a combination of several actions illustrated in Figure 2-3:

- Reducing plastics production (which could reduce the total expected production of plastics in 2040 by 30 percent);
- Substituting plastics with biodegradable material (which could account for a 17 percent reduction in plastics production by 2040);
- Recycling (which could reduce the total production of plastic in 2040 by 20 percent); and
- Responsible disposal (potentially reducing projected 2040 plastic production by 23 percent).

[47] Kaza et al., *What a Waste 2.0*.
[48] These are the estimated figures based on the weights, while volumes are very important for marine pollution of plastics and very limited data are available.
[49] The Pew Charitable Trusts and SYSTEMIQ, "Breaking the Plastic Wave."
[50] Plastic Soup Foundation, "Peak Plastic," January 8, 2017, available online.
[51] David Roberts, "Big Oil's hopes are pinned on plastics. It won't end well," *VOX*, October 28, 2020, available online.
[52] Laura Parker, "Plastic Rubbish Flowing into the Seas Will Nearly Triple by 2040 Without Drastic Action," *National Geographic*, published July 24, 2020, updated November 5, 2020, available online.
[53] The Pew Charitable Trusts and SYSTEMIQ, "Breaking the Plastic Wave."

Figure 3: A Wedges Analysis of Treatment Options for Plastic Entering the System



This "wedges" figure shows the share of treatment options for the plastic that enters the system over time under the System Change Scenario. Any plastic that enters the system has a single fate, or a single "wedge." The numbers include macroplastic and microplastic.

Source: The Pew Charitable Trusts and SYSTEMIQ (2020).

As part of this inclusive approach, effective recycling approaches could reduce projected 2040 plastic production by 20 percent, but this depends on waste collection and other relevant processes in economies. The section below explores the core problem of plastic pollution in APEC economies.

COMMON ORIGINS OF PLASTIC WASTE POLLUTION IN APEC ECONOMIES

Having robust solid waste collection systems are a critical step in managing plastic waste, yet research shows that the quality of this service and collection rates vary around the world.

Analysis reveals that APEC economies collect an average of 80 percent (by weight) of waste in cities (this reaches almost 100 percent in more developed economies such as Japan; Australia; Republic of Korea; and Singapore), but this proportion drops drastically to 40 percent or less in developing economies, where local disposal and burning of waste is common.[54] Furthermore, rapid population growth and urbanization continues to compound this problem. It is estimated that under the current trajectory, by 2040 about 4 billion people globally are likely to be without organized waste collection services.[55] A significant proportion of this will be in developing economies.

As official services are often limited in less developed economies, waste collection services are also hybrid in nature[56] and are commonly delivered as door-to-door or communal container collections.

---

[54] United Nations Center for Regional Development, *State of Plastics Waste in Asia and the Pacific – Issues, Challenges and Circular Economic Opportunities*, early release version, 2020, available online.
[55] The Pew Charitable Trusts and SYSTEMIQ, "Breaking the Plastic Wave."
[56] A British Academy-funded project called Rubbish, Resources, and Residues is looking into the hybridity of waste systems. It is being conducted by LSE Cities project of the London School of Economics. Information available online.

These services are provided by a combination of formal private waste management companies, local government, community-based organizations, and informal actors, such as individual waste pickers, many of whom are vulnerable and marginalized in society.

Even when plastic waste is source-separated and collected, many economies lack the capacity to process it. It can enter the environment when it is poorly managed – through littering, open dumping, open burning, and disposal in waterways. In the Philippines for example, 74 percent of plastic leaked into oceans and rivers originates from already collected waste due to poorly located dump sites adjacent to waterways.[57] Waste from several economies in the South and Southeast Asian region including APEC economies, (China; Indonesia; the Philippines; Viet Nam), reportedly accounts for up to 60 percent of the global total. Seven of the ten major rivers that account for up to 90 percent of all plastic waste transported via rivers into the oceans are located in the APEC region,[58] and include the Yangtze, the Indus, the Yellow River, the Hai He, the Pearl, the Amur, and the Mekong.[59] Another study[60] highlights that despite having well developed waste management systems, developed economies such as the United States as well as members of the European Union had significant plastic emissions into the ocean in 2010 due to the existence of large coastal populations and per capita waste generation rates.

Other challenges include poorly developed or implemented policies and strategies on waste management and an absence of policy direction and effective implementation of recycling initiatives. For example, although many economies have banned single-use plastics and increased policies on separation at source or increased duties on plastic imports, there are capacity constraints that limit the ability to implement such policies. This is demonstrated by Papua New Guinea's ban on single-use plastics. The policy direction was enacted in 2014 but has been met with significant challenges and delays in implementation.[61]

The lack of up to date and reliable data on plastic waste generation - the types of waste and flows - is also key constraint to enhanced waste management approaches. Having accurate data is key to enabling municipal governments to better plan and inform the development of strategic partnerships with the private sector or nongovernmental organizations to improve solid waste management systems.

Apart from having to cope with the challenge of poor waste management and recycling capacities, several APEC economies are also sites of production of virgin plastic polymer and products, with ambitious targets established to help meet global and domestic markets. China leads global production, with Thailand and the Philippines experiencing increased investment in their plastic manufacturing sectors.

Compounding this is the fact that APEC economies are also experiencing a rapid increase in the use of single-use items such as fast-food packaging and personal protective equipment (PPE) including face

---

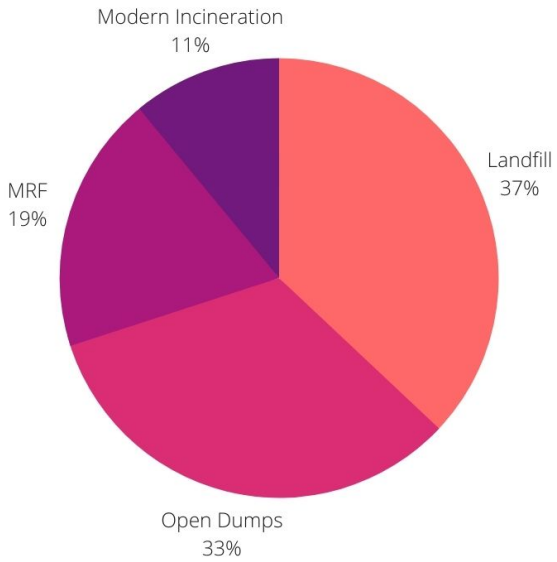
[57] World Wide Fund for Nature (WWF) Philippines, "EPR Scheme Assessment for Plastic Packaging Waste in the Philippines," October 2020, available online.
[58] C. Schmidt, T. Krauth, and S. Wagner, "Export of Plastic Debris by Rivers into the Sea," *Environmental Science & Technology* 51, no. 21 (2017): pp. 12246–53, available online.
[59] Alex Gray, "90 Percent of Plastic Polluting Our Oceans Comes From Just 10 Rivers," *World Economic Forum*, June 8, 2018, available online.
[60] Kara Law et al., "The United States' Contribution of Plastic Waste to Land and Ocean," *Science Advances* 6, no. 44 (2020), available online.
[61] Radio New Zealand, "PNG Imposes Full Ban on Plastic Shopping Bags," April 18, 2018, available online.

masks, disposable gloves, and related equipment used by the general public and in healthcare settings as a result of the COVID-19 pandemic. These waste types are adding significantly to plastic waste leakage into the environment, as the waste often is composed of materials that cannot be recycled and are often classed as hazardous waste items. A recent study indicates that 129 billion face masks and 65 billion plastic gloves are used and disposed of each month[62].

MISMANAGED LAND-BASED SOLID WASTE

The World Bank Group's *What a Waste 2.0* report estimates that, globally, around 37 percent of waste is disposed of in some type of landfill, 33 percent is openly dumped, 19 percent undergoes material recovery through recycling and composting, and 11 percent is treated through modern incineration. The composition of that waste is divided along the following lines: 44 percent food and green[63], 17 percent paper and cardboard, 14 percent other, 12 percent plastic, 5 percent glass, 4 percent metal, 2 percent wood, and 2 percent rubber and leather.

Figure 4: Waste Treatment Methods

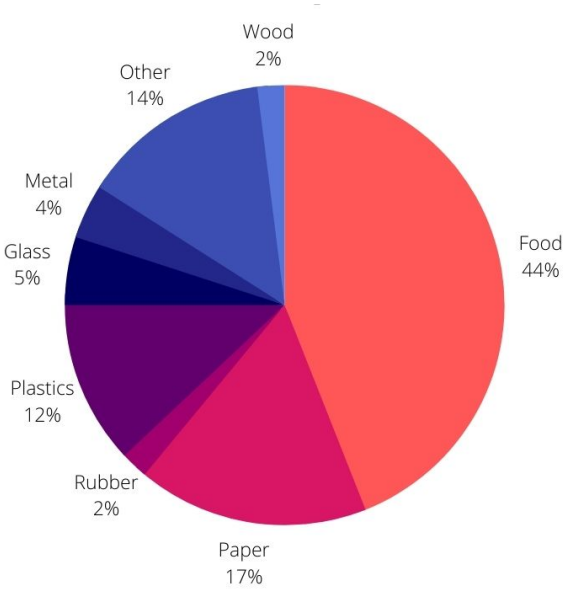


Source: Kaza et al., What a Waste 2.0 (2018).

Note: The World Bank definition of "developing" economies may differ from the term used in APEC.

[62] Aragaw and Mekonnen, "Current Plastics Pollution Threats Due to COVID-19."
[63] Food and green waste indicate food and yard related waste streams.

Figure 5: Waste Composition

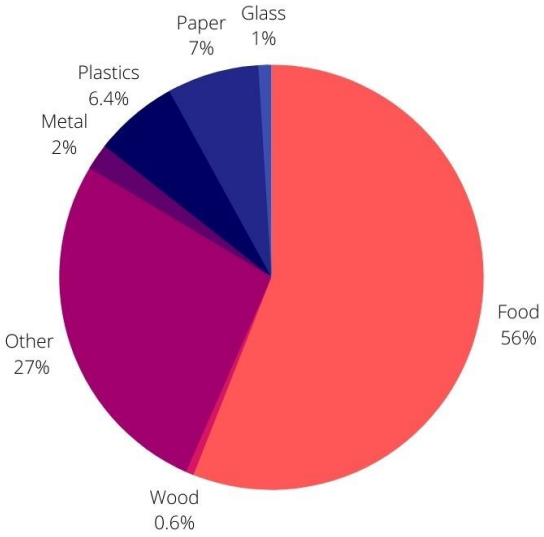


Source: Kaza et al., What a Waste 2.0 (2018).

Note: The World Bank definition of "developing" economies may differ from the term used in APEC.

The metrics vary somewhat when broken down further as demonstrated in the figure below. For example, in less developed economies, waste is composed of: 56 percent food and green, 7 percent paper and cardboard, 27 percent other, 6.4 percent plastic, 2 percent metal, 1 percent glass, and less than 1 percent wood.

Figure 6: Waste Composition – Less Developed APEC Economies



Source: Kaza et al., What a Waste 2.0 (2018).

Note: The World Bank definition of "developing" economies may differ from the term used in APEC.

In terms of waste generated per capita per day, the average person currently generates 0.74 kilograms of waste per capita per day, though this can fluctuate widely from 0.11 in lower income economies to 4.54 kilograms per capita per day in higher income and urbanized domestic settings. These numbers are likely to change as the total quantity of waste generated in low-income economies is expected to increase by more than three times by 2050.[64]

WASTE MANAGEMENT AND RECYCLING TRENDS IN THE ASIA-PACIFIC - KEY FINDINGS

As noted earlier solid waste pollution in the ocean is a transboundary issue and developing appropriate policy levers to address both the supply and demand of sustainable waste management and recycling practices, is critical.

In keeping with the objective of the study, an APEC-wide survey was used as a primary tool to gather information on current policy frameworks, practices as well as challenges faced by APEC economies in designing and implementing sustainable WMR. The survey questions focused on gathering information in four key issue areas: 1) Policy and legislative frameworks; 2) Attracting investment and financing in water management and recycling infrastructure; 3) Private sector engagement; and 4) WMR–specific enforcement. In addition to the survey, data was gathered via stakeholder interviews and desk research. The findings are detailed below.

POLICY AND LEGISLATIVE FRAMEWORKS

This section contains information on existing policy and regulatory trends in APEC economies, collated via the survey responses received from twelve (12) APEC economies.

Key Findings

Responses reveal that several APEC members recently developed comprehensive and overarching policy and legislative frameworks addressing waste management and recycling value chains.

- These include: Singapore's Green Plan 2030, the Waste Blueprint for Hong Kong 2035, Peru's National Plan for Comprehensive Solid Waste Management (PLANRES), and Papua New Guinea's Pacific Regional Waste and Pollution Management Strategy 2016–2025. Such legislative and regulatory efforts provide comprehensive long-term strategies for economies to set appropriate solid waste collection and recycling targets.

- All 12 economies that responded to the survey indicated that they have published Integrated Solid Waste Management (ISWM) plans**.** Waste characterization data is a critical basis on which strategic masterplans for waste management and recycling infrastructure are developed, therefore the existence of ISWM plans suggests the existence and availability of up-to-date waste characterization data and masterplans for waste management and recycling infrastructure in these economies.

[64] World Bank, "Solid Waste Management."

- Almost all of the economy-level respondents revealed that they had either a proposed or recently announced Extended Producer Responsibility (EPR) initiative or regulation in place.

- Several APEC members reported operating government-led community awareness programs and behavior change communication campaigns via social media on matters relating to solid waste management, recycling, and waste recovery. To complement such awareness raising efforts, many members also had enforceable mechanisms for the improper sorting and recycling of waste

- Three APEC economies in the last 3-5 years have recognized the role of waste pickers in environmental legislation.

- All economies that responded reported having specific strategies to promote innovation among small and medium sized enterprises (SMEs), start-ups, and international corporations that provide WMR services. Many of these members also had one-stop-shop facilities to assist and expedite registration of new companies and incentivize investments of any size in the waste management and recycling sectors.

- Several members' responses indicated that their governments provided tax incentives or waivers for start-ups or small and medium sized enterprises (SMEs) providing WMR services or importing technologies to recycle waste.

- Several members provided information on pioneering innovations in their economies in advanced electronic recycling, chemical recycling, composting technologies, and carbon trading and credit schemes.

- Some economies indicated the interest in promoting scrap material pre-processing (disassembly and sorting) and green shipment[65] across economies to access the best available recycling solutions, which require economies of scale to be viable.

ATTRACTING INVESTMENT AND FINANCING

Key Issues: Attracting capital investment for WMR infrastructure and value chains needs in economies require domestic, regional, and local (municipal) authorities to strengthen incentive and subsidy structures to create a suitable environment conducive for investment and working conditions in APEC economies. The research findings in relation to the economies' ability to attract investment and financing were analyzed using the following basic framework that contained the following elements:

- **Economies of scale**: Larger cities with significant potential are more likely to attract domestic and foreign investment. Waste management and recycling facilities require large quantities of waste to attain economies of scale; and big cities where larger populations exist generate adequate volumes of municipal solid waste. Generally speaking, cities that have high levels of private sector engagement and

[65] Referring to use of vessels that conform to International Maritime Organization (IMO) environmental regulations.

competition will present opportunities for public-private partnerships in waste management, which often are a prerequisite to attract domestic and foreign investment. Evidence of the presence of public-private partnerships in a city provides for a robust business case for investment.

- **Regulatory, fiscal, and legal incentives enabling private sector participation**: This demonstrates the political will of the government to attract private sector participants and improve investor confidence in investing in the waste management industry. Regulatory frameworks that require mandatory payments for waste collection and treatment by residents will attract investors in waste collection and treatment because of the revenue assurance. In addition, fiscal and legal incentives such as tax holidays, ease of profit repatriation, and access to land will attract investors.
- **The presence of a deep berth port** that can support the export/import recycling commodities market.
- **Identification of existing policy and fiscal incentives** to promote market-led industrial and commercial recycling activities. For example, value-added tax (VAT) and other relevant tax breaks on the trade of recyclables; caps on foreign ownership or employment of expatriates; the waiving of import duties on recycling technologies; free training and capacity building efforts for key recycling market players; and infrastructural support for the storage and transfer of recyclables.
- **Identification of key constraints faced by private and public stakeholders** to develop commercially viable operations, such as ease of land ownership; length of awards/tenders; ease of access to financing and interest rates for financing options; and recognition of innovative waste recovery practices among government departments. This also involves risk management approaches.
- **The types of public-private partnership** offered by municipal or domestic authorities (e.g. build-operate-transfer (BOT); build-own-operate (BOO); build-operate-own-transfer (BOOT); buy-build-operate (BBO); design-build (DB); design-build-finance (DBF); and design-construct-maintain-finance (DCMF)).
- **The existence and willingness of public stakeholders to provide reliable and transparent data** on waste characterization and composition to inform, for example, opportunities in waste-to-energy (WtE) investments.

Key Findings

The following include several examples of how the private sector has effectively partnered with the public sector by investing in solutions to support solid waste management and resource efficiency goals.

These investment vehicles provide capital to scale innovative projects that divert waste from the environment and into the recycling value chain in several Southeast Asia economies in the APEC region. Large-scale plastics recycling facilities and materials recovery facilities (MRFs) are being funded by companies such as Suez, Nestle, and Coca-Cola in the Philippines and Thailand, demonstrating a high degree of investor confidence in recycling processes. It is important to note that these companies are affiliated with partnerships and research programs reviewing viability of chemical recycling[66] at a commercial scale which could be replicated in other APEC contexts to help address issues with mechanical recycling of low-grade polymers.

[66] Chemical recycling refers to chemically reducing a polymer to its original monomer form so that it can eventually be processed (re-polymerized) and remade into new plastic materials that go on to be new plastic products. This addresses key issues of low-grade polymers that can't be recycled through standard mechanical processes.

- Legislative shifts in Papua New Guinea have paved the way for a new biomass project involving a multinational consortium and the Climate Change and Development Authority. Papua New Guinea (PNG) Biomass is an integrated renewable energy project which is a collaborative effort involving three investors—Oil Search (PNG), Swedish Energy, and AFRY Management Consulting (an industry and infrastructure design and consulting company). This is implemented in partnership with the Climate Change and Development Authority of Papua New Guinea. Situated in Morobe Province, the renewable energy project will consist of a 11-megavolt capacity solar photovoltaic farm and a 30 MW biomass power plant securing renewable power supply for the economy, in part, from the recovery of organic waste[67].

- Several large-scale waste-to-energy investments have also taken off in the Philippines, Thailand, and Malaysia (Metro Pacific Investments Corporation, TPI Polene Power, ALCP6, Super Energy Corporation, Cypark Resources Bhd, and Worldwide Holdings Bhd) that will add up to 75MW to the grid across these three economies, when completed.

- In the Philippines, the consortium of Metro Pacific Investments Corporation (MPIC), Covanta Energy, and Macquarie Group Limited was granted original proponent status by the Quezon City local government for its proposed P15 billion waste-to-energy (WtE) project. The project includes a biodegradable source separated organics treatment facility and a residual combustible waste treatment facility. The public-private partnership (PPP) has been designed to allow the operator to earn revenue from tipping fees paid by Quezon City, power generation, and the sale of by-products such as recyclables. The PPP will also provide electricity to between 60,000 and 90,000 homes. The project will be undertaken through a joint venture between the Quezon City government and the consortium.[68]

- Also in the Philippines, as part of its World Without Waste vision approach - Coca-Cola is working with the Basco local government to clear the Basco eco-center of 20,000 kilograms or 20 tons of post-consumer recyclable polyethylene terephthalate (PET) bottles, which have accumulated. The memorandum of understanding also establishes a post-consumer PET flow from Batanes to Gen. Trias, Cavite[69].

- Nestlé Philippines has partnered with the DENR to deliver its commitment to a waste-free future, which includes the building of a materials recovery facility (MRF) in Caloocan City.[70] To support the economy's waste management system, the facility will sort, segregate, compost, and recycle wastes in accordance with Republic Act. No. 9003 (or the Ecological Solid Waste

[67] EuropaWire, "AFRY Joins Collaboration on Biomass Project in Papua New Guinea," December 17, 2019, available online.
[68] Rappler, "QC Approves Metro Pacific-Led Group's Waste-to-Energy Project," March 27, 2017, available online.
[69] Bernie Cahiles-Magkilat, "Coke PH, Batanes LGU Sign PET Bottle Recycle Deal," *Manila Bulletin,* April 30, 2021, available online.
[70] BusinessWorld, "Nestlé-DENR to Build Materials Recovery Facility in Caloocan," March 26, 2021, available online.

Management Act of 2000). Under a Memorandum of Agreement, Nestlé Philippines will sponsor the construction of the facility in Barangay 164 in Caloocan City.[71]

- The TPI Polene Power WtE project in Thailand is a US$49 million project that aims to process a minimum 400 tons of waste per day. The concession will last for 20 years and will be located in Songkhla province. It will be supported by a tipping fee of THB 400 per ton, which will increase 10 percent every three years, and a power purchase agreement (PPA) of 7.9 MW. The feed-in-tariff will be THB 5.78 per megawatt-hour for the first eight years of the PPA and THB 5.08 per megawatt-hour for the next 12 years. The project is scheduled to be completed by 2023.[72]

- The Bangkok-listed Super Energy Corporation will develop a 20 MW WtE project in southern Thailand. The company has signed an agreement to jointly invest in the project with the Nakhon Si Thammarat municipality. The project will be backed by a 16 MW PPA with the Electricity Generating Authority of Thailand, with a feed-in tariff of THB 3.66 per kilowatt-hour. The contract will have a 20-year duration.[73]

- Under the ALCP6 WtE project in Thailand the ALCP6 plant will consume around 144,000 tons per year (400 tons per day) of municipal solid waste. The waste will be incinerated; the heat obtained is expected to be converted into 6.0 MW of electricity to be exported to the economy's grid.[74] The project is supported by Alliance Clean Power Co., Ltd., a subsidiary of Absolute Clean Energy.

- As a member of the Thailand's PPP for Sustainable Plastic and Waste Management, Suez announced the official opening of its Circular Polymer Plant in Bang Phli, Thailand. The plant is expected to convert some 30,000 metric tons of low-density polyethylene (LDPE) and linear low-density polyethylene (LLDPE) plastic packaging scrap into post-consumer resin (PCR) plastic.[75]

- Cypark Resources Bhd and the Johor State Government have established a cooperation agreement for WtE project under a PPP. The agreement allows the companies Permodalan Darul Ta'zim Sdn Bhd and Cypark to jointly collaborate to explore, develop, and resolve the state's waste management issues using time-tested and environmentally friendly technologies, including the development of WtE projects in Johor. Cypark sees the joint venture as a step towards its goal of developing a second WtE project (after developing Malaysia's first WtE project at Ladang Tanah Merah, Negeri Sembilan).

---

[71] ABS-CBN News, "Nestlé Philippines, DENR Ink Deal to Build Materials Recovery Facility," March 26, 2021, available online.
[72] YOG INFRA, "Infrastructure & PPPs in Thailand - Q12021 Update," March 31, 2021, available online.
[73] Asian Development Bank, "Thailand: Southern Thailand Waste-to-Energy Project," available online.
[74] Mott MacDonald, "ALCP6 Waste to Energy Project Has Commenced Construction, Thailand," October 19, 2020, available online.
[75] Brian Taylor, "Suez Commissions Thailand Plastics Recycling Plant," *Recycling Today*, December 3, 2020, available online.

- Also in Malaysia, Worldwide Holdings Bhd, a Selangor state government unit, has entered a joint development agreement with Western Power Clean Energy Sdn Bhd (WPCE) to develop a two-phase WtE facility on 15 acres of land in Jeram Sanitary Landfill. With waste capacity of 1,200 tons per day, the first phase of the facility will produce between 20 and 24 MW of green energy, enough to power 25,000 households in the vicinity of the plant.

PRIVATE SECTOR ENAGEMENT

Key Issues: To complement economy-level information sourced from the surveys and research of publicly available literature, the expert also conducted interviews with several private sector representatives from the corporate sector and non-governmental entities. This involved a more qualitative approach to gathering information. The responses received through this process enabled the consultant to effectively validate and test assumptions gathered on key constraints and opportunities in specific WMR value chain and how they were either inhibited or facilitated by existing policy frameworks.

Key Findings

Many private sector respondents felt that while government authorities were willing to invest in green infrastructure and engage in facilitating capital expenditure (CAPEX) investments, ensuring their sustainability was challenging. This was largely due to shortfalls in recurrent or operational expenditures and impediments in the implementation of investment business models due to skills and capacity constraints at the local (municipal) or provincial government levels. This green infrastructure was seen to be further challenged where government investment in a new waste recycling or recovery assets had to compete with subsidized landfilling fees, thus undermining the value proposition.

In some economies, such as Indonesia, large organizations, including the United Nations Development Program, noted the importance of public subsidies and ongoing financial support for the operational models of recycling and recovery infrastructure, making particular reference to island states and tourist destinations that are too remote to attract private sector-led service provision, but also produce high quantities of single-use plastic waste. Under these circumstances, the role of smart, tailored policy instruments to cross-subsidize or ring-fence public funding for solid waste management service models within the tourism sector, and facilitate trade in recyclable materials could be a viable option to consider.

Some private sector stakeholders noted how domestic and foreign direct investment in WMR infrastructure and technologies is often hindered by the public sector. Several challenges were identified which included WMR recurrent expenditures, issues relating to the lack of effective of coordination between relevant public sector agencies, lack of standards in terms of recycling business models, limitations of knowledge of emerging technologies and regulatory issues. These are detailed further, as follows:

- An observation of a disconnect between domestic financing of solid waste management and recycling infrastructure, and of the inability of local authorities to sustain the operation of these new infrastructural assets. In practice, central governments were able to commit funds for green infrastructure and capital expenditure investments, but operational or recurrent expenses and the underlying business model of the investment were the responsibility of local

and regional authorities, who were often unable to subsidize or fund such models after their inception.

- The need for standard recycling business models to support sustainable solid waste collection or recycling services in island states or remote tourist destinations, without the presence of public subsidies or higher collection fees being passed on to consumers and tourists. Properties and activities frequented by tourists typically produce large amounts of single-use plastics and non-recyclable waste. As these tourist locations are normally far from cities or commercial centers, the costs of extracting the recyclables and forwarding them to relevant markets can become prohibitive.

- A limited understanding of new, clean, and innovative waste recycling practices, such as chemical recycling. This has led to some hesitancy among local and regional authorities about supporting PPPs related to investments in chemical recycling or waste to energy for fear of public backlash and "not-in-my-backyard" (NIMBY) sentiments from the public. NIMBY is used to characterize the opposition of residents to a proposed development plan in their community.

- A limited understanding of different plastic/polymer types, recycling quality standards, and plastics that were falsely marketed as recyclable. Some members noted that more easily recyclable or reusable plastics, such as thick high-density polyethylene (HDPE) containers are taxed and regulated the same as low-density polyethylene (LDPE) film plastics (e.g., single-use carrier bags)—thus providing no incentive to manufacturers to steer away from difficult to recycle or reuse plastics and towards polymer types which can be easily re-used or recycled.

- The lack of recognition within the regulatory framework for food-grade recycled polyethylene terephthalate (rPET) and recycled high density polyethylene (rHDPE). This has had a number of knock-on effects such as reluctance of manufacturers to use rPET or rHDPE materials, undermining the value of waste segregation and recycling efforts throughout the value chain—from waste pickers to larger aggregators and waste processors.

- Limited appreciation among some APEC members between what constituted a "dirty" or "clean" method of waste treatment. Some members felt that prospective investments were often always bundled into a "dirty" activity, eliciting strong (not in my backyard) NIMBY sentiments from the general public and local communities.

- Lack of coordination in the implementation of policy responses was identified as a critical constraint which limited efficient recycling and reuse of waste products. For example, in some contexts a portion of all packaging products use rPET or rHDPE in manufacturing, but food, health, and safety authorities in these contexts were often resistant to certify rPET and rHDPE industries to a food-grade level so recycled resins can compete with virgin counterparts in those applications.

- Problems associated with low-cost landfilling was another challenge identified during the consultations with private sector representatives[76]. Respondents highlighted how this directly undermined the value proposition of alternative waste recycling and recovery infrastructure that they were marketing to municipalities.

- Long and expensive application and approval processes for new developments was seen as a key challenge. Development applications for composting plants, for example, were often shelved due to concerns of odor and runoff issues from local government and the general public—despite sound evidence that new technologies and composting practices would mitigate these effects beyond the property of the composting plant.

- The absence of a central coordinating government department or agency - or a "one-stop-shop" government facility for larger investments was noted as a key constraint to more effective development applications in the waste management and recycling sectors.

WMR-SPECIFIC ENFORCEMENT

Key Issues: Effective enforcement of solid waste management and recycling regulations underpins much of the potential success of investments in WMR value chains among APEC members. Therefore, the implementation of governmental and industry guidance and regulation on these matters sets an important precedent for industry, the private sector, and the general public. For example, survey responses and desktop research have revealed that Chinese Taipei and Singapore have very effective levels of enforcement and compliance for WMR regulations, supported by high fines and penalties for offenses relating to improper disposal of municipal solid waste or electronic waste types.

A large degree of enforcement and compliance control in the WMR sector also comes from traders of valorized waste[77] commodities themselves. The minimum acceptable standards and international evaluation of organic feedstock in composting markets, for example, largely governs itself.

The future of enforcement and compliance in WMR is really a story about the integration of digital solutions in WMR practices. The approach used for this section, while anecdotal, employed a strong case-by-case focus on the digitization of waste management and recycling service provision as well as technology and infrastructure development.

Key Findings

Key stakeholder interviews with industry representatives also underscored the important role and significant potential of recent digital solutions for WMR which had been integrated into their day-to-day operations. This included designing and employing digital solutions for citizen engagement and behavior change; enhancing operational efficiency through geographic information system (GIS) services

[76] Low-cost landfilling refers to small scale low-cost, low-maintenance landfills. These landfills do not meet all the specifications to be considered a sanitary landfill.
[77] Waste valorization refers to the process of reusing, recycling or composting waste materials and converting them into more useful products including materials, chemicals, fuels or other sources of energy.

and vehicle tracking; and using digital apps to improve the transparency of recyclables and commodities traded in international markets.

Several private sector respondents highlighted notable areas where digital solutions could be applied within their own companies. These include:

- Digital solutions for citizen engagement, behavior change education, awareness raising, and training programing. This could, for example, take the form of an educational mobile app or online course tailored to users in the WMR sector.
- Employing digital solutions to enhance operational efficiency. This is seen as particularly relevant for the high transport and logistical costs associated with the trade of recyclables and haulage, especially for cities and economies that do not have direct access to deep berth ports.
- Digital solutions to increase the transparency of recyclables trade and mitigate waste, crime, and the illegal trade of recyclables. This includes through the use of drone imagery, blockchain, and the publication and real-time update of price indexes for popularly traded recyclable commodities. It is expected that such applications will become increasingly relevant as the 2019 Basel Convention's amendments on waste trade stipulations which require traders to digitize Prior Informed Consent (PIC) procedures for the international trade of waste and scrap commodities.

While role and value of digital innovations in the WMR sector is abundantly clear and present - whether in the form of mobile apps, integrated payment systems or the use of artificial intelligence (AI) and machine learning instruments for planning and operational WMR activities – the WMR sector has been relatively late in adopting digital solutions, in terms of integrating mobile and digital solutions into their respective value chains.

Both public and private sector stakeholders working in the WMR space are now rapidly wielding information and communication technology (ICT) solutions to their advantage. A few notable examples where WMR organizations have adopted ICT in their activities exist in several APEC economies. These are presented in Table 1, below.

Organization	Economy	Link
GEPP Me	Thailand	https://gepp.me/en/
GooGreen	Thailand	https://www.googreens.com/login.php
Koomkah	Thailand	https://www.scgchemicals.com/en/products-services/technology-solutions/koomkah
Recycle Day	Thailand	https://www.recycledaythailand.com/
ASSIST	Indonesia	https://assistasia.org/
Rekosistem	Indonesia	https://rekosistem.com/
Solu	Philippines	https://e27.co/startups/solu/
Klean	Malaysia	https://www.klean.asia/

DEFINITIONAL ASPECTS

Environmentally sound and economically viable waste management and recycling practices are dependent on consistent definitions and local understanding of waste and recyclable materials, environmental regulation, materials quality standards, and processing health and safety standards.

The 2017 APEC study *Facilitating Trade and Investment in Sustainable Materials Management Solutions in the APEC Members Region* outlined some inconsistency among APEC members concerning both standard and advanced waste management and recycling activities. For example, of the 18 economies that provided a definition of waste, the definitions from five economies (Australia; Canada; Malaysia; Singapore; and the United States) included language that indicated that waste could include discarded material that could be recycled. The definitions from Australia; Canada; and the United States include the term "recycle" and the definitions from Malaysia and Singapore include the term "scrap material."

The importance of definitions and the understanding of waste and recyclable materials across the APEC members region is therefore essential for improving WMR practices and infrastructure and reducing any potential barriers to regional trade and investments. The section below aims to address definitional issues and aspects relating to standards.

DEFINITIONAL ISSUES – WASTE AND RECYCLABLE MATERIALS

The recyclable commodities traded globally are often guided by industry Harmonized System (HS) trade codes. Scrap plastic, for example, a mixed consignment of waste plastics, is normally identified using code #3915[78]. While there are fairly consistent and agreed-upon definitions among industry and private sector actors in the commodity trading industry, definitions for common waste typologies and WMR practices in the public sector are, concerningly, inconsistent and widely generalized. The lack of aligned definitions in WMR value chains directly constrains the global nature of WMR commodity trading activities among APEC economies. The survey responses also demonstrate the levels of inconsistencies in definitions used for common waste typologies and practices. To address inconsistencies in this global value chain, economies may wish to defer to definitions set by UN agencies and multilateral organizations.

Appendix D of this report aggregates a number of such definitions including those defined by HS trade codes, namely:

- HS codes relevant to all seven core sub-typologies of plastics
- HS codes relevant to sub-typologies of paper, cardboard, and card products
- HS codes relevant to ferrous and non-ferrous metals
- HS codes relevant to whole and cutlet glass

In addition, Appendix E includes a number of more generalized, non-trade related definitions for common WMR terms, including composting; construction and demolition waste; end disposal; hazardous waste; incineration, waste to energy; municipal solid waste; integrated solid waste management and recycling.

[78] Waste management and recycling practices are not "pinned" to HS codes; HS codes cover goods trade. Also, current HS codes at the 6-digit level are not granular enough to serve as a perfect representation of all recyclable commodities.

MATERIALS QUALITY STANDARDS

Materials quality standards in WMR value chains can undermine and constrain the already challenged global commodities market for recyclables. At present, there are no uniformly accepted global standards for material certification, traceability and labelling schemes. This can significantly constrain recycling schemes as the use of certain additives in plastics, for example, or the contamination of paper products can often eliminate the entire value of large consignments of valuable recyclables when doesn't meet specifications in differing economies. This following section outlines some of the overarching and most important quality standard considerations for commonly traded recyclables.

Several resources are also available to APEC members to guide work on benchmark materials quality standards and definitions for standard and more complex waste management and recycling activities. These include the U.S. Resource Conservation and Recovery Act (RCRA); and the American Society for Testing and Materials (ASTM) International Waste Management Standards, including: ASTM D5681–20: Standard Terminology for Waste and Waste Management, ASTM D5231–92(2016): Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste, and ASTM D5491–08(2014): Standard Classification for Recycled Post-Consumer Polyethylene Film Sources for Molding and Extrusion Materials; and definitions outlined by the Basel Convention. The following section provides further information of quality standards of several materials.

PAPER

Paper waste is one of the most lucrative and widely traded recyclable commodities globally, among WMR actors[79] and value chains. Unfortunately, paper recyclables are highly susceptible to contamination and the quality of materials is highly dependent on the presence of functional and integrated waste sorting, collection, transfer, storage solutions and infrastructure. A very broad range of quality standards apply to paper recycling. Some of the primary considerations include:

- Paper is easily contaminated or considered nonrecyclable if plastic and ink coatings on the paper product exceed 5 percent of the product's weight. Economies should note the importance of additives and plastic coatings on paper and the effects this can have on WMR value chains.
- Paper is easily contaminated if co-mingled with wet or organic waste. Paper recyclable commodities must retain a low moisture content rate to be traded internationally.
- Normally, paper can only be recycled up to seven times before the fibers become too weak and too short to make another product. The yield of each successive round of paper recycling reduces due to the fiber depreciation occasioned by the various recycling processes such as collection, deinking, and remanufacturing.

An important consideration is the variation in standards within the economy that export consignment are going to. For example, with respect to paper waste export to Europe, the European Standard (EN) 643[80] standard must be met. The EN 643 standard is a European list of standard grades of paper for

[79] The terminology used here of 'WMR actors' refers to anyone involved in the waste management and recycling value chain as has been indicated throughout the report.
[80] Export standards largely depend on the economy the waste is being shipped to and therefore the European standards is a relevant example in the context of waste being shipped out of the APEC region to Europe.

recycling and quality requirements. This includes setting limits on tolerance levels of non-paper components. The key elements of the EN 643 are as follows:[81]

- Provides a clear statement that paper from refuse collection (i.e., extracted from mixed residual fractions) is not usable in the paper industry.
- Provides clear requirement for paper from commingled collection to be specifically marked.
- Maximum moisture content of 10 percent.

The EN 643 standard has five groups for waste papers, with a total of almost 100 grades. The groups are:

- Group 1 – Ordinary grades (example: mixed paper).
- Group 2 – Medium grades (example: sorted office paper).
- Group 3 – High grades (example: white newsprint).
- Group 4 – Kraft grades (example: unused corrugated kraft).
- Group 5 – Special grades (example: used liquid packaging board).

PLASTICS

Plastics are affordable, lightweight, and long-lasting materials, which can easily be formed into various products used in a broad range of applications. The technical definition for plastics recycling is complex and sometimes confusing because of the wide range of recycling and recovery activities. These include four categories:

- Primary recycling (mechanical reprocessing into a product with equivalent properties);
- Secondary recycling (mechanical reprocessing into products requiring lower properties);
- Tertiary recycling (recovery of chemical constituents); and
- Quaternary recycling (recovery of energy).

Primary recycling is also known as "closed-loop recycling", while secondary recycling is mostly tagged as downgrading. Tertiary recycling is either described as chemical or feedstock recycling and applies when the polymer is de-polymerized to its chemical constituents. Quaternary recycling is energy recovery, energy from waste or valorization.[82] Under closed-loop recycling, waste plastics that are well sorted and clean are recycled into products that are identical to the original plastic products. However, the mix of polymers, additives, and dyes that make up low-value plastic dilute the quality of the recycled output (for primary recycling) and limit its viability as recycled content in many applications. For instance, mixed (commingled) plastics are usually downgraded through recycling to relatively low value composite products, where they substitute for wood or concrete, mostly in outdoor applications.

Another challenge involving plastic recycling is the recycling of plastic containers for food-grade packaging applications. This challenge stems from the concern that potentially hazardous contaminants

---

[81] Ulrich Leberle, "Quality: European Standards on Paper for Recycling," *Confederation of European Paper Industries*, December 2, 2016, available online.

[82] Jefferson Hopewell, Robert Dvorak, and Edward Kosior, "Plastics Recycling: Challenges and Opportunities," *Philosophical Transactions of the Royal Society of Britain* 364, no. 1526 (2009): pp. 2115–26, available online.

that might have been introduced into the container and absorbed by the plastic, might not be totally removed by the mechanical recycling process, and therefore might leach into the product and be consumed.

Consistency and grade are also issues to be considered when thinking about plastic recycling. Recycled plastic has traditionally not matched the consistency and grade of virgin plastic and is usually traded at lower prices, which limits the value generated from the recycling supply chain.

Quality considerations for recycled plastic output differ according to the polymer and product group, with key differences between polymer types (polyethylene terephthalate (PET), polyethylene (PE), polypropylene (PP), and other product types (food-contact material, other packaging, and film).[83] For PET, the key differentiators of quality are:

- Intrinsic viscosity (IV)—a measure of polymer molecular weight, which, in turn, is a measure of the mechanical strength capability of the material;
- Transparency;
- Suitability for food-contact material;
- Color (and presence of non-target color); and
- Presence of metals, paper, polyolefins, polyamide (PA), and polyvinyl chloride (PVC).

For high-density polyethylene (HDPE) and PP, the key differentiators of quality are:

- Melt-flow index (a measure of the viscosity of the polymer melt at a given temperature, force, and time period);
- Color;
- Odor; and
- Structural characteristics including consistency, and varying according to specific end-uses.

GLASS

Glass is one of the most readily recycled materials in the world. The different properties of glass cullet (broken glasses) relevant to quality, value, and end destination include:

- Physico-chemical composition;
- Color;
- Content of impurities; and
- Homogeneity (variation within the given specification).

Container glass (includes all soda-lime glass) is among the most versatile glass types (along with flat glass cullet) as it can be used to manufacture a large proportion of all glass products. Glass of other physico-chemical compositions (lead crystal tableware, wired glass, glass ceramics, lamp glass, and borosilicate glass) have higher melting points and cannot be used in container glass manufacture.

---

[83] Andy Grant, Mark Cordle, and Eric Bridgwater, *Quality of Recycling – Towards an operational Definition*, Poalo Canfora et al. editors, Luxembourg: Publications Office of the European Union, 2020, available online.

Different contaminants cause different problems for glass quality, if still present beyond low limits when the cullet goes to re-melt. The low limits for contaminants are as follows[84]:

- Ferrous metals: 50 ppm (parts per million);
- Non-ferrous metals: 60 ppm;
- Non-metal non-glass inorganics;
- 100 ppm for cullet size > 1mm (millimeter);
- 1,500 ppm for cullet size ≤ 1 mm; and
- Organics: 2,000 ppm.

The presence of contaminants, such as ferrous metals and organics, above the low limits causes undesirable coloration in the glass products. Non-ferrous metals have high tendency to cause defects in the glass furnace chamber, hence reducing the furnace's operational life. In addition, non-metal, non-glass inorganic materials (ceramics, porcelain, stones, and pyro-ceramics) cause fatal defects in the final manufactured glass products because they have a higher melting point than glass. This may even lead to health hazards for consumers if the product breaks when used.

METAL

Both ferrous and non-ferrous metals can be recycled continuously without changing their properties. However, the current global metal recycling rate is estimated at <50 percent[85]. The challenges of metal recycling lie in how to recover more metal waste for recycling.

The design of many metal products has also played a role in the low rate of metal recycling. Most modern appliances are complex in design, incorporating both metals of different melting points and other non-metal materials in the production of a single product; this leads to complex dismantling procedures that make the recycling of such products uneconomical. For instance, a typical smartphone contains more than 70 different materials including different metals and non-metals. Therefore, dismantling a mobile phone to extract the various materials for reuse in the production of new products becomes a difficult task.[86] Some of the quality requirements for recycled metals are as follows[87]:

- For steel and iron, the total amount of contaminants must not be more than 2 percent by weight, where the contaminants are combustible non-metallic materials, non-ferrous metals, non-conductors of electricity, and residues (for example sludge or dust).
- The criteria for aluminum are similar, but the total amount of contaminants must not be more than 5 percent by weight.

---

[84] Grant et al., *Quality of Recycling: Towards an Operational Definition*.
[85] Due to complexity on measurement and underreporting, precise recycling rates of metals is unknown. Figure used is derived from United Nations Environment Program, "Recycling Rates of Metals: A Status Report, A Report of the Working Group on the Global Metal Flows to the International Resource Panel," 2011, available online.
[86] Rick Leblanc, "An Introduction to Metal Recycling," *The Balance Small Business*, March 4, 2021, available online.
[87] Azo Materials, "The Affects Scrap Metal has on Quality Control Processes," February 11, 2020, available online.

ORGANIC FERTILIZER AND COMPOST

International compost markets have an extremely low tolerance and risk appetite for even trace amounts of heavy metals in compost consignments. Tests are regularly conducted to check for levels of arsenic, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. In economies where effective waste collection, transfer, and segregation systems are challenged by low compliance and awareness rates among waste producers, the ability to produce a scalable compost market is severely challenged by the risk of contaminants entering feedstock supply chains. Even for non-hazardous elements, compost markets are typically very strict. Total "foreign matter" greater than 3mm that exceeds 0.5 percent or 1.0 percent of the compost at dry weight is usually not accepted. For compost consignments that include plastics, total volumes cannot typically exceed 0.3 percent.

- The initial carbon: nitrogen (C:N) ratio of the blended feedstocks should be between 25:1 and 40:1;[88]
- The temperature must remain between 131°F and 170°F for three days in an in-vessel or static aerated pile; or 15 days in windrows, which must be turned at least five times during this period.[89]
- A preferred pH level range of 6 to 7.5.

PROCESSING AND OCCUPATIONAL HEALTH AND SAFETY STANDARDS

There are a wide range of occupational health and safety hazards within WMR value chains that practitioners and policymakers must consider. The International Labor Organization bundles considerations across three core areas: (1) handling and storage; (2) collection and transportation; and; (3) sorting, processing and disposal. The most frequent injuries in the recycling industry include: cuts, abrasions and lacerations; contact with sharp materials; strain lifting; particles that enter the eye; airborne dust and flying objects; repetitive motion and manual sorting.

Occupational health and safety standards are of increased importance in regard to electronic waste management and handling. Contact with fire retardants for plastics—including: TBBA (tetrabromo-bisphenol-A), PBB (polybrominated biphenyls), and PBDE (polybrominated diphenyl ethers)—and heavy metals (including arsenic, barium, beryllium, cadmium, chromium VI, lead, lithium, mercury, nickel, yttrium, europium, selenium, zinc sulphide, americium, and others) pose significant risks with regard to handling, storing, transporting, and safe disposal of such materials.

The impact of COVID-19 has also altered approaches to occupational health and safety practices in WMR value chains. The United States Centers for Disease Control and Prevention (CDC), for example, recommended in 2021 that waste workers follow appropriate infection control measures by using proper personal protection equipment, such as gloves and eye protection. The CDC and Occupational Safety and Health Administration (OSHA) also recommend the use of standard operational controls and personal protective equipment for waste workers given their vulnerability and exposure to diseases particularly in the context of the current pandemic.

---

[88] Monica Ozores-Hampton, "Guidelines for Assessing Compost Quality for Safe and Effective Utilization in Vegetable Production," *American Society for Horticultural Science* 27, no. 2 (2017): pp. 162–65, available online.
[89] Thea Rittenhouse, "Tipsheet: Compost," *National Center for Appropriate Technology*, July 2015, available online.

CASE STUDIES

This report showcases a series of case studies from APEC economies, which highlight sound policies and best practices that have been implemented to improve domestic waste management and recycling practices and infrastructure. While there are significant differences in the geographies, population densities, government capabilities, and waste management challenges across the region, these case studies provide potential solutions that economies could adopt. The case studies are grouped under four areas or categories reflecting the overarching scope of RMPP: (1) policies and regulation, (2) private sector engagement, (3) attracting investment, and (4) enforcement.

POLICIES AND REGULATION TO HARNESS PRIVATE SECTOR DEVELOPMENT

Domestic waste management and recycling policies and regulations often serve as a necessary precursor to strengthening WMR capacities and infrastructure. There are many types of policies and regulations that can improve WMR including:

- **Cross-border measures**, including harmonization classifications for distinguishing recyclable goods and lower tariffs on easier-to-recycle plastics;
- **Domestic measures**, including enabling foreign service providers the ability to offer recycling services within a domestic market; and
- **Transparency measures**, such as publishing domestic restrictions and waste management and recycling data.

Although promoting effective waste management and recycling is important to APEC economies, waste management projects have not been able to attract capital investments and financing, as the return on investments from waste management projects do not compare favorably with the real or apparent risks of implementing such projects.

According to the United Nations Environmental Program and the International Solid Waste Association (ISWA) *Global Waste Management Outlook* report, to achieve best practice, economies need to increase their waste collection rates to 95 percent and above, and spend up to one percent of their gross national income (GNI) on waste management projects. However, many APEC economies spend approximately 0.5 percent and in some cases as low as 0.01 percent of their GNI on waste management projects.[90]

INDORAMA VENTURES

Indorama Ventures, is a company with 119 manufacturing sites in 33 economies crossing six continents, and is listed on the Stock Exchange of Thailand (as of December 2019). Indorama Ventures staff were key respondent for this study. Indorama Ventures Public Company Limited is headquartered in Bangkok and started operations in 1994. It is one of the world's leading producers in the intermediate petrochemicals industry and a global manufacturer of wool yarns. The company has three products categories: feedstock, polyethylene terephthalate (PET), and fibers. The company's objectives are to reduce the amount of waste sent to landfills and incinerators; reduce natural resources consumption; and to increase efficient use of natural resources, thereby saving energy and water and reducing

[90] Asia-Pacific Economic Cooperation, "Overcoming Barriers to Financing Waste Management Systems and Reducing Marine Litter: APEC Policy and Practice Recommendations," November 14-15, 2016, available online.

emissions that contribute to climate change. Indorama Ventures has expressed concern regarding resource depletion requirement for sustainable packaging from its world-class customers by delving into the recycling business. Furthermore, the company has implemented its first corporate social responsibility flagship project to educate children on waste separation at source and plastics recycling. The educational material contained in the company's Recycling Education Program has been used as an accessible tool to explain the subject to children.

During the stakeholder consultation process representatives of Indorama identified several constraints they faced in operating in the global WMR value chain, and, in particular, plastic recycling activities. These include:

- A disconnect between various public sector agencies/ministries and their environmental intentions. For example, one economy had launched a number of policy initiatives to have a portion of all packaging products use recycled polyethylene terephthalate (rPET) or recycled high density polyethylene (rHDPE) in manufacturing. But food, health, and safety authorities in the same economy are still very resistant to certifying rPET and rHDPE industries in the economy to a food-grade level that would allow recycled resins to compete with virgin counterparts.
- The lack of recognition for food-grade rPET and rHDPE, which has had a number of knock-on effects, undermining the value of waste segregation and recycling efforts throughout the value chain—from waste pickers to larger aggregators and waste processors.
- In terms of addressing the constraints, representatives from Indorama suggested that by promoting rPET and rHDPE industries, governments can support commitments to reach carbon neutrality, as these products carry a lower carbon emissions cost to economies than manufacturing with virgin polymers would entail.
- Representatives of Indorama also suggested the need to establish a set of design for recycling guidelines, defined by industry, manufacturing associations, and government to root out difficult to recycle or reuse plastics. Large corporations such as Coca-Cola and Pepsi are making huge commitments to bottle recycling efforts, but Indorama argued that such companies may not be able to meet these targets if sufficient supplies of rPET and rHDPE do not exist.

PROMOTING DIGITAL INTEGRATION IN WMR SUPPLY CHAINS

Digital innovation is still nascent in the waste management and recycling sector. However, as noted earlier, public and private actors in WMR are now rapidly adopting ICT solutions to their advantage. The role and value of digital innovations in the global recyclables commodity market is also abundantly clear and present, whether in the form of a mobile app, an integrated payment system, or the use of AI and machine learning instruments for planning and operational WMR activities. Encompassing some of the most digitally advanced economies in the world, the opportunity for APEC members to support digital solutions in WMR is both a timely and appropriate investment.

The analysis identified a number of challenges associated with the wider adoption of digital solutions in WMR value chains, which could be addressed by APEC via targeted interventions. These include:

- There are limited levels of digital literacy among prospective and new users of mobile or computer-based apps which is a considerable challenge that needs to be addressed. As WMR stakeholders are adopting digital solutions very late and low-cost smartphones have only just begun to be

available and affordable for the urban poor in some contexts, the challenges associated with catching up and learning digital skills are significant. Other constraints include:

  - The high cost of mobile data, particularly where spatial mapping, blockchain, or media files are being uploaded and/or downloaded.
  - The legality of blockchain and mobile money services in certain economies which hinders digital innovation in these areas in its tracks.
  - The apprehension of the informal sector to adopt formal financial services and/or to begin paying taxes. Informal waste workers typically operate in a cash economy and often avoid formal banking or lack access to financial services due to the nature of their work.

- A number of notable applications of digital solutions that respondents presented within their own companies included the following examples:

  - Employing digital solutions for citizen engagement, behavior change education, awareness raising, and training programing. This could, for example, take the form of an educational mobile app or an online course tailored to users in the WMR sector.
  - Employing digital solutions to enhance operational efficiency. This is seen as particularly relevant for the high transport and logistical costs associated with the trade of recyclables and haulage, especially for cities and economies that do not have direct access to deep berth ports.
  - Employing digital solutions to increase the transparency of recyclables trade, and to mitigate waste, crime, and the illegal trade of recyclables. This includes using drone imagery and blockchain, and the publication and real-time updating of price indexes for popularly traded recyclable commodities. It is expected that such applications will become increasingly relevant as the Basel Convention's amendments requires traders to digitize Prior Informed Consent (PIC) procedures for the international trade of waste and recycling commodities.

Most of the current uptake of digital solutions profiled via the study was seen among small scale start-ups, pilot projects, or low-scale trials. The study highlights a summary of examples which are profiled below. For the majority of established WMR stakeholders, the study attempted to analyze and profile organizations that were employing more advanced digital tools such as GIS or financial service applications.

GooGreens (www.googreens.com)

GooGreens is an eco-conscious social enterprise that began a garbage saving bank, also known as Ruammit, in 2011. GooGreens operates a personal waste management system for door-to-door or point-to-point collections, where waste generators can sell their garbage and recyclables in exchange for points that can be redeemed for rewards or cash via the GooGreens application.

KoomKah (https://www.scgchemicals.com/en/products-services/technology-solutions/koomkah)

KoomKah is an application for waste sorting and collecting. It provides waste collectors and waste banks with a more convenient way to record and organize waste types, amounts, and prices. The application allows sorted waste to be sold at good prices and also delivers quality waste to recyclers and enables waste banks by helping them manage and plan waste purchase and logistics efficiently. The application also serves as an additional channel where waste collectors and waste banks can directly sell each type of waste to specific recyclers and incinerators.

BINTARI Foundation.

With support from the United States Agency for International Development (USAID), BINTARI assisted the Semarang city government with policymaking on waste management and recycling, while also improving the practices and capacities of community-organized waste banks, including through digital money mobile phone applications, and through training on business practices and by linking these banks to private sector recyclers and coordinating garbage collection with the city's SWM operation. BINTARI linked waste bank operators with the Indonesia State Bank (BNI) Agen46 program that facilitates access by small- and medium-sized enterprises to banking services such as savings accounts, digital financial services, and e-payment services.

Circularity Assessment Protocol. https://www.circularityinformatics.org/

Applying a circularity assessment of land-based plastic leakage. Partnering with its local subgrantee Save Philippine Seas, the University of Georgia (UGA) implemented its Circularity Assessment Protocol (CAP) in Metro Manila to collect community-level data on plastic usage. The team used the CAP to track litter patterns in 27 sites in Quezon City, Manila City, and Mandaluyong City, all located in Metro Manila and the Manila Bay watershed area. The survey data identified local plastic waste flows (e.g., the types and quantities of plastic waste, waste patterns among areas with varying population densities, and the origins of the plastic), including with the Marine Debris Tracker mobile app. These data are enabling authorities to make decisions on single-use plastic regulations, informing the private sector on the design/utilization of plastic material to enable its reuse, and encouraging urban communities to increase recycling to reduce land-based plastic waste leakage into Manila Bay. UGA provided technical assistance to another USAID grantee, Ecological Waste Coalition (EWC) of the Philippines, to support production of four technical studies on Manila Bay using the data collected by the CAP.

ATTRACTING INVESTMENT IN INDONESIA

Solid waste management implementation happens at the municipality and local level, but local governments across the Asia-Pacific region often lack the resources and support to attract sufficient credit for provincial projects. The inability to attract investment at this level can limit the total flow of capital to the solid waste management and recycling infrastructure and to the sector as a whole in APEC

economies. This report focuses on the investment climate in Indonesia and examines approaches used to attract investment in WMR.

The Indonesian Context

Indonesia is home to several examples of waste management and recycling projects that have successfully secured government support and foreign investment. These include local Waste Banks, the Tridi Oasis Group, and Waste4Change which are detailed below.

Because Indonesia is an archipelago which has over 17,000 islands, the economy's municipalities employ a wide range of waste management infrastructure solutions. Many islands do not have a viable market for, or existing infrastructure support to recycle plastic waste. The transportation costs make it economically inefficient to ship the waste. Due to this lack of infrastructure, Indonesia's government has acknowledged its role as one of the world's largest ocean plastic polluters.[91] The World Bank has reported that "waste management challenges facing Indonesia are formidable, but they are by no means insurmountable" and that "the bulk of Indonesia's challenge to halt marine litter involves addressing its inadequate municipal waste management service provision."[92]

Waste in Indonesia is made up a wide range of materials, and there is still a long way to go to effectively manage and process this waste. The Indonesian Ministry of Environment and Forestry estimates that plastic waste constitutes 11 percent of waste generation.[93] The World Bank estimates that organic waste comprises on average about 63 percent of municipal solid waste, although this figure is lower in larger cities with higher gross domestic product per capita such as Jakarta.[94]

The plastic industry is growing significantly in Indonesia, with a recent measurement of the present plastic consumption at 22.54 kilograms per capita per year. The food and beverage industry is the largest plastic user in Indonesia (60 percent of plastic production) using various types of polymers. The plastic recycling system for some types of plastic materials is quite established, but the National Food and Drug Agency has reported that a majority of plastic packaging products are still considered low value and difficult to recycle, thereby leading to a lower recycling rate.[95] Challenges to waste management infrastructure in particular include upgrading solid waste collection and sorting equipment; strengthening recycling facilities and ensuring there are facilities close to waste sources; and facilitating extended producer responsibility implementation recommendations such as packaging and take back collection.[96]

Four government agencies coordinate on solid waste management in Indonesia: the Ministry of Environment and Forestry (MoEF), the Ministry of Public Works and Housing (MPWH), the Ministry of Development (BAPPENAS), and the Coordinating Ministry of Maritime Affairs (CMMA). But as in many

---

[91] Ministry of Environment and Forest (Indonesia), "National Plastic Waste Reduction Strategic Actions for Indonesia," June 2020, available online.
[92] Iain G. Shuker and Cary Anne Cadman, *Indonesia - Marine Debris Hotspot Rapid Assessment: Synthesis Report,* Washington, DC: World Bank Group, April 1, 2018, pp. 13, available online.
[93] Ministry of Environment and Forest (Indonesia), "National Plastic Waste Reduction Strategic Actions."
[94] Shuker and Cadman, *Indonesia - Marine Debris Hotspot: Synthesis Report.*
[95] Ministry of Environment and Forest (Indonesia), "National Plastic Waste Reduction Strategic Actions."
[96] Ibid.

economies, it is regencies and municipal governments that are ultimately responsible for implementing and enforcing solid waste management.

There are numerous regulations and action plans that guide the government's waste management and recycling efforts, including the Solid Waste Management Act of 2008 and the Environment Protection and Management Law of 2009. The government of Indonesia also more recently adopted Presidential Decree No.97/2017 on a National Policy and Strategy on Management of Household Waste and Household-like Waste (JAKSTRANAS) and Presidential Decree No.83/2018 on marine debris management (Plan of Action on Marine Plastic Debris 2017–2025), which commits Indonesia to reduce marine plastic litter by 70 percent by 2025. In December 2019, the Ministry of Environment and Forestry published Regulation No. P.75/2019 on a roadmap for waste reduction by producers, also known as the roadmap of extended producer responsibility in Indonesia.[97] A redirection of and substantial increase in waste flows from other economies into Indonesia over the past few years has also prompted expansion plans by a number of domestic recyclers, especially of PET, but also HDPE, LDPE, and other higher-value plastics.[98]

Although the economy still faces many hurdles in improving domestic waste management, it has fostered a better enabling environment for private sector investment and foreign investment. This has given Indonesia a strategic advantage in this area. And as a result, Indonesia's impact investing ecosystem has been considered one of the most mature in Southeast Asia.[99] This, in turn, has increased investor confidence in projects overall—including local waste management and recycling projects. The following are three projects and firms in Indonesia that have successfully attracted investment.

Waste Banks

Waste banks in Indonesia are community-based organizations that treat waste as a commodity and allow community members to bring their waste to the bank for the monetary value of that waste, which then can be either paid out or stored in a personal account. The first bank was established in Yogyakarta in 2008. Since then, the total number of banks in Indonesia increased, with over 7,500 banks in 2018 and over 200,000 customers using the banks.[100] The banks are most common in lower- and middle-class communities where the incentives to participate are relatively high, whereas in wealthier neighborhoods citizens are more likely to pay high premiums for waste separation and disposal services.

The expansion of the waste bank model was possible in part because the government of Indonesia encouraged the private sector to finance waste bank programs as part of their corporate social responsibility strategies. As a result, the global corporation Unilever, which is reportedly one of the top plastic polluting businesses in Indonesia, began community involvement programs for improved waste management practices. This has meant investing in community waste banks and publishing a guidebook which includes inspirational success stories from 10 waste banks empowered by Unilever. In 2015, Unilever continued the expansion of the waste bank program into 17 cities and 12 provinces in

---

[97] Ibid.
[98] Circulate Capital, "Investing to Reduce Plastic Pollution in South & Southeast Asia: A Handbook for Action," 2019, available online.
[99] Abhilash Mudaliar et al., "The Landscape for Impact Investing in Southeast Asia," *Global Impact Investing Network and Intellecap*, August 2018, available online.
[100] Ministry of Environment and Forest (Indonesia), "National Plastic Waste Reduction Strategic Actions."

Indonesia. According to the company, the program supported 1,258 waste banks with a total of 55,000 members, reportedly absorbing over 3,700 tons of inorganic waste.[101]

It is estimated that waste banks' total reduction impact against all waste generation in Indonesia was 2.37 percent in 2018, and that waste banks have served as important triggers to promote better community education and waste management habits in the areas where the banks have been established.[102] Many waste banks have sustained their operations over years and are generating profits, such as the Satu Hati Waste Bank in West Jakarta which has generated over Rp 7.2 billion (US$511,736) in profits since its founding in 2017.[103] In practice, there are four business models of waste banks implementation in Indonesia; savings, health, community entrepreneurship, and energy. The varying business models are adjusted to best fit community needs, and this in turn improves financial sustainability of the banks.[104]

Waste banks are a good example of localized waste management solutions that require only minimalist infrastructure. The government of Indonesia has been supportive of waste banks as an alternative solution to the reduction of waste dumping, as evidenced by the mandate of Law No. 18 of 2008 on Waste Management.[105] By creating a selling value for waste, supporting investment in the banks, and demonstrating that many waste banks can be profitable, Indonesia has managed to attract private sector investment and funding for waste management solutions. The waste bank is a good example of how governments can help design and replicate opportunities for investment.

Tridi Oasis Group

Tridi Oasis Group is a women-owned company established in 2016, focused on processing plastic bottles. A significant portion of PET bottles in Indonesia are not recycled as a result of inadequate collection or contamination-related losses during the recycling process, signifying a crucial gap in the waste management chain. Tridi Oasis has established new recycling plants and the necessary infrastructure to address this gap, turning common plastic bottles into recycled polyethylene terephthalate (rPET) flakes that then get reused in packaging and textiles.

Tridi Oasis secured financing through foreign investment from Circulate Capital, a Singapore-based investment management firm, as part of a larger US$106 million investment into recycling companies. In detailing its reasons for investing in Indonesia, Circulate Capital references a 2018 Presidential Mandate that allows for 100 percent of foreign ownership of entities operating in waste management as a motivating factor for providing investment in the solid waste management sector.[106] The investment was also made in the form of debt financing, with 50 percent of the loan guaranteed by the United States International Development Finance Club (IDFC) in collaboration with USAID. Founder and CEO of Tridi

---

[101] Unilever Indonesia, "Unilever Environment Programme: The Need of Waste Management," 2020, available online.
[102] Ministry of Environment and Forest (Indonesia), "National Plastic Waste Reduction Strategic Actions."
[103] Ibid.
[104] Wawan Dhewanto et al., "Analysis of the Business Model of Waste Bank in Indonesia: A Preliminary Study," *International Journal of Business* 23, no. 1 (2018), pp. 73-88, available online.
[105] Ibid.
[106] Circulate Capital, "Investing to Reduce Plastic Pollution in South & Southeast Asia."

Oasis group, Dian Kurniawati, planned to use additional funding to build a larger recycling facility outside Jakarta, which will help the company to scale and expand its capacity.[107]

Since 2018, Tridi Oasis has processed approximately 60 million PET bottles per year. It works with the local supply chain to separate plastic waste with other material, and later the rPET flakes are distributed to consumer packaged-goods companies and textile producers.[108] The company is also considering expanding to process low-value plastics such as multilayered plastic or flexible plastic packaging like sachets, since those types of products more often end up in landfills or in rivers and the Pacific Ocean. In the long term, Tridi Oasis aims to increase its business activities, strengthen its business model, and replicate it in other locations.[109]

Waste4Change

Waste4Change is a collection and sorting infrastructure company that is growing collaborative and technology-based waste management services across Indonesia. Bijaksana Junerosano, the organization's founder, partnered with EcoBali Recycling to establish Waste4Change in 2014. Through this partnership, the company established its first material recovery facility in East Bekasi, Indonesia in 2015 and launched an extended producer responsibility program in 2016.[110]

Waste4Change has managed to grow significantly because of both domestic and foreign investment made possible through Indonesia's hospitable investment environment. After its initial launch and seed funding, Waste4Change has also acquired investment from the Indonesian and Japanese venture capital firms Agaeti Venture Capital, East Ventures, and Sinar Mas Digital Ventures (SMDV). In 2018, Waste4Change was selected as a social entrepreneurship finalist in the Social Venture Challenge Asia led by the Development Bank of Singapore Limited (DBS), a Singaporean multinational banking and financial services corporation; this led to future collaborations with DBS.

Waste4Change now has two principal revenue streams: consulting on responsible waste management, and collecting, sorting, and selling organic and inorganic municipal solid waste. Waste4Change operates household waste collection and treatment service that is tipping fee based, but also works with large firms on a client basis.[111] It is a case study on how waste management companies can grow quickly and be advisable investments with the right investment ecosystem.

ENFORCEMENT IN CHINESE TAIPEI

While policies and regulations are the framework for establishing domestic waste management and recycling practices, successful implementation of these practices relies on enforcement. Because enforcement often differs across municipalities, economies often exhibit varying levels of collection and processing of waste across different neighborhoods and cities. This is despite these localities falling

---

[107] The Star, "Indonesian Plastic Recycling Company Looks to Expand as Circular Economy Blooms," May 8, 2020, available online.
[108] Ibid.
[109] Ibid.
[110] Waste4Change, "Waste Management Startup, Waste4Change, Receives Investment from Agaeti Ventures and Partners," March 9, 2020, available online.
[111] Circulate Capital, "Investing to Reduce Plastic Pollution in South & Southeast Asia."

under the same economy-level regulations and action plans. For this reason, local enforcement is a critical element of the Asia-Pacific's larger waste management and recycling effort.

Chinese Taipei Context

Over the past several decades, Chinese Taipei has transitioned from an economy with relatively weak waste management enforcement to a global leader in waste management and recycling adherence, including collecting and sorting at the municipal level and the household level.

Chinese Taipei has developed an efficient WMR system that emphasizes community engagement and enforcement to ultimately generate more recyclable waste than non-reusable waste. Two major policies led to a significant change in waste management and recycling: plastics restrictions and economy-wide compulsory waste sorting. This two-pronged approach served to reduce the total amount of waste generated and reduce the volume of plastic pollution.[112]

In the 1980s and 1990s, Chinese Taipei was facing public challenges in designating further sites for waste landfills and the building of large incineration plants. As a result, local governments felt pressured to explore and create new recycling measures and infrastructure as an alternative approach to managing waste.[113] In 1997, the Waste Management Disposal Act as passed to support a formalized waste-recycling campaign.[114] This legislation designated the creation of a 4-in-1 recycling program that integrated the island's recycling facilities into a broader network and established a fund using fees levied on manufacturers and importers for subsidizing further waste management and recycling initiatives.[115] Chinese Taipei also implemented a plastic restriction policy in 2002. This policy included restrictions on the use of plastic shopping bags and disposable plastic silverware in all public facilities, including shopping centers, supermarkets, and convenience stores.[116]

In 2006, a compulsory economy-wide waste sorting program was launched to further augment the household recycling rate. Sorting of household waste into three different categories—organic waste, recyclables, and non-recyclable waste—became mandatory everywhere. Recyclable materials to be sorted included iron, aluminum, plastic containers, paper products, batteries, tires, lubricants, certain electronic appliances, and light bulbs.[117]

In the early 2000s in Chinese Taipei, the average citizen generated 1.20 kilograms of daily waste. By the late 2010s, as a result of these policies and more effective enforcement mechanisms, the average citizen produced only 850 grams, marking a noticeable decline. This was in sharp contrast with most other economies that were experiencing increases in waste generation. Chinese Taipei's total recycling rate doubled from 2002 to 2010, reaching 38 percent at the end of the decade.[118] The economy passed the

---

[112] Chung-Ling Chen, "Regulation and Management of Marine Litter," *Marine Anthropogenic Litter* (2015): pp. 395-428, available online.
[113] Jane Rickards. "From 'Garbage Island' to a Model of Recycling," *Taiwan Business Topics*, October 23, 2019, available online.
[114] Chen, "Regulation and Management of Marine Litter."
[115] Rickards, "From 'Garbage Island' to a Model of Recycling."
[116] Chen, "Regulation and Management of Marine Litter."
[117] Ibid.
[118] Marcello Rossi, "How Taiwan Has Achieved One of the Highest Recycling Rates in the World," *Smithsonian Magazine*, January 3, 2019, available online.

Environmental Education Act in 2011, requiring all high school students, as well as government employees, state-run enterprises, and statutory bodies receiving funding from the government, to attend at least four hours of environmental education courses.[119] This led to a much deeper understanding of individual waste management responsibilities and best practices. It also helped Chinese Taipei establish the collection process as a community ritual with widespread involvement.

By 2015, there were more than 1,600 recycling companies in operation on the island, generating US$2 billion in annual revenues.[120] Overall, Chinese Taipei now generates more recyclable waste than non-reusable waste.[121] It is home to one of the world's most efficient recycling programs, claiming 55 percent of waste collected from households and commercial use and 77 percent of industrial waste.[122]

Enforcement Strategies

There are a range of strategies that Chinese Taipei employs to strengthen local WMR practices and enforcement. The first major strategy is establishing waste management as a community practice and educating citizens on how to properly deal with waste at the household and commercial levels. This leads to better individual knowledge about how to sort household waste and serves to build a sense of community responsibility and ownership over the processes of waste management.

Intensive collection infrastructure with clear guidance for citizens helps to ensure that waste is properly disposed of. Waste collection in Chinese Taipei is routine, with active engagement expected from citizens. Distinguishable classical music from collection trucks alerts residents to bring their sorted waste out to the street, already separated into recyclable materials and non-reusable waste. A yellow collection truck collects non-reusable waste, while a smaller white truck behind contains a variety of bins into which people can deposit organic waste and recyclable materials.[123] Consumers are required to ensure that any recyclable items in their waste piles are properly separated and that all recyclable materials are delivered to the second truck. Volunteers and municipal officials also help citizens sort their waste properly.

The waste management and recycling fund established through the 4-in-1 Recycling Program also subsidizes the collection of recyclable materials and their processing through licensed enterprises, as managed by Chinese Taipei's Recycling Fund Management Board of the Environmental Protection Administration (EPA). The fund subsidizes the resale of unprofitable secondhand items and scrap. There are 13 categories for the 33 items that are eligible for subsidies if resold by licensed companies. They include aluminum and glass containers, discarded automobiles, motorcycles, televisions, light bulbs, and laptops. Manufacturers and importers of the 33 items, as well as the creators of their packaging and containers and producers of certain raw materials, are all required to register with the EPA and pay recycling fees into the fund.[124]

---

[119] Rickards, "From 'Garbage Island' to a Model of Recycling."
[120] Rossi, "How Taiwan Has Achieved One of the Highest Recycling Rates in the World."
[121] Ibid.
[122] Ibid.
[123] Ibid.
[124] Rickards, "From 'Garbage Island' to a Model of Recycling."

Collected materials are then sent to facilities where they are sorted, and recyclable materials are sent to companies to be processed. Some nonrecyclable waste is sent to landfills or incinerated. [125] The organic scraps collected by the trucks are eventually processed into compost or pig feed.[126]

The second strategy is disincentivizing improper waste management at the individual level through punishments or fees. Because waste collection is well-organized with clear directives and careful monitoring, local authorities can track community members who are not following the local waste management guidelines. Improper sorting or disposing of solid waste and recyclables therefore carries a higher risk of receiving an enforceable fine or punishment, incentivizing citizens and businesses to be intentional in their disposal of all types of recyclables and nonrecyclable waste.

The EPA has noted that for effective domestic waste management, local governments need to educate the public to support 3R approaches. Authorities also need to ensure that proper waste disposal sits firmly in the public consciousness.[127] Those caught trying to get rid of waste improperly may risk fines and public notices of noncompliance. Fines for placing discarded recyclables into the regular collection truck or not properly sorting waste can range from NT$1,200 to NT$6,000 (US$40 to US$210).[128]

There are also other incentives used to discourage non-recyclable waste and encourage recycling. The city of Taipei requires that waste be disposed of in designated color-coded plastic bags. The bags are available for purchase from convenience stores, with prices varying according to size. Charging a fee for the bags is purposeful, to provide a disincentive to create waste and to impose a "polluter-pays system." The system thereby also encourages recycling, as recyclable materials can be placed in disposal bags for free.[129] In another experimental innovation, the city of Taipei has also installed a smart recycling booth that adds value to a citizen's transit access card for every recyclable bottle or can deposited. [130]

Enforcement, clear directives, community education, and economic incentives all help to shape an effective waste management and recycling system in Chinese Taipei.

---

[125] Rossi, "How Taiwan Has Achieved One of the Highest Recycling Rates in the World."
[126] Rickards, "From 'Garbage Island' to a Model of Recycling."
[127] Rossi, "How Taiwan Has Achieved One of the Highest Recycling Rates in the World."
[128] Rickards, "From 'Garbage Island' to a Model of Recycling."
[129] Ibid.
[130] Rossi, "How Taiwan Has Achieved One of the Highest Recycling Rates in the World."

STUDY RECOMMENDATIONS

There is significant potential for APEC members to address the problem of plastic pollution; develop appropriate policy levers to effectively reduce, recycle, reuse, and recover waste; and facilitate trade in new technologies and collectively promote appropriate recycling and recovery solutions. Leveraging work undertaken to date while examining emerging, cutting-edge solutions to achieve concrete, sustainable actions can guide effective WMR solutions. Therefore, the following recommendations are proposed based on the study's findings:

RECOMMENDATIONS:

1. **Based on the information contained in this report and leveraging existing knowledge and practices, develop a list of practices and technologies that can drive robust policy responses to support cutting-edge, innovative recycling and recovery practices in WMR value chains in the Asia Pacific region[131].**

The limited application of existing knowledge, best practices and financing efforts to support cutting-edge and innovative WMR practices risks undermining the entrepreneurial potential of APEC members. To address this, increasing members' awareness through knowledge sharing of emerging innovative recycling and recovery policies and practices can drive appropriate policy and investment decisions in the Asia Pacific region.

A dynamic and discretionary approach may be employed by economies to adopt emerging and innovative waste management, recycling and treatment applications being pioneered in some contexts. For example, advanced forms of food contact grade / bottle-to-bottle recycling processes to produce recycled polyethylene terephthalate (rPET) and recycled high density polyethylene (rHDPE), could be solutions that can provide economies with potentially viable opportunities to further invest in sustainable non-virgin petrochemical manufacturing. However, this nascent approach that has not been considered widely across APEC member economies by food-grade certification authorities due to a host of reasons - including the lack of technical knowledge of emerging technologies and limited policy direction. An enhanced understanding of risks, cutting edge, innovative recycling and recovery solutions such as this could enable APEC economies to take further steps to increase non-virgin polymer usage across fast moving consumer goods value chains and food contract packaging.

The adoption of such practices should be underpinned by appropriate public policy and robust governance arrangements. For example, a coordinated approach to the development and implementation of government policy responses that recognize recyclers who are operating clean and safe technologies in the WMR value chain, are needed. In addition, further recognition and support for new innovations through targeted information sharing, branding and marketing campaigns will also help to manage the misplaced "not in my back yard" (NIMBY) sentiments from the public.

[131] The information contained in this report focuses on basic, long-standing WMR practices and technologies which can inform practices in the various APEC economies and be adopted based on context specific needs.

2. Promote clearer materials quality standards for plastics, paper, and organics.

One of the key recommendations of this report is for APEC members to promote the establishment of transparent, consistent and comprehensive recycled material standards by driving a suite of legislative, voluntary and industry led policy initiatives which leverage best practice examples from existing regional and global frameworks.

While acknowledging voluntary and other standards that are already out there, and also considering challenges involving plastic standardization (such as the use of various plasticizers and other proprietary inclusions) exploring ways of developing approaches to support a practical, informed, and dynamic set of quality standards for recyclable commodities is essential to foster industries' efforts in this space. Transferring these quality standards to all plastics—most notably, opaque plastics and plastics that have been manufactured using fillers like calcium carbonate—is also an approach that can be adopted to enhance waste recycling rates in APEC economies.

3. Improve the financial sustainability of WMR investments by improving ways of securing public expenditure.

Waste management efforts suffer from chronic underinvestment in infrastructure and underfunding for collection services in developing economies. This is mainly at the municipal level. There are also capital expenditure needs of waste management and recycling infrastructure in developing economies which are twin challenges to be addressed to improve sustainable WMR practices.

The challenges with securing ongoing recurrent and operating expenditures at the municipal level to ensure the long-term sustainability of new WMR infrastructure investments supported under public-private partnerships is a critical challenge facing developing economies. As this capital expenditures / operating expenditures (CAPEX/OPEX)[132] disconnect often occurs at the municipal level, broader coordination between domestic, regional, and local authorities on both pipeline and active public-private partnerships could help mitigate funding shortfalls for key infrastructural assets.

A popular mechanism to help local authorities sustain the costs of domestically financed infrastructural development is to grant them the authority to 'ring-fence[133]' revenue collected locally (e.g., property rates, local taxes, environmental fees, and levies) for expenditure on relevant environmental planning expenses.

Ring fencing is particularly important where standard recycling business models cannot support sustainable solid waste collection or recycling services based on user fees alone. For example, in island economies, remote tourist destinations or smaller economies where the scales of economy do not lend themselves to strong private sector engagement and investment, the absence of public subsidies for operational expenses can often lead to no recycling services existing at all. Because properties and activities frequented by tourists normally produce large amounts of single-use plastics and nonrecyclable waste and these tourist locations are normally far away from industrial cities or commercial centers, the costs of extracting the recyclables and forwarding them to relevant markets can become prohibitive. Further, this type of

[132] CAPEX (Capital Expenditure); OPEX (Operational Expenses)
[133] Ring-fence is referring to formal guarantee that funds allocated for a particular purpose will not be spent on anything else.

initiative could be implemented alongside EPR schemes to provide a regulatory clarity on the responsibility within waste producers and WMR actors on solution design, development and implementation.

4. **Develop one-stop-shop agencies in economies to coordinate investments and public-private partnerships to support WMR.**

Explore the potential benefits of establishing "one-stop shops" to facilitate a practical approach to implement more conducive definitions, materials quality standards, and tailored subsidy instruments. The importance of a solution of this nature for the Asia Pacific region cannot be understated. By aggregating relevant governmental standards and enforcement authorities under the same roof to facilitate effective and timely intragovernmental coordination and to streamline approval processes for prospective and active public-private partnerships, the one-stop-shop investment model can be perceived as the so-called silver bullet of investment incentives. For example, in the Philippines, a Public-Private Partnerships Center, which serves as a central coordinating and monitoring agency for all public-private partnership projects, has facilitated 17 waste management public-private partnership projects as of 2017.

5. **Explore the potential of digital solutions to support effective waste management services, enforcement mechanisms, and quality control.**

The research undertaken as part of this study indicates that the future of effective waste management services, enforcement and quality control lie in innovative digital solutions. The study highlights several examples of cutting-edge solutions that can be adopted and replicated in APEC economies. There is considerable potential in promoting initiatives that can help the integration of appropriate digital solutions to improve WMR. Supporting economies to integrate digital solutions into WMR service provision, compliance, enforcement, and quality control can lead to substantial transparency and efficiency gains in public and privately derived services. Whether through the integration of basic GIS tracking services for transport and route planning or the indexing of commodity prices on a public, digital, mobile app to realize greater inclusivity in WMR value chains, the benefits of digital integration in the WMR supply chain are clear.

6. **Support new policy, legislative and regulatory developments**

Over half a dozen respondents noted they are currently or imminently planning to launch substantial legislative and regulatory updates or reviews related to waste management and recycling approaches. APEC members should invest in knowledge sharing initiatives between developed and developing economies and the provision of targeted technical assistance.

CONCLUSION

The study clearly demonstrates that APEC members are committed to improving effective waste management in the Asia-Pacific region. The pathway to action – which includes adopting appropriate and new legislative frameworks, technologies, or infrastructure—is clear. Solutions, a number of which have been outlined in this report, are achievable and economically advantageous when compared to a business-as-usual approach.

Supporting sound policy, legislative practices and regulatory reforms and innovations are particularly relevant in the APEC context and the study findings indicate that many economies are currently actively revamping legislative and regulatory frameworks, from white papers and master plans to new Integrated Solid Waste Management (ISWM) plans and Extended Producer Responsibility (EPR) mechanisms. These policy resources, if well targeted and carefully designed, can help to streamline decision making and enhance the efficiency of the operational governance and enforcement of localized service provision.

These new policy, legislative and regulatory overhauls are encouraging. The developments represent timely opportunities for members to take meaningful action—setting a precedent for innovation, private sector engagement, and investment facilitation for decades to come. The legislative recognition and support for clean, cutting-edge recycling and recovery practices, as one example, is a critical opportunity.

Promoting entrepreneurial potential in the WMR value chain and creating a policy environment conducive to guide innovation is essential to APEC members in meeting their own environmental targets or broader commitments. Economies should ensure that restrictive legislation does not hinder prospective investors working to provide a basic public utility service on behalf of a public authority.

The analysis also clearly demonstrated that technology and digital solutions have an exciting future in WMR value chains, from helping public authorities to increase transparency and diversify payment models, to helping the private sector harness the supply chain advantages of spatial mapping and GIS instruments.

APEC members are very well positioned to leverage APEC's convening power to work alongside other global multilateral and regional organizations including ASEAN and the United Nations to enhance WMR efforts. Leveraging sound practices that are tried and tested and harnessing new knowledge can help to lead the way to pioneer innovative waste management and recycling (WMR) solutions in the region and beyond.

APPENDIX A: APEC SURVEY

SURVEY QUESTIONS

1. Policy and Legislation

a. What is in the "regulatory/legislative/policy framework pipeline" in your economy? For example, are you working on white papers, large city masterplans, or new directives or regulations, to better address waste management and recycling (WMR) challenges in your economy? **Please explain in detail and reply, YES or NO, below.**

   i. An Integrated Solid Waste Management Plan (ISWMP)
   ii. A government-led waste characterization or composition study
   iii. A proposed, in-development or recently announced extended producer responsibility (EPR) initiative or regulation
   iv. A new policy or regulation to facilitate domestic and/or international trade of recyclables (e.g., the designation of a special-economic zone, tax holidays, or subsidies)

b. How does your economy support key legislation, regulation, or policy through communications and enforcement mechanisms? **Please explain in detail and reply, YES or NO, below.**

   i. Does your economy run government-led community awareness programs and behavior change communication campaigns via social media?
   ii. Does your economy have enforceable mechanisms for the improper sorting and recycling of waste (e.g., fines, penalties, or criminal offenses)?
   iii. Are the fines and penalties higher for offenses relating to electronic waste types (e.g., electronic waste being disposed of improperly)
      a. What public authorities are responsible for monitoring and issuing fines and penalties for environmental offenses (e.g., littering, not sorting e-waste)?

2. Private Sector Engagement

a. Does your economy formally recognize the role of waste pickers?

b. Does your economy have a specific strategy or approach to promote innovation among small and medium-sized enterprises (SMEs), start-ups, and global corporations that provide WMR services? **Please explain in detail and reply, YES or NO, below.**

   i. A "one stop shop" to facilitate and expedite registration and incorporation of new companies and incentivize investments, of any size.
   ii. Grant financing (e.g., via innovation competitions)
   iii. Tax incentives or waivers, for start-ups or small and medium sized enterprises (SMEs) providing WMR services or importing technologies to recycle waste.
   iv. Broader engagement with global corporations to source private investments or capital in WMR services?

c. Does your economy require special licenses, training or quality monitoring for private companies that wish to manage or recycle electronic waste?
d. Does your economy coordinate or cooperate with other economies to manage and/or recycle electronic waste?
    i. How does your economy certify or verify that waste imports/exports will be managed/recycled in an environmentally sound manner?

3. Attracting Investment

a. What are some of the success stories from your economy in attracting large-scale investment from the private sector and global corporations? Have you been able to attract domestic or international investment to help finance? **Please explain in detail and reply, YES or NO, below.**

    i. Electronic waste management (safe disposal) or recycling facilities.
    ii. Materials recovery facilities (MRFs)
    iii. Chemical recycling facilities
    iv. Waste-to-energy (WtE) technology and infrastructure
    v. Large-scale composting (black soldier fly (BSF), effective microorganisms (EM-1), vermicomposting, windrow)
    vi. Carbon trading and credit schemes

b. What are some of the success stories from your economy in setting up basic public-private partnerships (PPPs) for the provision of waste management, recovery and recycling services?

c. Has your economy helped facilitate foreign direct investment in relation to:

    i. Export processing or special economic zones (EPZ, SEZ) for the processing, valorization, value-addition or export of high-grade recyclables.
    ii. Trade-facilitative incentives (e.g., Harmonized System (HS) codes, import/export duties)
    iii. Tax waivers, holidays, rebates, (e.g., value-added tax (VAT), import duty relief, business tax)
    iv. Foreign ownership (e.g., exclusive foreign ownership, work permits)

d. How does your economy publicly invest in solid waste management, recovery, and recycling services? Popular options might include:

    i. The cross-subsidization of collection or disposal services (e.g., charging wealthier areas a premium for waste collection to subsidize lower income residential areas).
    ii. The ringfencing of special revenues (e.g., new tax instrument, fines, and penalties for littering) for expenditure on WMR expenses or investments.
    iii. The provision of central government level subsidies to local municipalities, where localized taxes (e.g., property rates) cannot cover the cost-of-service provision.

The bundling of utility charges (e.g., water, electricity, and waste are charged together) to reduce administrative costs and combat citizen apathy.

APPENDIX B: CATEGORIES OF PLASTICS

Resin Identification Number	Resin	Resin Identification Code – Option A	Resin Identification Code – Option B	Description
1	Polyethylene terephthalate (PET)			PET is from the polyester family and is used in beverage, food, and other liquid containers. It can be semi-rigid to rigid and is very lightweight. It acts as a good barrier to alcohol (requires additional "Barrier" treatment) and solvents. It is strong, impact-resistant, and naturally colorless and transparent. Common uses: soft drink bottles, cooking oil bottles, peanut butter jars, products containing essential oils, some fruit juices, alcohol beverage bottles, and space blankets.
2	High density polyethylene (HDPE)			HDPE is made from petroleum and has a stronger intermolecular force and tensile strength than low-density polyethylene (see below). It is also harder and more opaque, and can withstand somewhat higher temperatures: 120 °C for short periods, 110 °C continuously. Common uses: milk jugs, distilled water, large vinegar bottles, grocery bags, liquid laundry and dish detergent, fabric softener, motor oil, antifreeze, bleach, and lotion.

Resin Identification Number	Resin	Resin Identification Code – Option A	Resin Identification Code – Option B	Description
3	Polyvinyl chloride (PVC)			Nearly 57 percent of PVC is chlorine, requiring less petroleum than other plastics. PVC is biologically and chemically resistant. It is the third-most widely used plastic after PET and polypropylene. PVC is ideal for storing shampoos, oils, and other chemicals. PVC plastic bottles are durable for long periods of time and can withstand various environmental demands. Common uses: chemical spray bottles, pipes, electrical wire insulation, clothing, bags, upholstery, tubing, flooring, waterbeds, pool toys, and bottles.
4	Low-density polyethylene (LDPE)			LDPE is made from oil. Its tensile strength and density are lower, but its resilience is higher than high-density polyethylene. It can withstand temperatures of 80 °C continuously and 95 °C for a short time. It can be translucent or opaque; it is flexible, tough, and almost unbreakable. Common uses: dry-cleaning bags, produce bags, trash can liners, food storage containers, bread bags, squeezable containers, six-pack soda can rings, and food storage.
5	Polypropylene (PP)			PP is often used for food packaging. It is not as tough as HDPE, but it is less brittle. PP is less flexible than LDPE, somewhat stiffer than other plastics, reasonably economical, and can be translucent, opaque, or of any color. PP has very good resistance to fatigue. PP has a melting point of 320 °F (160 °C). Food containers will not melt in the dishwasher nor during industrial hot filling processes.

Resin Identification Number	Resin	Resin Identification Code – Option A	Resin Identification Code – Option B	Description
				Common uses: bottle caps, drinking straws, hinged containers, battery cases, dairy tubs (e.g., sour cream, cottage cheese), and cereal box liners.
6	Polystyrene (PS)			Polystyrene is made from petroleum. Pure solid polystyrene is a colorless, hard plastic with limited flexibility. It can be cast into molds with fine detail. Polystyrene can be transparent or can be made to take on various colors. Common uses: bottle caps, drinking straws, yogurt cups, clear carryout containers, vitamin bottles, fast food, spoons, knives and forks, hot cups, meat and produce trays, egg cartons, clamshell carryout food containers.
7	Other resins			This is the catch-all category of all other plastics. Many biodegradable, photo-sensitive, and plant-based plastics fit in this category. Basically, any plastic that is not HDPE, LDPE, PET, PVC, PS, or PP is put into this category. Additionally, any plastic resin type that has been developed since the original six resin types were established in 1988, are marked with the 7 or other resin identification code. As such, listing common uses for these kinds of plastics is nearly impossible since their applications and characteristics are so diverse.

Source: Waste4Change, "7 Types of Plastic that You Need to Know," available online.

APPENDIX C: HARMONIZED SYSTEM (HS) TRADE CODES

Waste Typology	HS Code	Description
Plastics	39011090	Polyethylene with a specific gravity of < 0.94 kg/m³ (kilogram per cubic meter), in primary forms (excluding linear polyethylene)
Plastics	39021000	Polypropylene, in primary forms
Plastics	39031100	Expansible polystyrene, in primary forms
Plastics	39031900	Polystyrene, in primary forms, excluding expansible polystyrene.
Plastics	39041000	Polyvinyl chloride, in primary forms, not mixed with any other substances.
Plastics	39076100	Polyethylene terephthalate, in primary forms, having a viscosity number of >= 78 ml/g (milliliters per gram).
Plastics	39076900	Polyethylene terephthalate, in primary forms, having a viscosity number of < 78 ml/g.
Plastics	39033000	Acrylonitrile-butadiene-styrene copolymers (ABS), in primary forms.
Paper	47062000	Pulps of fibers derived from recovered "waste and scrap" paper or paperboard.
Paper	47071000	Recovered "waste and scrap" paper or paperboard of unbleached kraft paper, corrugated paper, or corrugated paperboard.
Paper	47072000	Recovered "waste and scrap" paper or paperboard made mainly of bleached chemical pulp, not colored in the mass.
Paper	47073010	Old and unsold newspapers and magazines, telephone directories, brochures, and printed advertising material.
Paper	47079010	Unsorted, recovered "waste and scrap" paper or paperboard (excluding paper wool).
Paper	48021000	Handmade paper and paperboard of any size or shape.
Paper	48025620	Uncoated paper and paperboard, of a kind used for writing, printing, or other graphic purposes, and non-perforated punch cards and punch-tape paper, in rectangular sheets with one side measuring 297 mm and the other side 210 mm A4-format, not containing fibers obtained by a mechanical or chemi-mechanical process.

Waste Typology	HS Code	Description
Paper	48131000	Cigarette paper in the form of booklets or tubes.
Paper	48171000	Envelopes of paper or paperboard (excluding letter cards).
Paper	48172000	Letter cards, plain postcards, and correspondence cards, of paper or paperboard (excluding those with imprinted postage stamps).
Non-ferrous	76011000	Aluminum, not alloyed, unwrought.
Non-ferrous	76010011	Turnings, shavings, chips, milling waste, sawdust, and filings of aluminum; waste of colored, coated or bonded sheets and foil of a thickness "excl. any backing" of <= 0.2 mm.
Non-ferrous	76020090	Scrap of aluminum (excluding slags, scale, and the like from iron and steel production, containing recoverable aluminum in the form of silicates, ingots, or other similar unwrought shapes, of remelted waste and scrap of aluminum, and ashes and residues from aluminum production).
Non-ferrous	74040010	Waste and scrap of refined copper (excluding ingots or other similar unwrought shapes, of remelted refined copper waste and scrap, ashes and residues containing refined copper, and waste and scrap of primary cells, primary batteries and electric accumulators).
Ferrous	72041000	Waste and scrap of cast iron (excluding radioactive).
Ferrous	72042110	Waste and scrap of stainless steel containing by weight >= 8 percent nickel (excluding radioactive, and waste and scrap from batteries and electric accumulators).
Ferrous	72042900	Waste and scrap of alloy steel (excluding stainless steel, radioactive or waste and scrap from batteries and electric accumulators).
Ferrous	72043000	Waste and scrap of tinned iron or steel (excluding radioactive, and waste and scrap of batteries, and electric accumulators).
Glass	70010010	Cullet and other waste and scrap of glass (excluding glass in the form of powder, granules, or flakes)
Glass	70010099	Glass in the mass (excluding optical glass). Unbroken glass.

Source: European Customs Portal, available online.

APPENDIX D: WASTE MANAGEMENT TERMINOLOGIES

WASTE TERMINOLOGIES	
TERMINOLOGY	**DEFINITION**
Compost, composting	The conversion of the biodegradable organic matter in solid waste into a material which can be used by farmers and horticulturists for soil improvement and, to a lesser extent, fertilizing crops.
Co-composting	The addition of other materials such as sewage sludge to the composting material to increase the fertilizing benefits.
Construction and demolition debris	Waste derived from the construction or demolition of buildings including concrete, brick, stone, etc., with some wood and steel reinforcing.
Disposal	Defined as all actions concerned with placing waste and residues in their final resting place. Disposal in many economies generally means crude or open dumping, but this method of disposal is unsatisfactory because of the pollution of air, water, and land that it causes. Satisfactory methods of disposal are known as sanitary landfilling.
Hazardous solid waste	Any waste that requires special handling or treatment during or before disposal because of its reactive, toxic, corrosive, inflammable, or explosive nature. In many economies, legislation defines which wastes are hazardous. Some items that may be found in household wastes are hazardous, but the larger sources are industries and healthcare facilities (such as hospitals and clinics).
Incineration	The combustion of waste at high temperatures and in controlled conditions so that the volume of the resulting ash is as small as possible, and the resulting air and water pollution are minimized.
Municipal solid waste	Unwanted materials and items (that are not discharged from the premises in a pipe) that originate in homes, shops, offices, and institutions, and in streets and public places. This category may include solid wastes that are not more hazardous than domestic wastes and that originate in small industries and medical facilities.
Solid waste	There are many complex legal definitions of solid waste. For the purposes of this report, solid waste is defined as any item or material that is discarded by its owner and that is not discharged in gaseous form to the atmosphere, to a pit latrine, or via a pipe or channel. Solid waste may include gases and liquids in containers.
Solid waste management	This encompasses all the activities undertaken or required to minimize the impact of solid waste on health, the environment, the economy, and aesthetics.
Recycling	The returning to the economy of items or materials that someone else has discarded. The stages involved in recycling may include picking, transporting, trading, sorting, cleaning, and processing. In some cases, manufacturing may also be included. Reuse of items for the same purpose that they were originally used for (such as soft drink bottles) is also included.

WASTE TERMINOLOGIES	
TERMINOLOGY	**DEFINITION**
Waste	A term for unwanted items or materials. Synonyms include: garbage, refuse, trash, and rubbish. Also defined as materials for which the initial user has no further use in terms of his/her own purposes of production, transformation, or consumption, and of which he/she wants to dispose. Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. Residuals recycled or reused at the place of generation are excluded.
Sewage	Defined as water-carried waste, in solution or suspension, that is intended to be removed from a community.
Waste management	The collection, transport, recovery, and disposal of waste, including the supervision of such operations and the after-care of disposal sites, and including actions taken as a dealer or broker.
Recovery	Any operation that principally results in waste serving a useful purpose by replacing other materials that would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the factory or in the wider economy.
Treatment	Recovery or disposal operations, including preparation prior to recovery or disposal.
Waste-to-energy / energy-from-waste	The conversion of non-recyclable waste materials into useable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolization, anaerobic digestion, and landfill gas (LFG) recovery.
Anaerobic digestion	A process through which bacteria break down organic matter—such as animal manure, wastewater biosolids, and food wastes—in the absence of oxygen. Anaerobic digestion for biogas production takes place in a sealed vessel called a reactor, which is designed and constructed in various shapes and sizes specific to the site and feedstock conditions.
Pyrolysis	A thermal process that transforms organic materials into gaseous components and a solid residue (coke) containing fixed carbon and ash.
Gasification	A commercially proven technology used to convert carbon-containing materials, waste, into carbon monoxide and hydrogen gas.
Circular Economy Models	A circular economy approach ensures that materials are retained within productive use, in a high value state, for as long as possible. It focuses on reshaping business and economic systems so that waste is ‘designed out’ of how we live.

APPENDIX E: OCCUPATIONAL HEALTH AND SAFETY (OHS) IN WASTE MANAGEMENT

Name	Description	URL
Skip and Container Safety in Waste Management and Recycling – Formal Guidance Document	Guidelines on eliminating and reducing the risk of serious injury associated with the use of mismatched or damaged skips or containers. In addition to design and manufacturing issues, it provides information on safe use, inspection, and maintenance.	https://www.wishforum.org.uk/wp-content/uploads/2020/10/Waste-06.pdf
Waste Industry Safety and Health Forum – Formal Guidance Document: Safe Operation of Waste and Recycling Collection Vehicles	Guidelines on controlling safety and health risks in the waste management industry associated with operating waste and recycling collection vehicles. Guidance on waste and recycling collection activities in street/urban environments. Focus on operational issues associated with the use of collection vehicles, particularly in areas where members of the public could come into close proximity with moving vehicles. Guidance on managing risks associated with vehicle operations and movement, and practical examples of how to eliminate or reduce the risk of serious injury.	https://www.wishforum.org.uk/wp-content/uploads/2020/10/WASTE-04-Safe-operation-of-waste-and-recycling-collection-vehicles-September-2019.pdf

Name	Description	URL
Safe Transport in the Waste Management and Recycling Industry - Formal Guidance Document	Helping control safety and health risks in the waste management industry associated with traffic management at waste and recycling sites. Guidance on preventing transport-related accidents among people who work at or visit a range of waste management and recycling facilities where there is a potential to come into close proximity with moving vehicles. Guidance targeted at employers, managers, and supervisors of a range of waste and recycling facilities such as landfill sites, recycling plants, waste transfer stations, and waste treatment facilities. Advice on how to assess the main hazards associated with transport-related activities. Practical examples of how to eliminate or reduce risk of serious injury and ill health. In particular, guidance on planning and organizing sites. Concentrates on promoting site safety, pedestrian safety for workers and visitors, and vehicle safety.	https://www.wishforum.org.uk/wp-content/uploads/2019/06/WASTE-09-.pdf
Designing and Operating Materials Recovery Facilities (MRFs) Safely – Formal Guidance Document	Basics of safe design and operation of recycling facilities (MRFs)	https://www.wishforum.org.uk/wp-content/uploads/2019/06/WASTE-13-.pdf
Hand Sorting of Recyclables ("Totting") with Vehicle Assistance – Formal Guidance Document	Guidelines for designing locations, operating safety, and other safety issues associated with the high-risk activity of manual picking from the floor ("totting").	https://www.wishforum.org.uk/wp-content/uploads/2019/06/WASTE-18-.pdf
Health and Safety Training in the Waste Management and Recycling Industry – Formal Guidance Document	Planning and delivering safety training for waste management activities, including key areas for training to cover,	https://www.wishforum.org.uk/wp-content/uploads/2020/05/WASTE-21-Health-and-safety-training-v3-Jan-2020.pdf
Safe Waste and Recycling Collection Services – Formal Guidance Document	Safe collection of municipal wastes (household, etc.), including client issues and management of task-and-finish operations.	https://www.wishforum.org.uk/wp-content/uploads/2019/06/WASTE-23-.pdf

Source: Waste Industry Safety and Health (WISH) Forum, available online.

APPENDIX F: POLICY DIRECTIVES & APEC PROJECTS/INITIATIVES

Document Name	Topic/ Group	Author	Date	Description/Key Information	Link to Document
Strategic Framework for Chemicals in the Asia-Pacific Region 2020–2023	APEC Forum	APEC Chemical Dialogue	Nov. 20, 2020	The APEC Virtual Working Group on Marine Debris is a cross-cutting initiative to promote development of and investment in innovative solutions to land-based waste management and ensure coherence on marine litter initiatives across the Chemical Dialogue, the Oceans and Fisheries Working Group, and other APEC fora and sub-fora.	https://www.apec.org/-/media/Files/Groups/CD/2020/CD-Strategic-Framework-2020---2023-endorsed.DOCX
APEC Chemical Dialogue: Strategic Framework for Chemicals in the Asia-Pacific Region 2020–2023	Group	APEC Chemical Dialogue	Nov. 20, 2020	The strategic objectives of the APEC Chemical Dialogue Strategic Framework 2020–2023 include: promoting the sound management of chemicals and waste; and promoting the development of innovations and new technologies to improve waste management	https://www.apec.org/-/media/Files/Groups/CD/2020/CD-Strategic-Framework-2020---2023-endorsed.DOCX
APEC Chemical Dialogue: Regulatory Cooperation Report	Group	APEC Chemical Dialogue	Dec. 1, 2020	The Latin America Regulatory Cooperation Forum promotes information sharing and technical discussions on chemical and waste regulatory developments in Latin America and supports regulatory cooperation events.	https://www.apec.org/-/media/Files/Groups/CD/2020/Chemical-Dialogue-Regulatory-Cooperation-Report---clean.docx
APEC Chemical Dialogue: Regulatory Cooperation Report	Group	APEC Chemical Dialogue	Dec. 1, 2020	The Report aims to identify, share, and capture best practices and actionable approaches for APEC chemical regulators seeking to engage in regulatory cooperation with trade partners. The Report provides a range of regulatory cooperation mechanisms available in the chemical sector through case studies from current bilateral cooperation, regional cooperation, and global cooperation.	https://www.apec.org/-/media/Files/Groups/CD/2020/Chemical-Dialogue-Regulatory-Cooperation-Report---clean.docx

Document Name	Topic/ Group	Author	Date	Description/Key Information	Link to Document
The 23rd Meeting of the Chemical Dialogue ("CD 23"): Final Report	Group	APEC Chemical Dialogue	Jan. 21, 2020	Under the APEC Sustainable Plastics Eco System, the concept note aims to use a model that Chinese Taipei pioneered to turn waterway waste plastics into fountain pens in order to preserve the habitat for the endangered Black-faced Spoonbills.	https://www.apec.org/-/media/Files/Groups/CD/2020/CD23--Meeting-Report--Final-Jan-21-2019--Clean.DOCX
Compendium of Policies and Preventive Measures to Reduce Land-based Marine Debris in APEC Economies	Group	APEC Policy Support Unit	Nov., 2019	Marine debris (or marine litter) can be defined as "litter that ends up in oceans, seas, and other large bodies of water." An estimated 80 percent of all marine litter are plastics, a non-biodegradable, synthetic organic polymer. About 80 percent of plastic waste in the oceans comes from land-based sources.	https://www.directemar.cl/directemar/site/artic/20191125/asocfile/20191125115836/apec_compendium_of_preventive_measures_for_md_13nov1630_clean.pdf
Twenty-First Meeting of the APEC Chemical Dialogue (CD21)	Group	APEC Chemical Dialogue	Jan. 15, 2019	The Marine Debris Virtual Working Group (MDVWG) focuses on innovative solutions to land-based waste management. In 2017, the MDVWG hosted an Asia-Pacific Infrastructure Partnership meeting in Indonesia focused on financing waste management.	https://www.apec.org/-/media/Files/Groups/CD/2019/CD21-Final-Report.docx
Twentieth Meeting of the APEC Chemical Dialogue	Group	APEC Chemical Dialogue	May 22, 2018	The MDVWG 2017 work program included: (1) promoting implementation of the Policy and Practice Recommendations for Overcoming Barriers to Financing Waste Management Systems and Reducing Marine Litter (2016/CSOM/010); and (2) hosting an APEC High-Level Meeting on Accelerating Waste Management Solutions to Reduce Marine Litter.	https://www.apec.org/-/media/Files/Groups/CD/2018/CD20--Final-Report---May-22-2018.DOCX

Document Name	Topic/ Group	Author	Date	Description/Key Information	Link to Document
The Twenty-Second Meeting of the Chemical Dialogue (CD22): Final Report	Group	APEC Chemical Dialogue	June 21, 2019	Th MDVWG implemented an APEC project (OFWG 01 2018A) to update the 2009 APEC Report on the Economic Costs of Marine Debris to APEC Economies to include updated statistics, identification of urban marine litter hot spots that could benefit from targeted control interventions, and evaluation of the costs and benefits of potential interventions.	https://www.apec.org/-/media/Files/Groups/CD/2019/CD22--Final-Report--Final–14-June-2019.docx
APEC Roadmap on Marine Debris	Group	APEC Ministerial Documents	Aug. 30, 2019	Marine debris (or marine litter), including plastic litter in the marine environment, is an increasing global challenge needing a cooperative response. In addition, the severity of the marine litter problem is particularly acute in the APEC region. Guidelines adopted include: policy development and coordination; capacity building, research, and innovation; and financing and private sector engagement.	https://www.apec.org/Meeting-Papers/Annual-Ministerial-Meetings/2019/2019_AMM/Annex-B
APEC Workshop on Marine Debris and Microplastics: Blue Citizenship	Group	Oceans and Fisheries Working Group (OFWG)	2019	Since 2015, the APEC Marine Sustainable Development Center has worked with APEC economies to address marine litter. To further implement sustainable development and APEC declarations and plans to reduce marine litter, this project aims to raise public awareness and shape eco-wise behavior among stakeholders.	https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2450
Our Combating Strategies to the Marine Debris	Group	APEC (Chinese Taipei)	Feb. 8, 2020	This project uses satellite images from sources such as Sentinel-1 and SPOT-6/7 to conduct regular marine monitoring and use simulation tools to track the sources of marine litter.	http://mddb.apec.org/Documents/2020/OFWG/OFWG1/20_ofwg1_012.pdf

Document Name	Topic/ Group	Author	Date	Description/Key Information	Link to Document
APEC on Marine Debris Study 2018 – Update of the 2009 Report: Understanding the Economic Benefits and Costs of Controlling Marine Debris in the APEC Region (OFWG 01 2018A)	Group	APEC (United States)	Aug. 21, 2019	The project aims to provide an updated assessment of the value of marine economies; assess the economic impacts of marine litter in APEC; and identify major urban marine litter hot spots that could benefit from targeted control interventions.	http://mddb.apec.org/Documents/2019/OFWG/OFWG2/19_ofwg2_026.pdf
APEC Clean City and Urban Initiative	Group	APEC (United States)	Aug. 21, 2019	The project connects city and municipal leaders to technical and financial resources to prevent and reduce marine litter through: reducing plastic production; innovative materials and product design; reduced waste generation; improvements in global waste management; improvements in litter capture and reductions in input concentrations.	http://mddb.apec.org/Documents/2019/OFWG/OFWG2/19_ofwg2_031.pdf
Introduction of Training Seminar on Plastic Waste Management by Japan Initiative for Marine Environment	Group	APEC (Japan Chemical Industry Association)	Nov. 06, 2020	The project's goals include: promoting collected and analyzed information sharing and appropriate actions to policy makers; outreach to support improvement of plastic waste management in Asian (training seminar on plastic waste management); domestic activities (creating a DVD for elementary school and high school science teachers to use in classes); and promoting capacity building for scientific knowledge and evidence.	http://mddb.apec.org/Documents/2020/CD/CD2/20_cd2_007.pdf

Document Name	Topic/ Group	Author	Date	Description/Key Information	Link to Document
Recyclable Materials Policy Program (RMPP)	Group	Committee on Trade and Investment	June 13, 2020	The RMPP aims to develop the capacity of APEC economies to identify and frame domestic policies that promote waste management and recycling infrastructure, addressing barriers to trade and increasing markets for recyclable materials while respecting economies' domestic laws and regulations.	https://aimp2.apec.org/sites/PDB/Supporting%20Docs/Forms/Supporting%20Docs.aspx?RootFolder=%2fsites%2fPDB%2fSupporting%20Docs%2f4314%2fProposal%20Attachments%20%28if%20any%29&FolderCTID=&View=%7bCA72D0E0%2d295E%2d45DF%2dB491%2dF7BF6581A22F%7d
Circular Economy Roadmap – Malaysia's Practice	Group	APEC (Malaysia)	Feb. 14, 2020	The roadmap seeks to improve plastic resource productivity, reduce plastic waste generation, and promote high value-added plastic recycling and innovate plastic waste collection systems.	http://mddb.apec.org/Documents/2020/PPSTI/PPSTI1/20_ppsti1_029.pdf
APEC Extended Producer Responsibility in Circular Economy Plastic Conference	Group	APEC (Malaysia) – Ts. Roslina Muhammad (Senior Analyst-Green Growth)	Feb. 14, 2020	Addresses international issues on weaknesses in waste management at the level of local communities, mismanaged plastic waste, and single-use plastic waste pollution. Spreads information, capacity building, and knowledge on extended producer responsibility (EPR) schemes benefit amongst APEC economies in key sectors in plastic such as packaging.	http://mddb.apec.org/Documents/2020/PPSTI/PPSTI1/20_ppsti1_031.pdf
APEC Sustainability Coastal Cities Symposium	Group	APEC (Malaysia)	Feb. 14, 2020	Objectives include: proposing new policies to address sustainability of coastal cities and promote Industrial Revolution 4.0 digital supply chain management of plastics (white paper); resolving trans-boundary waste management issues; and promoting global cooperation.	http://mddb.apec.org/Documents/2020/PPSTI/PPSTI1/20_ppsti1_033.pdf

Document Name	Topic/ Group	Author	Date	Description/Key Information	Link to Document
Ocean and Fisheries Working Group (OFWG) Proposed Work Plan for 2021	Group	APEC OFWG	Feb. 26, 2021	Work plan featuring activities and the sharing of best practices and scientific and technological methods for identification, characterization, risk assessment, and remediation of micro- and nano-plastics in APEC economies. This includes reducing, recycling, and upcycling plastics to minimize plastic waste and its impacts on marine and terrestrial environments.	https://www.apec.org/-/media/Files/Groups/OFWG/OFWG–2021-Work-plan_Final.pdf
Capacity Building on Global Marine Debris Monitoring and Modelling: Supports Protection of the Marine Environment	Group	APEC OFWG	June, 2020	Capacity building covering marine litter monitoring through ocean modelling, integrated with marine litter tagging and also a focus on marine litter sources, trajectory simulation, and impacts on coastal areas and marine ecosystems.	https://www.apec.org/-/media/APEC/Publications/2020/6/Capacity-Building-on-Global-Marine-Debris-Monitoring-and-Modeling/220_OFWG_Capacity-Building-on-Global-Marine-Debris-Monitoring-and-Modeling.pdf
Circular Economy: Don't Let Waste go to Waste	Group	APEC Policy Support Unit	Jan., 2020	Plastics in the oceans are expected to cost US$1.3 billion per year to the tourism, fishing, and shipping industries in the APEC region. As a result, the APEC economies are championing the adoption of circular economy within its region.	https://www.apec.org/Publications/2020/01/Circular-Economy---Dont-Let-Waste-Go-to-Waste

Document Name	Topic/ Group	Author	Date	Description/Key Information	Link to Document
Key APEC Documents 2018	Group	APEC Secretariat	Dec., 2018	APEC recognizes that marine litter and inadequate sea and land-based management have significant environmental, economic and social costs to the APEC region. APEC calls on member economies to take concrete action to improve liquid and solid waste management systems to mitigate and manage negative impacts of marine litter. APEC also encourages economies to increase regional and international cooperation to reduce and prevent marine litter.	https://www.apec.org/Publications/2018/12/2018-Key-APEC-Documents
Guidebook for the Development of Sustainable Cities Focusing on Resource Circulation and Waste Management	Group	Senior Officials' Meeting (SOM) Friends of the Chair on Urbanization (APEC)	Apr., 2018	The purpose of the guidebook is to promote the use of appropriate solutions for urban environmental problems and contribute to the development of sustainable cities. This will promote the prevention of waste generation and resource circulation in cities and help reduce marine litter.	https://www.apec.org/Publications/2018/05/Guidebook-for-Development-of-Sustainable-Cities
Update of the 2009 APEC Report on Economic Costs of Marine Debris to APEC Economies	Group	SOM Steering Committee on Economic and Technical Cooperation, the OFWG	Mar. 2018	This report proposes domestic government level waste governance plans to address marine litter hot spots; provides technical litter traps on rivers to improve marine litter prevention and remediation; and promotes private sector and public involvement in models that extend both producer and consumer responsibility.	https://www.apec.org/Publications/2020/03/Update-of-2009-APEC-Report-on-Economic-Costs-of-Marine-Debris-to-APEC-Economies

Document Name	Topic/ Group	Author	Date	Description/Key Information	Link to Document
APEC Marine Sustainable Development Report 2 (AMSD 2): Supporting Implementation of Sustainable Development Goal (SDG) 14 and Related Goals in APEC	Group	APEC OFWG	Dec. 2019	AMSD 2 reflects APEC and its economies' efforts to achieve the SDGs, especially SDG 14, and identify the remaining challenges in promoting ocean-related sustainable development in the APEC region.	https://www.apec.org/Publications/2019/12/APEC-Marine-Sustainable-Development-Report-2

Source: Asia-Pacific Economic Cooperation, available online.

BIBLIOGRAPHY

ABS-CBN News. 2021. "Nestlé Philippines, DENR Ink Deal to Build Materials Recovery Facility." March 26. https://news.abs-cbn.com/business/03/26/21/nestl-philippines-denr-ink-deal-to-build-materials-recovery-facility.

Ali, Mansoor, and Veronica Di Bella. 2016. *Topic Guide: Solid Waste Management*. Evidence on Demand, UK. April. https://assets.publishing.service.gov.uk/media/57a08954e5274a31e000001c/EoD_Topic_Guide_Solid_Waste_Management_Final.pdf.

APEC Oceans and Fisheries Working Group. 2019. "APEC Workshop on Marine Debris and Microplastics: Blue Citizenship." APEC Projects Database. https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2450.

APEC Oceans and Fisheries Working Group. 2019. "Good Practice and Innovative Workshop for Marine Debris Prevention and Management in the APEC Region." OFWG 02 2019A Project Update. October 20. http://mddb.apec.org/Documents/2020/OFWG/OFWG2/20_ofwg2_012.pdf.

APEC Oceans and Fisheries Working Group. 2019. "Promoting APEC Innovative Models in Reducing and Managing Land-based Debris into Oceans for Sustainable Development." APEC Project Database. https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2484.

APEC Oceans and Fisheries Working Group. 2020. "Capacity Building on Global Marine Debris Monitoring and Modeling: Supports Protection of the Marine Environment." Bali, Indonesia. February 18–20. APEC#220-OF-04.2. https://www.apec.org/publications/2020/06/capacity-building-on-global-marine-debris-monitoring-and-modeling.

Aragaw T.A., and B.A. Mekonnen. 2021. "Current plastics pollution threats due to COVID-19 and its possible mitigation techniques: a waste-to-energy conversion via Pyrolysis." *Environmental Systems Research* 10(8) 1-11. January 20. https://doi.org/10.1186/s40068-020-00217-x.

Asian Development Bank. n.d. "Thailand: Southern Thailand Waste-to-Energy Project." Project webpage. https://www.adb.org/projects/49067-001/main.

Asia-Pacific Economic Cooperation. "The Virtual Working Group on Marine Debris." https://www.apec.org/marinedebris.

Asia-Pacific Economic Cooperation. 2010. "APEC Paracas Declaration and Paracas Action Agenda," October 10-11. https://www.apec.org/Meeting-Papers/Sectoral-Ministerial-Meetings/Ocean-related/2010_ocean/action-agenda.

Asia-Pacific Economic Cooperation. 2014. "Fourth APEC Ocean-Related Ministerial Meeting (AOMM4): Towards New Partnership through Ocean Cooperation in the Asia Pacific Region." Xiamen, People's Republic of China. August 28. https://www.apec.org/Meeting-Papers/Sectoral-Ministerial-Meetings/Ocean-related/2014_ocean.

Asia-Pacific Economic Cooperation. 2016. "Overcoming Barriers to Financing Waste Management Systems and Reducing Marine Litter: APEC Policy and Practice Recommendations." Lima, Peru. November 14-15. 2016/CSOM/010. http://mddb.apec.org/Documents/2016/SOM/CSOM/16_csom_010.pdf.

Asia-Pacific Economic Cooperation. 2019. "APEC Roadmap on Marine Debris: Third Senior Officials' Meeting." Puerto Varas, Chile. August 29-30. https://www.apec.org/meeting-papers/annual-ministerial-meetings/2019/2019_amm/annex-b.

Association of Southeast Asian Nations. 2019. "ASEAN Framework of Action on Marine Debris." June 22. https://asean.org/asean2020/wp-content/uploads/2021/01/3.-ASEAN-Framework-of-Action-on-Marine-Debris-FINAL.pdf.

Association of Southeast Asian Nations. 2021. "Launch of the ASEAN Regional Action Plan for Combating Marine Debris in the ASEAN Member States (2021-2025)." May 28. https://asean.org/launch-of-the-asean-regional-action-plan-for-combating-marine-debris-in-the-asean-member-states-2021-2025/.

Azo Materials. 2020. "The Affects Scrap Metal has on Quality Control Processes." February 11. https://www.azom.com/article.aspx?ArticleID=18846.

Beachapedia. 2021. "Plastic Pollution Facts and Figures." Updated April 2. Webpage. http://beachapedia.org/Plastic_Pollution_Facts_and_Figures.

BusinessWorld. 2021. "Nestlé-DENR to Build Materials Recovery Facility in Caloocan." March 26. https://www.bworldonline.com/nestle-denr-to-build-materials-recovery-facility-in-caloocan/#:~:text=Food%20and%20beverage%20manufacturer%20Nestl%C3%A9,capacity%20for%20proper%20waste%20disposal.

Cahiles-Magkilat, Bernie. 2021. "Coke PH, Batanes LGU Sign PET Bottle Recycle Deal." *Manila Bulletin*. April 30. https://mb.com.ph/2021/04/30/coke-ph-batanes-lgu-sign-pet-bottle-recycle-deal/.

Chen, Chung-Ling. 2015. "Regulation and Management of Marine Litter." Bergmann M., Gutow L., Klages M. (editors). *Marine Anthropogenic Litter* 395–428. Springer, Cham. June 2. https://doi.org/10.1007/978-3-319-16510-3_15.

Circulate Capital. 2019. "Investing to Reduce Plastic Pollution in South & Southeast Asia: A Handbook for Action." https://docs.wixstatic.com/ugd/77554d_3bb19c2c7b75435f8d2817edfc15a28f.pdf.

Dhewanto, W., Y. Dwi Lestari, S. Herliana, and N. Lawiyah. 2018. "Analysis of the Business Model of Waste Bank in Indonesia: A Preliminary Study." *International Journal of Business* 23(1): 73-88. January. https://www.researchgate.net/publication/323250069_Analysis_of_the_business_model_of_Waste_Bank_in_Indonesia_A_preliminary_study.

EuropaWire. 2019. "AFRY Joins Collaboration on Biomass Project in Papua New Guinea." Press release. December 17. https://news.europawire.eu/afry-joins-collaboration-on-biomass-project-in-papua-new-guinea-12894312/eu-press-release/2019/12/17/13/11/43/76229/.

Ferronato, N., and V. Torretta. 2019. Waste Mismanagement in Developing Countries: A Review of Global Issues. *International Journal of Environmental Research and Public Health* 16(6):1060. March. https://dx.doi.org/10.3390%2Fijerph16061060.

Galgani, L., R. Beiras, F. Galgani, C. Panti, and A. Borja. 2019. "Editorial: Impacts of Marine Litter." *Frontiers in Marine Science* 6. April 26. https://doi.org/10.3389/fmars.2019.00208.

Global Partnership on Marine Litter (GPML). n.d. Webpage. https://digital.gpmarinelitter.org/about-us.

Grant, A., M. Cordle, and E. Bridgwater. 2020. *Quality of Recycling – Towards an operational Definition*. P. Canfora, M. Dri, I. Antonopoulos, and P. Gaudillat, editors. Luxembourg: Publications Office of the European Union. https://publications.jrc.ec.europa.eu/repository/handle/JRC122293.

Gray, Alex. 2018. "90 Percent of Plastic Polluting Our Oceans Comes from Just 10 Rivers." World Economic Forum. June 8. https://www.weforum.org/agenda/2018/06/90-of-plastic-polluting-our-oceans-comes-from-just-10-rivers/.

Hopewell J., R. Dvorak, and E. Kosior. 2009. "Plastics Recycling: Challenges and Opportunities." *Philosophical Transactions of the Royal Society B: Biological Sciences* 364(1526): 2115–26. July 27. https://royalsocietypublishing.org/doi/10.1098/rstb.2008.0311.

International Union for the Conservation of Nature (IUCN). 2018. "Issues Brief: Marine Plastic Pollution." Published May 2018, updated November 2021. https://www.iucn.org/resources/issues-briefs/marine-plastic-pollution.

Jaffe, Oren. n.d. "Global Recycled Standard (GRS)." SCS Global Services. Online resource. https://www.scsglobalservices.com/services/global-recycled-standard.

Kaza S., L. Yao, P. Bhada-Tata, and F. Van Woerden. 2018. *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. Urban Development; Washington, DC: World Bank. License*: CC BY 3.0 IGO*. https://openknowledge.worldbank.org/handle/10986/30317.

Krushelnytska, Olha. 2018. *Solving Marine Pollution: Successful Models to Reduce Wastewater, Agricultural Runoff, and Marine Litter.* Washington, DC: World Bank Group. September. http://documents.worldbank.org/curated/en/651521537901259717/Solving-Marine-Pollution-Successful-Models-to-Reduce-Wastewater-Agricultural-Runoff-and-Marine-Litter.

Landrigan, Philip J. et al. 2020. "Human Health and Ocean Pollution." *Annals of Global Health* 86(1): 151. December 3. http://doi.org/10.5334/aogh.2831.

Laville, Sandra. 2019. "Single-Use Plastics A Serious Climate Change Hazard, Study Warns." *The Guardian*. May 15. https://www.theguardian.com/environment/2019/may/15/single-use-plastics-a-serious-climate-change-hazard-study-warns.

Law, K., N. Starr, T. Siegler, J. Jambeck, N. Mallos, and G. Leonard. 2020. "The United States' Contribution of Plastic Waste to Land and Ocean." *Science Advances* 6(44). October 30. https://www.science.org/doi/10.1126/sciadv.abd0288.

Leberle, Ulrich. 2016. "Quality: European Standards on Paper for Recycling." *Confederation of European Paper Industries*. December 2. https://www.cepi.org/paper-for-recycling-quality-control-guidelines/.

Leblanc, Rick. 2021. "An Introduction to Metal Recycling." *The Balance Small Business* (website). March 4. https://www.thebalancesmb.com/an-introduction-to-metal-recycling-4057469.

McIlgorm, A., K. Raubenheimer, and D. E. McIlgorm. 2020. *Update of 2009 APEC report on Economic Costs of Marine Debris to APEC Economies*. A report to the APEC Ocean and Fisheries Working Group by the Australian National Centre for Ocean Resources and Security (ANCORS), University of Wollongong, Australia. December. https://www.apec.org/-/media/APEC/Publications/2020/3/Update-of-2009-APEC-Report-on-Economic-Costs-of-Marine-Debris-to-APEC-Economies/220_OFWG_Update-of-2009-APEC-Report-on-Economic-Costs-of-Marine-Debris-to-APEC-Economies.pdf.

Ministry of Environment and Forest (Indonesia). 2020. "National Plastic Waste Reduction Strategic Actions for Indonesia." June. https://www.unep.org/ietc/resources/policy-and-strategy/national-plastic-waste-reduction-strategic-actions-indonesia.

Mott MacDonald. 2020. "ALCP6 Waste to Energy Project Has Commenced Construction, Thailand." Press release. October 19. https://www.mottmac.com/releases/alcp6-waste-to-energy-project-has-commenced-construction-thailand.

Mudaliar, Abhilash, Rachel Bass, Hannah Dithrich, Jennifer Lawrence, Mukund Prasad, Stefanie Bauer, Amar Gokhale, Shreejit Borthakur, and Harish Reddy. 2018. "The Landscape for Impact Investing in Southeast Asia." *Global Impact Investing Network and Intellecap*. August. https://thegiin.org/assets/Indonesia_GIIN_SEAL_report_webfile.pdf.

Ozores-Hampton, Monica. 2017. "Guidelines for Assessing Compost Quality for Safe and Effective Utilization in Vegetable Production." *American Society for Horticultural Science* 27(2):162–65. April. https://doi.org/10.21273/HORTTECH03349-16.

Parker, Laura. 2020. "Plastic Rubbish Flowing into the Seas Will Nearly Triple by 2040 Without Drastic Action." *National Geographic*. July 24. https://www.nationalgeographic.co.uk/environment-and-conservation/2020/07/plastic-trash-flowing-into-the-seas-will-nearly-triple-by-2040.

The Pew Charitable Trusts and SYSTEMIQ. 2020. "Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution." July 23. https://www.oneplanetnetwork.org/sites/default/files/breakingtheplasticwave_report.pdf.

Plastic Soup Foundation. 2017. "Peak Plastic." Webpage. January 8. https://www.plasticsoupfoundation.org/en/2018/01/peak-plastic/.

Radio New Zealand. 2018. "PNG Imposes Full Ban on Plastic Shopping Bags." April 18. https://www.rnz.co.nz/international/pacific-news/355385/png-imposes-full-ban-on-plastic-shopping-bags.

Rappler. 2017. "QC Approves Metro Pacific-Led Group's Waste-to-Energy Project." March 27. https://www.rappler.com/business/quezon-city-mpic-covanta-macquarie-waste-energy-project.

Rickards, Jane. 2019. "From 'Garbage Island' to a Model of Recycling. " *Taiwan Business Topics*. October 23. https://topics.amcham.com.tw/2019/10/garbage-island-to-recycling-model/.

Rittenhouse, Thea. 2015. "Tipsheet: Compost," *National Center for Appropriate Technology*. July. https://www.ams.usda.gov/sites/default/files/media/Compost_FINAL.pdf.

Roberts, David. 2020. "Big Oil's hopes are pinned on plastics. It won't end well." *VOX* (website). October 28. https://www.vox.com/energy-and-environment/21419505/oil-gas-price-plastics-peak-climate-change.

Rossi, Marcello. 2019. "How Taiwan Has Achieved One of the Highest Recycling Rates in the World." *Smithsonian Magazine*. January 3. https://www.smithsonianmag.com/innovation/how-taiwan-has-achieved-one-highest-recycling-rates-world-180971150/.

Schmidt C., T. Krauth, and S. Wagner. 2017. "Export of Plastic Debris by Rivers into the Sea." *Environmental Science & Technology* 51(21): 12246–53. October 11. https://doi.org/10.1021/acs.est.7b02368.

Secretariat of the Pacific Regional Environment Program. 2015. "Historic First Steps Towards A Cleaner Pacific." July 16. https://www.sprep.org/news/historic-first-steps-towards-cleaner-pacific.

Shuker, Iain G., and Cary Anne Cadman. 2018. *Indonesia - Marine Debris Hotspot Rapid Assessment: Synthesis Report.* Washington, DC: World Bank Group. April 1. http://documents.worldbank.org/curated/en/983771527663689822/Indonesia-Marine-debris-hotspot-rapid-assessment-synthesis-report.

The Star. 2020. "Indonesian Plastic Recycling Company Looks to Expand as Circular Economy Blooms." May 8. https://www.thestar.com.my/news/regional/2020/05/08/indonesian-plastic-recycling-company-looks-to-expand-as-circular-economy-blooms.

Taylor, Brian. 2020. "Suez Commissions Thailand Plastics Recycling Plant." *Recycling Today*. December 3. https://www.recyclingtoday.com/article/suez-thailand-ldpe-plastics-recycling-facility/.

World Bank. 2019. "Solid Waste Management." The World Bank Group. September 23. https://www.worldbank.org/en/topic/urbandevelopment/brief/solid-waste-management.

Unilever Indonesia. 2020. "Unilever Environment Programme: The Need of Waste Management." Webpage. https://www.unilever.co.id/en/about/unilever-indonesia-foundation/environment-programme.html.

United Nations Environment Program. 2011. "Recycling Rates of Metals - A Status Report, A Report of the Working Group on the Global Metal Flows to the International Resource Panel." https://www.resourcepanel.org/sites/default/files/documents/document/media/metals_status_report_full_report_english.pdf.

United Nations Environmental Program. 2014. "Plastic Waste Causes Financial Damage of US$13 Billion to Marine Ecosystems Each Year as Concern Grows over Microplastics." Press release. June 23. https://www.unep.org/news-and-stories/press-release/plastic-waste-causes-financial-damage-us13-billion-marine-ecosystems.

United Nations Environmental Program. 2018. "Single-Use Plastics: A Roadmap for Sustainability." Revised edition. June 5. https://wedocs.unep.org/bitstream/handle/20.500.11822/25496/singleUsePlastic_sustainability.pdf?sequence=1&isAllowed=y.

United Nations Environment Program. 2021. "From Pollution to Solution: A Global Assessment of Marine Litter and Plastic Pollution." https://wedocs.unep.org/bitstream/handle/20.500.11822/36965/POLSOLSum.pdf.

United Nations Center for Regional Development. 2020. *State of Plastics Waste in Asia and the Pacific-Issues, Challenges and Circular Economic Opportunities*. Early release version. https://www.uncrd.or.jp/index.php?page=view&nr=506&type=230&menu=214.

Waste4Change. n.d. "7 Types of Plastic that You Need to Know." Online resource. https://waste4change.com/blog/7-types-plastic-need-know/.

Waste4Change. 2020. "Waste Management Startup, Waste4Change, Receives Investment from Agaeti Ventures and Partners." Press release. March 9. https://waste4change.com/blog/waste-management-startup-waste4change-receives-investment-from-agaeti-ventures-and-partners/#:~:text=Jakarta%2C%209%20March%202020%20%E2%80%93%20Waste4Change,2024%20and%20the%20development%20of.

Waste Industry Safety and Health (WISH) Forum. n.d. "Wish Guidance." Online resource. https://www.wishforum.org.uk/wish-guidance/.

World Wide Fund for Nature (WWF) Philippines. 2020. "EPR Scheme Assessment for Plastic Packaging Waste in the Philippines." *WWF-Philippines*. October. https://wwf.org.ph/wp-content/uploads/2020/12/WWF_REPORT_EPR_Philippines_2020.pdf.

YOG INFRA. 2021. "Infrastructure & PPPs in Thailand - Q12021 Update." March 31. https://www.yoginfra.com/post/infrastructure-ppps-in-thailand-q12021-update.

Zipporah, Musau. 2017. "Plastics Pose Biggest Threat to Oceans." *Africa Renewal* (United Nations), May-July. https://www.un.org/africarenewal/magazine/may-july-2017/plastics-pose-biggest-threat-oceans.

APEC Project: CTI 04 2020S

Produced by
Office of the U.S. Trade Representative
600 17th St NW, Washington, DC 20508, USA

Nathan Associates Inc.
1777 N Kent St #1400, Arlington, VA 22209, USA

For
Asia-Pacific Economic Cooperation Secretariat 35
Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

APEC#222-CT-01.6