The Challenges of Plastic Waste: Legislation, Regulation, and Management Strategies

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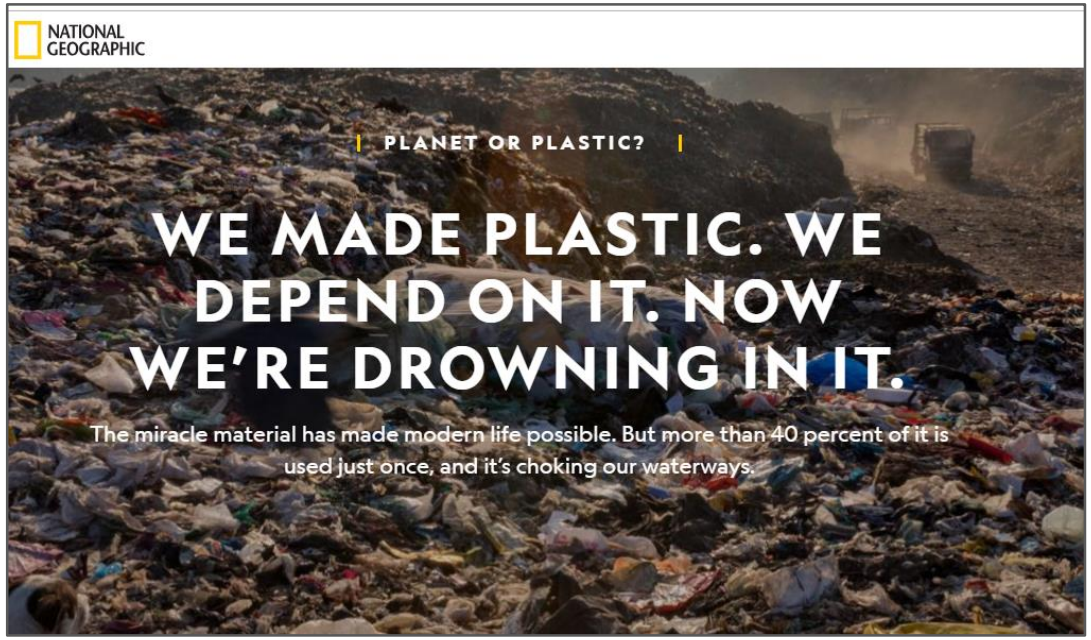
"Caring for the Country's Carrying Capacity", NAST Regional Scientific Meeting
Summit Hotel, Tacloban City, March 20, 2019

BEAT PLASTIC POLLUTION | WORLD ENVIRONMENT DAY | INDIA 2018 | UN environment

- Plastic pollution is a defining environmental challenge for our time.
- In the next 10-15 years global plastic production is projected to nearly double.
- Avoiding the worst of these outcomes demands a complete rethinking of the way we produce, use and manage plastic.

If you can't reuse it, refuse it.



YAHOO!

News

Cimatu calls on Pinoys to cut down plastic use

UNTV News, UNTV News 43 minutes ago

In celebration of World Wildlife Day 2019, the Department of Environment and Natural Resources (DENR) Secretary Roy Cimatu calls on Filipinos to cut down on the use of plastic.

(March 14, 2019)

Plastic Pollution

- Clean environment
- Garbage collection
- Shift to biodegradables

(http://www.ecowastecoalition.org)

Plastic Waste

- Reduce, Reuse, Recycle
- Waste management
- Waste to raw material

Plastic Products

- Consumerism
- Back to nature
- Sustainable?

Outline

1. **What is Plastic Waste?**
2. From 3R's to 4R's
3. Philippine Laws and Regulations on Plastic Waste
4. Strategies for the Management of Plastic Waste in the Philippines

What are plastics?

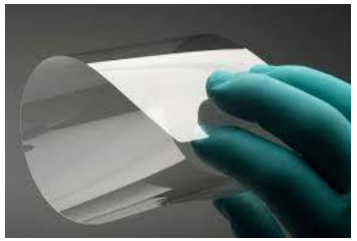
- Plastics are synthetic polymer materials that can be formed into useful shapes having desirable characteristics.
- Plastics contain additives to attain properties for specific applications, to prolong life, and to reduce cost.
- Plastics have become ubiquitous. They have replaced many natural materials, such as wood, leather, and metals, and expanded into new uses.

The A320 is the first subsonic aircraft to incorporate primary fiber-reinforced plastic composite materials using aramid, glass, and carbon fibers.

A brief history of plastics

- Early plastic materials
  - Clay (pottery), glass

Clays are finely-grained phyllosilicate minerals. Clays are plastic due to particle size, geometry, and water content. They become hard and non-plastic upon drying and firing.



L: Flexible glass from Rome (ca. 14-37 AD).
R: Willow glass, an ultra-thin, lightweight and conformable glass made by Corning.

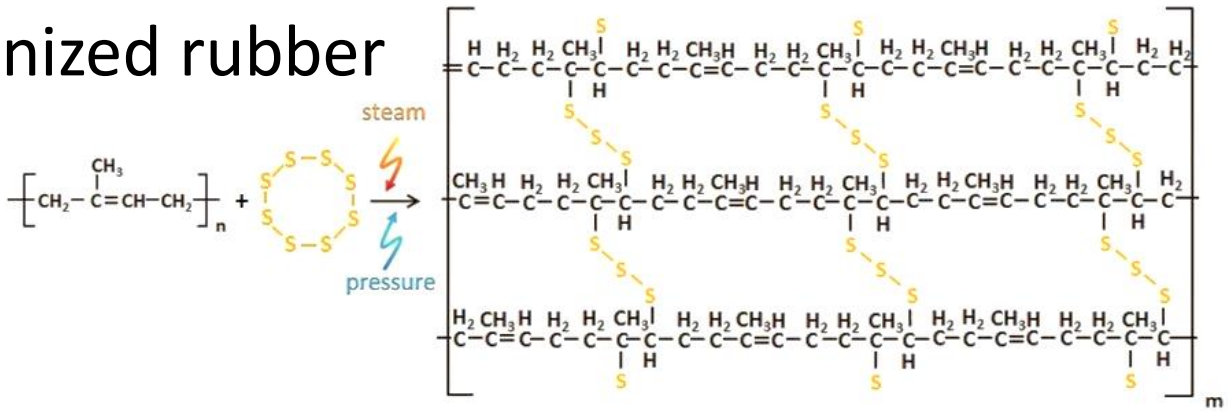
  - Plant exudates

Natural rubber from *Hevea brasiliensis* was first used by indigenous peoples of the Amazon basin in South America.

Gum from the apricot tree (*Prunus armeniaca*). Gums are polysaccharides.

A brief history of plastics

- Early plastic technologies:
  - Vulcanized rubber



The vulcanization of natural rubber (polyisoprene) is achieved by reaction with elemental sulfur under steam and pressure. Vulcanization increases hardness and rigidity, and resistance to heat and oxidation. Vulcanization was developed by Charles Goodyear in 1839.

  - Celluloid

Celluloid, which was developed in the 1860s-70s is the first polymeric plastic to be synthesized. Celluloid was made from plant matter.

Cellulose —(nitration)→ Nitrocellulose → Celluloid
Camphor → Celluloid

Celluloid is a tough, flexible, moldable and inexpensive plastic that is resistant to water, oils, and dilute acids. It was used for various products, such as photographic films, toiletry items, and other consumer goods.

A brief history of plastics

- The term “plastic” was coined by Leo Baekeland in 1907 to describe Bakelite, a phenol-formaldehyde polymer.

Coal tar → Phenol, Formaldehyde → Bakelite

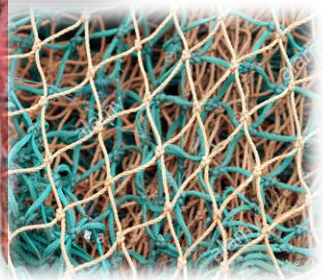
Bakelite is the first plastic to be produced completely from fossil fuels (coal / petroleum).

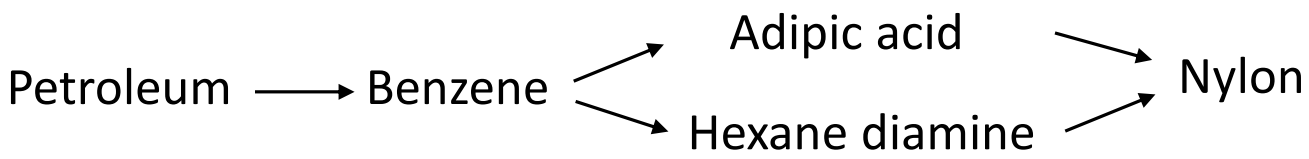
A brief history of plastics

- In the 1930s, Dupont chemist Wallace Carruthers invented nylon, a strong lightweight fiber which could be made into clothing, tents, bags, ropes, and parachutes. Nylon was used extensively during WW II.

  Nylon was made from benzene, a petrochemical product.

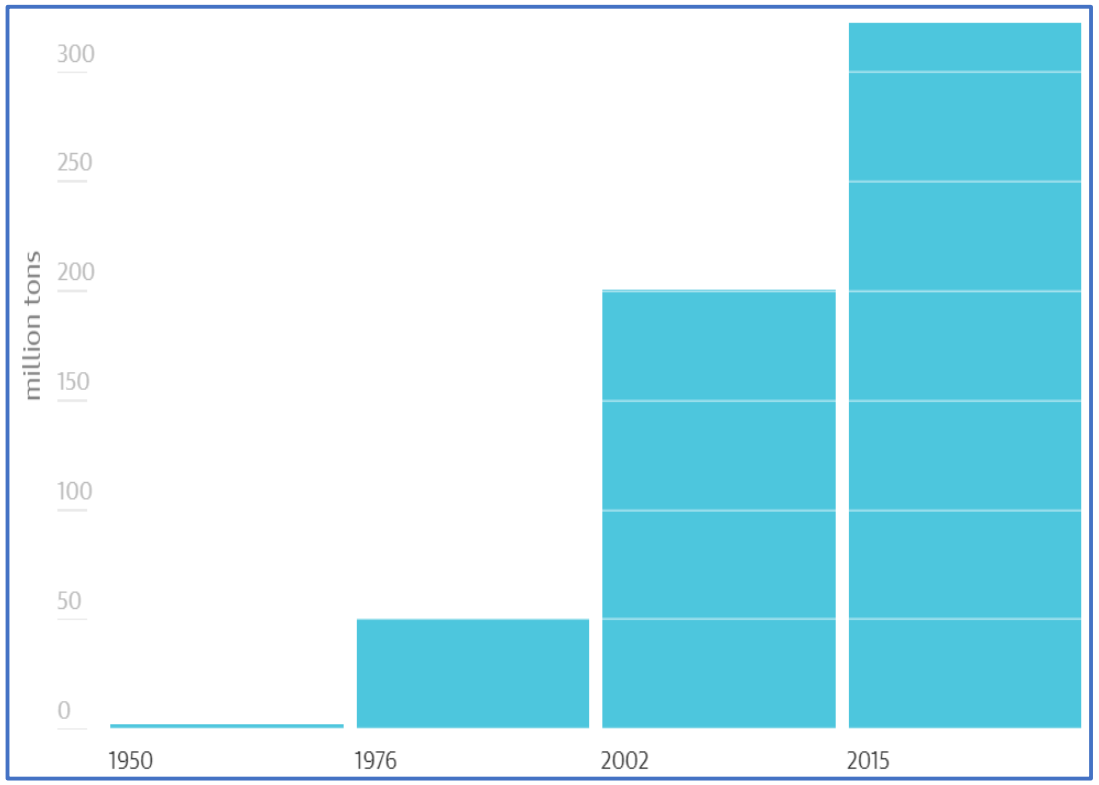


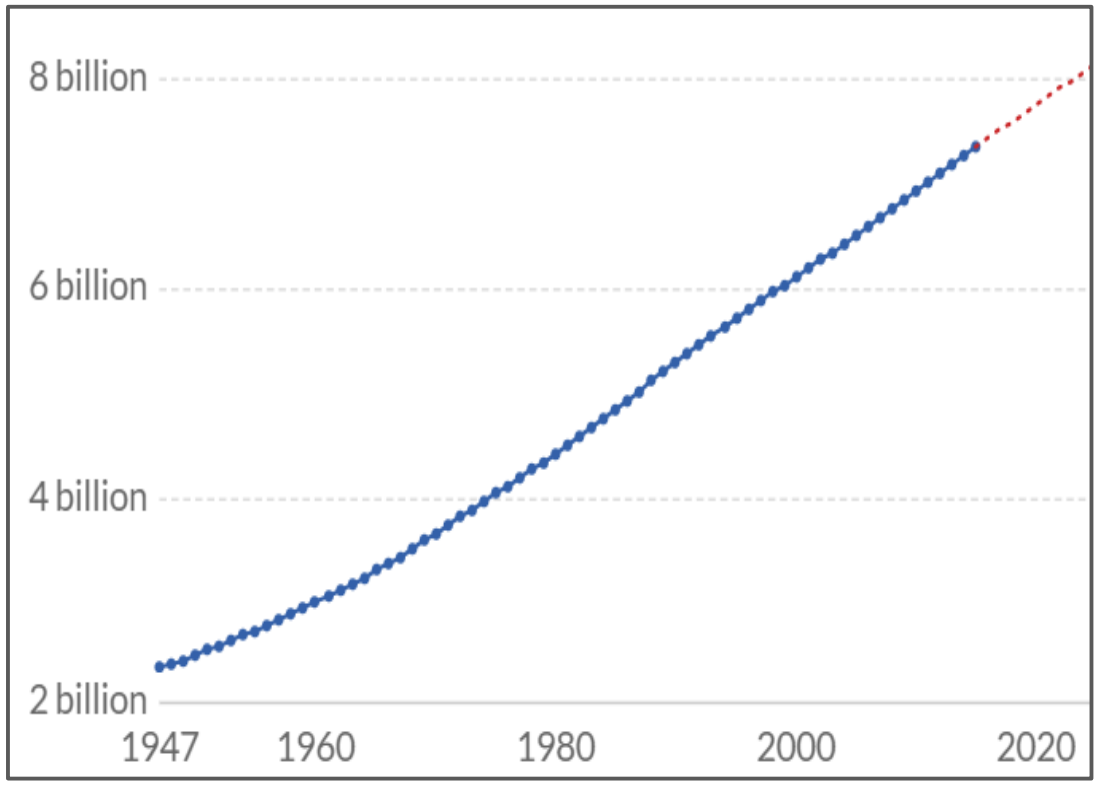
Growth of the plastics industry

Global plastic production



(Source: Statista, PlasticsEurope)

World Population



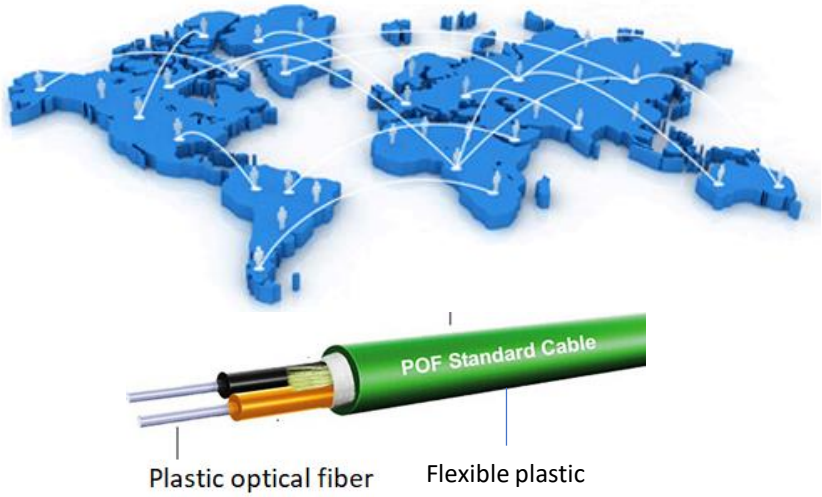
(Source:Medium Projection, UN Population Division, 2015 edition)

The total amount of plastic produced in a year is roughly the same as the entire weight of humanity.

(7.5 billion people x 40 kg/person = 300 million tons)

Industry 4.0 depends on plastics

3-D Printing



Fiber optics

Flexible solar cells

Types of plastics based on polymer composition

Acrylonitrile butadiene styrene (ABS)
Acrylic (AC)
Epoxy resin (thermoset) (EP)
Fiberglass (FG)
Perfluorinated polymers (PTFE)
Polyamide (PA, nylon)
Polycarbonate (PC)
Polycaprolactone (PCL)
Polyethylene
  High density (HDPE)
  Low density (LDPE)

Polyethylene terephthalate (PETE)
Polyglycolide (PGA)
Polylactide (PLA)
Polypropylene (PP)
Polystyrene (PS)
Polyurethane (PU)
Polyvinyl alcohol (PVA)
Polyvinyl chloride (PVC)
Silicone polymers (Si)

Polymers and their uses

Acrylonitrile butadiene styrene (ABS)	: common thermoplastic, injection molding, 3D printing
Acrylic (AC)	: transparent sheets and containers, nail polish
Epoxy resin (thermoset) (EP)	: coatings, paints, adhesives, composite materials
Fiberglass (FG)	: reinforced plastics for industrial and consumer products
Perfluorinated polymers (PTFE)	: coating for cookware, clothes, electronics, semiconductors
Polyamide (PA, nylon)	: fabrics, clothing, bags, tents, parachutes, string, rope
Polycarbonate (PC)	: glass substitute, roofing, eyewear, CD discs
Polycaprolactone (PCL)	: biomedical implants and materials, plasticizer
High density polyethylene (HDPE)	: bottles, toys, chemical containers, pipes
Low density polyethylene (LDPE)	: bags, cups and cartons (lining), trays, tubing

Polymers and their uses

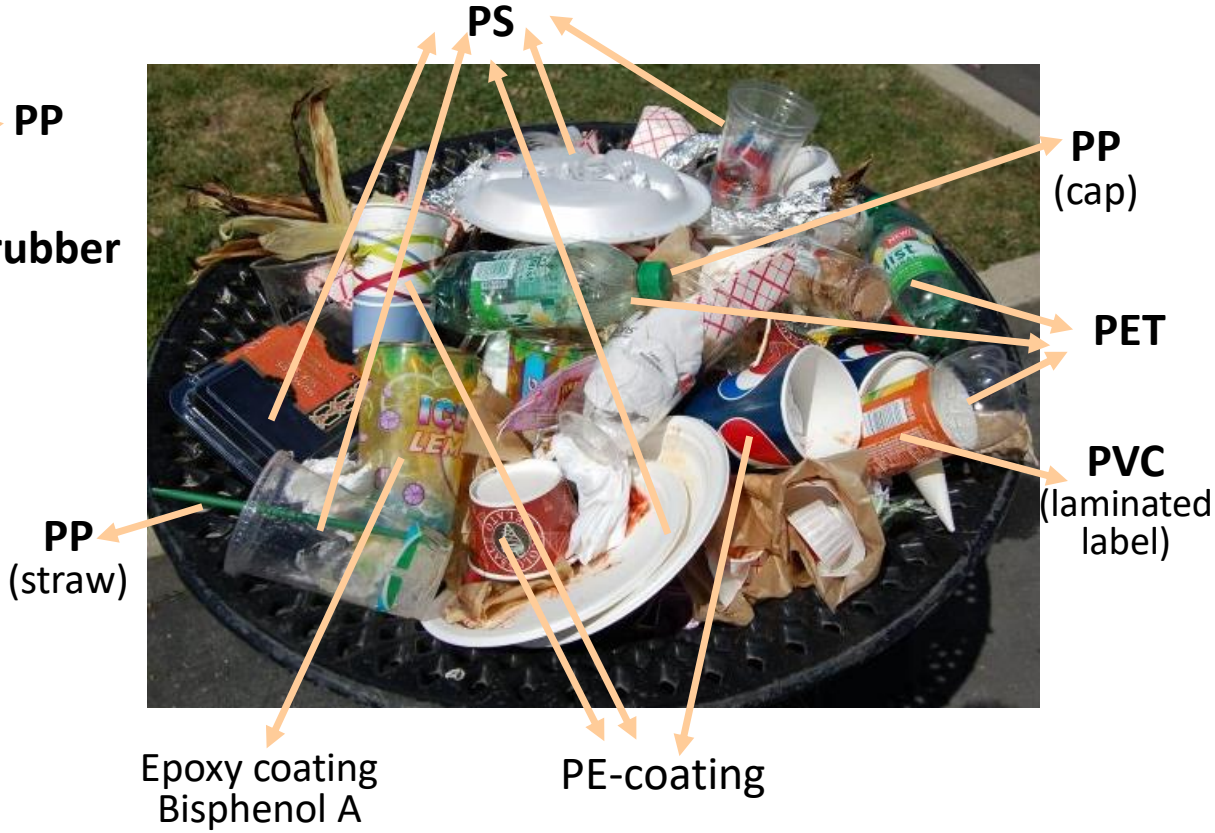
Polyethylene terephthalate (PETE)	: bottles, fibers, composites (polyester fabrics)
Polyglycolide (PGA)	: biomedical materials, sutures
Polylactide (PLA)	: biomedical materials, sutures, food handling
Polypropylene (PP)	: durable goods, chemical-resistant materials, electrical insulation, piping
Polystyrene (PS)	: foam, film, rigid containers, latex, rubber, co-polymers, composites
Polyurethane (PU)	: foam, thermal insulation, coatings, adhesives, construction, shoes, autos
Polyvinyl alcohol (PVA)	: films, emulsifiers, adhesives, paper and textile sizing
Polyvinyl chloride (PVC)	: building and construction, flooring, appliances, pipes, electronics, autos, blood bags, electrical insulation
Silicone polymers (Si)	: sealants, adhesives, lubricants, cooking and medical implements, thermal and electrical insulation

Recycling plastic waste

Uses and recycling of plastics

Single-use	: AC, **HDPE**, **LDPE**, **PETE**, **PP**, PU, Si
Durable goods	: ABS, AC, FG, PTFE, PA, PC, **HDPE**, **LDPE**, **PETE**, **PP**, PU, Si
Clothing	: PA (nylon), **PETE**, PTFE (Teflon), **PETE**-PU (Lycra)
Electrical	: PTFE, **PP**, **PVC**, Si
Home appliances	: ABS, FG, **PP**, **PVC**
Automotive	: ABS, AC, EP, FG, PTFE, PA, PC, **PP**, PU, **PVC**, Si
Construction	: ABS, AC, EP, FG, PTFE, PA, PC, **PP**, PU, **PVC**
Engineering	: ABS, AC, EP, FG, PTFE, PA, PC, **PP**, PU, **PVC**, Si
Optical fiber	: AC, PTFE

Recycling plastic waste

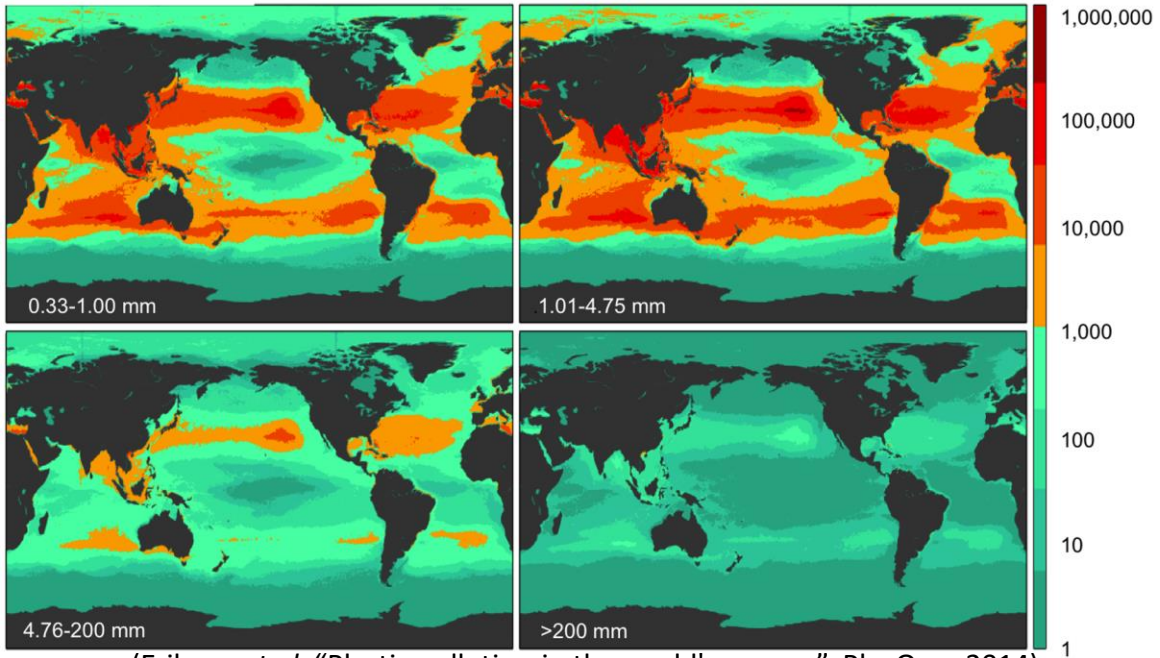


Recycling plastic waste

ABS PCL
AC PGA
EP PLA
FG PU
PTFE PVA
PA Si
PC

Classifying plastic waste by size

- Macro- and micro-plastics (< 5mm)



(Eriksen *et al*. "Plastic pollution in the world's oceans", PlosOne, 2014)

- Microfibers

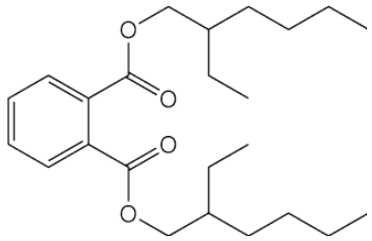
- Nano plastics

Macroplastic ➔ Microplastic ➔ Nanoplastic

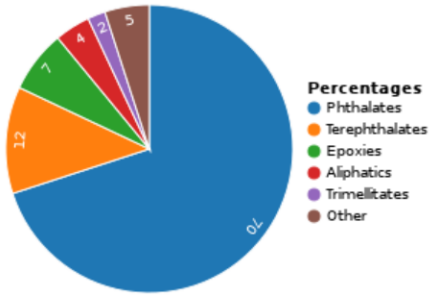
Plastic degradation in the environment produces macro-, micro-, and nano-plastic pollutants. Nano-plastics are able to enter organs to affect cells directly. (Lehner, Nanoplastic Impact on Human Health, 2018)

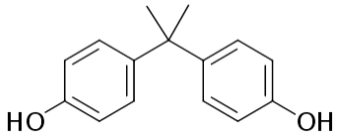
Chemical additives in plastics

- Plasticizers



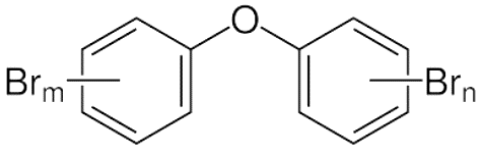
Bis(2-ethylhexyl) phthalate



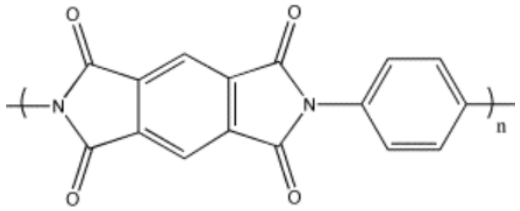


Bisphenol A
(polycarbonate, epoxies)

- Photochemical and fire retardants

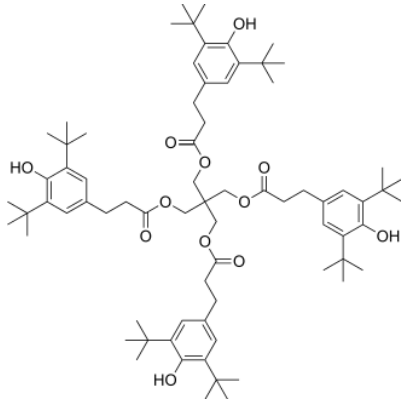


Polybrominated diphenyl ether

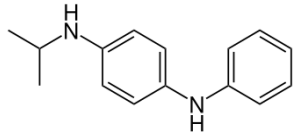


Polyimide

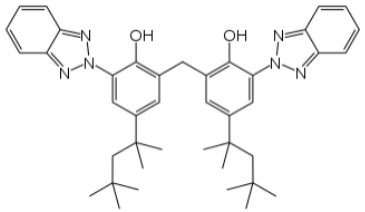
- Antioxidants, free-radical scavengers, acid scavengers, anti-ozone, anti-UV, stabilizers



A primary antioxidant



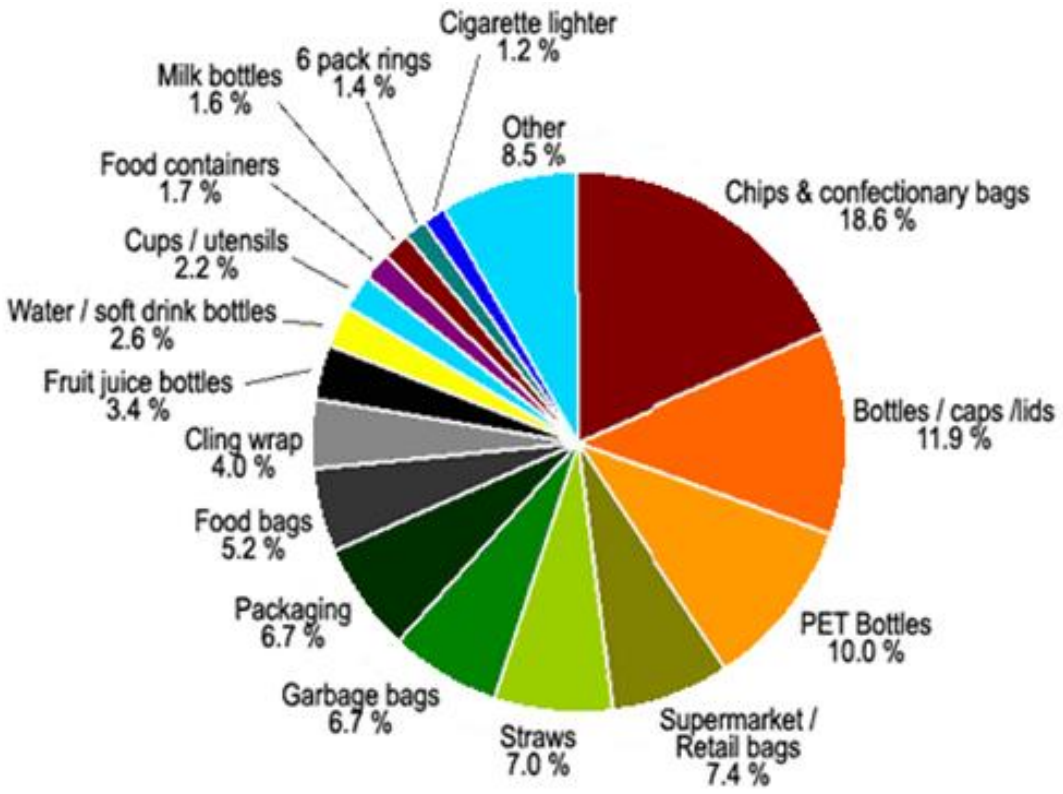
Anti-ozonant



Anti-UV

Ba	Cd	Pb	Zn
Barium	Cadmium	Lead	Zinc

Metal stabilizers



India

(Source: Siddiqui & Pandey, 2013)

Understanding plastic waste

1. Plastic waste differs among societies and depends on lifestyle and use, economics, collection efficiency, etc.
2. Plastic waste is not homogenously distributed. It is concentrated and dispersed by physical forces (e.g., tides, wind). It is difficult to accurately quantify.
3. The amount of plastic waste is usually measured in terms of weight or number of pieces collected.
4. Different plastics have different health and environmental impact.

Environmental impact of plastics

LIVESCIENCE

Your Dumb Party Balloons Are Killing All the Seabirds

By Mindy Weisberger, Senior Writer | March 5, 2019 03:32pm ET

Swallowing plastic can be lethal for seabirds, and balloons are especially deadly.

Philippine Journal of Science
145 (1): 17-23, March 2016
ISSN 0031 - 7683

Ingestion of Marine Plastic Debris by Green Turtle (*Chelonia mydas*) in Davao Gulf, Mindanao, Philippines

Neil Angelo S. Abreo[1,4*], **Edison D. Macusi**[2,4], **Darrell D. Blatchley**[3] and **Ginalyn C. Cuenca**[1]

[1]Davao Del Norte State College, Panabo City, Philippines
[2]Aquaculture and Fisheries Group, Wageningen Institute of Animal Sciences
Wageningen University of Life, Wageningen, The Netherlands
[3]D' Bone Collector Museum, Inc., Davao City, Philippines
[4]Regional Integrated Coastal Resource Management Center (RIC-XI),
Davao Oriental State College of Science and Technology (DOSCST),
Mati, Davao Oriental

Figure 2. Carcass of the *Chelonia mydas* recovered in Davao City.

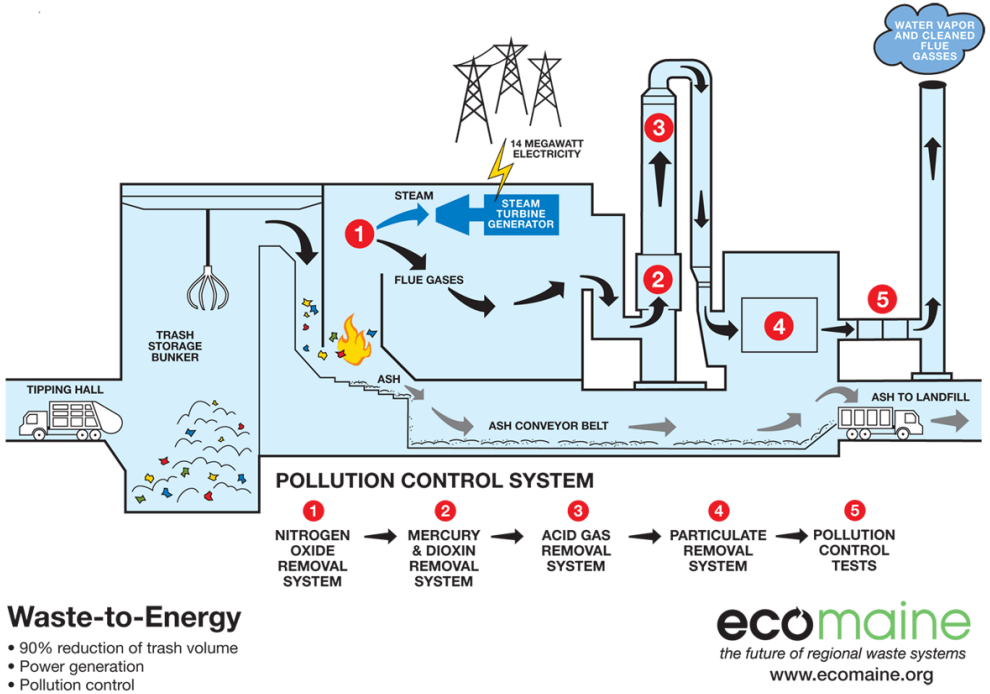
Figure 3. Stomach contents of the recovered *Chelonia mydas*.

Out of sight, out of mind

- **Are oxy-degradable plastics biodegradable?**

Oxo-degradable plastics are conventional plastics which include additives to accelerate fragmentation into very small pieces, triggered by UV radiation or heat. The plastic fragments over time into microplastics, with similar properties to microplastics originating from the fragmentation of conventional plastics. (EC report, 2018)

- **Is incineration a solution?**



(www.renewableenergyworld.com)

The challenges of plastic waste

- There are numerous types of polymers and plastic composition
- Most plastics are not biodegradable
- Hazards of plastic waste depend on the size: macro-, micro-, nano-. Non-biodegradable plastics produce micro- and nano- particles and fibers.
- Chemical additives are harmful: endocrine disrupting compounds, carcinogens
- A significant proportion are single-use plastics of modern lifestyle: fastfood, snack foods, convenience foods
- Ubiquitous use = ubiquitous waste

Outline

1. What is Plastic Waste?
2. **From 3R's to 4R's**
3. Philippine Laws and Regulations on Plastic Waste
4. Strategies for the Management of Plastic Waste in the Philippines

Consumer

All sectors are responsible for the 3R's

	Consumer	Retailer	Industry
Reduce	• Reduce consumption • Minimize single-use plastic • Use deposit system • Purchase larger volumes	• Reduce packaging • Minimize single-use plastic • Institute deposit system	• Minimize production of single-use plastic • Reduce use of virgin materials
Reuse	• Extend use of product	• Encourage re-usable containers	• Extended producer responsibility (EPR): Take-back policy
Recycle	• Segregate for collection and recycling	• Segregate for collection and recycling	• Convert plastic waste into new plastic products

Reduce – Reuse - Recycle

1. Minimize single-use plastics, such as: disposable shopping bags, bottled drinks (soda, juice, water), plastic plates and straws.
2. Minimize use of single-use products which contain plastics: diapers.
3. Eliminate non-essential plastic products
4. Reduce packaging.
5. Purchase larger volumes to minimize packaging waste: sachés, bottles.

A large proportion of plastic waste is single-use plastic.

Reduce – **Reuse** - Recycle

Reduce – Reuse - **Recycle**

https://readersportaltoday.net/2019/02/20/filipino-engineer-recycles-plastic-garbage-and-made-it-into-school-chairs/

Filipino Engineer Recycles Plastic Garbage And Made It Into School Chairs.

Winchester Lemen, a mechanical engineer from Davao City, found a way to recycle plastic garbage turning it into cute school chairs. He runs the Envirotech Waste Recycling, a project to turn plastic garbage into chairs.

Reduce – Reuse - **Recycle**

Recycling of Polyethylene into Strong and Tough Earth-Based Composite Building Materials

Salifu T. Azeko[1]; Kabiru Mustapha[2]; Ebenezer Annan[3];
Olushola S. Odusanya[4]; and Winston O. Soboyejo[5]

Conclusions. The PE-reinforced laterite composites have much higher strengths and fracture toughness than concrete mortar produced from river sand and portland cement. This suggests that PE-reinforced laterite blocks can replace conventional cement blocks produced from river sand and cement.

Thermo Poly Rock for home construction from Affresol.

Building Science

October 16, 2012 2 Like

Synthetic Solutions

CAN PLASTICS SUPPLANT WOOD AND CONCRETE AS A STRUCTURAL BUILDING MATERIAL?

Will plastics be the new structural building material?

By John Caulfield

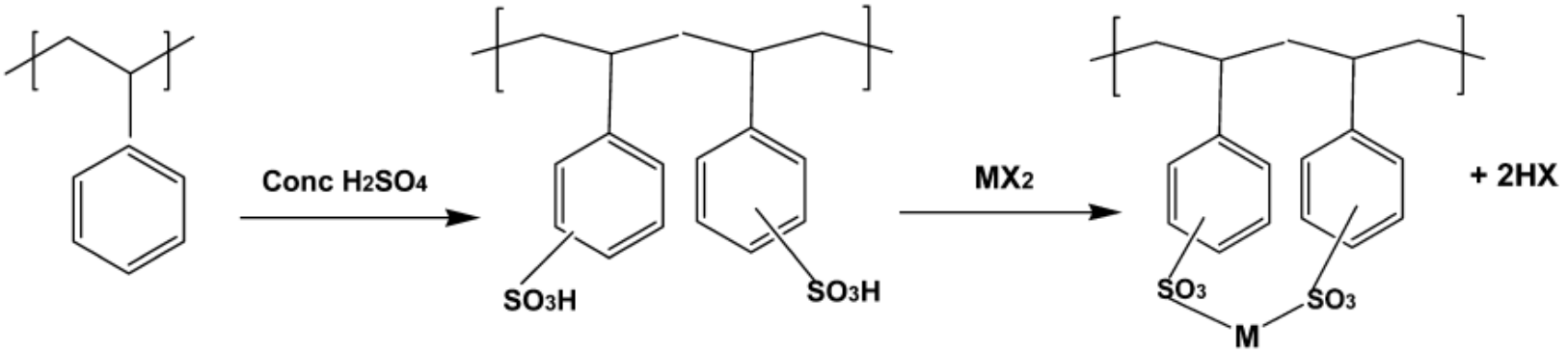
Reduce – Reuse - **Recycle**

ACS Sustainable Chemistry & Engineering

ACS Sustainable Chem. Eng. 2016, 4, 819–827

Conversion of Waste Styrofoam into Engineered Adsorbents for Efficient Removal of Cadmium, Lead and Mercury from Water

Mohamed E. Mahmoud,*,† Azza E. H. Abdou,† and Somia B. Ahmed‡



Reduce – Reuse - **Recycle**

Rajagopalan Vasudevan

(imagui.eu)

India

Recycling plastic waste into roads. In 2001, India started using plastic for road building. These plastic roads developed no potholes and cracks after years of use, and were cheaper to build.

(www.macrebur.com)

U.S.A.

Each km of road uses the equivalent weight of 684,000 bottles or 1.8 million single use plastic bags. 1 ton of MacRebur mix contains the equivalent of 80,000 plastic bottles.

Reduce – Reuse - **Recycle**

GMA NEWS ONLINE
YOUR NEWS AUTHORITY

SCITECH

Filtered By: Just In

Roads built of recycled plastics? They will soon be constructed in PHL

Published March 11, 2019 6:19pm

By DONA MAGSINO, GMA News

Innovations in the infrastructure industry are being developed to sustainably utilize plastic waste.

In the Philippines, San Miguel Corporation (SMC) is set to build roads out of hard-to-recycle plastics by incorporating them as a raw material input — an ingredient! — to make asphalt.

The initiative is part of the company's goal to address solid waste pollution.

"Developing roads using plastics that would otherwise end up in landfills or our bodies of water is an environment-friendly method of disposing scrap plastics," SMC president and COO Ramon S. Ang said.

"We can help our environment and at the same time improve the quality of our infrastructure projects," he added.

Reduce – Reuse - **Recycle**

PlasticRoad

Construction of 2nd PlasticRoad bicycle path in Overijssel, Netherlands, Nov 22, 2018

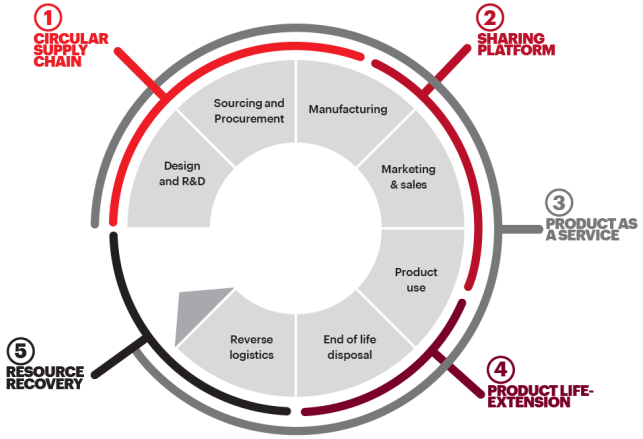
Plastic Road is a completely circular product that is based on recycled plastics. It has a significantly smaller carbon footprint than traditional road structures thanks to the longer lifespan and the reduction of transport movements involved in its construction. (https://www.plasticroad.eu/en/)

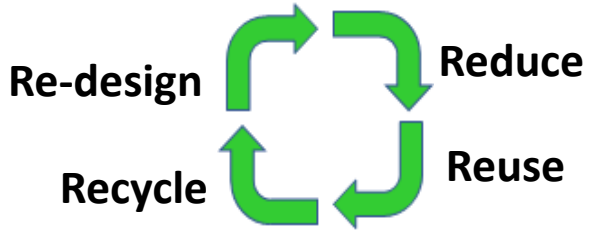
Are the 3Rs enough?

(Getty images)

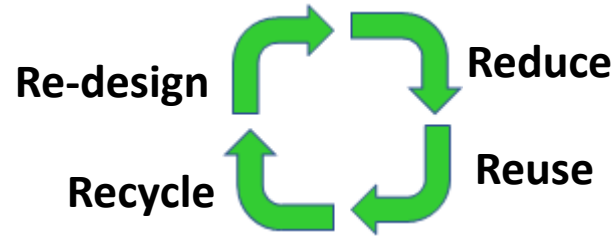
From: Cradle to Grave and the 3R's

To: Circular Economy and the 4R's





Re-design



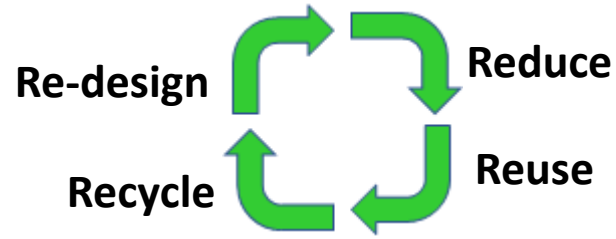
Edible / biodegradable disposable plastics

(10) International Publication Number
WO 2012/098448 Al

(54) Title: ECO-FRIENDLY AND BIODEGRADABLE EDIBLE UTENSILS INCLUDING CUTLERY AND CHOPSTICKS AND METHODS OF MAKING THEM

(57) Abstract: Eco-friendly, biodegradable and edible cutleries, chopsticks, and all utensils used to lift food into mouth wherein the cutleries, chopsticks, and all other such utensils are made of flours having about 65% w/w or above carbohydrate content and contain no added preservatives or chemical additives and having a shelf life of a year or more. The method of preparing Eco- friendly, biodegradable and edible cutleries, chopsticks, and all utensils used to lift food into mouth.

Re-design

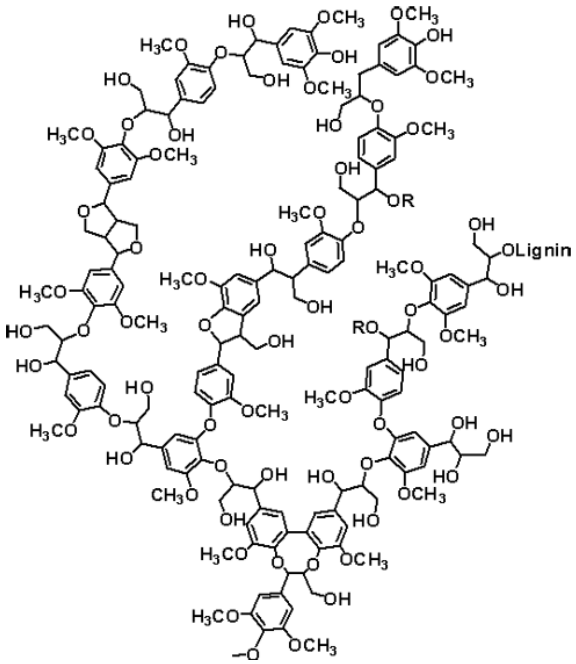


Lignin as renewable feedstock for biodegradable plastics

Coconut coir

Agroforestry

Extract



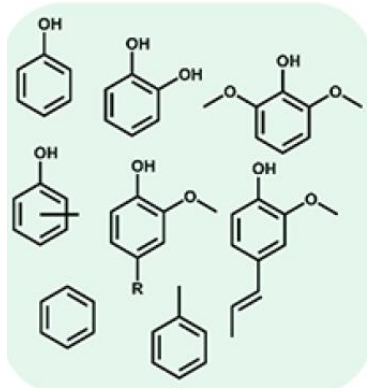
Lignin

poly(vinyl alcohol) (PVA),
poly-ε-caprolactone) (PCL)

Co-polymerize

Biodegradable lignin-based composite polymers (1)

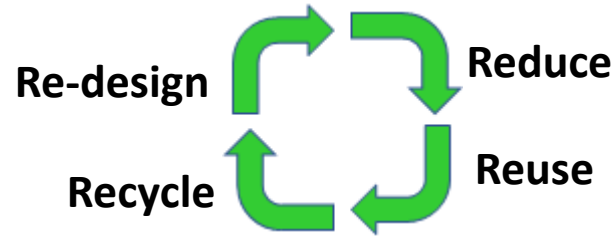
Pyrolysis



(2)

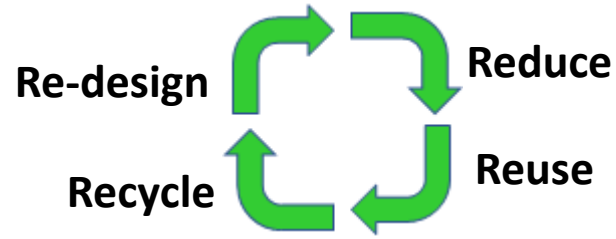
Refs:
(1) Corti., et al.,in Biodegradable Polymers and Plastics, 2003.
(2) Jampa, et al. ACS Sustainable Chem. Eng. 2019

From 3R's to 4R's

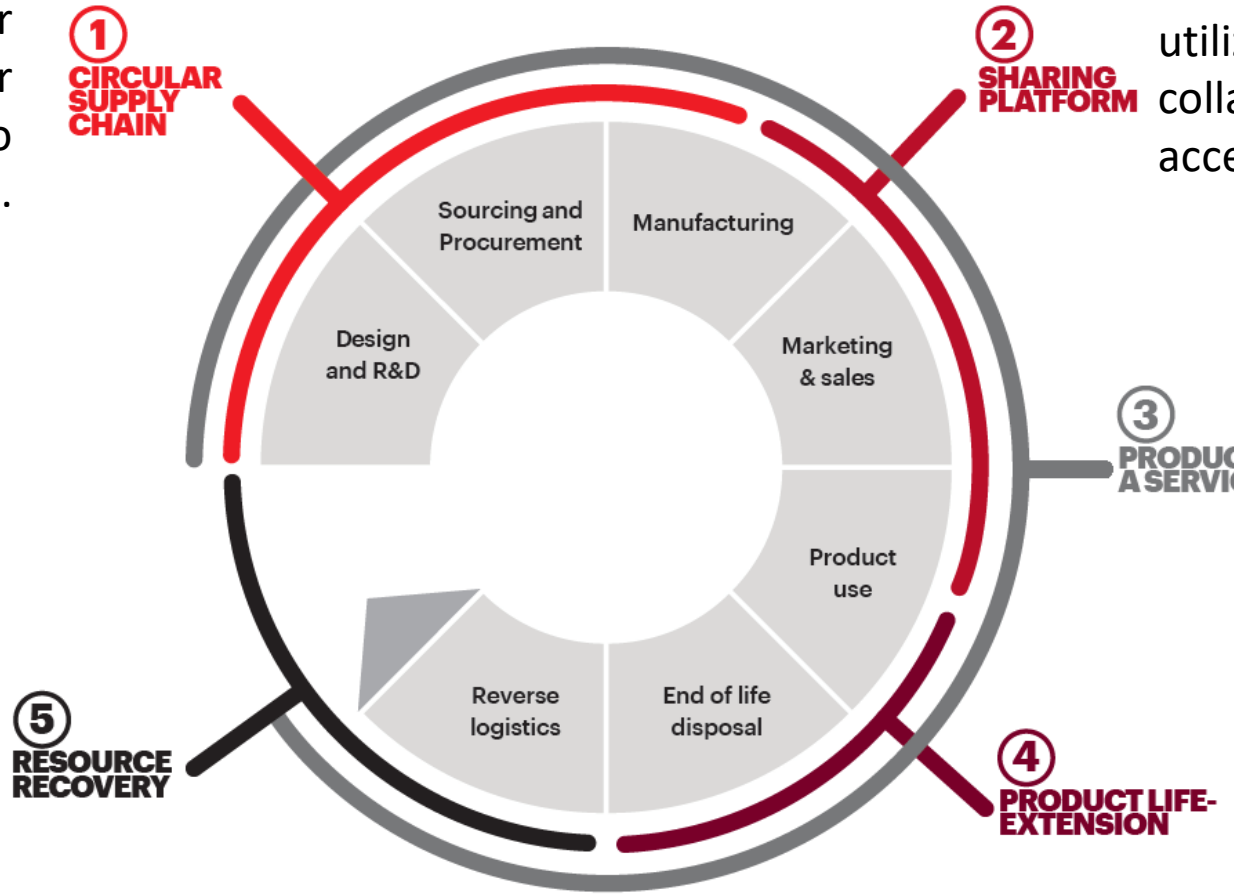


	Consumer	Retailer	Industry
Reduce	• Reduce consumption • Minimize single-use plastic • Use deposit system • Purchase larger volumes	• Reduce packaging • Minimize single-use plastic • Institute deposit system	• Minimize production of single-use plastic • Reduce use of virgin materials
Reuse	• Extend use of product	• Encourage re-usable containers	• Extended producer responsibility (EPR): Take-back policy
Recycle	• Segregate for collection and recycling	• Segregate for collection and recycling	• Convert plastic waste into new plastic products
Re-design	• Modify activities to decrease consumption • Change of lifestyle • Eliminate non-essential plastic products	• Assist manufacturer in re-design of products.	• Develop new biodegradable polymers and plastics that can be re-used and recycled more readily • Replace harmful additives • Eliminate non-essential plastic products

Re-design plastics towards a Circular Economy



① **Circular Supply Chain**: Use of circular materials, either renewable, bio-based, or highly-recyclable to replace virgin inputs.



② **Sharing Platform**. Increase utilization rates of products through collaborative models for usage, access, or ownership.

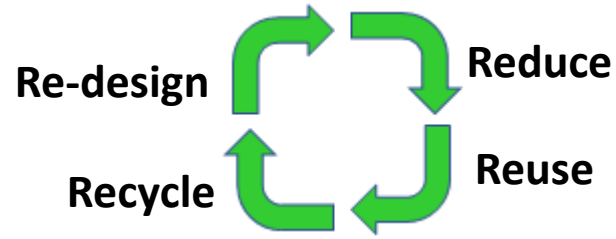
③ **Product as a Service**. Offer of product use with retention of the product ownership by the producer to increase resource productivity.

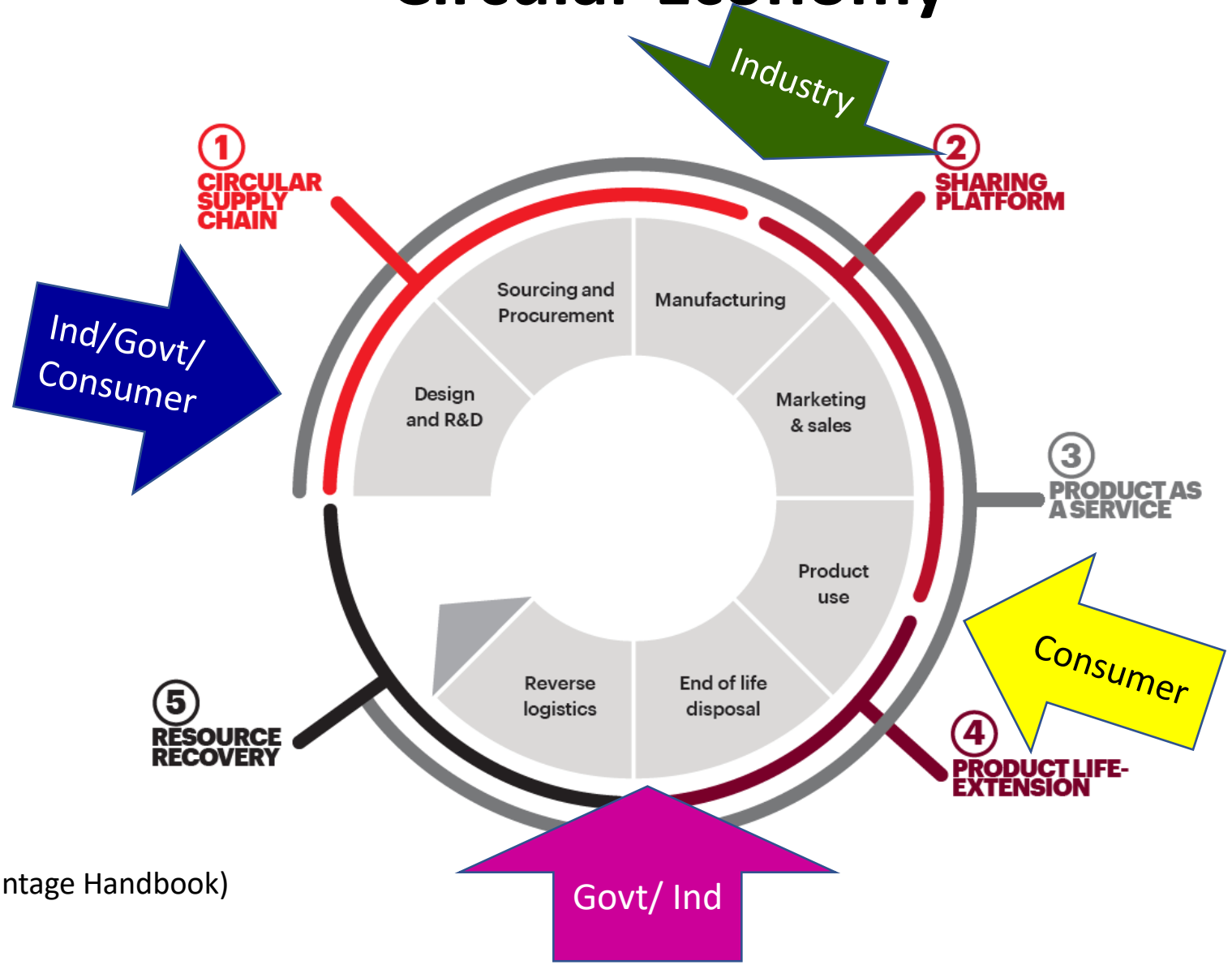
④ **Product Life- Extension**: Prolongation of the lifecycle through repair, reprocessing, upgrading and resale.

⑤ **Resource Recovery**: Recovery of usable resources or energy from waste or by-products.

(from: The Circular Advantage Handbook)

Role of various sectors in a Circular Economy





(from: The Circular Advantage Handbook)

Outline

1. What is Plastic Waste?
2. From 3R's to 4R's
3. **Philippine Laws and Regulations on Plastic Waste** (With Queenie Cunanan)
4. Strategies for the Management of Plastic Waste in the Philippines

International Commitments

Technological progress is also key to finding lasting solutions to both economic and environmental challenges. Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.

Achieving economic growth and sustainable development requires that we urgently reduce our ecological footprint by changing the way we produce and consume goods and resources. Encouraging industries, businesses and consumers to recycle and reduce waste are important to move towards more sustainable patterns of consumption by 2030.

Protect marine and coastal ecosystems from pollution.

Systemic issues

- Enhance global macroeconomic stability, including through policy coordination and policy coherence.
- Enhance policy coherence for sustainable development.

Philippine Laws Related to Plastic Waste

1. Ecological Solid Waste Management Act of 2000 (R.A. 9003)

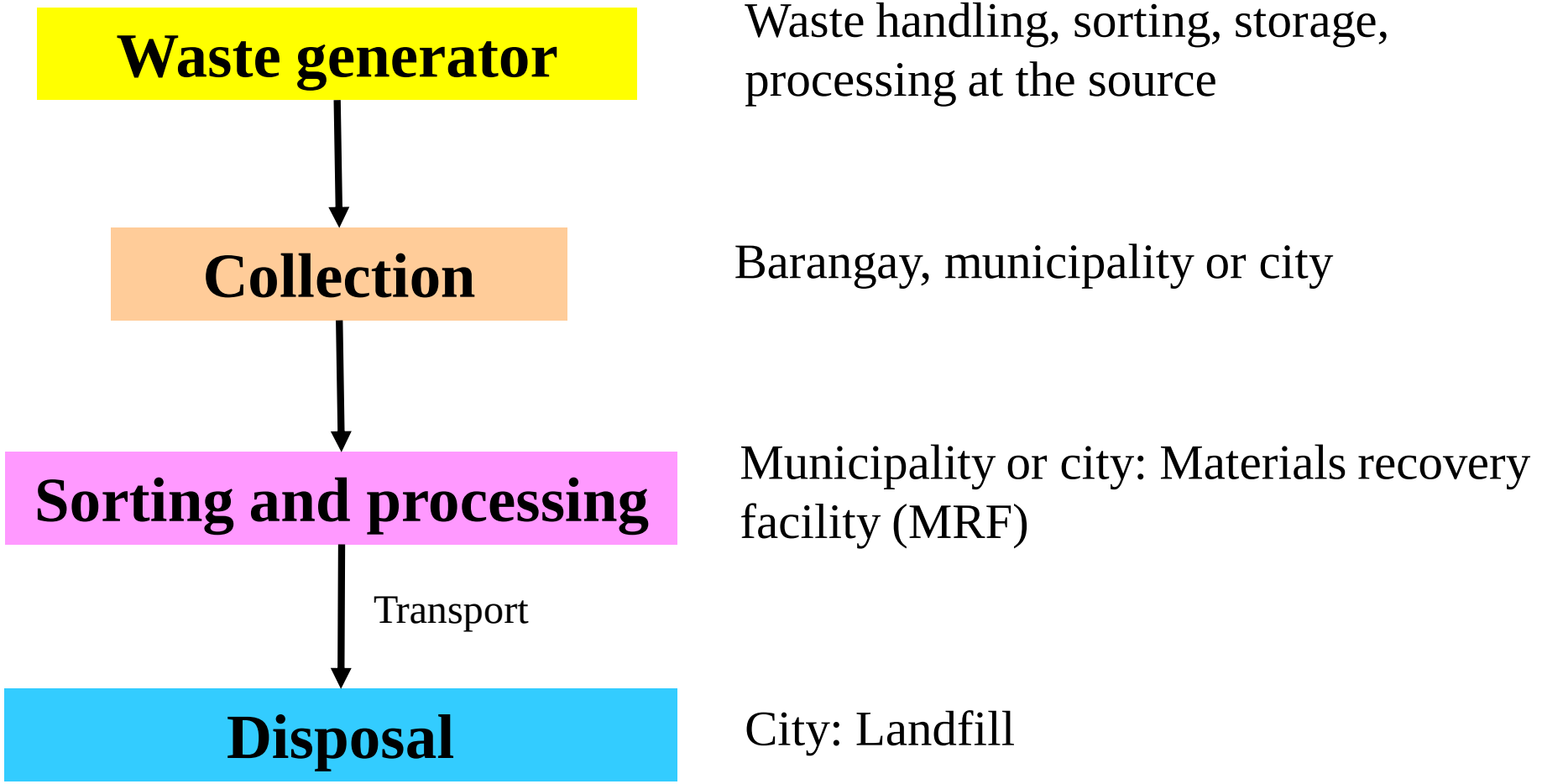
2. Local Government Code of 1991 (R.A. 7160)

What is Solid Waste Management (SWM)?

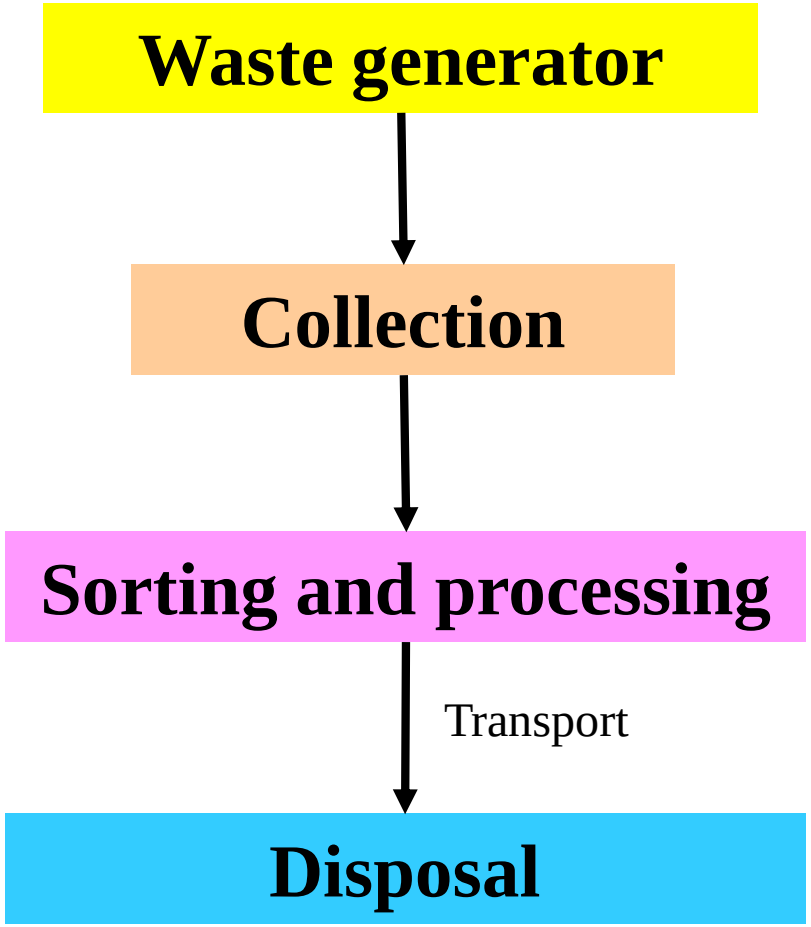
"Solid waste management shall refer to the discipline associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations, and that is also responsive to public attitudes."

What are the components of SWM?

- Waste must be managed from the point of generation to the point of disposal
- Multi-disciplinary: planning, administration, financial, legal, engineering



How waste is managed?



- Waste avoidance
- Waste minimization
- Waste segregation

- Rule IX: Waste segregation at source
- Rule XII: Implementing a recycling program

How waste is picked up

- Rule X: Collection, transport & handling of solid waste

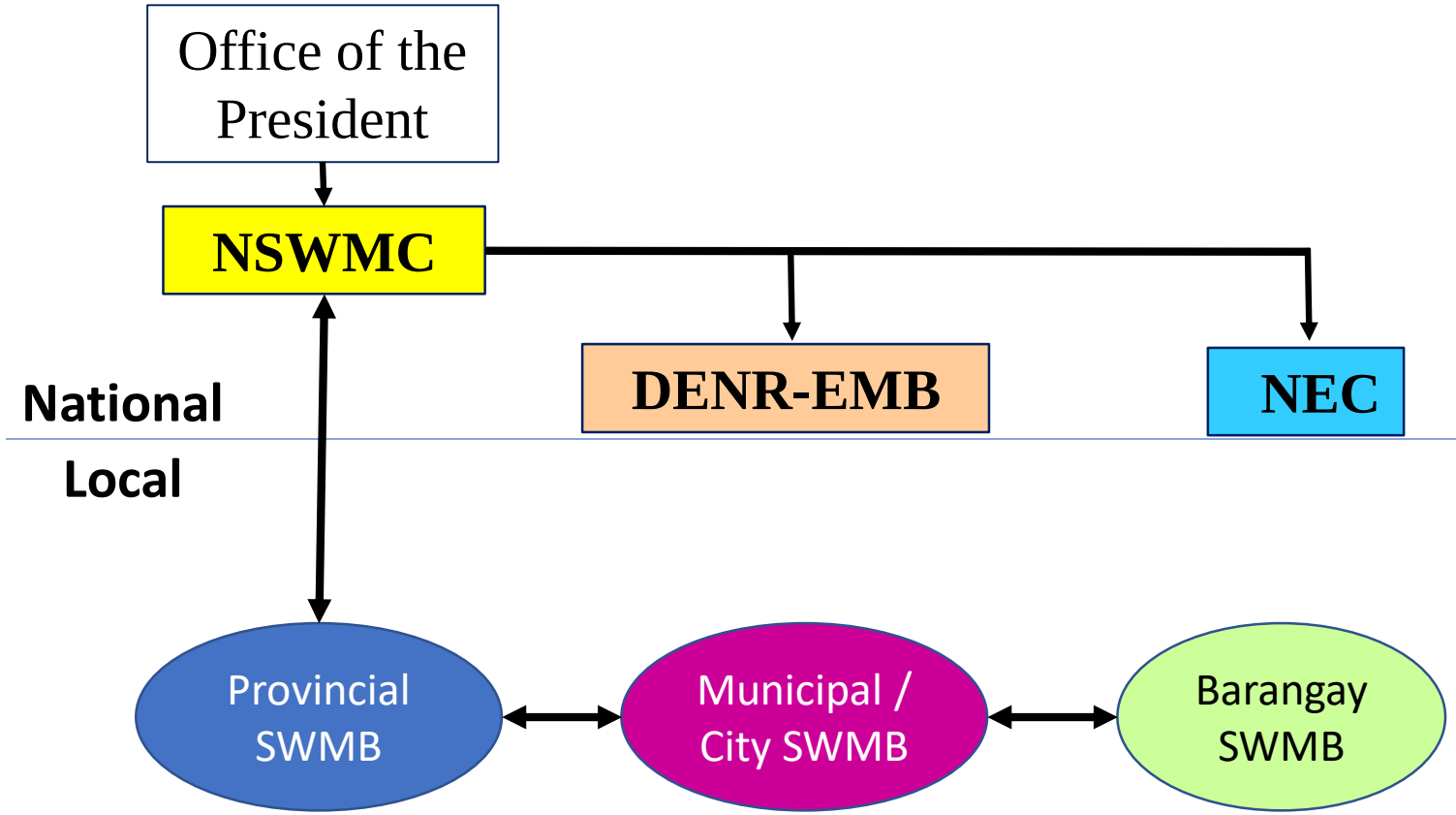
How waste is treated & made useful

- Rule XI: MRF & composting

How waste is finally discarded

- Rule XIII: Operation of controlled dumpsite
- Rule XIV: Operation of sanitary landfill

Institutional Members

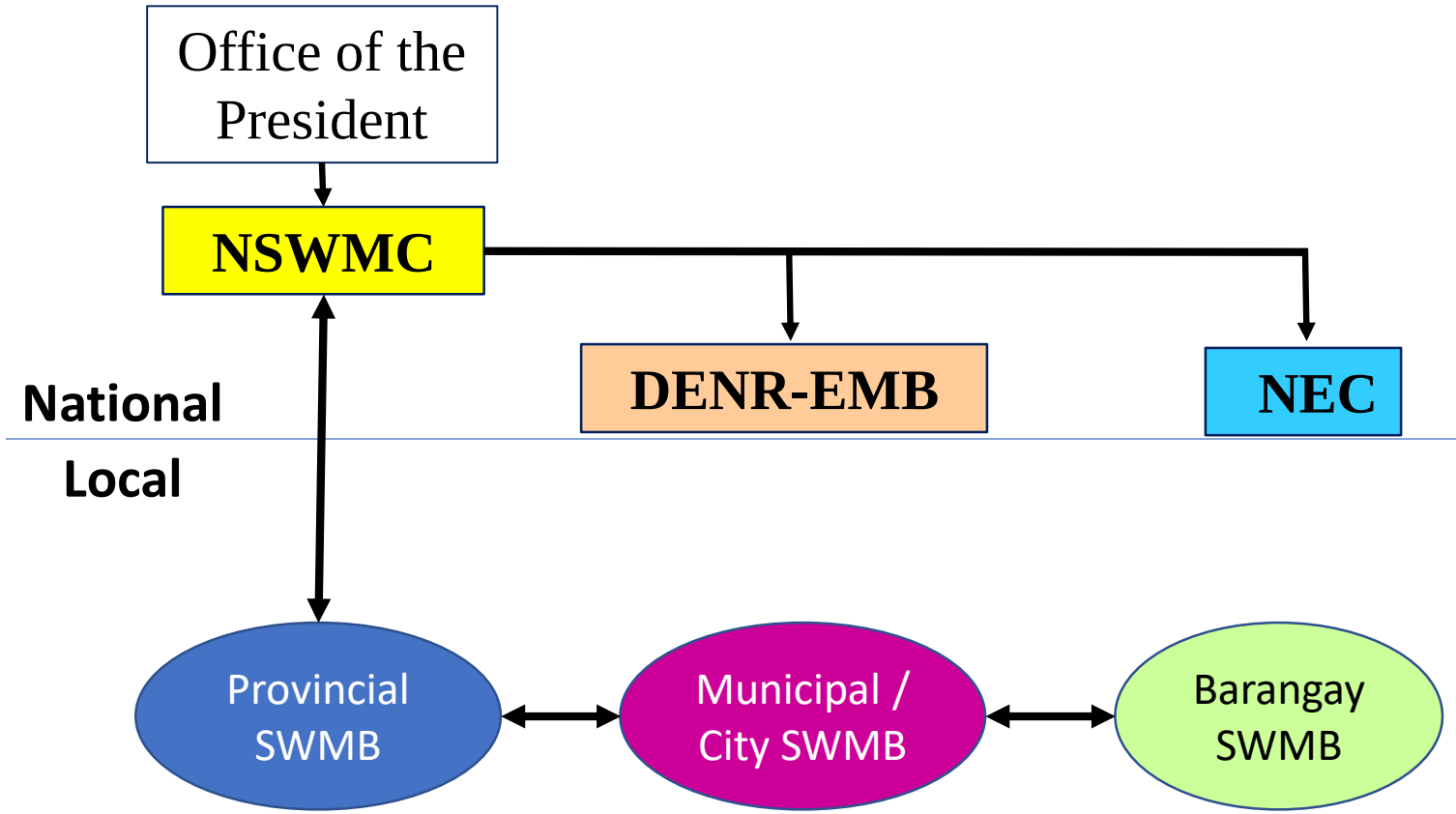


NSWMC:
Govt: DENR, DOST, DOH, DA, DILG, DPWH, DTI, MMDA, TESDA, PIA, MMDA, TESDA, League of Prov. Gov., League of Mun. Mayors, Assoc. of Brgy. Councils
Priv.: NGO, Recycling industy, Mfg./ Pkg. Industry

Provincial SWMB Mayors, Sangg. Panlalawigan, Health officer, ENR officer, Prov. Engg., Cong. Rep., NGO, Recycling industry, Mfg.,/Pkg. industry

Municipal/city SWMB: Sangg. Panlungsod, Pres. Assoc. Brgy. Councils, Kabataan Fed., NGO, Recycling industry, Mfg./Pkg. industry,

Institutional Functions



NSWMC: oversees the implementation of SWM plans & prescribes policies

DENR-EMB provides secretariat support to NSWMC

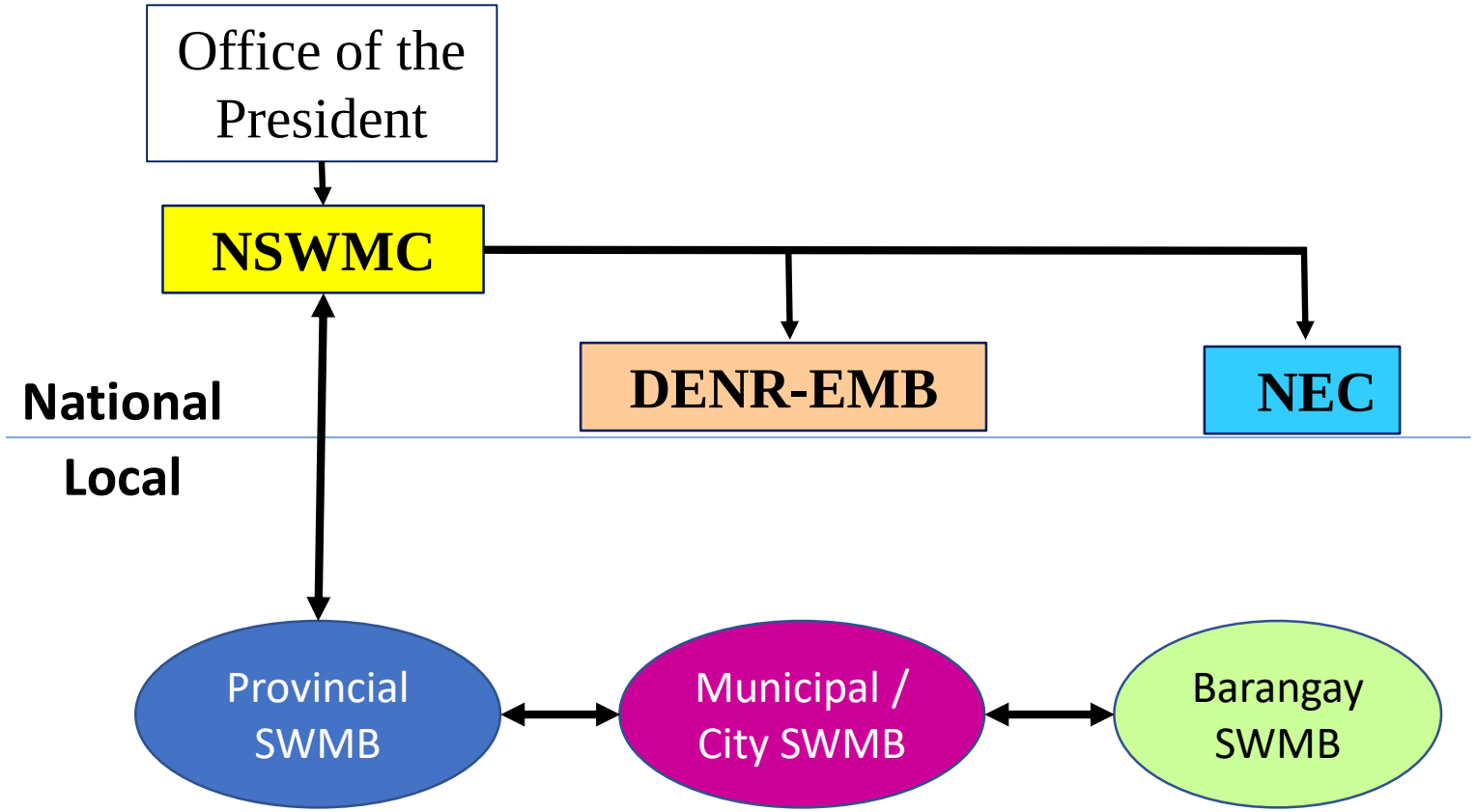
NEC provides technical expertise, training, networking services

Provincial SWMB consults and consolidates plans from SWMBs of municipalities and cities for NSWC approval

Municipal/city SWMB consults and consolidates plans and strategies from barangays

Barangay SWMB formulates SWM program consistent with city/ municipality plan

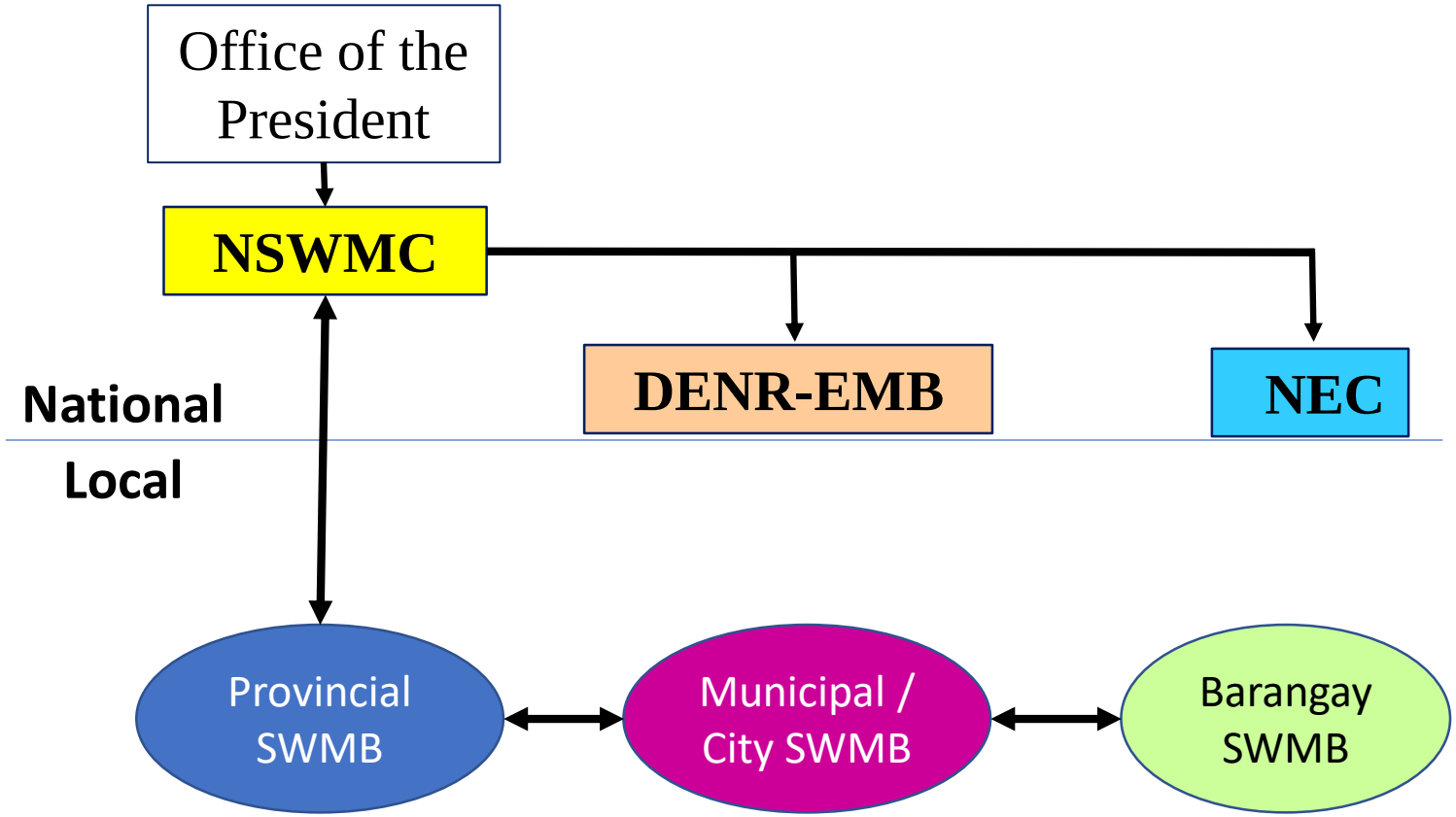
Institutional Functions



- Municipal/city SWMB assists barangays if it is unable to manage SW
- Collect and dispose of non-recyclable/non-recoverable waste and special wastes

- Barangay SWMB: collect & segregate biodegradable, compostable, reusable waste
- Establish MRF
- Manage and raise funds
- Organize waste coordinators

Institutional Functions



MRF, Balamban, Cebu

RULE XI Sec. 1 MRF shall be established in a barangay-owned or leased land or any suitable open space to be determined by the barangay through its Sanggunian.

Landfill, Cebu (Alamy stock photo)

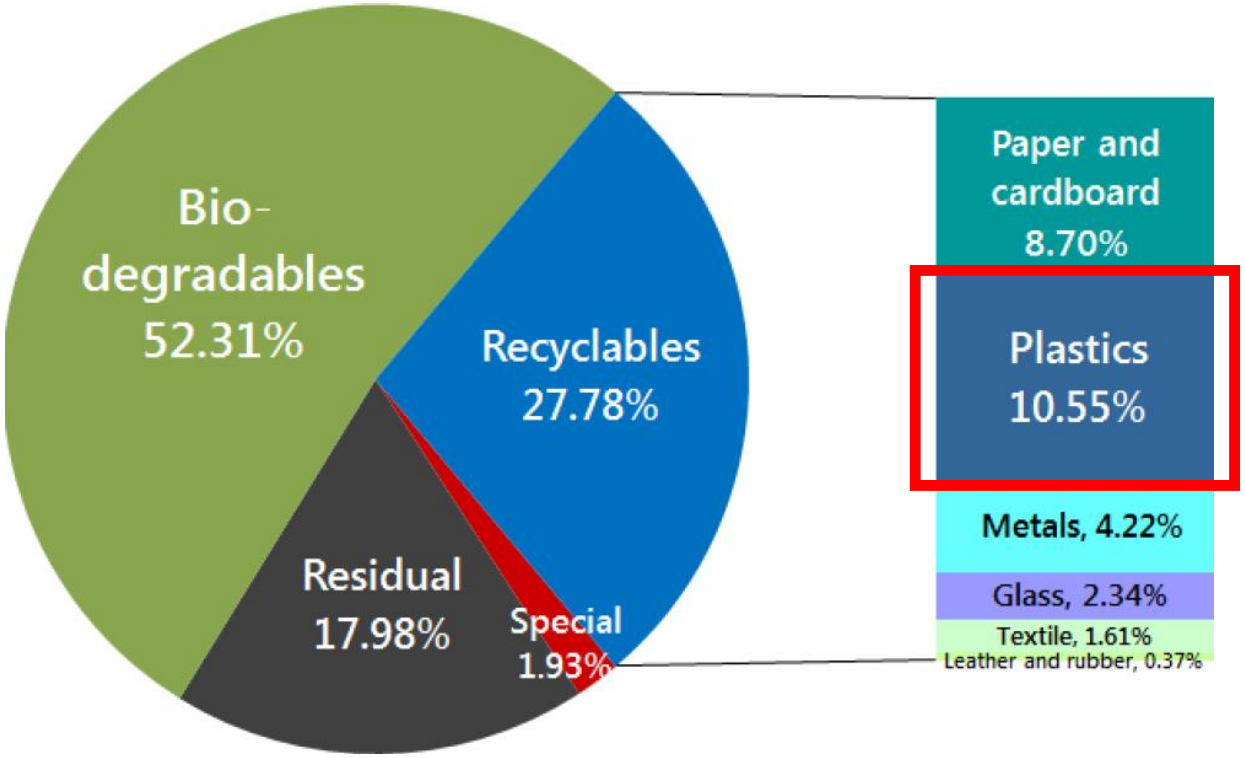
Sanitary landfill shall be developed and operated as a final disposal site for solid and residual wastes of a municipality/ies or city/ies.

Funding for Solid Waste Management

SWM Fund	Incentives	Cost Recovery
Administered by NSWMC	Fiscal and non-fiscal incentives	Local SWMBs can impose fees and can undertake MOAs with private sector
Source of Fund: • Donations, grants • GAA • Fines	Encourage LGUs, private sector and civil society to participate in SWM programs, such as operation of MRF	Cities & municipalities may impose fees on barangay for disposal of SW into landfills (tipping fees)
LGU may avail of 1 project every 3 years @ P1.5M		
Establish local FUND administered by local SWMB		

Municipal solid waste in the Philippines

2008-2013, % by weight (EMB, 2018)



Plastic at iba pa

- Plastics should be treated as a separate category of solid waste.

Municipal solid waste in the Philippines

Quezon City

- Population: 2.77 m
- 736,083 tons of solid waste
  - 250,455 tons (34%): collected by the informal sector. About 92% of this amount is valorized (recycled).
  - 476,407 tons: collected by municipal collection
  - 9,221 tons: uncontrolled disposal
- Proportion of plastic waste: 16%
  - PET 1.9%
  - HDPE 1.6%
  - Film Plastic/LDPE 12.5%
  - Diapers/Cigarette Butts 4.6%
  - Textiles 2.9%
  - Rubber 0.3%

(source: UN-Habitat, 2009)

Payatas

- Largest landfill in the Philippines
- Area: 220,000 m^2
- ~1,300 tons/day (2003) → ~2,300 tpd (2017)

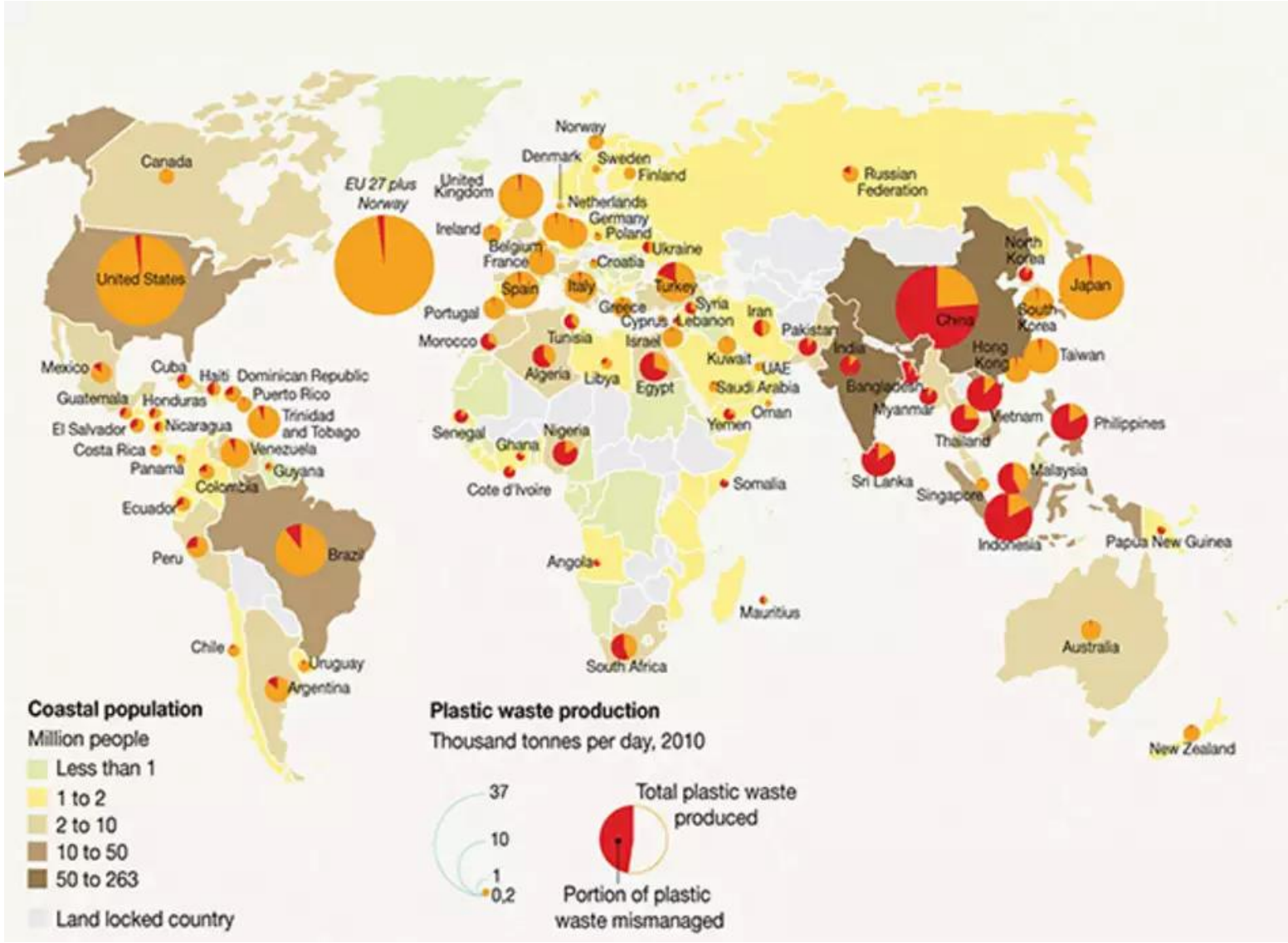
(https://childrenofthedump.org.uk/what-we-do/life-at-payatas-dump/)

From municipal solid waste to recycled polymer resins

Polyethylene, polypropylene, polystyrene, and polyester recycled polymer resins

Mismanaged plastic waste

(from: Jambeck, *Science*, 2015)



Top 20 countries by mass of mismanaged plastic waste, 2010.

Rank	Country	% Mismanaged waste
1	China	76
2	Indonesia	83
3	**Philippines**	**83**
4	Vietnam	88
5	Sri Lanka	84
6	Thailand	75
7	Egypt	69
8	Malaysia	57
9	Nigeria	83
10	Bangladesh	89
11	South Africa	56
12	India	87
13	Algeria	60
14	Turkey	18
15	Pakistan	88
16	Brazil	11
17	Burma	89
18	Morocco	68
19	North Korea	90
20	United States	2

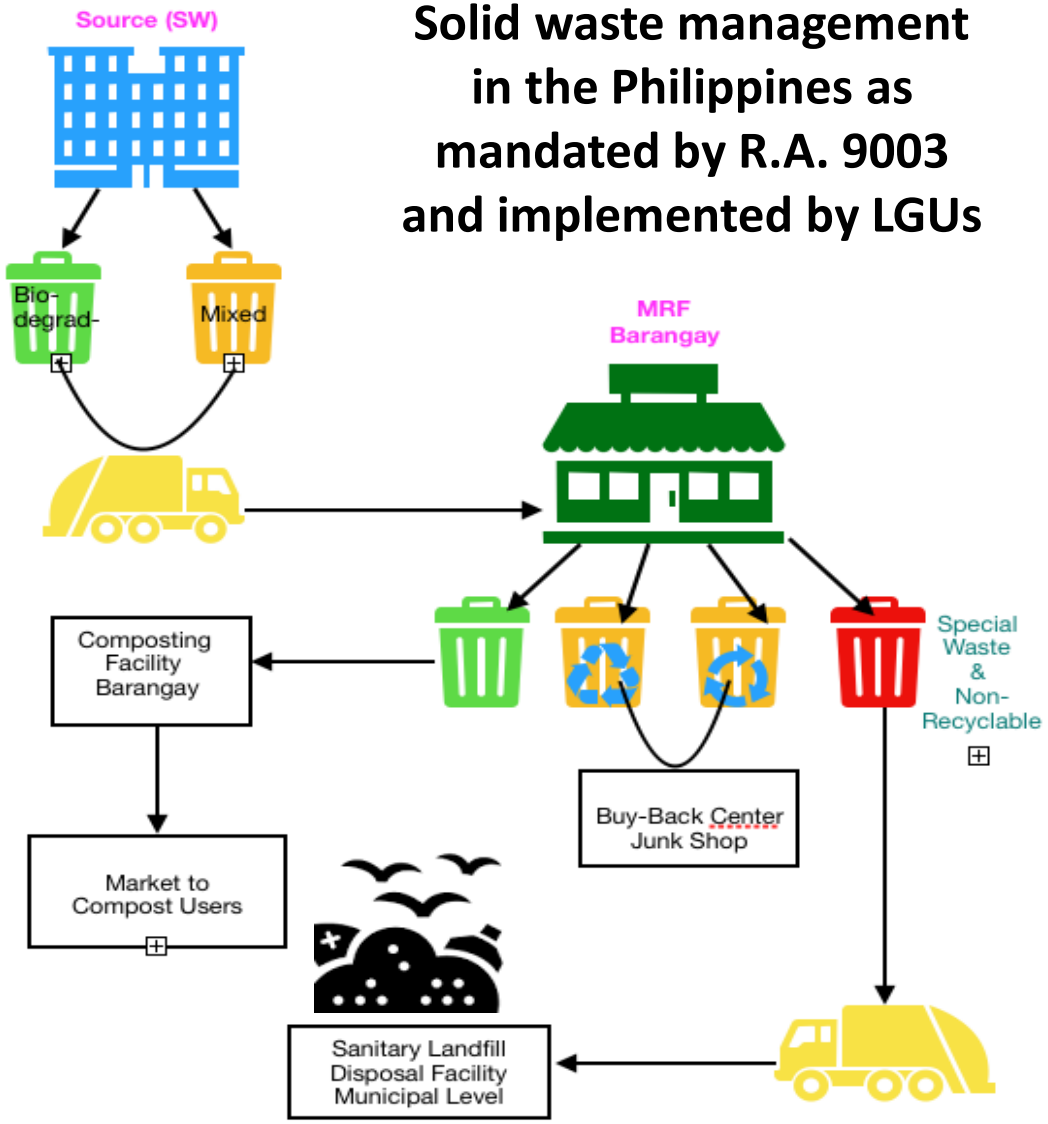
Why have we been unable to address plastic waste?

- **Plastic waste is complex problem that goes beyond the objectives and scope of R.A. 9003.**

Outline

1. What is Plastic Waste?
2. From 3R's to 4R's
3. Philippine Laws and Regulations on Plastic Waste
4. **Strategies for the Management of Plastic Waste in the Philippines**

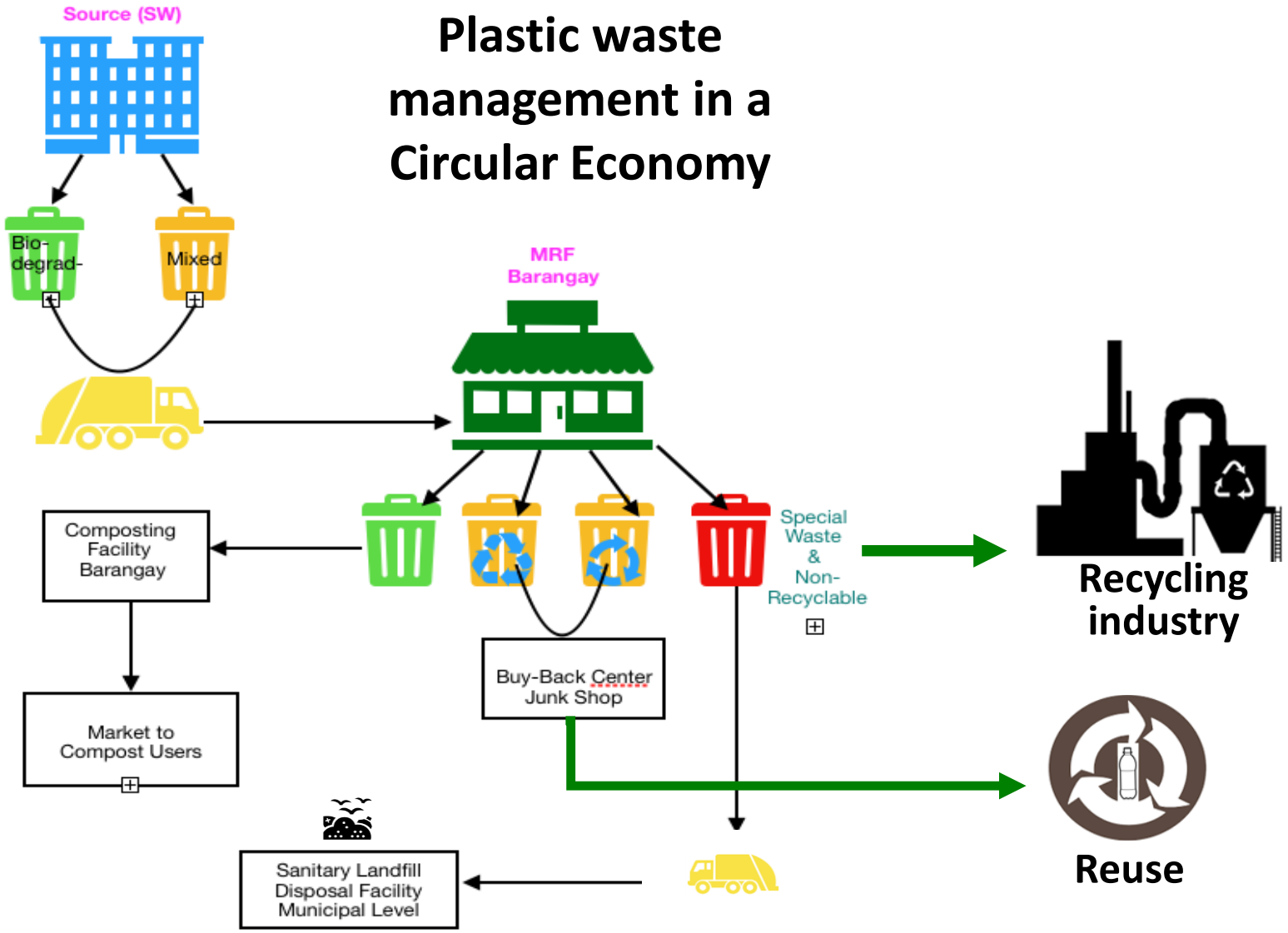
Solid waste management in the Philippines as mandated by R.A. 9003 and implemented by LGUs



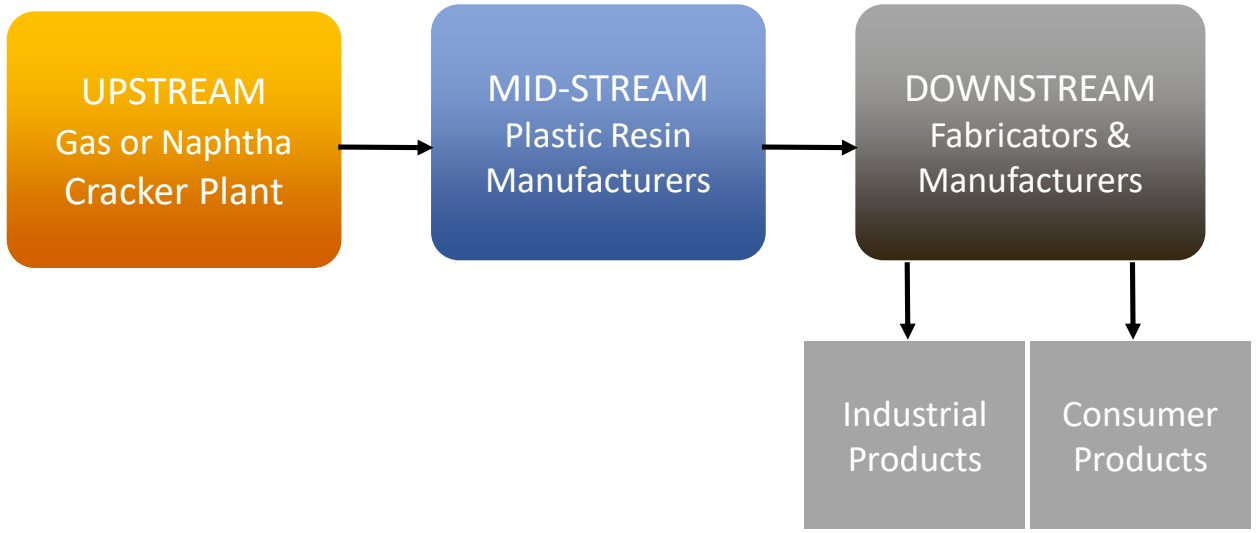
(Queenie Cunanan)

1. R.A. 9003 tackles solid waste as a whole. However, plastic waste needs a different strategy.
2. R.A. 9003 is based on "end of pipe" approach and dependence on landfills.
3. Lack of attention to S&T of plastics.
4. Minimal role assigned to DTI and DOST.
5. Minimal support for plastic industry and plastic recycling industry.

Plastic waste management in a Circular Economy

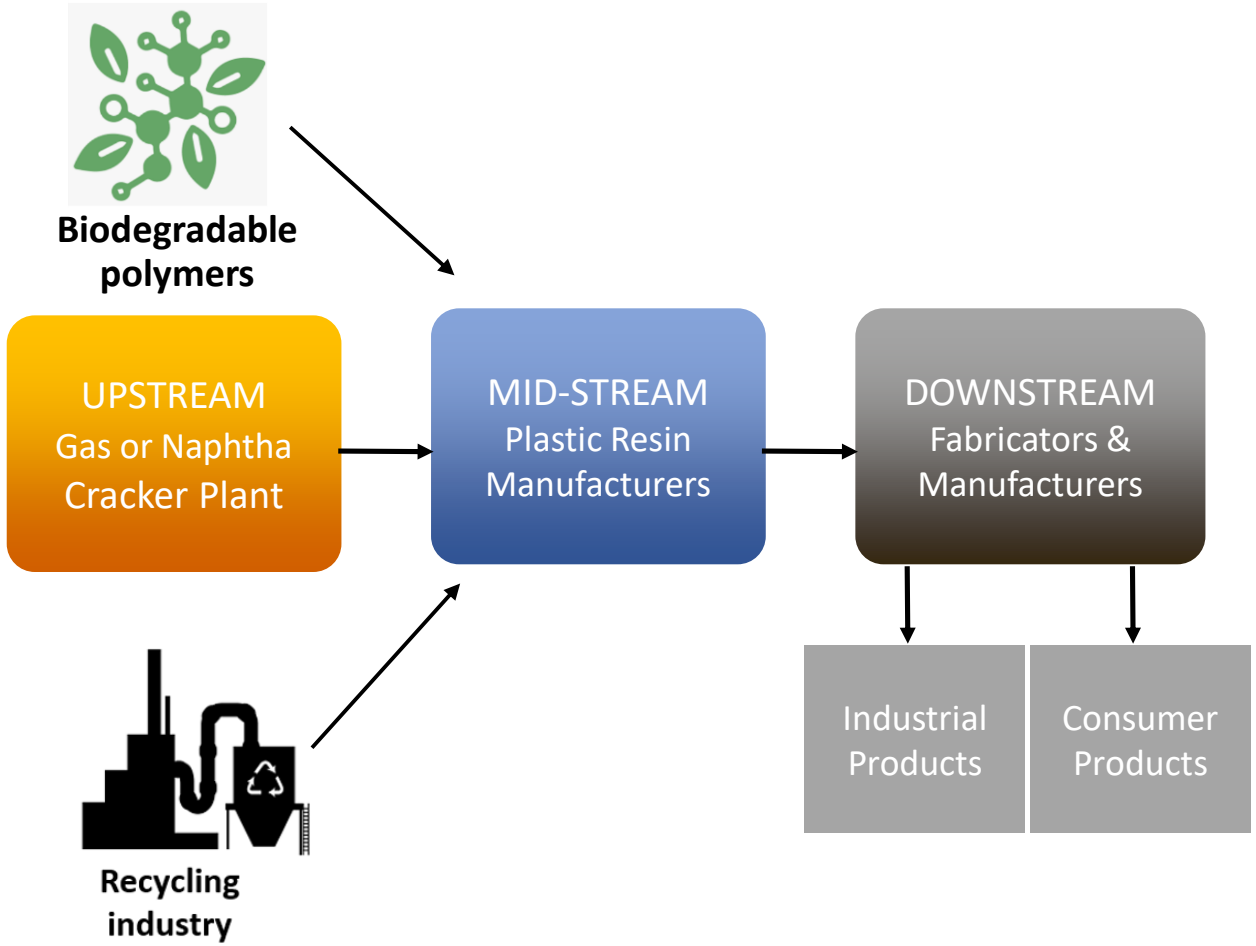


Plastics Industry Supply Chain (present)



(from: Philippine Plastics Industry Association, Supply Chain & Industry Linkages, 2016)

Plastics Industry Supply Chain (future)



(modified from: Philippine Plastics Industry Association, Supply Chain & Industry Linkages, 2016)

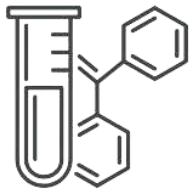
Successful management of plastic waste needs the right ecosystem

Stakeholder governance

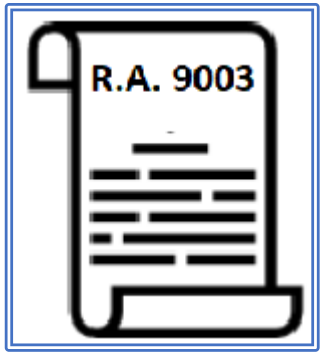
Global

Consumers

Public education



R&D



Policy makers

Biodegradable plastics industry

Plastic recycling industry

Regulators

Local government units

A holistic strategy for the management of plastic waste

1. Abandon the “end of pipe” approach to plastic waste; end dependence on landfills.
2. Move from 3R’s to 4R’s.
3. Engagement of all stakeholders is essential: industry, government, consumers.
4. Education for a sustainable lifestyle and responsible consumption.
5. Eliminate non-essential plastic products, especially single-use plastics.
6. Industry should adopt a circular economic model for plastic production cycle.
7. An improved governance framework (laws, regulations, and implementation) within a supportive ecosystem.
8. R&D needed for: recycling of plastic waste; new biodegradable materials; safe chemical additives; non-fossil fuel-based starting materials.
9. Strengthen and harmonize global programs, monitoring, and assessment of plastic products to meet UN SDG targets.

Reduce
Reuse
Recycle
Re-design

Thank you !

Acknowledgments

- NAST: for fellowship grant
- Queenie Cunanan: for research assistance