TECHNOLOGY & INNOVATIVE SOLUTIONS INVENTORY REPORT FOR PREVENTING AND MANAGING PLASTIC POLLUTION

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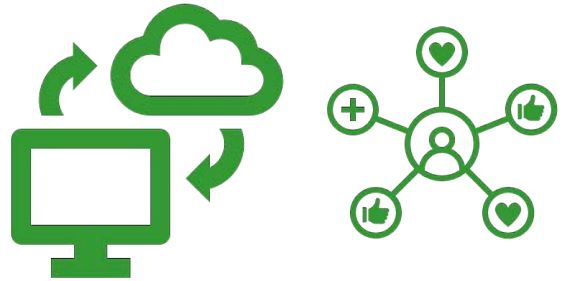
This Presentation will cover..

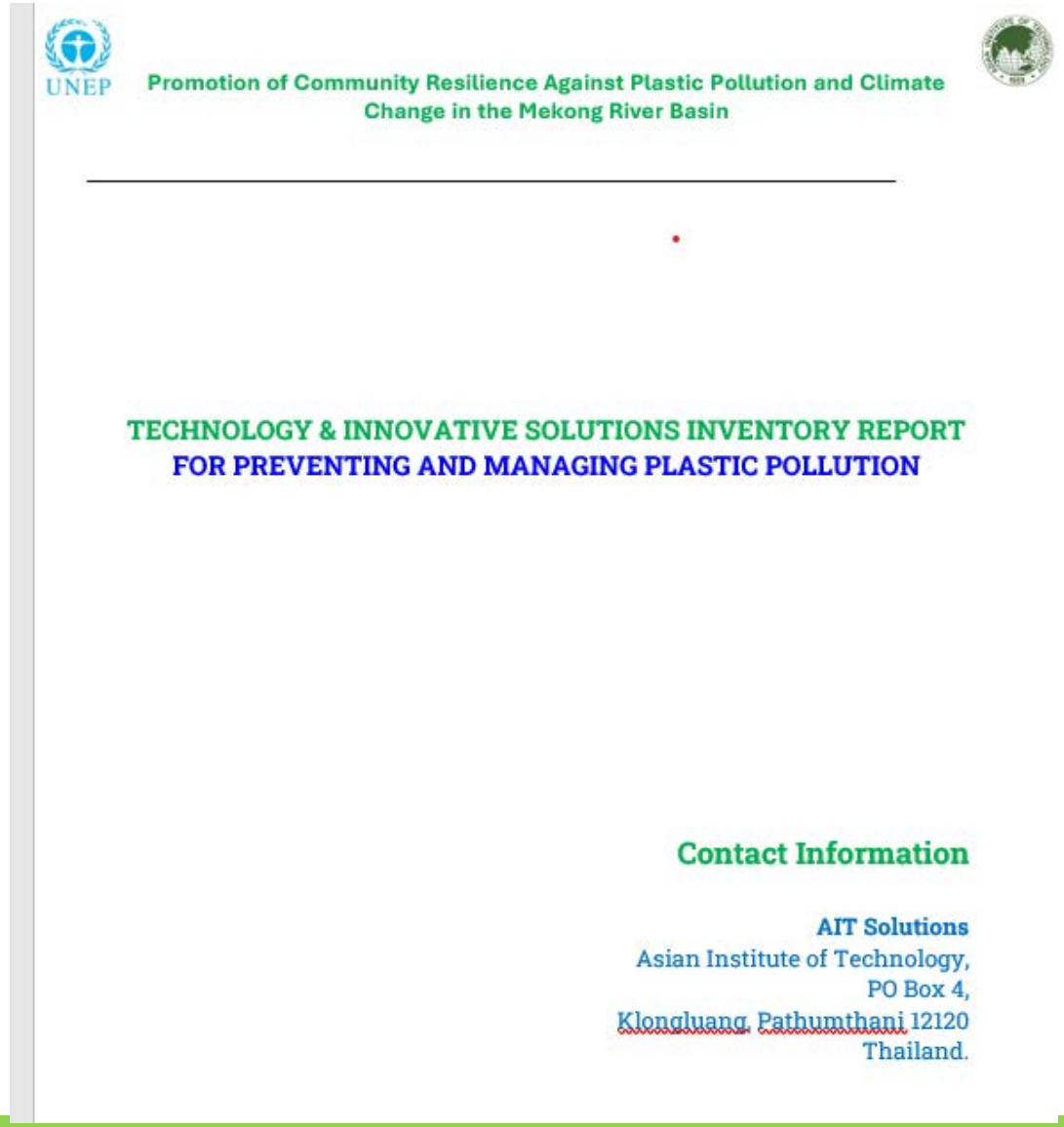
- ✓ Introduction
- ✓ Plastic Pollution Prevention & Management Technology Landscape Mapping
  - Trends in Plastics Technology Innovations
  - Technology Evaluation Criteria
  - Existing Frameworks to Select Appropriate Technology Options
  - Initiatives to Promote Technological Innovations to Fight Plastic Pollution
- ✓ Overview of Technology & Solutions Compiled
- ✓ Conclusions



The Outline of the

UNEP Tech Inventory Report

60 Page Report with a detailed Excel file



UNEP

Promotion of Community Resilience Against Plastic Pollution and Climate Change in the Mekong River Basin

TECHNOLOGY & INNOVATIVE SOLUTIONS INVENTORY REPORT
FOR PREVENTING AND MANAGING PLASTIC POLLUTION

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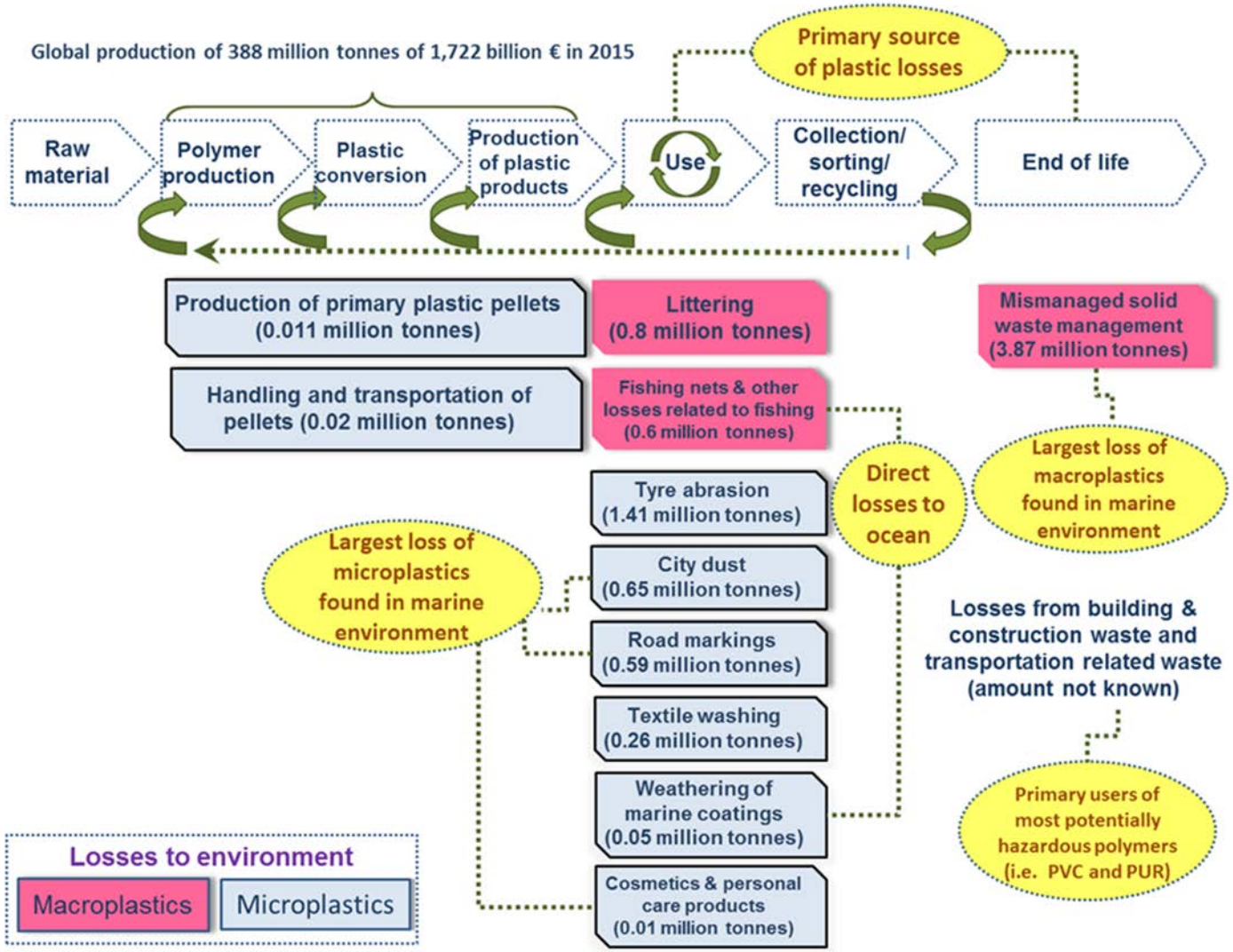
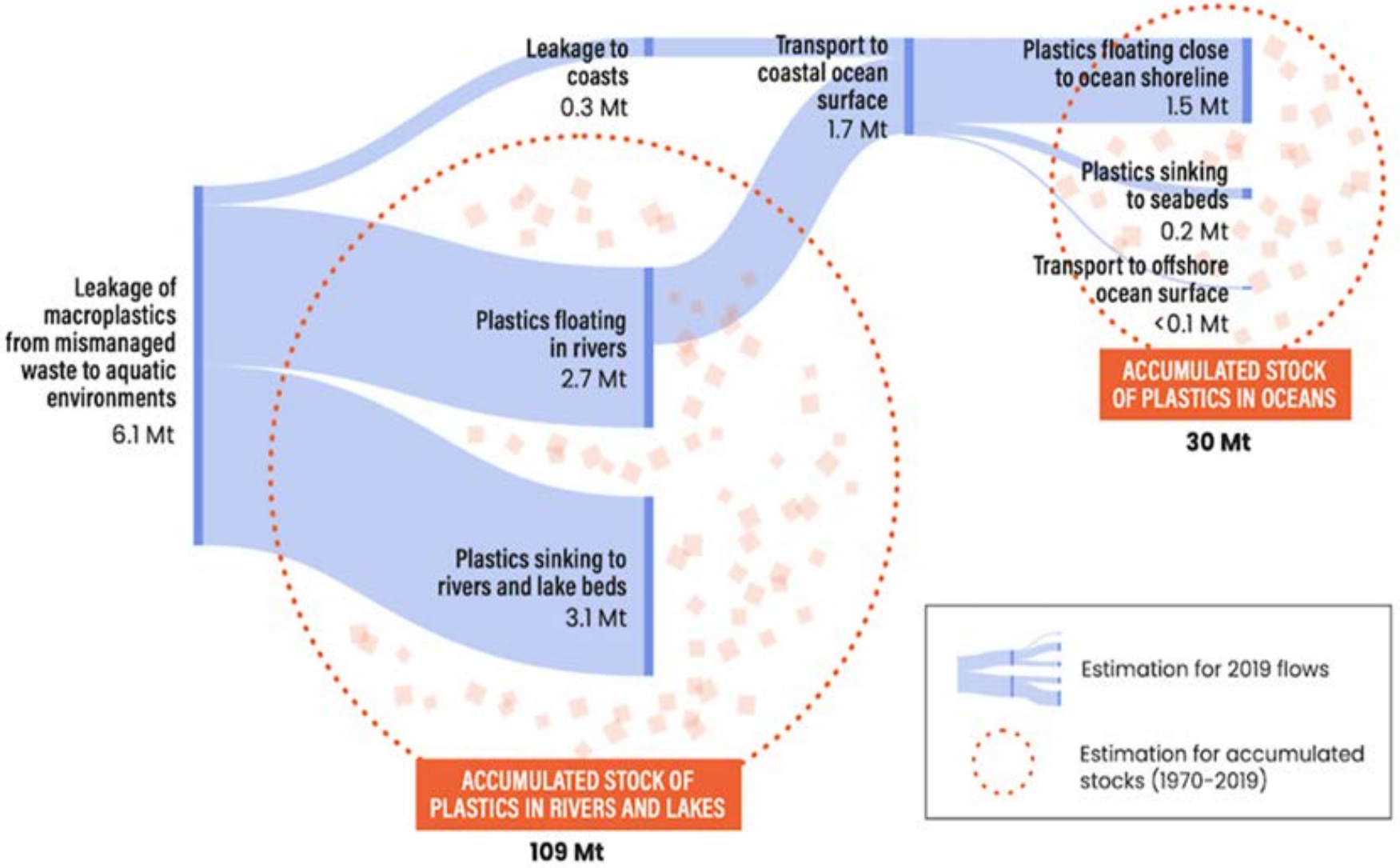
Plastics Losses from and Carbon Lock-ins in Plastic Value Chains

- ✓ Linear Flow of plastic through the value chain leads to a significant loss of plastic to the environment
- ✓ Out of 388 million tonnes of global plastic production, approximately 3 million tonnes of microplastics and 5.3 million tonnes of macroplastics were found to be lost to the environment annually.
- ✓ Not only the plastic losses into the environment but plastics largely derived from fossil-fuel are also connected to various sources of carbon lock-ins in its production, consumption, disposal stages.



Better manage

Plastic Leakage Hotspots



- ✓ Mismanaged plastics entering plastic waste from rivers and lakes (major contributors) to oceans and accumulating in the aquatic environment through complex pathways
- ✓ It is estimated that 1,000 rivers are accountable for nearly 80% of global annual riverine plastic emissions (ranging between 0.8 and 2.7 million tonnes per year) into the ocean (Meijer et al. 2021).

Plastic Pollution prevention & Management Technology Landscape: Technology/ Solution Categories

- ✓ Rise technological innovation in products, processes, and business models for reducing plastics pollution in recent years

- ✓ Broad categorizations of these technologies into
  - Prevention
  - Collection
  - Conversion
  - Recycling, and
  - Technologies for plastic leakage monitoring and leakage removal.

Classifications of innovations in environmentally relevant plastic technologies

Prevention Technologies

- ✓ Design for longer lifespans
- ✓ Light weighting or design for recycling
- ✓ Alternatives to petroleum-based plastics (e.g., biodegradable plastics - crop-based, algae-based, fundi-based feedstocks)
- ✓ Business models/solutions to reduce plastic consumption (e.g., refill solutions)
- ✓ Reuse, repair & repurposing

Collection, Transportation & Sorting Technologies

- ✓ Automated collection (e.g., smart bins, RFID tags on waste collection bags)
- ✓ Use of Apps for waste collection
- ✓ Digital pay/tokens to waste collectors/recyclers
- ✓ Real time-based automatic scheduling for waste transport/digital route planning & GPS/Digital trackers for waste transportation fleet
- ✓ Automated/sensor-based sorting (of plastic products from separate and mixed waste streams OR sorting of different types/grades/colors of plastics) for recycling

Conversion/Recycling Technologies

- ✓ Waste to Energy (WtE) Technologies
- ✓ Mechanical recycling
- ✓ Chemical recycling
- ✓ Digital marketplace for recyclers
- ✓ Block chain technologies to track and verify recycling

Leakage Monitoring Technologies

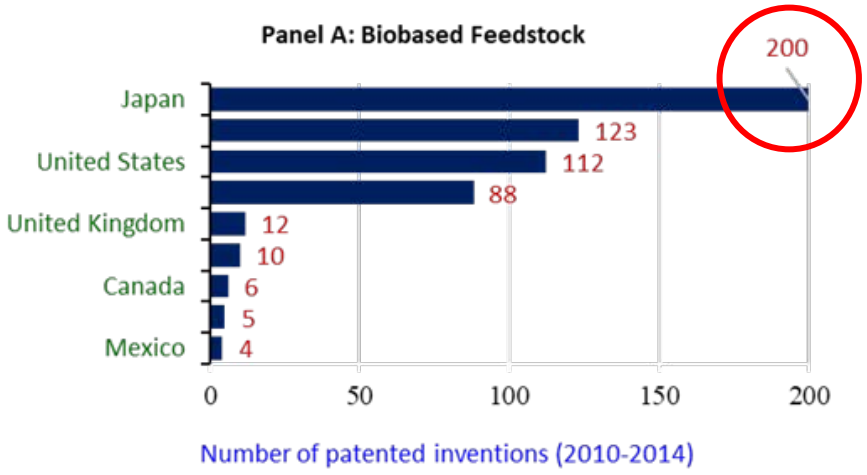
- ✓ AI-based litter identification
- ✓ Satellite observation of river and ocean plastics
- ✓ Apps to report illegal littering and leakage (citizen-science)
- ✓ Sampling equipment to trace plastics from surface, water column, sediment and shorelines

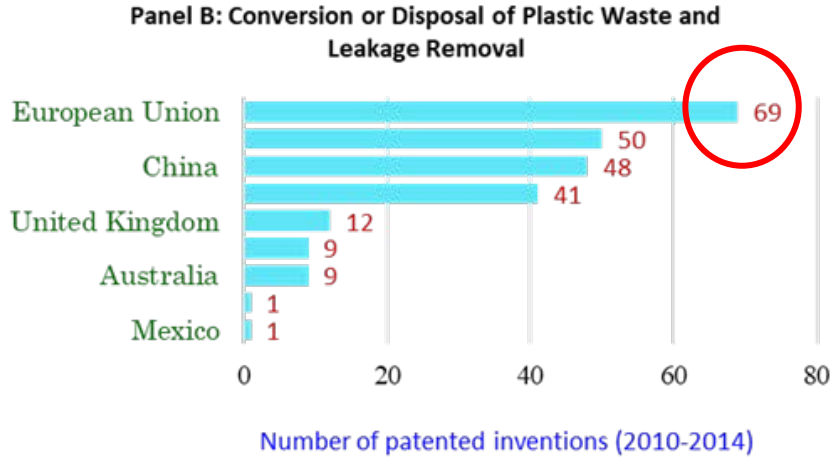
Leakage Removal/ Plastic Capture Technologies

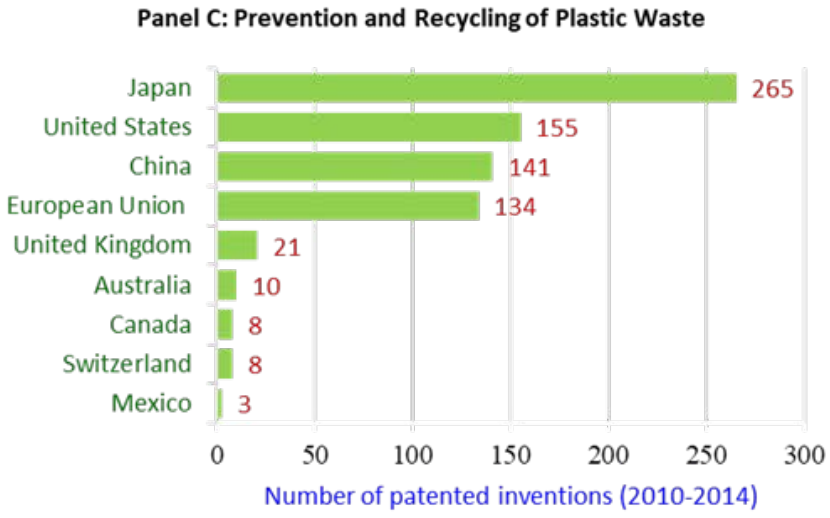
- ✓ Booms/Fences/Screens/Barriers/Traps/Skimmers (STATIONARY Structures/Devices fitted onto a floating pontoon or across the width of a river)
- ✓ Watercraft vehicles/Boats/Skimmers (Buoyant structure made for travelling on the water to collect plastic debris)
- ✓ Stormwater and Wastewater Filters (Pre-screening device)
- ✓ Sand filters/Hoover/Pumps/Vacuum beach sand cleaners
- ✓ Autonomous Skimming vessels integrated with AI/Robots/Drones

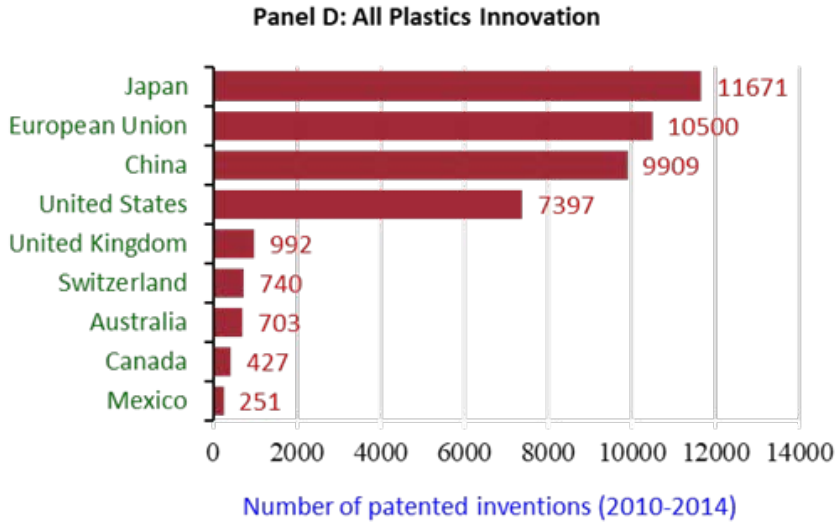
Plastic Pollution prevention & Management Technology Landscape: Innovation Trends

- Between 1995-2017, global innovation in recycling and pre-treatment of plastic waste was seen increased rapidly as compared to innovation in plastic waste prevention
- Japan patented the highest number of inventions in biobased feedstock
- The European Union has the highest number of patented innovations related to conversion or disposal of plastic waste and leakage removal
- There is also an increasing trend in digital technology solutions that uses various digital systems





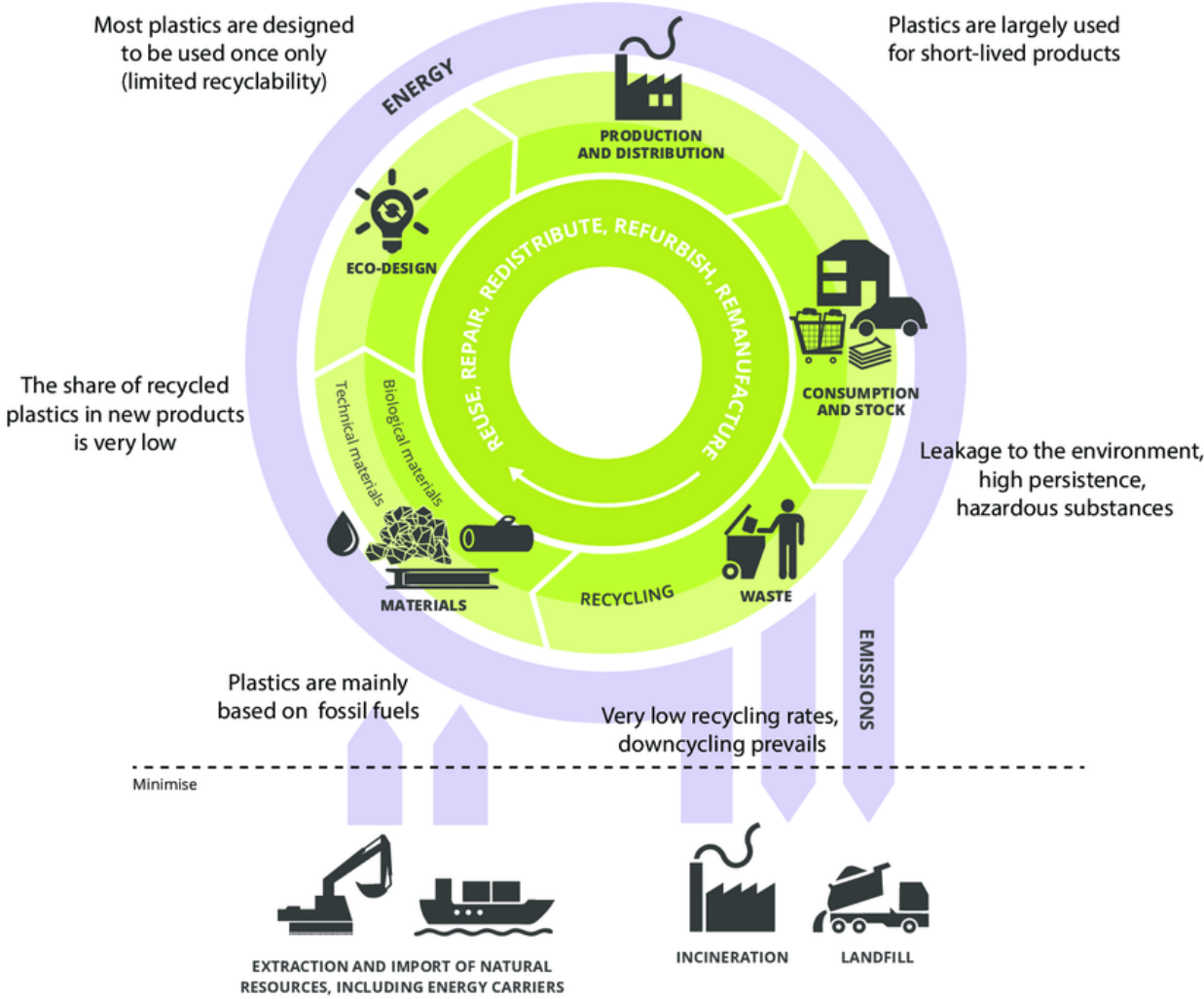




Technology Evaluation Criteria

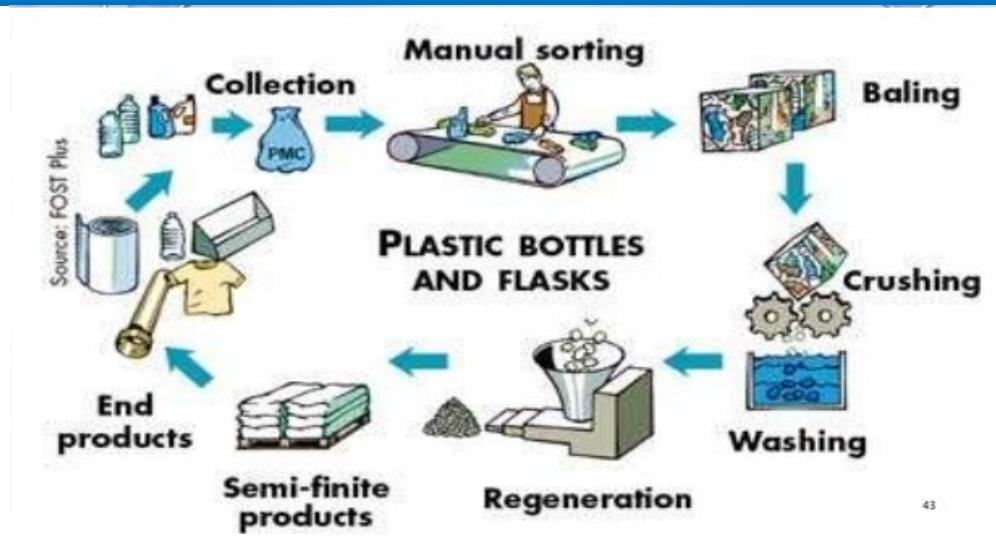
- ✓ Selecting the most appropriate technology depends on multiple factors and criteria among numerous commercially available technology and solutions to manage plastic waste:

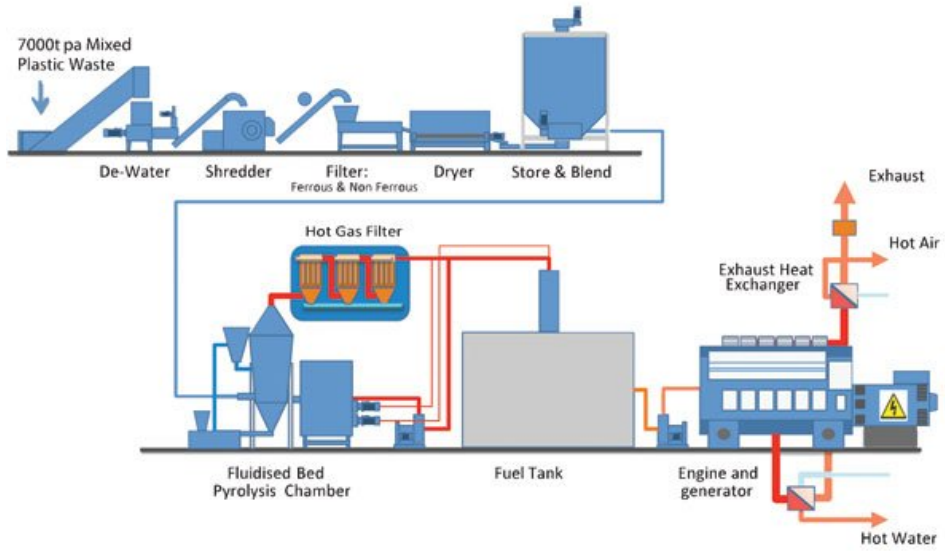
  - **Type of plastics**: macro, microplastics, both
  - **Point of intervention**: land-based, sea-based, river-based
  - **Plastic value chain stages**: Upstream value chain solutions (preventive technology solutions); Midstream value chain solutions (targeting plastic use/demand, consumption), and Downstream value chain solutions (technologies dealing with collection, sorting, transportation, processing, treatment and recycling, and final disposal of post-consumption plastic waste)



Technology Evaluation Criteria

- ✓ Selecting the most appropriate technology depends on multiple factors and criteria among numerous commercially available technology and solutions to manage plastic waste:
  - **Plastic value chain actors:** National governments or municipalities; Industry (plastic manufacturers/polymer converters); Businesses (Brands/distributors/traders/retailer); Citizens (consumers, community); Informal/formal waste management service sector (collector, recyclers)
  - **Functionality of the technologies**: Prevention or reduction of plastic waste generation; Collection, sorting, transportation of plastic waste from source of generation (households, commercial areas); Recovering value from plastic waste (recycling, waste to energy recovery); Detection/monitoring of plastic waste/leakage – both scientific or Citizen-science data collection; Preventing plastics leakage from entering waterways/Capturing floating plastics wastes from waterbodies (beaches, rivers, canals oceans).





Technology Evaluation Criteria

- ✓ **Operation & Maintenance of the technologies:** Manually (on-site operator required); Autonomously (no on-site operator required); Remote controlled or combination thereof.
- ✓ **Geographical focus and relevance/location of technology development and technology use:** Global; Europe; North America; Latin America; Middle East; Asia-Pacific; Africa
- ✓ **Cost of technology:** High-cost/Expensive; Moderate cost, Low-cost; Free-of-cost participation (example: free downloadable Mobile Apps), and product-based pricing, especially for products made from alternative/substitutes to single-use plastics (SUP)
- ✓ **Energy used:** Fuel-based; Renewable energy source; Fuel-based with options to use renewable energy source fully or partially, (example – rechargeable batteries using fuel-based electricity or solar power sources), and Passive (no energy source required)

Operation & Maintenance

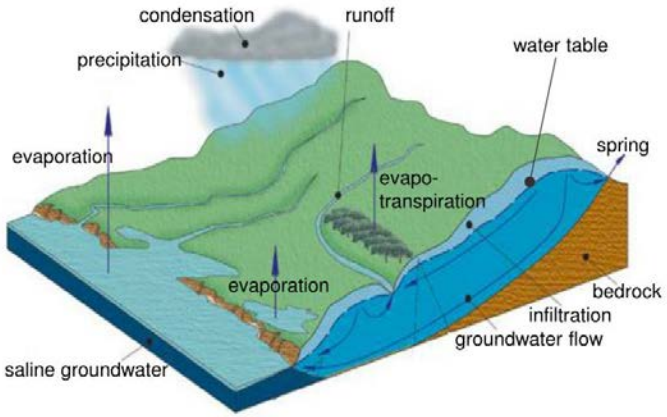
Location

Cost of Technology

Energy Consumption

Technology Evaluation Criteria

- ✓ **Technology maturity:** Proven technology with commercial operation cases – technology use-cases in more than one country; Technology at research stage (Prototype/Research & Development/Incubation/lab testing phase), and Technology prototype demonstration/piloting – technology
- ✓ **Technology impact landscape**: Socio-economic impacts such as job and business opportunities for informal sector, community engagement, Enhanced awareness and positive behavioral changes; Environmental impacts - positive or negative impact on wildlife, aquatic life, pollution, or any environmental and public health risks; Climate impacts/climate performance - GHG emissions reduction/low Carbon footprint of the technology/solution
- ✓ **Other suitable conditions**: hydrological conditions (high/low water current, width of the river etc.); finance, national /local regulations, human resources, and capacity to operate the selected technology



Overview of Technology/Solutions Compiled

- ✓ Started with the existing technology inventory, such as:
  - The Duke University's Plastic Pollution Prevention and Collection Technology Inventory Search (Nicholas Institute for Energy, Environment & Forestry) https://nicholasinstitute.duke.edu/plastics-technology-inventory
  - Ministry of Environment, Government of Japan's online pavilion "Japan Platform for REDESIGN: Sustainable Infrastructure" (http://jprsi.go.jp/en) - a platform to introduce the Japanese environmental technologies including fighting plastic pollution
  - Japanese technologies shortlisted by the feasibility study project conducted by Japan International Cooperation Agency (JICA) and the Ministry of Environment Japan (MOEJ)
  - Technology solutions submitted to various competition/challenges including the world Global Plastic Innovation Network, World Economic Forum's UpLink Innovation portal etc.
- ✓ Information collated from secondary sources was packaged as the Technology Factsheet (TFS)
- ✓ Via email communication, the draft TFSs were sent to the technology developer/distributor/user for review and verification as well as for inputting additional information on the TFS, if any.
- ✓ Depending on the response received the TFSs were then revised, updated, and finalized.
- ✓ 93 Technology factsheet compiled through secondary sources

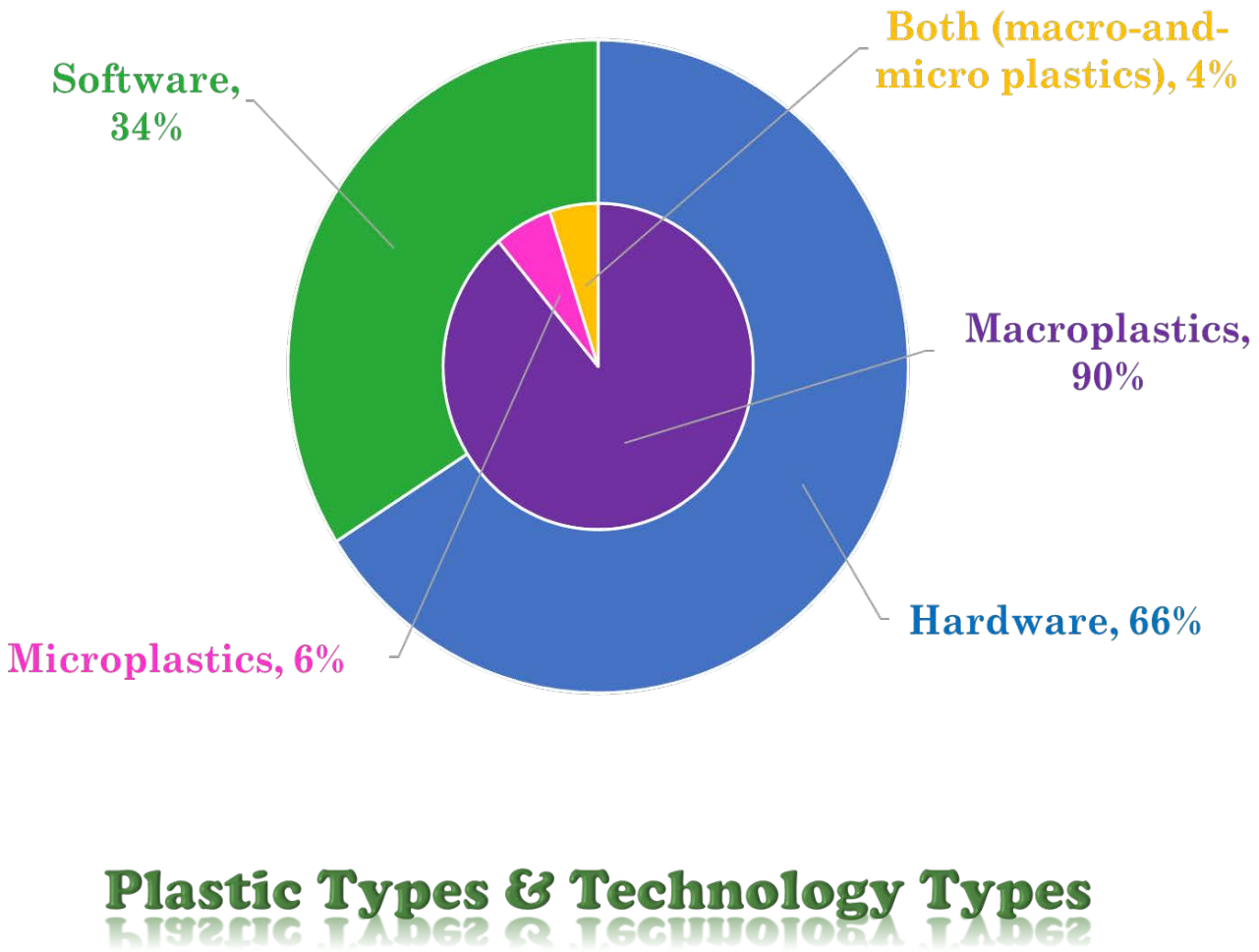
Overview of Technology/Solutions Compiled

Hardware Vs Software Technology:

- ✓ Out of 93 technology/solution compiled,
  - Number of software solutions (business model, apps, software, environmentally friendly consumable products) = 32
  - Number of hardware technologies (machine/infrastructure/device) = 61

Plastics Type:

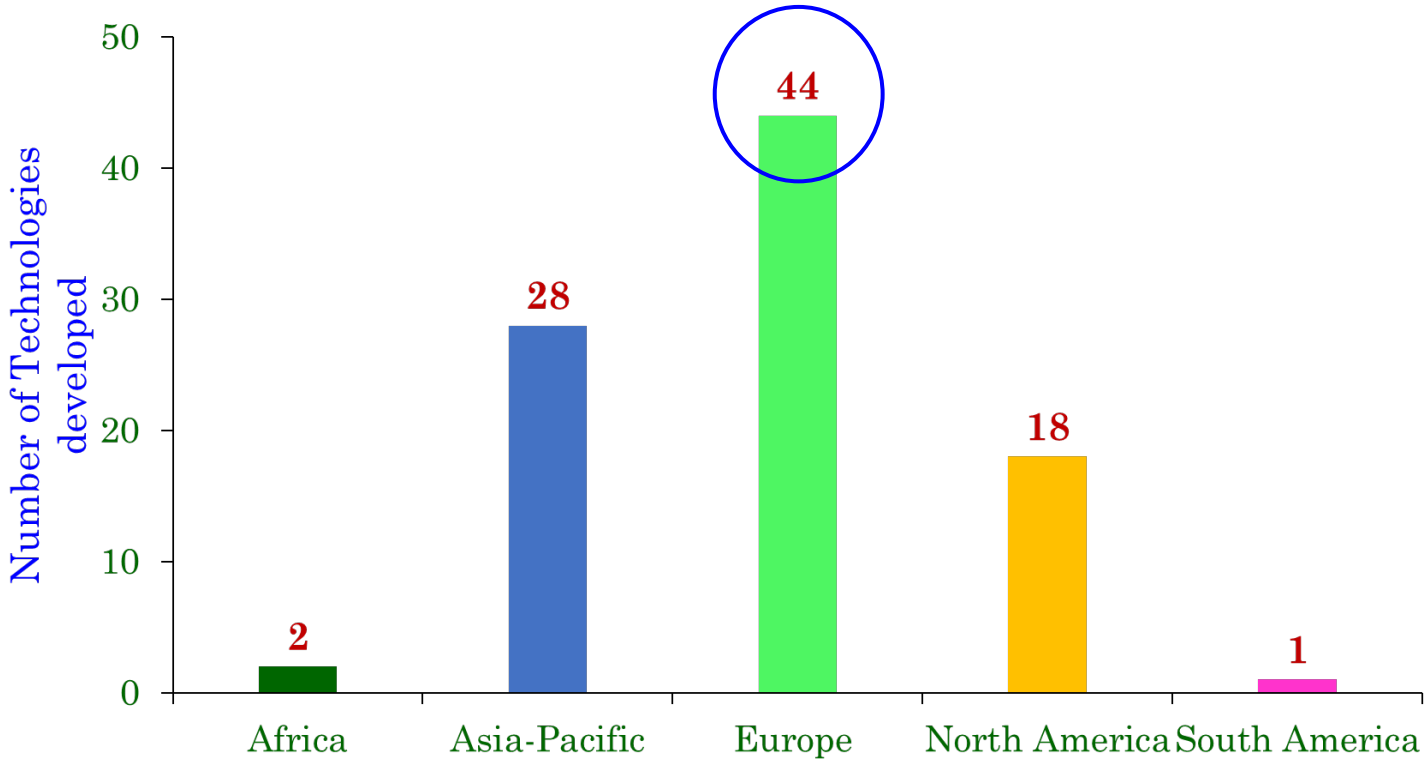
- ✓ Number of majority technology/solution compiled to macroplastics = 84,
- ✓ Number of technology/solutions applicable to address both macro-and-microplastics = 5, and
- ✓ Number of technologies targeted to microplastics = 4.
- ✓ All the software solutions are identified as addressing macroplastics.



Overview of Technology/Solutions Compiled

Geographical coverage:

- ✓ Of 93 technology/solutions compiled,
  - Number of technologies developed from Europe = 44 followed by Asia-pacific, and North America
- ✓ More software solutions developed from Asia - Pacific inventions especially the refill and reuse, and community-based waste collection business models.
- ✓ Hardware technologies, especially plastic capturing technologies,
  - USA based technologies counted the highest, followed by European technology developers - Germany, Netherlands, UK, and France.

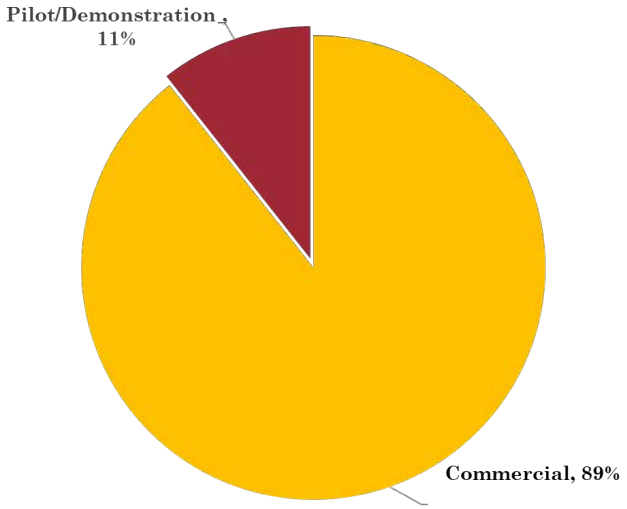


Geographical Distribution of Technology Development

Overview of Technology/Solutions Compiled

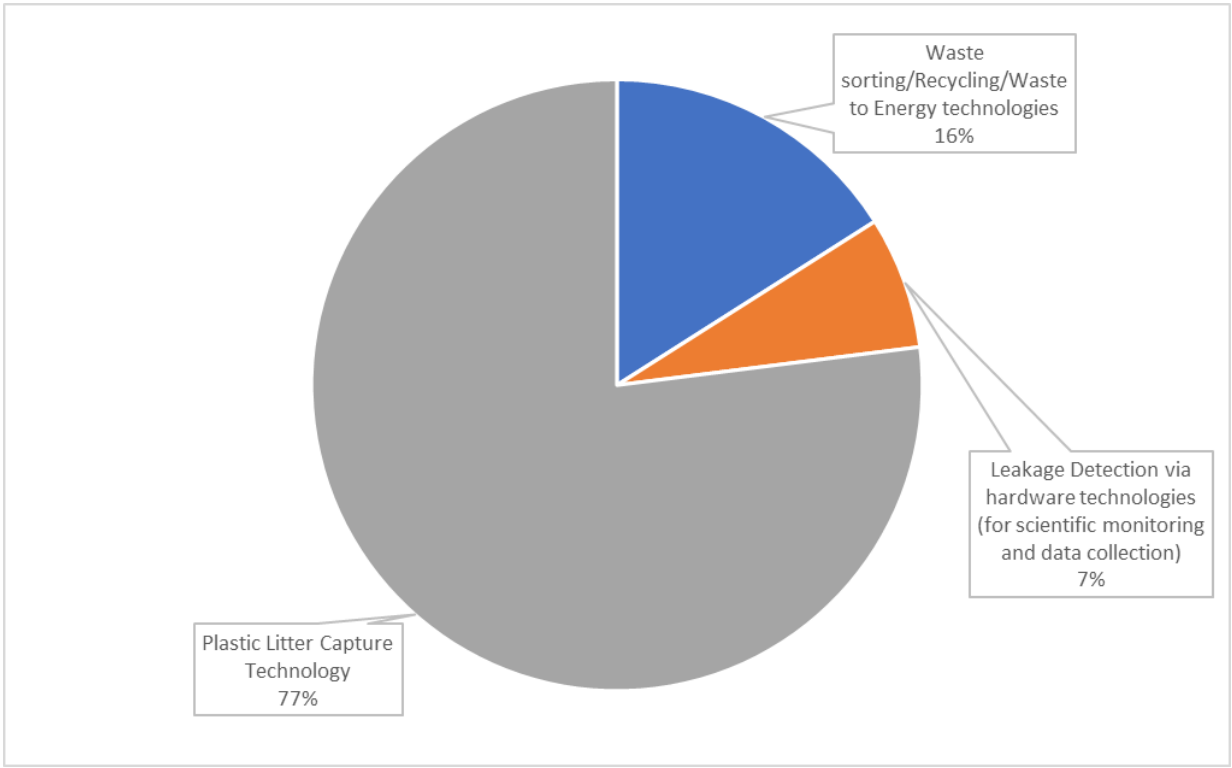
Technology maturity:

- ✓ 66% of the 93 technology/solutions compiled are found to operating commercially.
- ✓ This ensures these technologies are proven technologies with high applicability potential.
- ✓ Rest is also proven technologies available in but are currently being applied in one city or one country only.



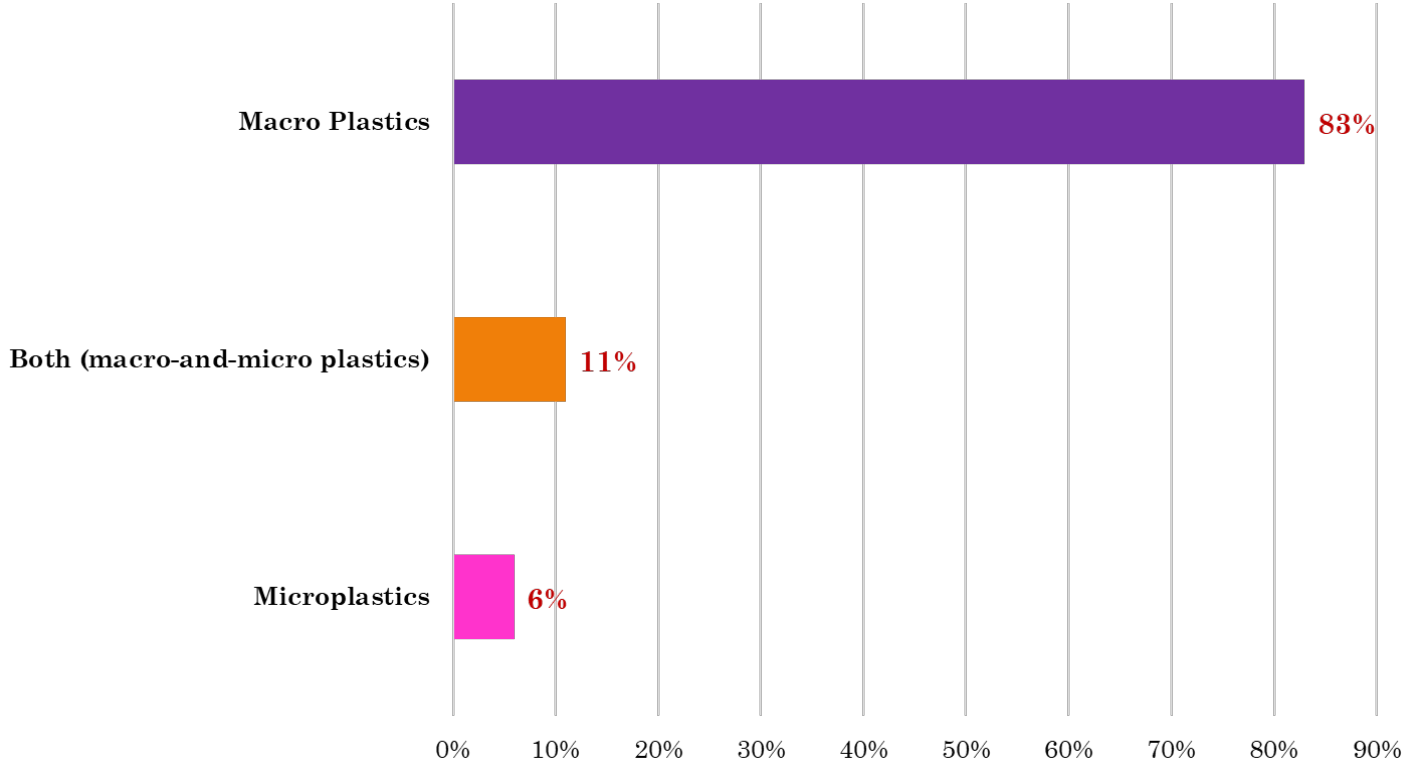
Functionality of the hardware technologies

- ✓ Of the 61 hardware technologies compiled,
  - 77% technology serves the function of removing/capturing plastics, followed by technologies facilitating waste sorting, recycling and energy recovery.



Overview of Plastic Capture Technology

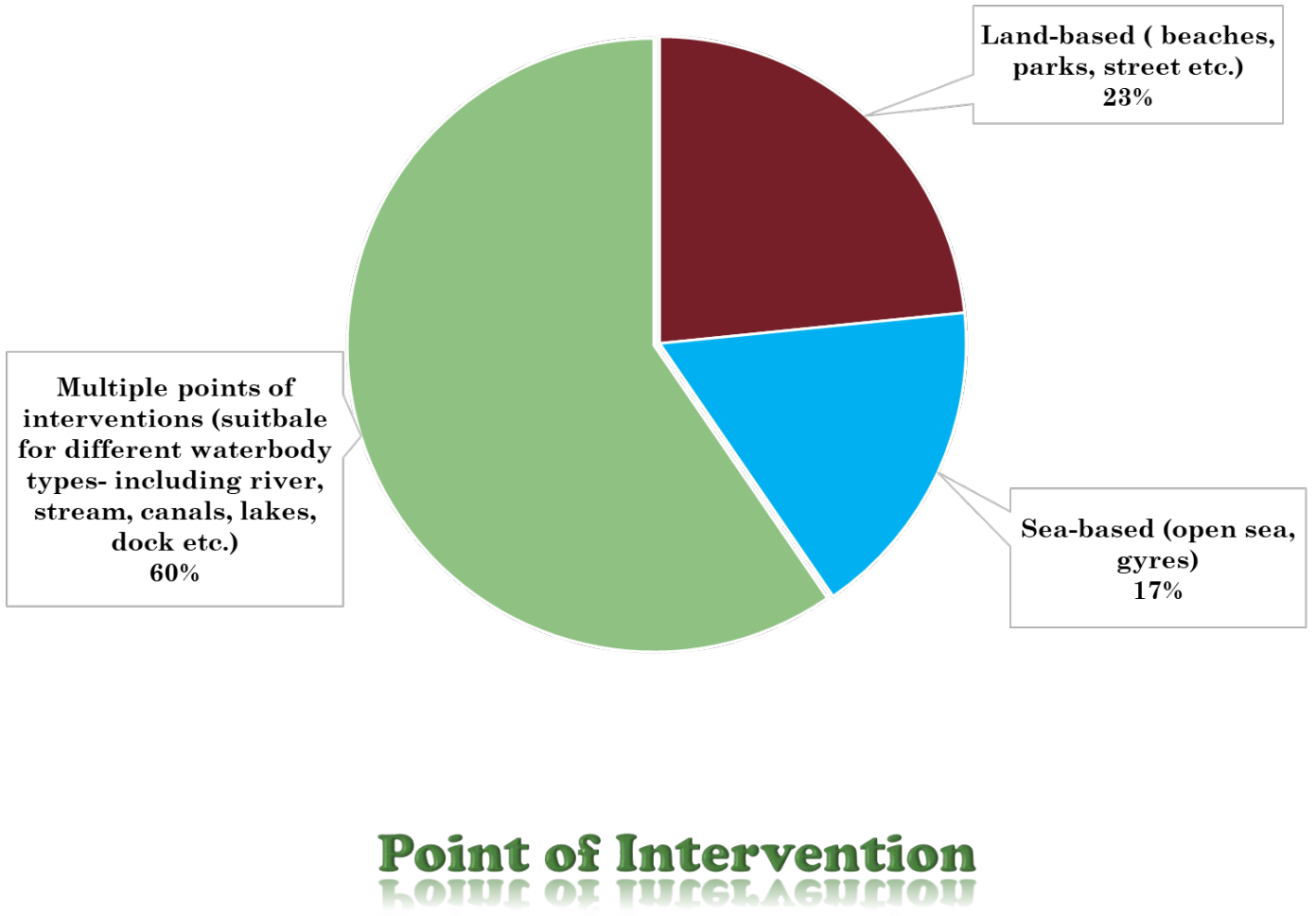
- 47 of the 93 (50.5%) of the total technology factsheet - plastic capture technologies
- Since all these plastic capture technologies are classified as hardware (physical device, machine, infrastructure), 77% of the 61 hardware technologies are compiled
- (39 out of 47) of these hardware plastic capture technologies are targeted to capture macroplastics, followed by 5 technologies applicable to both macro-and-microplastics, and the only 3 plastic capture technologies targeted to resolve the issue of microplastics (capturing nurdle from beaches).



Plastic types vs Plastic Capturing Technologies

Overview of Plastic Capture Technology

- **Point of Intervention**: Land-based plastic capture technologies remove plastics from beaches, shoreline, coastal areas, parks, streets, and stormwater and wastewater treatment plants.
- Water-based technologies are the ones that removes floatable plastics from different types of water bodies from rivers, streams, canals, lakes, dock etc.
- Many (60%) of these waster-based plastic capture technologies are found to be applicable at multiple point of interventions.
- However, 8 out of 47 plastic capture technologies are meant to be sea-based (open sea/gyresfrom beaches).



Overview of Plastic Capture Technology

Plastic Accumulation Hotspot target	Technology	Count (#)	%
Pre-screen/filters for stormwater, city drainage/wastewater treatment plants	PumpGuard (TFS # 44) Storm X Netting Trash Trap (TFS #45) Trash Rack Cleaner (TFS #46) Trash Rake Hydrorake (TFS #47)	4	8.5
Sand filter/beach sand cleaner technologies	Hoola One Plastic Removal Technologies (TFS #48) BeachTech Sweepy Hydro (TFS #49) Surf Rake (TFS #50) Barber Sand Man 850 (TFS #51) Marine Microplastic Removal Tool (TFS #52) Nurdle Trommel (TFS #53) Nurdle Machine (TFS #54)	7	15
(STATIONARY Structures/Devices fitted onto a floating pontoon or across the width of a river/canal/stream/dock): Booms/Fences/Screens/Barriers/Traps/Skimmers	Plastic Fischer Trash Boom (TFS #55) The Great Bubble Barrier (TFS #56) Clear River Litter Traps (TFS #57) The Litterboom (TFS #58) Bandalong Litter Trap (TFS #59) SCG-DMCR Litter Trap (TFS #60) Litter Gitter (TFS #61) PermaFence (TFS #62) Shoreliner (TFS #63); River Cleaning Systems (TFS #64); DESMI Rise (A & S series) (TFS #65); DESMI Enviro Enhancer (TFS #66); DESMI Aware (TFS #67); Seabin V5 (TFS #68); The Interceptor Original (001) (TFS #69); Inner Harbor Water Wheel/Mr. Trash Wheel (TFS #70)	16	34

Overview of Plastic Capture Technology

Plastic Accumulation Hotspot target	Technology	Count (#)	%
(Buoyant structure made for travelling on the water-rivers, canals, sea, lakes to collect plastic debris): Watercraft vehicles/Boats/Skimmers	WasteShark Class A (TFS #71) Floating Horizon Autonomous Skimming Vessel (TFS #72) Floating Robot to Eliminate Debris (FRED) (TFS #73) Sea Vax, Sea Vax - Robotic Vacuum Ship (TFS #74) Jellyfishot (TFS #75) Clean Sea PG Aqua Pod (TFS #76) Electric Versi-Cat Trash Skimmer Boat (TFS #77) Elastec Omni Catamaran (TFS #78) One Earth-One Ocean SeaKuh (TFS #79) One Earth-One Ocean SeaHamster (TFS #80) One Earth-One Ocean SeaElefant (TFS #81) Thomsea Trawl Net (TFS #82) Scavenger 30 Aquatic Master Conveyor (TFS #83) Collectix Garbage Collection Boat (TFS #84) Pelikan (TFS #85) Cataglop® range (CG) (TFS #86) Workglop (TFS #87); Multi Cleaner 128 (TFS #88); Sea Hunter Pro Trash Boat (TFS #89); KDYT 200 (TFS #90)	**20**	**42.5**
Total		**47**	**100**

Overview of Plastic Capture Technology

Geographical coverage/location of plastic capture technology development:

- ✓ 31 out of 47 (i.e., 66%) of the plastic capture technologies are developed by European countries followed by 14 technologies developed by North American countries (USA and Canada)
  - USA (10 technologies)
  - Germany (7 technologies)
  - France (6 technologies)
  - Netherlands (5 technologies)
  - UK (4 technologies)
  - Turkey (3 technologies)
  - Canada (2 technologies) and
  - one technology each by South Africa, Norway, Australia, Thailand, and Singapore.
- ➢ 89% of these plastic capture technologies have been commercially available and used in more than one country.
- ➢ Rest, 11% are also matured technology but their application is currently limited to one country only.

Conclusions

- As rising the problem of plastic problem, there also has been a welcoming growth in innovative technology and solutions targeted around product design, business models and supply chain processes for responsible consumption, sorting collection, recycling and recovering energy from post-consumption waste, as well as monitoring and capturing leaked plastics from land and water bodies.
- However, as seen in the case of 93 commercially available plastics technology and solutions compiled, the majority of the technology is found to be targeted to downstream solutions, especially in capturing/removing plastics leaked in different types of water bodies – canals, lakes, rivers, streams, beaches, ports, and open seas.
- Taking references from this technology compilation and assessing their suitability in a lower-income community residing on the waterfront (Wat Bangbua, Ladprao canal), the following three technology and solutions are proposed to reduce the mismanaged plastic waste resulting in leakage into waterways located in the project location.

  i) Closed-circuit camera surveillance for monitoring plastic leakage in the canal,

  ii) Litter Trap to capture floatable plastics from the canal, and

  iii) Zero-packaging waste exchange grocery shop by the community for the community.

Thank You!