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# NUclear TEChnology for Controlling Plastic Pollution

IAEA-ADB Joint Webinar  
16 March 2023



# IAEA NUTEC Initiative



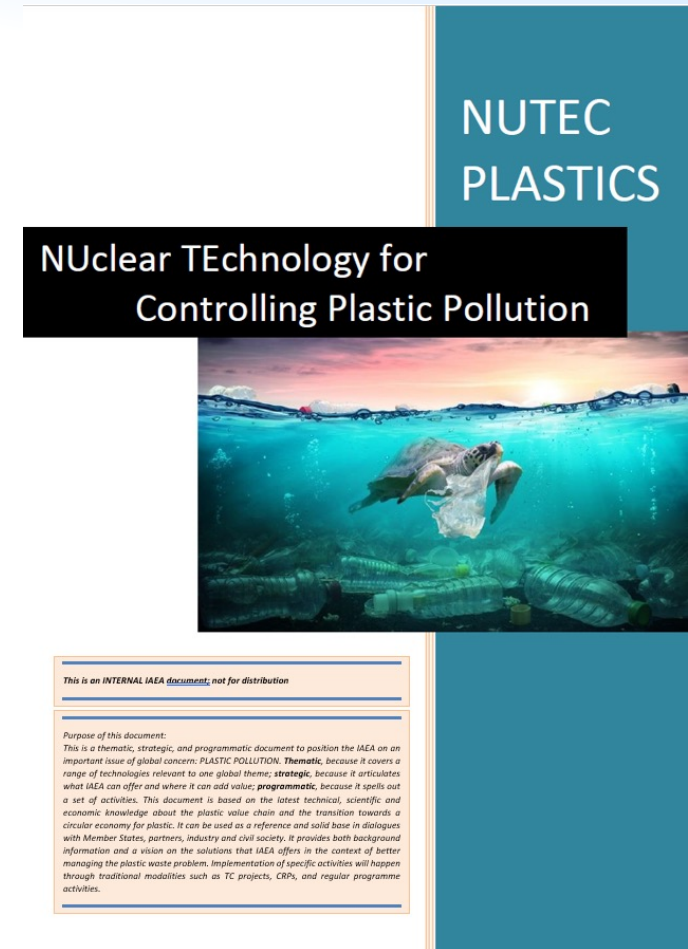
**NU**clear **TE**chnology for Controlling Plastic Pollution (NUTEC Plastics)  
new strategic IAEA initiative (launched in 2020)



# IAEA Strategic Approach

## *Nuclear Solution to Plastic Pollution*

- Under the NUTEC umbrella:
  - *Upstream component*: Plastic recycling using radiation technology
  - *Downstream component*: Marine monitoring of microplastics using isotopic tracing techniques
- NUTEC Plastics builds on a portfolio of ongoing and future:
  - *Coordinated Research Projects*
  - *Technical Cooperation projects*

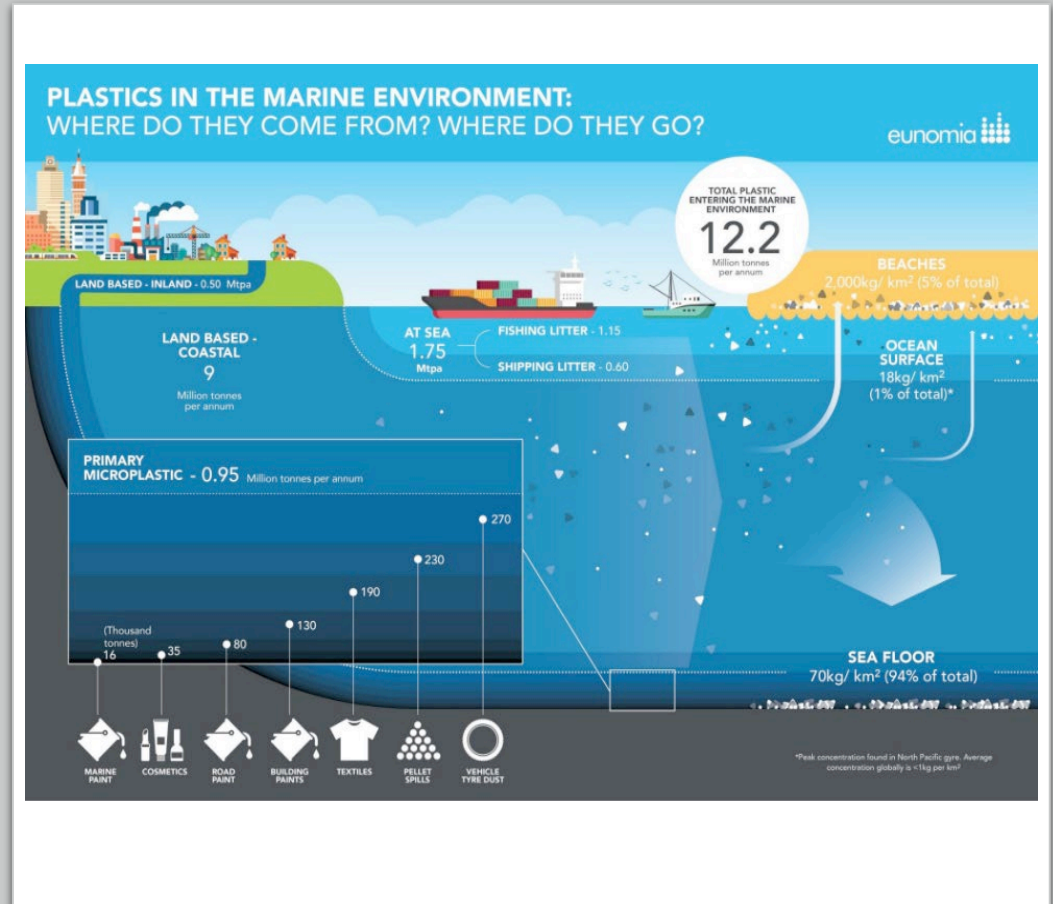




NUTEC  
DOWNSTREAM  
ACTIVITIES  
*Marine Plastic  
Monitoring*

# FACTS..... What do we know?

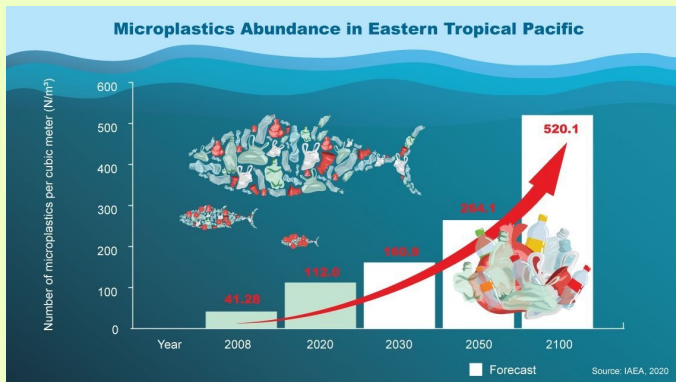
- Marine microplastic particles are everywhere
- Air, water, dust and food are all important exposure routes
- Plastic toxicity is size- and exposure- dependent (micro-nano plastic)
- Many marine animals and even humans ingest microplastics





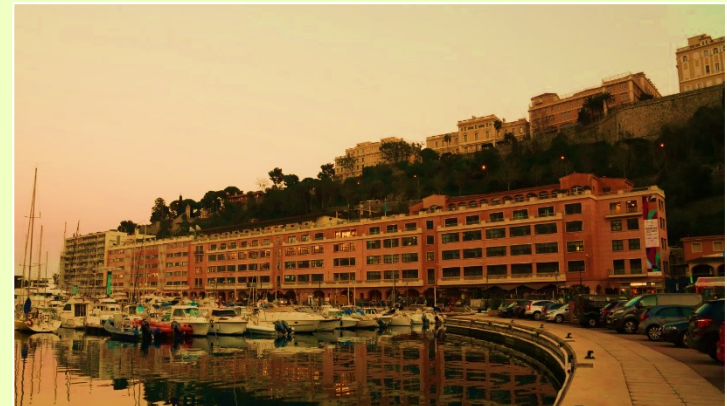
- **Why Regional Project**

- ❑ **All TCAP MS**
- ❑ **However Plastic Pollution is a concern in AP, in particular in South East Asian Countries**
- ❑ **Why Near half of the global plastic leakage from land to sea comes from a few countries in Southeast Asia**



- **Why IAEA?**

- ❑ **The IAEA in Monaco: The only marine laboratory in the UN system**
- ❑ **IAEA Radioecology Labs, using radiotracers**



# RAS7038: Monitoring the Marine Environment for Enhanced Understanding of the Abundance and Impact of Marine Plastic Pollution

SDG 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development



**The project aims at:**

- **Enhancing the understanding of the abundance and impact of marine plastic pollution in the Asia and Pacific Region.**
- **Improving plastic management in the Asia and Pacific region through the establishment of downstream baseline surveys, and the status and trends of marine plastic pollution impacts**

# Working with Member States to bridge science to policy

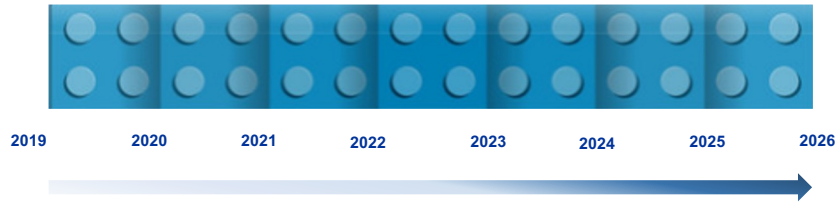
- ❑ Committed to report on Sustainable Development Goals SDG 14 “Life Below Water”
- ❑ Engaged with the topic of reducing plastic pollution strategy, regulations, national and international projects





# NUTEC Plastics - DOWNSTREAM

*Downstream Activities: Monitoring and assessing impact of marine microplastics*

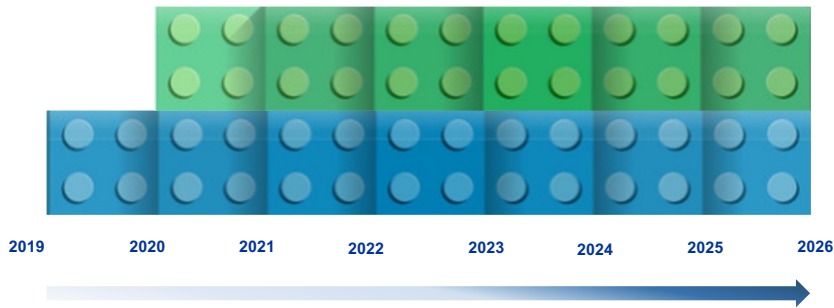


**STAGE I: Harmonized Protocols  
(Capacity Building)**



# NUTEC Plastics - DOWNSTREAM

*Downstream Activities: Monitoring and assessing impact of marine microplastics*



**STAGE II: Transfer of Knowledge / Capacity Building**

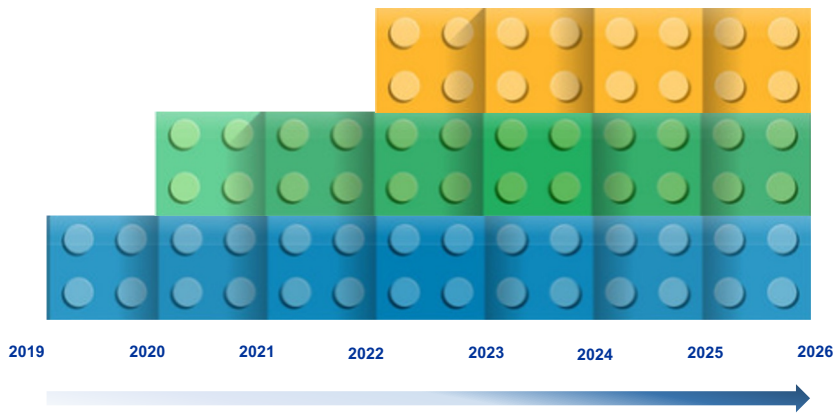


**STAGE I: Harmonized Protocols (Capacity Building)**



# NUTEC Plastics - DOWNSTREAM

*Downstream Activities: Monitoring and assessing impact of marine microplastics*



**STAGE III: Establishment of a Reference Laboratory at NAML**



**STAGE II: Transfer of Knowledge / Capacity Building**

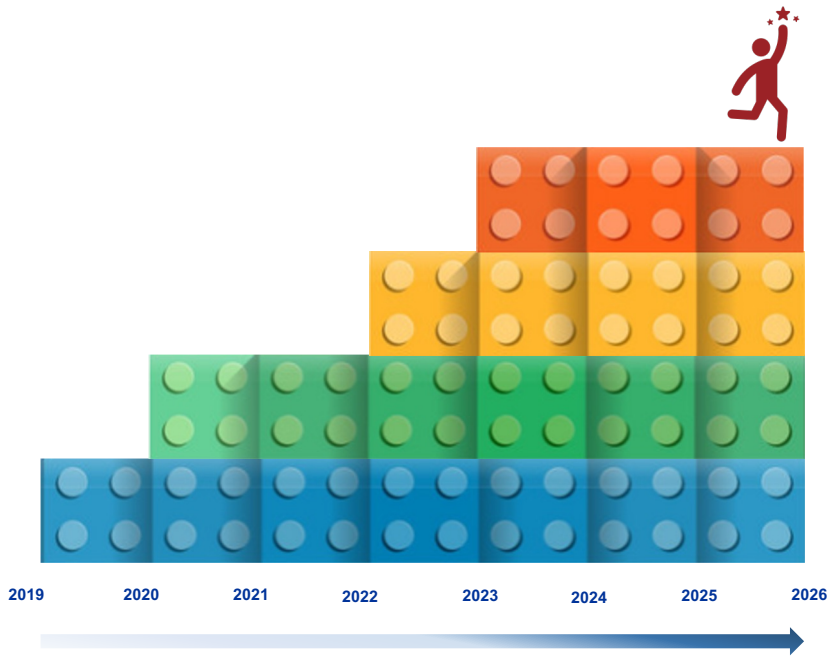


**STAGE I: Harmonized Protocols (Capacity Building)**



# NUTEC Plastics - DOWNSTREAM

*Downstream Activities: Monitoring and assessing impact of marine microplastics*



**STAGE IV: Building a Network of Laboratories**



**STAGE III: Establishment of a Reference Laboratory at NAML**



**STAGE II: Transfer of Knowledge / Capacity Building**



**STAGE I: Harmonized Protocols (Capacity Building)**



# Project Progress



## Establishment of harmonized, standardised protocols to identify microplastics in environmental samples

- The development of the draft Protocol with harmonized manual of procedures (SOP) 10-20 July 2022;
- Experts meeting group in order to finalise the protocol and agree on the details for the sampling and analysis campaign, (15-18 November, 2022).
- Meeting with all project counterparts to review and endorse the protocol (Q1, 2023) .

## Upgrading Environmental Monitoring Laboratory capabilities

- Provision of the Kit to Sampling and Basic analysis (Ongoing)

## Training Activities

- Regional Training Course on Training course on strategies and design of microplastics monitoring programs (collection, preparation, identification and counting of particles) and reporting of indicator (Q2, 2023)

## Engaging Partners and establishing NUTEC Network

- Development of network communication products and website



## Way Forward ...

- Early engagement between science and policy
- Optimizing and sustaining the regional network and capabilities
- Collaboration amongst organizations to ensure optimum use of resources, as well as complementarity of results and avoid duplication or overlaps
- Explore and forge formal cooperation and synergies with institutions and stakeholders of the national, regional and global initiatives





## Essential pre-requisite to ensure project impact



**Identifying and establishing synergies with the *institutions* and *stakeholders* of the national, regional and global initiatives for SDG 14 reporting**



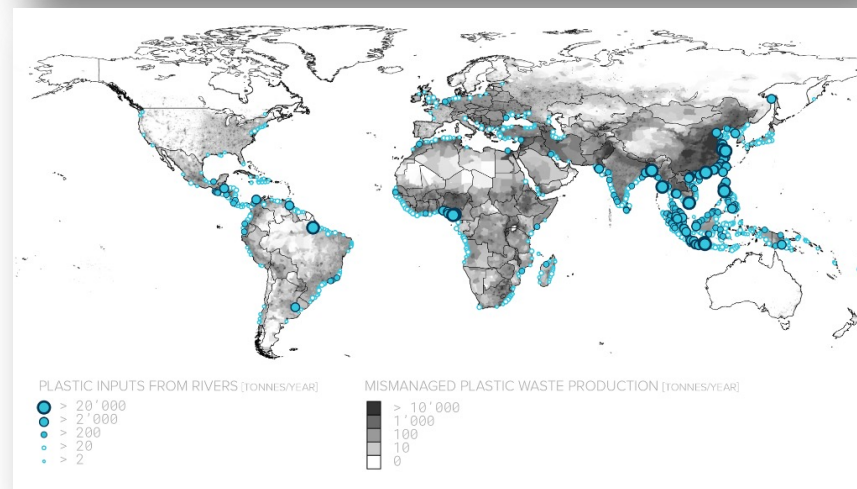


**NUTEC**  
**UPSTREAM**  
**ACTIVITIES**  
*Plastics Recycling*



# Background and Objective

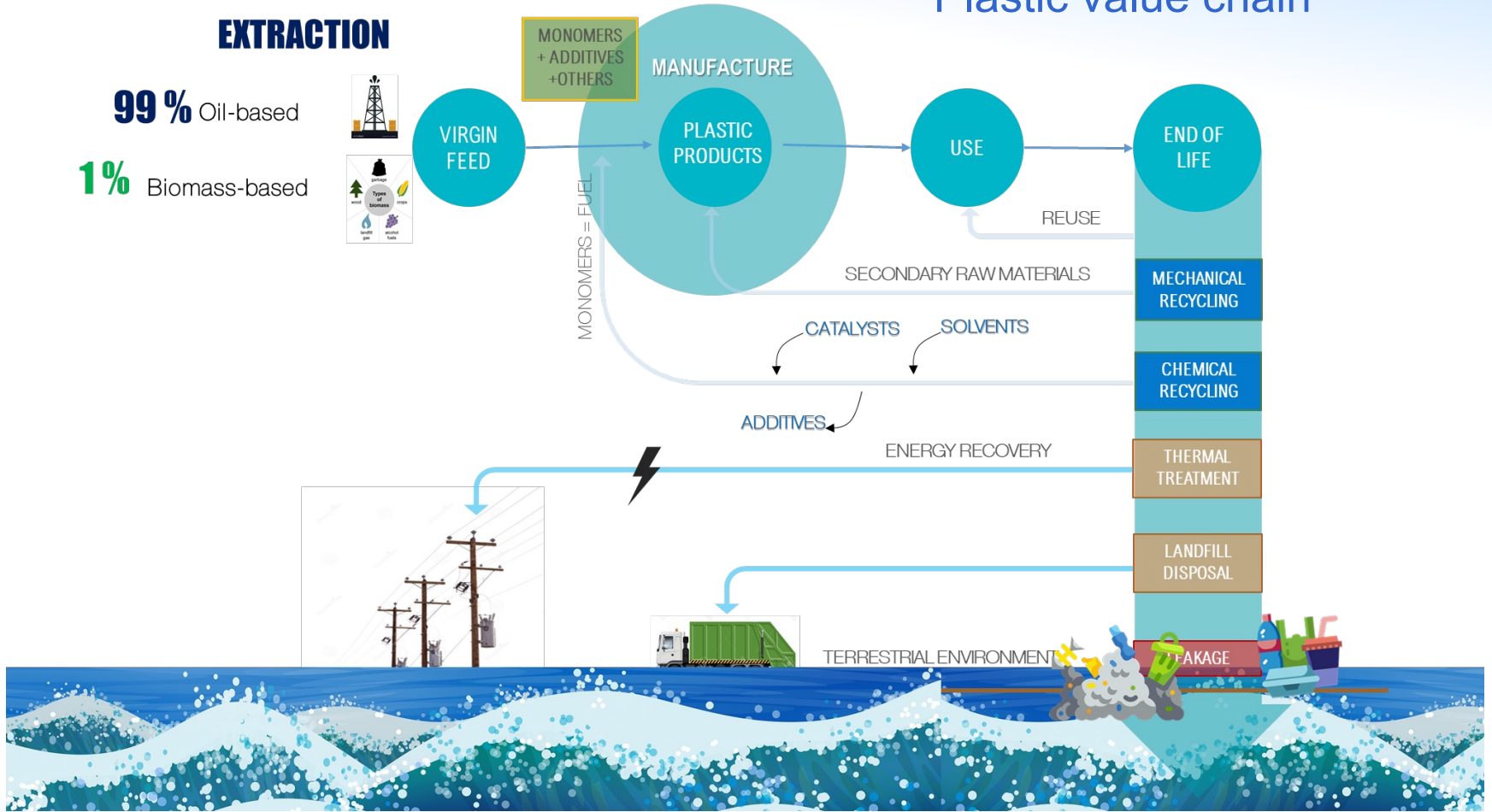
## Background



<https://theoceancleanup.com/updates/quantifying-global-plastic-inputs-from-rivers-into-oceans/> (2019)

# Background and Objective

## Plastic value chain



UNEP-CHW-PWPWG.1-INF-4.English (1)

# NUTEC in Asia and the Pacific

- **RAS1024 project:** Reutilizing and Recycling Polymeric Waste through Radiation Modification for the Production of Industrial Goods
  - 10 countries in the region
  - 4 pilot countries: Philippines, Indonesia, Malaysia and Thailand
- **Objective:** To strengthen regional capabilities in the application of radiation for developing value added new materials from waste polymers for industrial applications.



## Crosslinking/Branching

Enhancing thermomechanical properties



## Grafting

Imparting compatibility or functionalities



## Oxidation

Improving miscibility, forming reactive points



## Scission

Breakdown to valuable LMW compounds

Credits: Bin Jeremiah D. Barba & Jordan Madrid

## Ionizing radiation has the capability of:

- altering the structure and properties of bulk materials in various forms and states at moderate conditions or
- synergise reactions, saving energy with little to no additional chemical reactants

# NUTEC in Asia and the Pacific

- Pilot countries deploy (and combine) different approaches to **polymers recycling**
- Main difference: the type of **radiation-induced reactions** used for the technologies being under development



## Crosslinking/Branching

Enhancing thermomechanical properties



Philippines  
Indonesia  
Thailand



## Grafting

Imparting compatibility or functionalities



Philippines  
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## Oxidation

Improving miscibility, forming reactive points



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## Scission

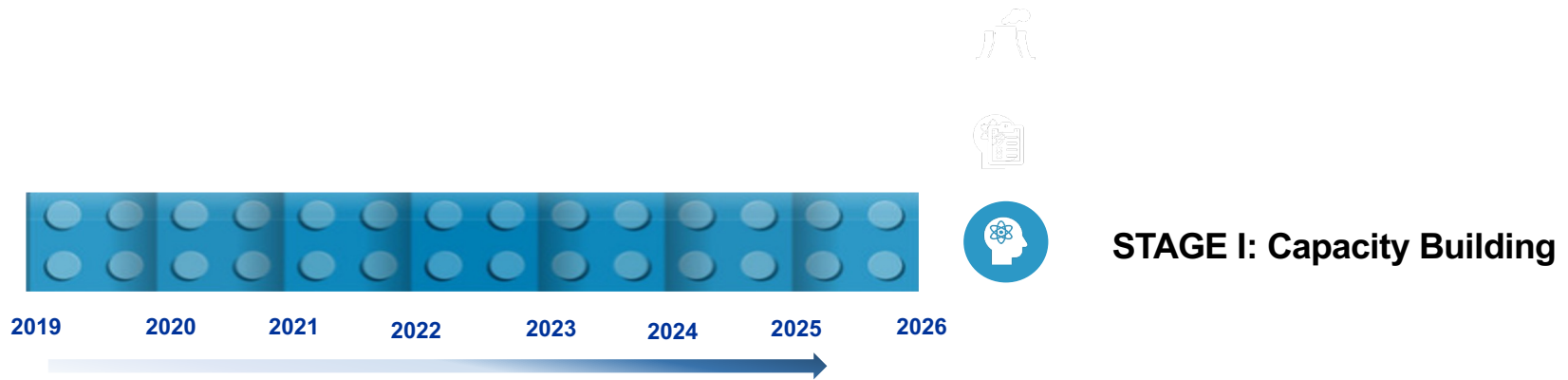
Breakdown to valuable LMW compounds



Malaysia

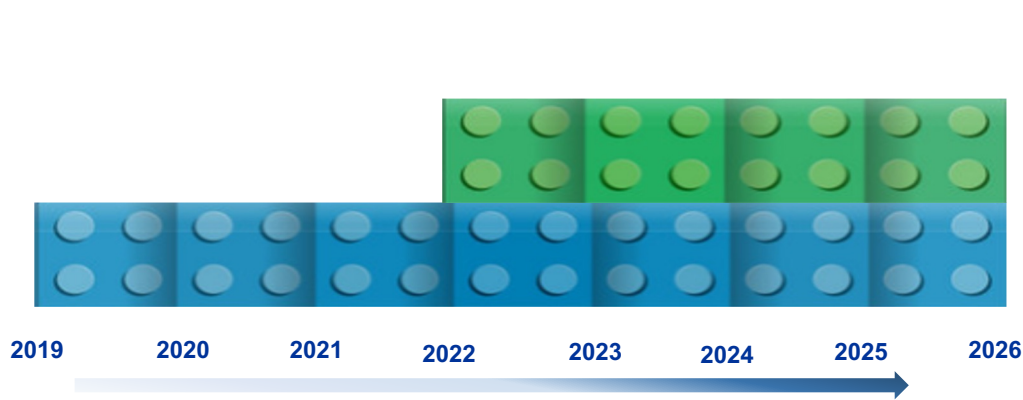
# NUTEC Plastics - Upstream

*Upstream Activities: Reduce plastic waste using radiation technologies*



# NUTEC Plastics - Upstream

*Upstream Activities: Reduce plastic waste using radiation technologies*



**STAGE II: Verification of proof of concept and economic feasibility**

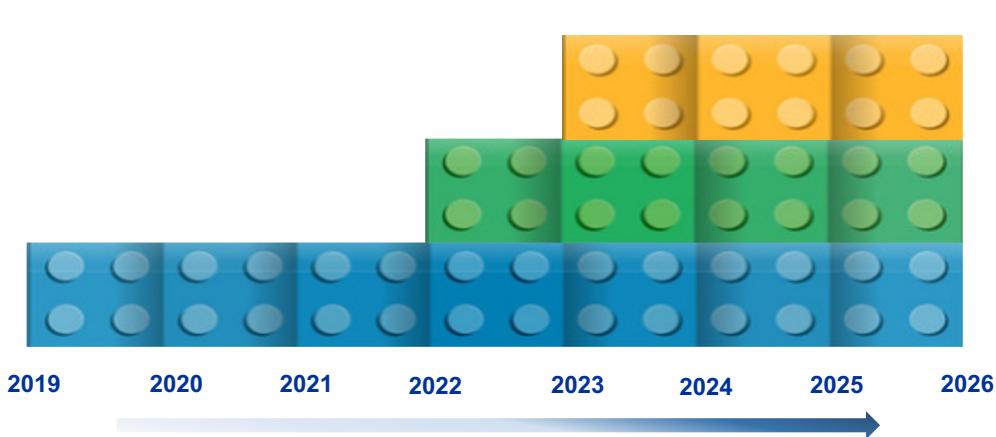


**STAGE I: Capacity Building**



# NUTEC Plastics - Upstream

*Upstream Activities: Reduce plastic waste using radiation technologies*



**STAGE III: Pilot plant build and operation of irradiation-assisted plastic recycling plant(s)**



**STAGE II: Verification of proof of concept and economic feasibility**

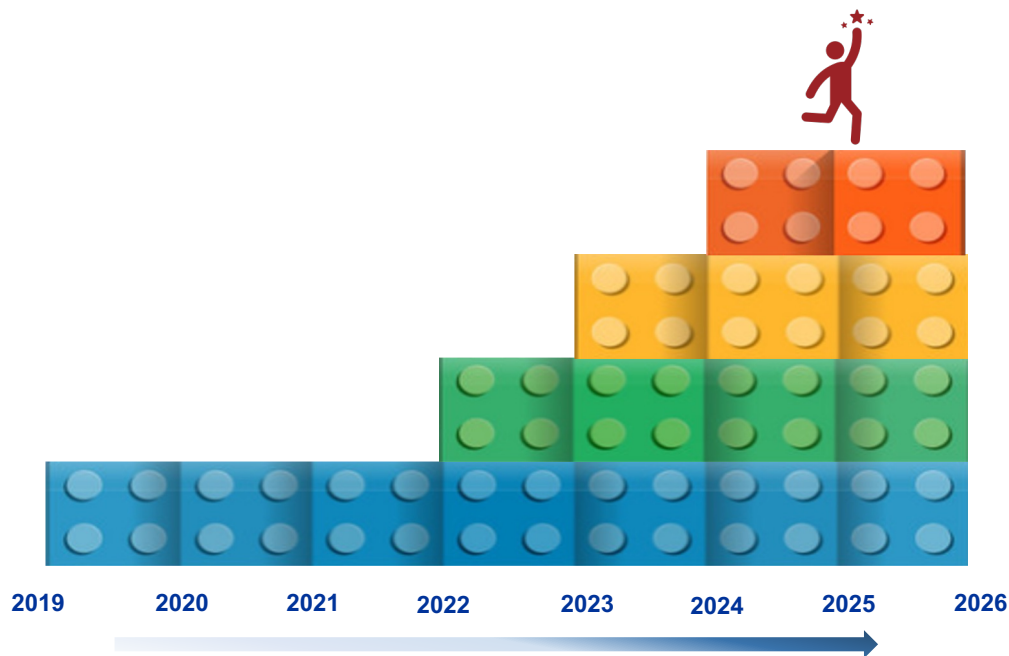


**STAGE I: Capacity Building**



# NUTEC Plastics - Upstream

*Upstream Activities: Reduce plastic waste using radiation technologies*



**STAGE IV: Ultimate upscaling to commercialisation in partnership**



**STAGE III: Pilot plant build and operation of irradiation-assisted plastic recycling plant(s)**



**STAGE II: Verification of proof of concept and economic feasibility**

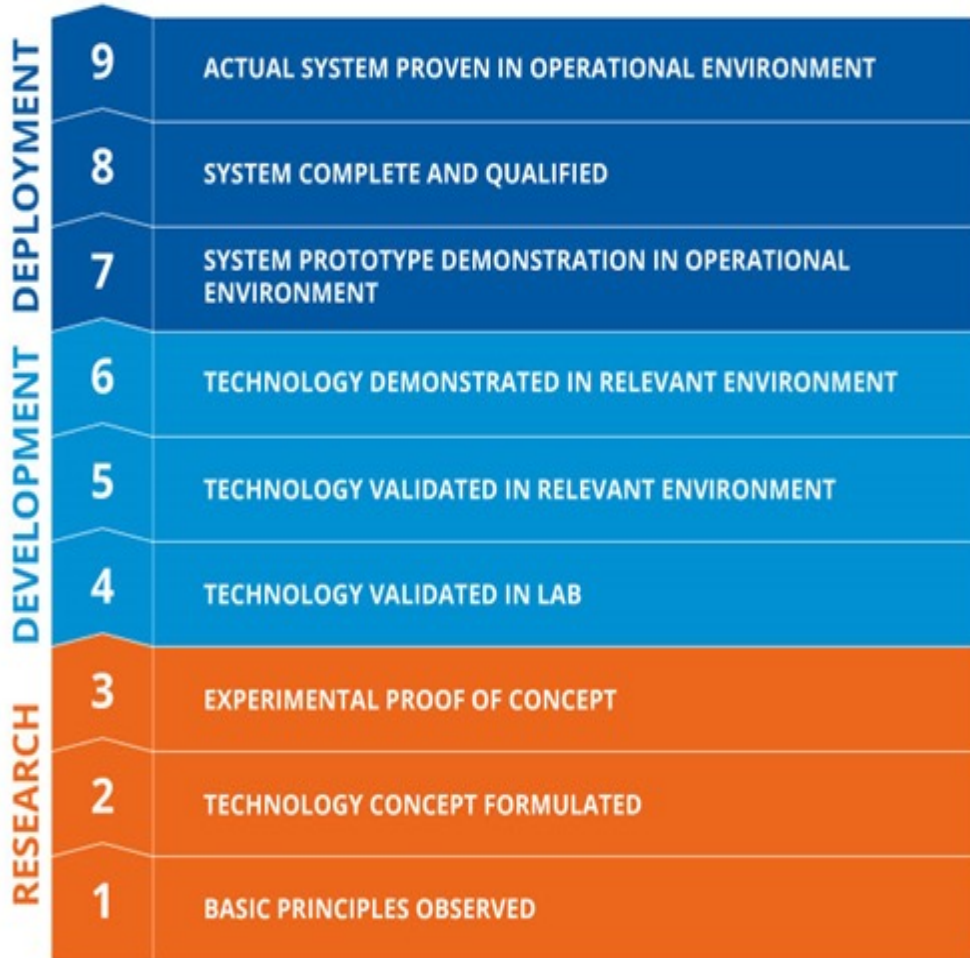


**STAGE I: Capacity Building**



# General Project Approach

## TECHNOLOGY READINESS LEVEL (TRL)



**Pilot countries** - advanced programmes with highest chances for pilot plants construction:

- *Philippines*
- *Malaysia*
- *Indonesia*
- *Thailand*

Late 2024-2025 (expected) – pilot countries

Late 2023-2024 (expected) – pilot countries

Q1-Q2 2023 (expected) – pilot countries; confirmed schedule per February 2023 project coordination meeting

# Philippines: National Progress

- TRL3 – planned to be achieved by Q2 2023
- **Project:** process plastic wastes through irradiation to enhance physical properties
  - Goal: production of housing construction materials such as tiles and bricks
- **Cooperation:**
  - **Research entities:** DOST – Industrial Technology Development Institute
  - **Industrial partners:** Envirotech Waste Recycling, Inc.



		PROJECT GANNT CHART																					
No.	Activities	Duration (months)	2022																				
			J	F	M	A	M	J	J	A	S	O	N	D									
1	<b>Phase 1 – TRL3</b>																						
	i. Business activities/ public relations																						
	ii. Technical/experimental activities																						
	iii. Documentation of results																						
	iv. Evaluation of all subtasks																						
2	<b>Phase 2 – TRL4</b>																						
	i. Business activities/ public relations																						
	ii. Technical/experimental activities																						
	iii. Documentation of results																						
	iv. Evaluation of all subtasks																						
3	<b>Phase 3 – TRL5</b>																						
	i. Business activities/ public relations																						
	ii. Technical/experimental activities																						
	iii. Documentation of results																						
	iv. Evaluation of all subtasks																						

# Malaysia: National Progress

- Two sub-projects:
  - **Recycling of PTFE** using Irradiation – more advanced stage; TRL3 expected by Q2 2023
  - **Plastic Radiation Pyrolysis**: new one; based on the interest of industrial partners
    - convert and enhance mix-plastic recycling
    - TRL3 expected by Q4 2023
- Advanced level of progress on recycling of PTFE
  - for post-TRL3 progress more advanced equipment needed (industrial scale)



# Indonesia: National Progress

- **TRL3** – planned to be achieved Q2 2023
- **Project:** develop a compatibilizer that is intended to be used with wood plastic composites (WPC) made of recycled polyethylene (rPE)
- **Current status:** promising results of surface properties of modified rPE-based compatibilizer after irradiation treatment followed by heating treatment
- **Industrial collaboration:** VIRO company is a possible industrial partner
- **Academic partners:** BRIN and Universitas Indonesia signed letter of intent on collaboration



# Thailand: National Progress

## Two sub-projects:

- **Recycled HDPE Pellets made from discarded fishing nets:**
  - TRL3 expected by March 2023
  - This focused modification of the project is particularly interesting: directly touches the issue of marine plastic pollution
- Project on **Wood Plastic Composite (WPC)** – newer initiative based on discussions with PMO and TO on enhanced collaboration between national research teams
  - TRL3 expected by Q4 2023



# Project Progress in 2022 and Plans for 2023

## National Stakeholders Meetings

- *Malaysia, October 2022 – organized*
- *Indonesia, October 2022 – organized*
- *Philippines, September 2023 – planned*
- *Thailand, October 2023 – planned*



## Regional Training Courses

- *Regional Training Course on progressing from TRL3 to TRL7, Indonesia, October 2022 – organized*
- *Regional Training Course on the use of low- to medium Energy E-beam for polymer modification purposes, Thailand, October 2023 – planned*

## Midterm Project Coordination Meetings

- *Midterm Project Coordination Meeting, Indonesia, October 2022 – organized*
- *Midterm Project Coordination Meeting, Thailand, October 2023 – planned*





**IAEA**

International Atomic Energy Agency

*Thank you!*

