IAEA
International Atomic Energy Agency
*Atoms for Peace and Development*

REPORT ON UPSTREAM COMPONENT

# NUTEC PLASTICS

## UPCYLING POLYMER WASTE BY RADIATION-ASSISTED TECHNOLOGY IN

**ASIA & THE PACIFIC REGION**

No. 1, June 2024

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# EXECUTIVE SUMMARY

### MISSION

To address the global challenge of plastic pollution using nuclear technologies

### VISION

To reduce existing plastic waste volumes, augment conventional recycling strategies with the benefits of radiation technologies to generate higher value recycled products

## PERIOD

2020 - 2023 (4 years)

## OBJECTIVE

To strengthen regional capabilities in the application of radiation technology for developing value-added new materials from waste polymers for industrial applications, validating the technology at the lab and at pilot scales.

## INVOLVED COUNTRIES

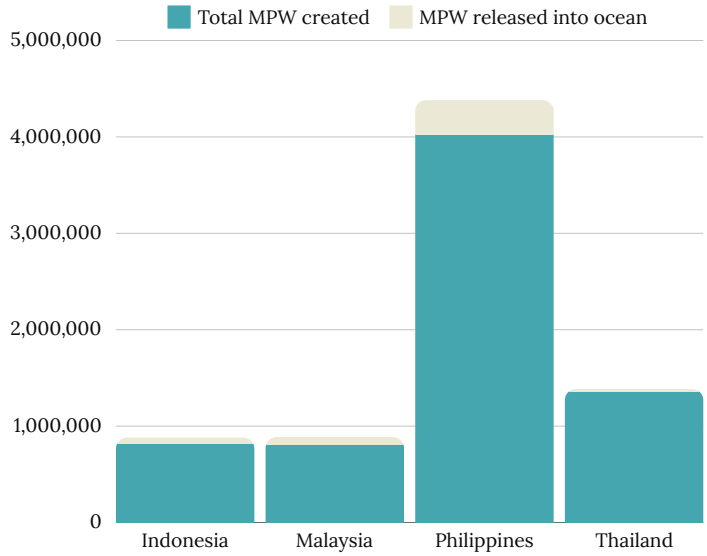
Bangladesh, China, India, Indonesia, Japan, Republic of Korea, Malaysia, Myanmar, Pakistan, Philippines, Sri Lanka, Thailand, Viet Nam

## FUTURE PLANS

To develop promising upscaled products or processes from plastic waste using radiation technology by 2026, showcasing them in relevant industrial pilot demonstrations. The main focus is on collaborating with potential end users to facilitate the transition to commercial scale.

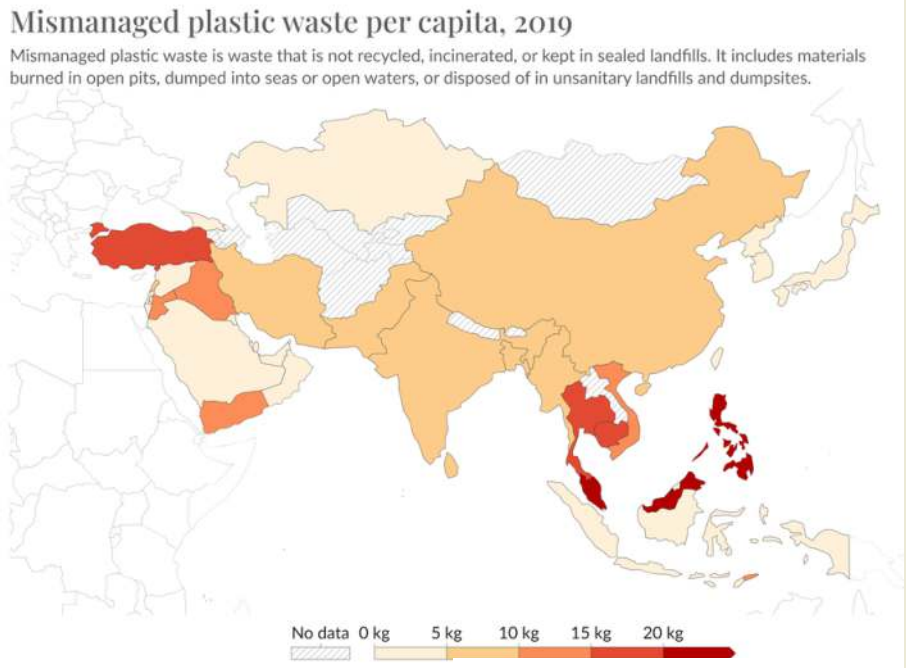
# PLASTIC POLLUTION

in Asia and the Pacific




Note: Data statistics in 2021. All values expressed in tons. MPW stands for Mismanaged Plastic Waste, which indicates plastic waste that evades proper disposal or recycling and instead ends up decaying on land or more frequently in the ocean.

Data source: World Population Review




Data source: Meijer et al. (2021).

## MISMANAGED PLASTIC WASTE (MPW)

Humans have produced billions of tons of plastic, of which more than half ended up in landfills and only about 9% was recycled. When plastic is mismanaged, it becomes an environmental pollutant that can adversely affect ecosystems. Mismanaged plastic waste is waste that is not recycled, incinerated, or kept in sealed landfills.

Asian countries, in comparison to other parts of the world, record a higher percentage of mismanaged plastic waste (MPW) which ultimately ends up in the ocean. It is estimated about 4.8 to 12.7 million metric tons of plastic enter the ocean each year, and a study found about 80% of MPW released into the ocean stems from just five Asian countries: China, Indonesia, Philippines, Thailand and Vietnam (1).

**NUclear TEChnology for Controlling Plastic Pollution (NUTEC Plastics)**, an initiative of the International Atomic Energy Agency (IAEA), assists Member States, including Asia and the Pacific region to deal with plastic pollution through a two-pronged approach: (1) a downstream approach that aims to monitor marine microplastics and understand their environmental and economic impact using nuclear and nuclear-derived techniques and (2) an upstream approach targeting the mitigation of plastic waste volumes using radiation technologies to enable innovative upcycling, developing high-performance products from plastic waste, including hard-to-recycle plastics, and providing sustainable alternatives for producing bio-based plastic products using radiation technologies.

> *The IAEA is poised to provide unique nuclear solutions to plastic pollution through development and promotion of radiation technologies to help replace petroleum-based plastics with biodegradable ones, to improve conventional recycling practice, and to renew end-of-life plastic.*" - Najat Mokhtar, IAEA Deputy Director General and Head of the Department of Nuclear Sciences and Applications.

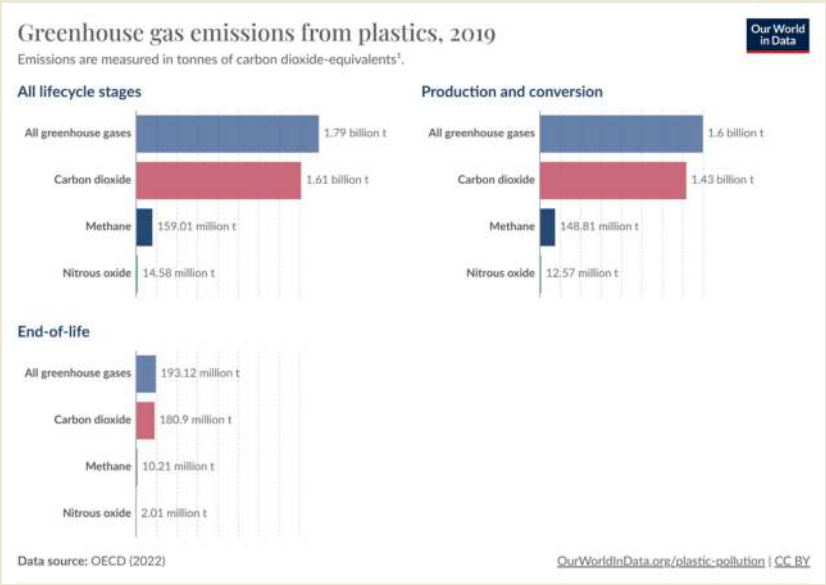
# FATE OF PLASTIC

in Asia and the Pacific

The global production of plastic, including polymer resins, synthetic fibres, and additives, follows a complex journey from its creation to its ultimate fate, with outcomes ranging from continued use, recycling, incineration, to eventual disposal. Packaging and single-use plastic are the largest contributors to plastic wastes.

Plastic contributes to greenhouse gas emissions at various lifecycle stages, from production to disposal. Mitigating the contribution of plastic to greenhouse gas emissions require a comprehensive approach, including reducing the reliance on fossil fuels in plastic production, improving recycling and waste management systems, and promoting the development and use of more sustainable materials.

The ongoing challenge lies in developing sustainable practices, policies and innovations, and transition towards a more circular and environmentally friendly approach.




**Carbon dioxide equivalents (CO2eq):** Carbon dioxide is a well-known greenhouse gas, but not the only one. To capture all greenhouse gas emissions, researchers use the quantity in "carbon dioxide equivalents" (CO2eq). CO2eq takes all greenhouse gases into account, not just CO2, weighting each one by its global warming potential (GWP) value. GWP measures the amount of warming a gas creates compared to CO2. CO2 is given a GWP value of one. One kilogram of gas with a GWP of 10 generates ten times the warming effect as one kilogram of CO2. Total greenhouse gas emissions - measured in CO2eq - are calculated by summing each gas CO2eq value.

## How do we tackle

plastic pollution?

Recycling is a better option to displace new plastic production than incineration or landfill; however, the majority of plastic can be recycled only once or twice. Therefore, it is crucial to prioritize high-impact solutions in addressing the challenges posed by plastic waste.

**NUTEC Plastics** is the IAEA's flagship initiative to fight plastic pollution on two fronts:
(i) at its source: strengthening the use of biomass over fossil sources to produce more sustainable bio-based plastics, while concurrently enhancing product design to facilitate recyclability; *and*
(ii) offering innovative upcycling technology, that utilizes ionizing radiation to enable the generation of value added products from post-consumer and plastic waste.

The IAEA supports Member States in their efforts to achieve the UN Sustainable Development Goals (SDGs) life on land (SDG 15) and life below water (SDG 14), for which plastic pollution poses a huge threat, and (SDG 9) industry, innovation and infrastructure.

IAEA NUTEC PLASTICS

# PLASTIC WASTE RECYCLING

Basic principles of recycling

## RECYCLING CATEGORIES

Plastic recycling involves the process of transforming plastic waste into new and valuable products, offering a way to reprocess and re-purpose materials.

| Primary | Secondary | Tertiary | Quaternary |
|---|---|---|---|
| Recovered plastics are used in products with performance characteristics that are equivalent to those made using virgin polymers. Ideally, closed loop recycling transfers the recovered material and back into the original application. | Often involves mechanical recycling using cleaning, sorting and melt processing. Recovered plastic is used in products other than the original application. Often the product has less demanding performance requirements than the original application. Transforming the used plastic materials into new, higher-value products is possible. | Also known as chemical or advanced recycling. Waste plastics are converted in a high temperature process to chemicals and fuels, such as pyrolysis of plastics which produces oils, and by-products such as gases and char. | Thermal recycling is where energy is generated from plastic waste by incineration. Plastic materials derived from fossil oils possess a very high calorific value. A number of environmental concerns are associated with thermal recycling of plastics, including emission of air pollutants such as carbon dioxide, sulphur dioxide and nitrogen oxides. |

## STRIVING FOR SUSTAINABLE EXCELLENCE

Primary recycling focuses on a small portion of uncontaminated plastic waste, consisting of single plastic with known compositions and properties similar to the virgin plastics. Quaternary recycling is less preferable, as all the carbon waste is converted into carbon dioxide. Hence, in the NUTEC Plastics upstream component, our work is concentrates on the **secondary and tertiary recycling** methods, aiming to repurpose plastic waste sustainably, thereby alleviating plastic pollution.

# THE TECHNOLOGY

EXEMPLARY APPLICATIONS OF RECYCLING PROCESSES

Radiation-assisted

## ELECTROSTATIC SORTING

involves separating mixed thermoplastic waste following electron treatment electrostatic sorting. The electron treatment leads to polymer specific charging of polyolefins and results in clear sorting.

Radiation-thermal

## PYROLYSIS

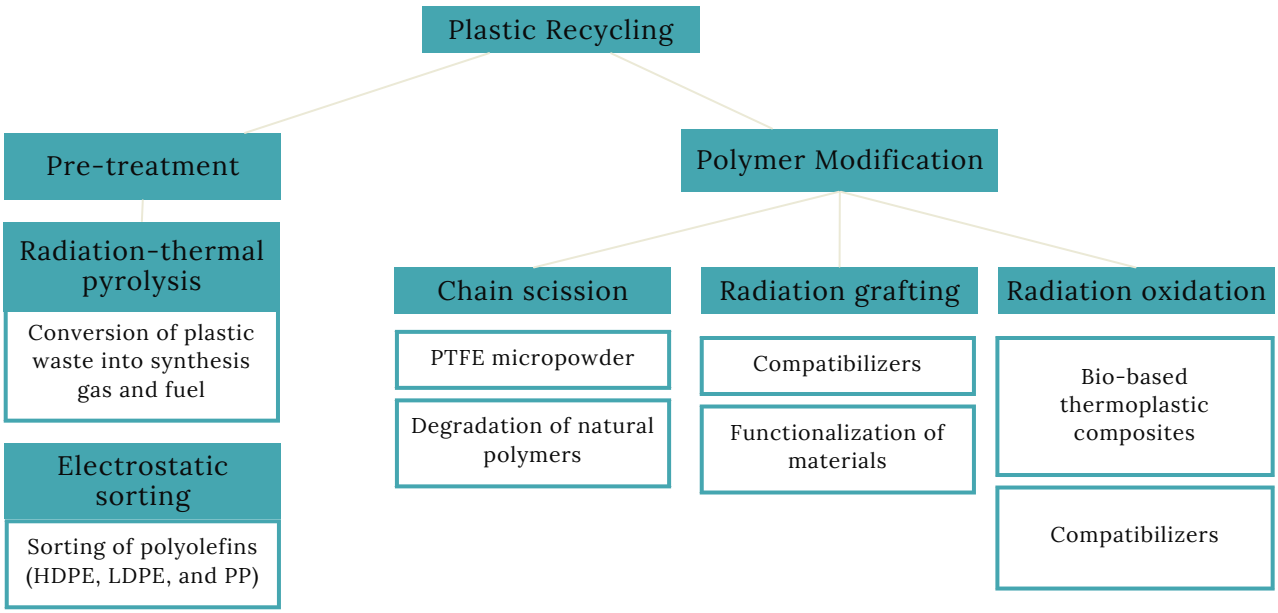
combines pyrolysis and radiolysis, offering various benefits including lower processing temperatures, conversion of absorbed radiation energy into heat, and the simultaneous generation of reactive radicals within all components of the mixture.

Radiation-induced

## POLYMER MODIFICATIONS

is used for customised degradation, functionalization, or grafting of plastic to produce chemically reactive plastic for reactive melt processing. Absorbed radiation provides the energy necessary to initiate chemical reactions in polymers. This enables the production of high-performance polymer materials from plastic waste.

## ADOPTING THE TECHNOLOGY



# THE TECHNOLOGY

Polymer Modifications

## MAIN POSSIBILITIES FOR THE USE OF RADIATION:

1. Improving the mechanical properties and performance of recovered materials or blends. This is primarily achieved through radiation-induced enhanced interfacial adhesion between different blend phases.

2. Inducing or enhancing decomposition of polymers, especially through chain scission. This facilitates the recovery of low molecular weight mixtures or powders, usable as chemical feedstocks or additives.

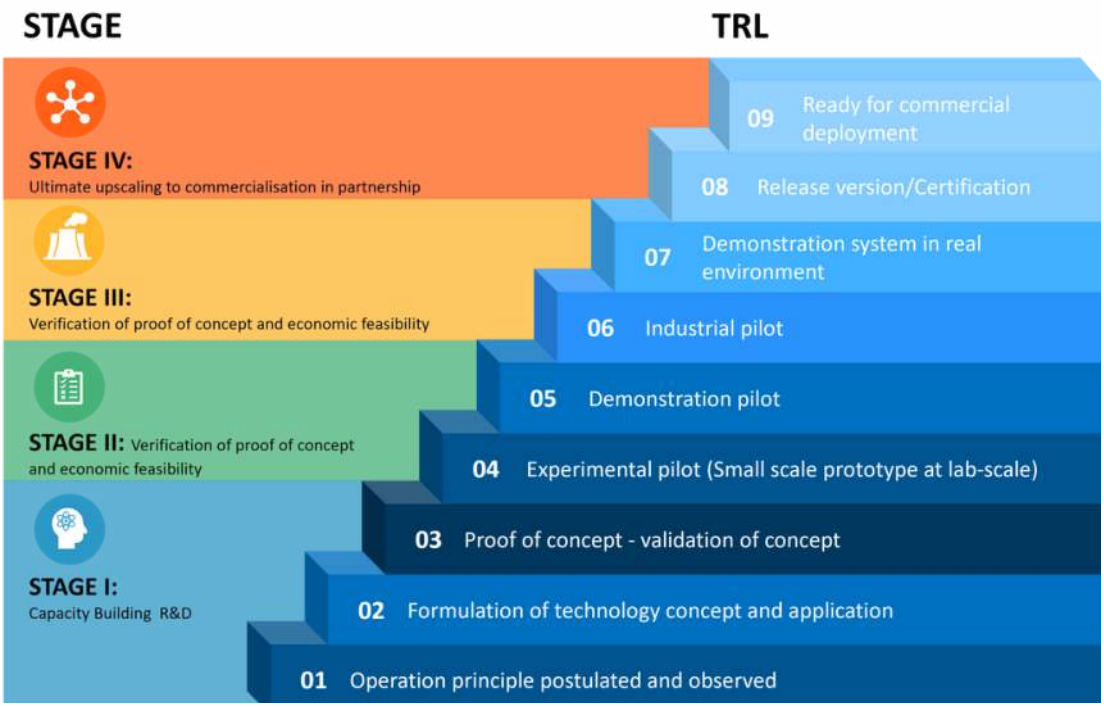
3. Creating advanced polymeric composites via radiation-induced grafting or functionalization, designed specifically for environmental compatibility.

The nuclear techniques employed involve high-energy radiation to initiate chemical reactions in plastic waste without any use of chemical reaction initiators. This method is advantageous because ionizing radiation can effectively modify the structure and properties of various bulk polymeric materials, making it applicable to nearly all types of polymers. Consequently, irradiation shows promise in addressing the challenge of polymer waste.

# MONITORING & ASSESSMENT

## PROGRESS MONITORING

The progress in setting up pilot plant(s) for plastic waste upcycling follows the IAEA's strategic four-stage approach and is related to Technology Readiness Levels (TRLs). These levels offer a comprehensive assessment of new technology maturity and are universally employed by industry and government organizations. The TRLs span from the inception of basic principles (Level 1) to the validation of highly resilient technologies for industrial application (Level 9) enable detailed monitoring of accomplishments at each stage of development.




## ASSESSMENT

Assessment is done using two Microsoft Excel based application tools developed by the experts under the NUTEC Plastics Initiative

| Excel-Based Economic Assessment Modelling (E-BEAM) Tool | Excel-Based Application Tool (EBAT) |
|---|---|
| • This tool provides users with a quick and easy way to determine the economic profitability of investments in nuclear technologies for plastic recycling. | • This tool assesses the Technology Readiness Level (TRL) throughout the project by providing an overview of the progress achieved concerning the work plan and TRL. |

# FIRST STEPS

**Stage I**: R&D and Capacity Building

IAEA aids Member States by supporting R&D efforts and facilitating technology transfer mechanisms by enhancing capacity building through activities such as trainings, fellowships, scientific visits, expert support via expert missions, and provision of necessary laboratory equipment and supplies, significantly contributing to their research and development capabilities. These efforts are not limited to national and regional projects, but also encompass global initiatives, with a particular focus on collaborating with potential end users in pilot countries.

## 2020 / 2021

- Launch of IAEA Nuclear Technology for Controlling Plastic Pollution-NUTEC Plastics initiative
- NUTEC Plastics Roundtable for the Asia and the Pacific Region
- Regional project RAS1024 First Project Coordination Meeting
- Regional Consultancy Meeting on Recent Achievements in Radiation-Processed Products from Natural Polymers
- Virtual Workshop on the Technical-Economic Feasibility Studies to Implement Radiation Technology for the Recycling of Polymer Waste
- Virtual Regional Training Course on Applied Radiation Technology as a Tool for Recycling of Polymer Waste
- Launch of Coordinated Research Project on Recycling of polymer waste using ionizing radiation

## 2022

- Regional Training Course on *Filling the gaps between TRL3 and TRL7 for the development of pilot scale plastic waste recycling using irradiation* - Jakarta Indonesia, 10 - 14 October
- Workshop on *Integrating electron beam technology into recycling polymer process* - Jeong-up Korea, 17 - 21 October
- Launch of Guideline document & project assessment tools (EBEAM & EBAT)

**MEETINGS:**

- National Stakeholders Meeting MALAYSIA, 6 – 7 *October*
- National Stakeholders Meeting INDONESIA, 10 *October*
- RAS1024 Mid-term Project Coordination Meeting

## 2023

- Regional Training Course on *Expanding the use of low and medium e-beam accelerator for surface modification for polymer waste recycling* - Manila Philippines, 6 - 10 November
- Launch of Coordinated Research Project on the use of Biomass for Synthesis of Bioplastics and Other Compounds

**MEETINGS:**

- National Stakeholders Meeting THAILAND, 18 – 20 *October*
- National Stakeholders Meeting PHILIPPINES, 6 *November*
- RAS1024 Final Project Coordination Meeting

## OTHER ACTIVITIES

**EXPERT MISSIONS:**

7 4

**FELLOWSHIPS:**

8 4

**COORDINATED RESEARCH PROJECTS:**

**36 Contracts**
**5 Agreements**

**SCIENTIFIC VISITS:**

5 3

Global approaches for

# TECHNOLOGY VALIDATION

## 1 RESEARCH AND DEVELOPMENT

Member States propose projects ideas that are discussed and refined to ensure a competitive and viable application, with aligned objectives. Global Coordinated projects are launched to harmonise criteria and provide the adequate tools to support MSs.
The **E-BEAM** tool serves as an assessment instrument to evaluate project feasibility costs. Further insights are gained through research and consultations with experts, facilitating continuous refinement and enhancement.

## 2 CAPACITY BUILDING

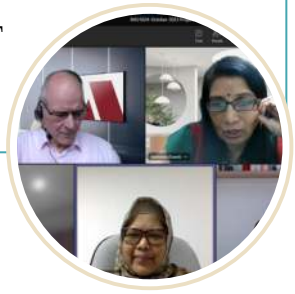
Capacity Building empowers both individuals and institutions to cultivate an innovative R&D culture. The IAEA supports Member States by enhancing skill development through various means such as **training courses, workshops, fellowships and scientific visits.** This enhances the immediate project effectiveness and also lays the groundwork for sustained growth and ongoing development.

## 3 STRENGTHENING INFRASTRUCTURE

Enhancing Member States' infrastructure by supplying **laboratory supplies and equipment** accelerates the pace of research and development.
**The IAEA Collaborating Centres** foster regional collaboration, offering technological capabilities and expertise to bolster support in this regard.

## 4 PROGRESS MONITORING

- Monthly **coordination meetings** attended by experts for regular status updates and reports.
- One-on-one **expert consultations** provide personalized guidance, tailored to specific project components.
- Assessment tools like EBAT and SWOT analysis add valuable insights to progress tracking.



## 5 INFORMATION DISSEMINATION

- **National Stakeholders Meetings** are organized in all pilot countries* to serve as a platform to connect diverse stakeholders from various sectors including decision-makers, government bodies, industries and community representatives.
- **Outreach materials** are developed to ensure accessible information.

**** Pilot countries are countries targeting to build and operate a radiation-assisted plastic waste recycling pilot plant.***

PROGRESS STATUS

# IN PILOT COUNTRIES

## 01 INDONESIA

### Development of Compatibilizers Generated from Recycled PE/PP

- **Technology adopted:** Radiation grafting & oxidation
- **Achievement:** TRL 4 by Q2/2024
- **Industrial partner:** PT. VIRO

Radiation-induced surface modification of recycled Polyethylene (PE)/ Polypropylene (PP) to generate compatibilizers for the production of Wood Plastics Composites (WPC). Compatibilization is essential in enhancing the interfacial adhesion between the plastics and biomass during WPC production.

Utilizing ionizing radiation for transforming polytetrafluoroethylene (PTFE) waste into valuable micro powder for industrial applications. Results highlight the positive impact on wear resistance and mechanical properties, affirming the recyclability of PTFE waste.

## 02 MALAYSIA

### Recycling of PTFE using Irradiation

- **Applications:** Production of high-performance polymers, paints, coatings, lubricants with high wear resistance
- **Technology adopted:** Radiation degradation
- **Achievement:** TRL 4 by Q2/2024
- **Industrial partners:** HDD Technology Sdn Bhd & Vamptech Sdn Bhd

## 03 PHILIPPINES

### Post-radiation Reactive Extrusion of Plastic Waste

- **Applications:** Wood Plastic Composites (WPC) for structural material
- **Technology adopted:** Radiation grafting & oxidation
- **Achievement:** TRL 4 by Q2/2024
- **Industrial partner:** Envirotech Waste Recycling Inc.

Alteration of plastic waste with radiation to enhance their compatibility for blending and producing composite materials. These materials, with improved mechanical properties, will be utilized in manufacturing housing building materials like tiles, bricks, and lumber.

Fabrication of light-weight composites with neutron shielding properties. The composites were successfully prepared from recycled HDPE pellets made from discarded fishing nets and boron carbide. The prototype product from this project will be used for internal utilization at TINT's neutron imaging laboratory.

## 04 THAILAND

### Fabrication of Recycled Plastic Composites

- **Applications:** Neutron shielding materials
- **Technology adopted:** Radiation grafting
- **Achievement:** TRL 3 by Q1/2024
- **Industrial partner:** CirPlas Thailand

# FUTURE PLANS & MILESTONES

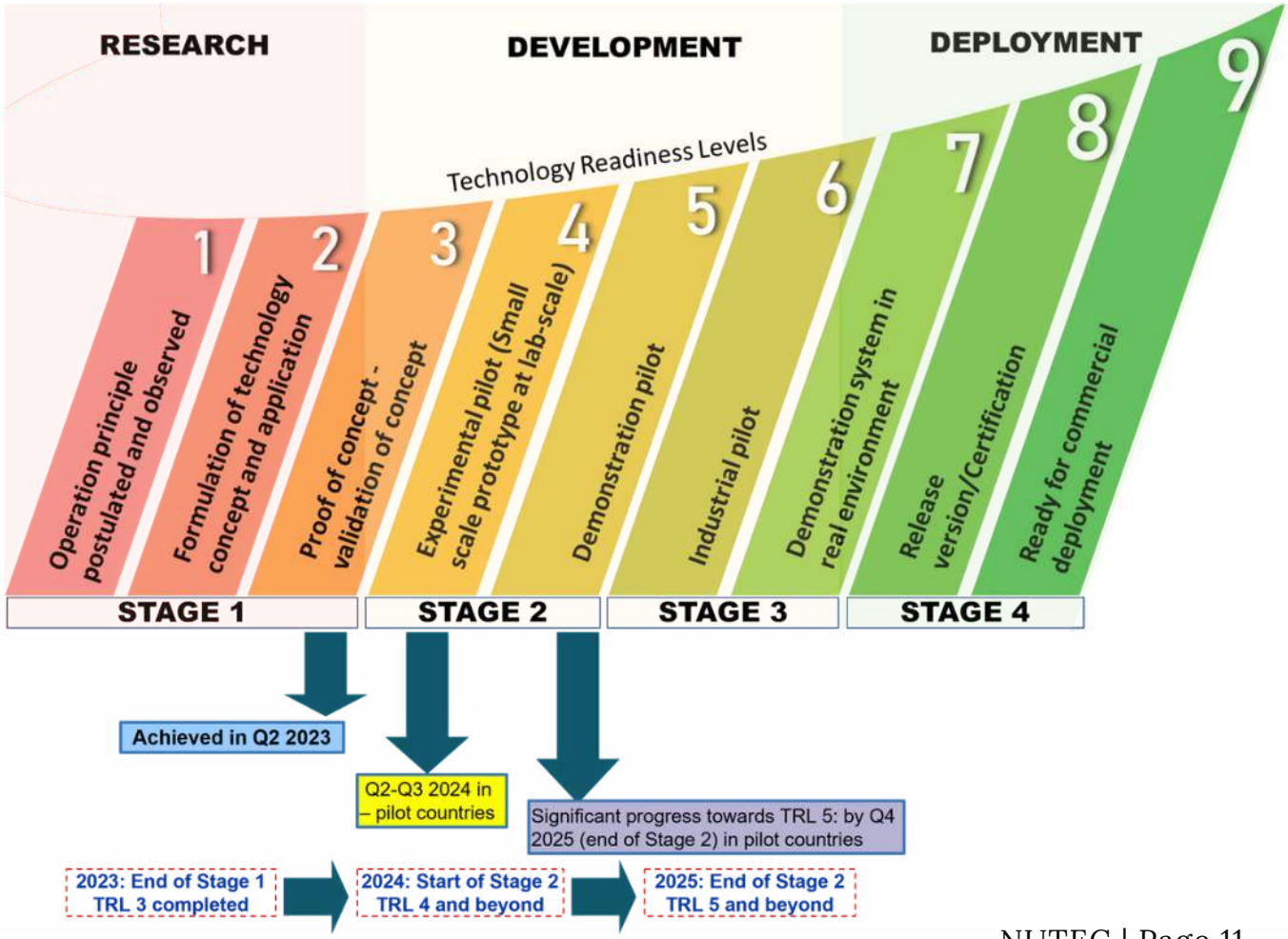
Advancing to **Stage II**: Verification of proof of concept and economic feasibility

**2023**
Pilot countries projects advanced to TRL 3

**2024**
Start Stage 2: Reutilizing and Recycling Polymeric Waste through Radiation Modification for the Production of Industrial Goods

**2025**
Pilot countries to reach TRL 5 and beyond, ready for demonstration or industrial pilot

**2026**
Significant progress towards TRL 6



# EXPANDING THE APPLICATION

Due to the successful implementation of projects within Member States, several countries are eager to embark on a second application modelled after the achievements of the existing project.

## RADIATION-ASSISTED THERMAL PYROLYSIS

- **Scope**: This project targets the treatment of end-of-life plastic waste, including Polyethylene (PE) and Polypropylene (PP), with the goal of transforming them into valuable products such as fuel or naphtha oil using ionizing radiation. The innovative approach is designed to lower decomposition temperature and activation energy, ultimately contributing to waste reduction and the creation of sustainable energy sources.

### INTERESTED MEMBER STATE: MALAYSIA, INDONESIA

- **Technology adopted**: Radiation degradation
- **Expected Achievement**: TRL 3 by Q3/2024

## WOOD PLASTIC COMPOSITES (WPC)

- **Scope**: The use of recycled plastic in WPC can result in degradation of mechanical properties due to incompatibility between wood and plastic. Radiation-induced oxidation can be applied to increase hydrophilic functionalities on the surface of recycled plastic thus making it more compatible with wood. The irradiated recycled plastic will serve as a compatibilizer in the production process of WPCs using recycled plastic and biomass.

### INTERESTED MEMBER STATE: THAILAND

- **Technology adopted**: Radiation oxidation
- **Expected Achievement**: TRL 3 by Q2/2024

# RECASTING RESOURCES

Voices from the NUTEC Plastics Vanguard in Asia-Pacific

## INSIGHTS AND TESTIMONIALS

Any project's success hinges on the adaptability of the people involved to diverse environments and their capability to navigate unique challenges. The National Project Coordinator in the NUTEC Upstream projects is instrumental in the project successful implementation. Let's explore the insights and experience of these individuals. Their experiences provide invaluable lessons and inspiration for those seeking successful project journeys across borders.

## Ms. Tita Puspitasari

Indonesia

***What inspired you or your team to start this project?***
Indonesia's food and beverage industries are the biggest users of plastic, accounting for 60% of plastic production in the country. Unfortunately, this results in a significant accumulation of plastic waste in the environment. Radiation processing applications using nuclear technology can convert single-use plastic waste into new product materials like compatibilizers, which can be used in WPC. By utilizing plastics and biomass waste, we can contribute to decreasing the waste in the environment and promote sustainable manufacturing practices.


***Contact Information:***

Ms. Tita Puspitasari
Head of Research Center for Radioisotope, Research Organization for Nuclear Energy, National Research and Innovation Agency (BRIN), Indonesia

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***Did you engage with the local community or other stakeholders during the project?***
Yes, ADUPI (Association of Indonesia Plastics Recyclers) supplied the recycled plastics for the experiment, and The Ministry of Environment and Forestry (KLHK) disseminated the program.

***What key performance indicators or metrics do you use to measure the success of this project?***
The compatibilizers developed by radiation processing, specifically surface modification through radiation oxidation can meet the company's expectations and substitute the commercial compatibilizers.

***Could you share some of the valuable lessons learned throughout the journey of this project?***
Developing a project from basic concept to proof of concept and then proceeding to real implementation with the assistance of IAEA Experts through constructive discussions and suggestions is a very valuable experience.

***Here** is the full interview transcript*

## WORDS OF ADVICE

*Tita's advice to individuals or organizations who are interested in starting their own plastic recycling/upcycling initiatives:*

- Try to capture the high demand for promising products that can use plastic waste as raw materials.
- To achieve a particular target, it is crucial to explore all the possible techniques of radiation processing and then identify the most practical and straightforward method. It is essential to consider all possible alternatives and solutions to accomplish the objective at a very early stage.
- To achieve a specific objective, focus on specific techniques and optimize all the procedures.
- To reach a process, consider the feasibility of the technique and its economics.

## Mr. Ting Teo Ming

Malaysia

***What was the project's primary objective to the country?***

The primary objective is to establish a pilot-scale facility for irradiating PTFE plastic waste, transforming it into valuable additives.

***What inspired you to start this project?***

The project was inspired by a need in Malaysia. Currently, there is no established method for recycling PTFE plastic waste into micro-powder suitable for industrial applications resulting in all PTFE waste ending up in landfills.

***What were the major obstacles you encountered when starting this project?***

- Determining the ideal process conditions
- Accessing an irradiation facility
- Aligning the produced product with industry requirements.

*"It's crucial to acknowledge the challenges that lie ahead including the availability of radiation treatment facilities and the economic aspects of processing plastic waste to make it more attractive to the industry."*

***Did you collaborate with any organizations, businesses or individuals to make this project a success?***

- Academia such as Universiti Teknologi Petronas (UTP), Universiti Kebangsaan Malaysia
- Industrial partner - HDD Technology Sdn Bhd (waste materials from industries and product utilization) and Vamptech Sdn Bhd (pilot scale optimization testing)

***What are your future goals and aspirations for this project?***

To have a functional pilot-scale facility equipped with the necessary machinery to produce products suitable for diverse industrial applications at affordable prices for industrial stakeholders.

***Contact Information:***

Mr. Ting Teo Ming
Manager, Radiation Processing Technology Division, Malaysian Nuclear Agency, Ministry of Science, Technology & Innovation, Malaysia

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*Here is the full interview transcript*

# Mr. Jordan F. Madrid

Philippines

***Give us a brief overview of the project.***
It involves the use of an Electron Beam (EB) to modify post-consumer plastic wastes which will be used to create products with improved mechanical properties that could be used as housing building materials such as tiles, bricks, and lumber.

***What inspired you or your team to start this project?***
Every day, large volumes of sachets and plastic labo (single-use plastics) are used in the Philippines. We cannot simply ban everything and be done with plastic since many people, particularly the poor, rely on it. We can say that single-use plastics are sometimes essential to people's daily life. We cannot simply dismiss this and this is another issue that must be addressed. Through this effort, we intend to contribute to reducing the landfilled plastic wastes and mitigate plastic waste pollution.

***Did you collaborate with any organizations, businesses, or individuals to make this project a success?***
PNRI and Industrial Technology Development Institute (ITDI) will collaborate in the research and development phase of the project, while Envirotech Waste Recycling Inc. will be the private company partner to provide the plastic wastes and testing of the developed process at higher technology readiness levels.

> *If we look at it from a different perspective, used plastics could be considered as a resource that could be used as input in manufacturing industries rather than being treated solely as waste. According to a World Bank study published in 2021, several structural challenges cause market failure for plastic recycling leading to a plastic material value loss of $ 790-890 million per year. Strengthening the demand for recycled plastics through various initiatives including this project will prevent the loss of such materials and their corresponding economic value."*

***Can you share some of the innovative solutions or technologies used in the process?***
EB irradiation is used to modify the properties of plastic wastes making them more compatible for blending and producing composite materials. The proposed solution does not use chemical additives and can be carried out to complement existing manufacturing facilities.

If found financially viable, it could be adopted by companies designated as waste diverters under the Extended Producer Responsibility (EPR) Law of the Philippines. This adoption would empower diverters to handle increased plastic waste volumes through technology advancement, significantly reducing plastic waste in the country and fostering environmental sustainability.


*Here is the full interview transcript*

***Contact Information:***

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For more information, visit the PNRI website at www.pnri.dost.gov.ph

# Ms. Kasinee Hemvichian

Thailand

***Could you give us a brief overview of the project?***
The primary objective is to demonstrate, disseminate and promote the useful application of radiation technology as one of the promising tools for recycling of polymeric waste and turning it into useful value-added products.

***Can you share some of the innovative solutions or technologies used in the process?***
We turned recycled plastic waste (made from discarded fishing nets) into composites with neutron shielding properties. Additionally, we also utilizing radiation processing to modify plastic waste to make it more compatible with other raw materials.

***What is the economic benefit?***
With positive preliminary results, the project can create demand for recycled plastic waste, which in turn will create opportunities for both local plastic waste collectors in Thailand as well as for Thailand's National Plastic Waste Management Roadmap.

***How does your project contribute to environmental sustainability and reduce plastic waste?***
Our project can help reducing the amount of plastic waste going into landfills or the oceans, by supporting local plastic waste collectors in Thailand as well as by promoting the transformation of plastic waste into other products. The latter will result in more impactful utilization of plastic waste if the technology can be transferred and ultimately leading to commercialization.

***What advice would you give to individuals or organizations interested in starting their own plastic recycling/upcycling initiatives?***
There is no better time to start your plastic recycling/upcycling initiatives than now. We need more collaboration and efforts on this issue in order to mitigate problems caused by plastic waste.

***Contact Information***

Ms. Kasinee Hemvichian
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Head of Material Science Technology Section, Thailand Institute of Nuclear Technology (Public Organization), Thailand

***Here*** *is the full interview transcript*

*"Plastic is a highly useful material if correctly used and taken care of. For the general public, it is very important that people,especially the young generation, are aware of the pollution caused by plastic waste and ways to prevent it so that we can reduce the amount of plastic waste sent to landfills and the ocean. For researchers, collaborating and networking with local industries and government agencies - both at local and international levels - can offer insights into waste reduction strategies and recycling initiatives."*

- Ms. Kasinee on the RAS1024 Project

# CONTACT US
## FOR FURTHER INQUIRIES


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Learn more here

https://nutec.iaea.org

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