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Editor's Note

Welcome to the latest issue of our magazine, dedicated to the inspiring world of Green Business & Circularity Technology. As we navigate the challenges of the 21st century, the importance of sustainability and environmental consciousness has become increasingly evident. In this edition, we delve into the innovative and transformative initiatives that are driving the green business revolution and advancing circularity technology.

Our planet is facing urgent environmental concerns, from climate change and resource depletion to waste management and pollution. However, amidst these challenges, there is a growing wave of academicians, businesses, and entrepreneurs who are embracing sustainability as a core principle. From renewable energy solutions to eco-friendly manufacturing processes, these pioneers are redefining how we do business and proving that profitability and sustainability can go hand in hand.

Within these pages, you will find a diverse range of stories, insights, and expert perspectives that explore the advancements in green business practices. This issue shines a spotlight on the businesses and individuals who are leading the way in implementing sustainable strategies, showcasing their innovative business solutions and services that prioritize the well-being of our planet.

Additionally, this issue delves into the exciting world of circularity technology, which is revolutionizing how we consume, produce, and manage waste. Circular economy principles aim to minimize waste, maximize the value of resources, and create a regenerative and inclusive system.

By highlighting the stories of those who are making a difference, this issue hopes to ignite a spark of inspiration within each reader and encourage them to take meaningful actions towards a greener and more circular world.

I am thankful to all authors for sharing their knowledge and experience, as well as our editorial team for their efforts in editing and designing this issue.

This magazine is a knowledge product of AIT Solutions and a professional communication platform for experts and researchers and a window to its readers to the technologies, events, and developments.

We welcome your valuable feedback and opinions.

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Implementing Circular Economy Principles in Small and Medium-sized Enterprises (SMEs) in Emerging Economies

The circular economy is an increasingly popular approach to address climate change and environmental challenges by practicing a closed loop model that maximizes resource efficiency and minimizes waste.

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The circular economy (CE) is gaining popularity as an approach to address the issue of climate change, as well as other environmental and social challenges. It is practiced as a closed loop economy model through make-use-recycle which aims to keep resources in use for as long as possible, minimize waste and maximize the efficiency of resources. However, it slowly gained the momentum in practice and research in relation to emerging economies (Gedam et al., 2021) and small and medium-sized enterprises (SMEs) (Thorley & Garza-Reyes, 2021). Prior research has shown that implementing CE principles can help SMEs in emerging economies to create value, reduce greenhouse gas emissions, extend product life cycles (Agyemang et al., 2019), and create a new industrial ecology (Kalmykova et al., 2018).

Despite these potential benefits, many SMEs in emerging economies are still lagging behind in closing the loop of CE (Malik et al., 2022). Even though SMEs play a vital role in the economy of many countries, they contribute to a significant environmental footprint (Koirala, 2019). Most importantly, the existing knowledge on this field proved that resource constraints which SMEs and emerging economies specifically face, act as barriers towards closing the loop of CE. Hence, ample gaps exist to reveal feasible methods for SMEs in emerging economies to close the loop of CE. In the journey of fulfilling this gap, our attention was drawn towards frugal innovation (FI) which is one of the resource constrained innovations originated from emerging economies.

FI has been arisen as a solution for the resource constraints including resource scarcity, institutional voids and affordability constraints in emerging economies (Bhatti et al., 2018). Initially, it was targeting low- and middle-income customers in emerging economies who were neglected by the high-valued products and services of traditional innovations sourced from advanced economies (Pisoni et al., 2018). According to Agarwal et al. (2017), higher the severity of resource constraints adds more frugal features to the product or service. As Weyrauch and Herstatt (2017) defined, FI simultaneously fulfills substantial cost reduction, concentration on core functionalities and optimized performance level criteria.

Main focus of FI is to reduce the cost as much as possible and this is prioritized during the development and the production process. As a result, low-income customers in emerging economies receive affordable, accessible and good enough quality products and services. For example, grassroot entrepreneur, Mansukhbhai Prajapati from India developed Mitticool, a clay refrigerator which can function without electricity and an emerging economy multinational company, Tata Group in India developed Tata Swach, a low-cost water purifier with natural elements like rice husk ash (see Fig.1).

Mitticool Refrigerator

Tata Swach Water Purifier

Figure 1: *Examples of frugal innovation*

Due to the fact that FI concentrates on core functionality, removing frills, reducing costs in souring, production, distribution and consumption, some conceptual and qualitative case studies argued that FI achieves environmental sustainability. Ezeudu et al. (2022) also proved with qualitative methods that FI of SMEs leads to CE implementation. On the contrary, another group of researchers stated based on multiple FI case studies that FI does not relate to sustainability (Rosca et al., 2017). Moreover, some studies predicted that FI might create negative environmental impacts such as extracting raw material unsustainably, technology cobbling with non-eco-friendly components and environmentally harmful disposing. Therefore, we conducted research to quantitatively investigate the effect of FI on implementing CE principles in SMEs in emerging economies (see Fig.2).

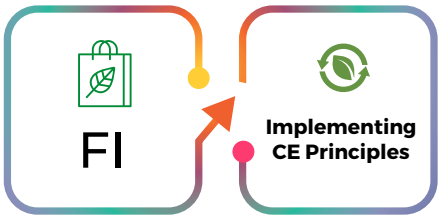

Figure 2: *FI effects on CE implementation*

For our quantitative study, we collected data from India and Pakistan. We reached top level managers of SMEs in these two countries using both online and offline methods. After distributing 1000 questionnaires in each country, we received 306 responses in total from both India and Pakistan. Our survey consists of questions related to demographics of SMEs, FIs and CE principles. We developed these questions based on prior research and checked them for the content validity with experts. Further, we had to translate our questionnaire from English to the respondents' local languages. In our research, we measured FI mainly based on substantial cost reduction, concentration on core functionalities and optimized performance level criteria while CE was measured mainly on retaining the value in the economy by closing the loop through reduce, reuse and recycle (see Table 1). Next, we analyzed our collected data through partial least square structural equation modelling (PLS–SEM) using SmartPLS4 software. After ensuring the validity and reliability of the data set, we were able to prove FI has a significant relationship with implementing CE principles. FI positively effects on implementing CE principles in SMEs in emerging economies.

After ensuring the validity and reliability of the data set, we were able to prove FI has a significant relationship with implementing CE principles.

Table 1: Itemization of FI and Implementing CE principles

Frugal Innovation	Implementing CE Principles
Our products attract customers and offer value.	We design our products to be easily repaired/refurbished.
Our products focus on the core functionality, rather than on additional functionalities.	We design our products to be easily biodegradable/ recyclable.
Our products are not complicated and can easily be used.	We design our products to be energy efficient.
Our products meet the prescribed quality standards.	We use biodegradable / recyclable packaging for our products.
Our products have significant cost reductions in the operational process.	We reuse our own production waste/recycled material in making new products.
Our products have significant reductions in the final price to the customers and/or low maintenance costs.	We use less resources and raw materials to make our products.
Our products are durable (not easily spoiled).	We ensure high level of energy (e.g. electricity, fuel) efficiency during our operations.
Performance level of our products fit with the local conditions (e.g. infrastructure) of our target market.	We transfer / sell by-products to other firms.
	We reuse bi-products/recycled materials from other firms.

Our research findings support the impact of FI on implementing CE principles and demonstrate a positive relationship between FI and environmental sustainability, helping to address the research gap in FI. While FI originated in emerging economies, it has gained traction in advanced economies as affluent customers embrace simplicity and sustainable production. In emerging economies, however, FI primarily targets low-income customers who may not prioritize environmental sustainability. Therefore, instead of directly promoting CE implementation, we suggest SMEs in emerging economies focus on developing and selling familiar frugal products to achieve both frugality and circularity, offering a feasible solution to close the CE loop.

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Green Business with Bio-Circular Economy: The Essence of Investing towards Social Responsibility- Progression of the Process & Way forward

Social inequality and global warming have merged as the two most prominent social-environmental issues, as a result corporates began expanding their approach beyond traditional CSR methods to address these challenges, introducing GREEN Solutions.

Author:

Bhargab Mohan Das

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The term "Business" has always been synonymous with the endeavors geared towards maximizing profit, with any actions aimed at improving society and the environment being viewed as acts of "Charity". It is here that the concept of Corporate Social Responsibility (CSR) surfaced, serving as a means for companies to enhance their public image and ultimately, boost profits.

Undoubtedly, this trend has spurred numerous business houses worldwide, yielding tremendous materialistic success stories. However, it has also given rise to alarming phenomena, with social inequality and global warming emerging as two of the most prominent socio-environmental issues.

By the first decade of the new millennium, it became apparent that the situation was cause for concern. As a result, corporates began expanding their approach beyond traditional CSR methods to address these challenges, introducing ***GREEN Solutions***. However, these solutions were largely restricted to those who could afford to pay a premium price. Rather than being implemented solely to benefit the environment, the introduction of these solutions was seen as a value-added service to drive commercial gains. As such, the focus remained on achieving a break-even point for the additional investment via enhanced returns, with efforts to promote such activities via CSR and marketing events coming in as a distant second priority. While these new initiatives certainly opened eyes to new possibilities, they were unable to fully address the pressing needs at hand, prompting business visionaries to seek more pragmatic approaches to tackling these issues.

In the latter half of the second decade of the new millennium, three distinct events came to pass:

- Through relentless efforts on the part of manufacturing brands, GREEN Products eventually started to get on par or became commercially more viable, than conventional means due to economies of scale.

- The global environmental situation deteriorated to an all-time low, raising grave concerns about the survival of future generations.

these solutions were largely restricted to those who could afford to pay a premium price. Rather than being implemented solely to benefit the environment

- Owing to the enhanced awareness via social media, there has been an increasing emphasis on the urgent need to address existing social disparities.

These events made the policy makers and the financial institutions to slowly but certainly shift their focus towards promoting all these endeavors which has made the Green Investment a more viable phenomenon as:

- It is not dependent on Policy Based subsidies/premium incentives.

In fact, currently certain Green Technologies (vis a vis Solar Photovoltaic-PV) are seen as the cost saving replacements of the conventional predecessors

- The enhanced awareness among the prospective customers, reduced the ignorance and made the acceptance of such endeavors much easier.
- The emergence of Entrepreneurial Instincts in smaller business sectors has been prioritized, enabling aspiring entrepreneurs to disseminate their initiatives without being excessively reliant on policies and fund availabilities.

The vision is to view actions taken to tackle such challenges as a profession, rather than as merely charitable endeavors.

This has led to the development of concepts pertaining to the development of two brand new highly inter-related concepts, namely.

- Bio-Circular Green (BCG) Economy Development
- Environmental and Social Governance (ESG) framework by the Corporates

While staying true to its core business of developing renewable energy generation facilities (primarily solar PV), CNES is dedicating significant time, effort, and resources to the two aforementioned aspects, with the goal of addressing socio-environmental concerns. The vision is to view actions taken to tackle such challenges as a profession, rather than as merely charitable endeavors.

Currently under execution in the Thawung district of Lopburi Province in Thailand, one of the pioneering projects in this sector is being developed as a “Carbon Negative Sustainable Park,” comprising:

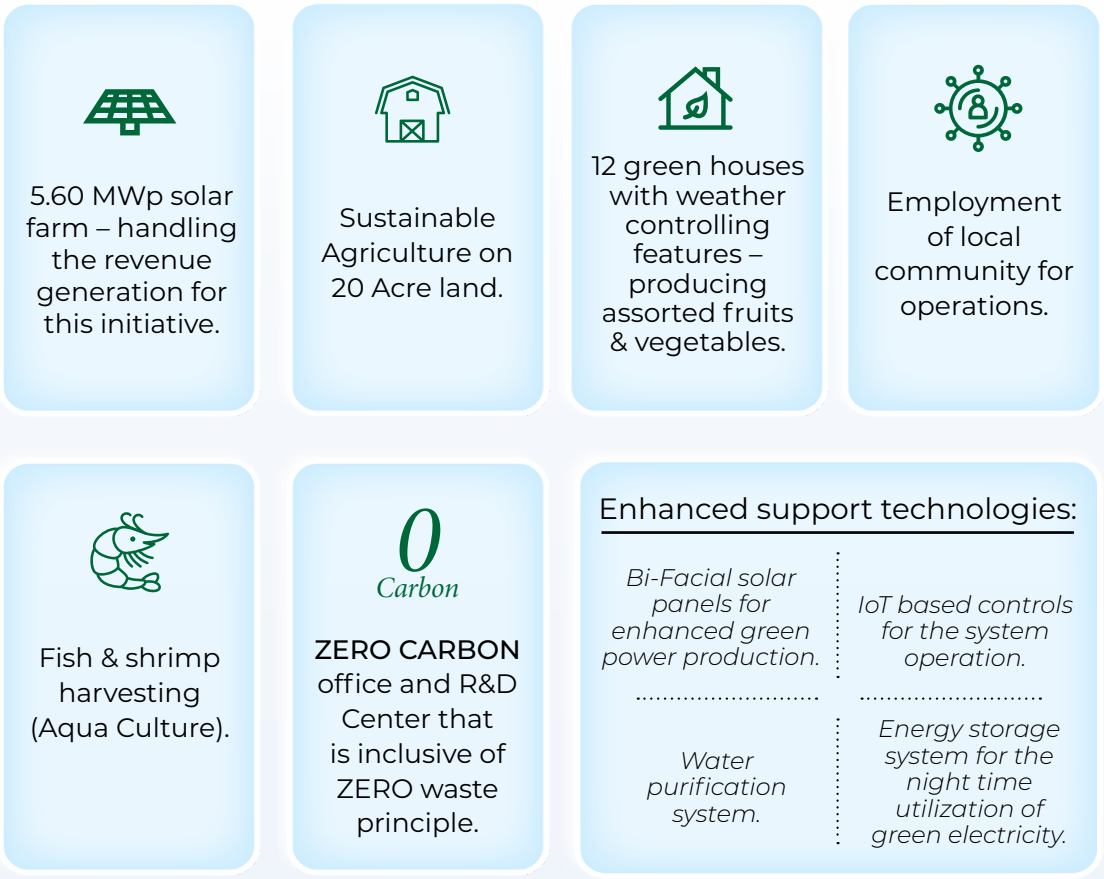

Figure 1: *Key Highlights of Carbon Negative Sustainable Park being developed by CNES in Lopburi Province, Thailand*

Techno-Commercial Yields

- Generation of more than 8.50 million units of green power per year
- Offsetting in excess of 4000 metric tons of carbon emission per year
- Provision of employment to more than 30 local individuals.
- Generating revenue in excess of Thai Baht 20 million per annum.
- Created the trend of starting ZERO Carbon Operating Facilities.

Figure 2: *Techno-commercial Yields of Carbon Negative Sustainable Park by CNES in Lopburi Province, Thailand*

As time progresses, the vision, in collaboration with sector partners, is to make the development of such facilities a routine process. The fundamental principles of zero-carbon and local employment remain consistent, while the revenue-generating business sector may vary from case to case. By virtue of these two basic principles, such facilities will enhance the ESG scorecard of any corporate entity in the future.

In the past two decades, the Green Business has transformed from a mere supplement to CSR activities to become the most lucrative one, while fulfilling the corporates' social responsibilities in a more meaningful manner. The trend is continuing to rise, where all like-minded business ventures can collaborate and amplify their respective businesses, making our planet a better place to live.

Building Bridges Between Business & Environmental Aspirations

An interview with Mr. Yash Lohia, the Chairman of Indorama Ventures' Environmental, Sustainability and Governance Council shares his journey and insights.

Yash Lohia, Chairman of Indorama Ventures' (IVL) Environmental, Sustainability and Governance (ESG) Council, has taken on the challenge of embedding sustainability in the multi-billion-dollar petrochemical business.

Having grown up in the world of business, Yash initially lacked passion for the industry. However, through his hard work and dedication, he has become a bridge between the environmental aspirations of the next generation and the established business models.

During his talk at the Asian Institute of Technology's Distinguished Entrepreneur Talk Series in November 2022, Yash shared his experiences and insights. In this exclusive Q&A, we delved deeper into his journey and the lessons he has learned along the way.

Q **Did you always want to be part of your family's business?**

A *I'm an Indian by birth, educated in England, and have been living in Thailand for over 30 years. Joining the family business was ingrained in me from an early age. However, when I initially joined IVL, I wasn't excited or passionate about what we made.*

Q What are the lessons you've learned along the way?

A *One important lesson was the need to question assumptions and double-check information. Trusting others' work is essential, but it's equally important to question and verify to avoid oversights or mistakes. I also learned the significance of understanding people's strengths and weaknesses, which can greatly impact a project's success. It's crucial to have the right people in the right roles and ensure a well-designed organizational structure.*

Indorama is the world's largest producer of PET or Polyethylene terephthalate which is actually used to make plastic bottle.

Q Then what happened?

A *I worked my way through the ranks at IVL, gaining experience in different business segments. I started in the Packaging Business, which was the smallest segment at the time, to get a better understanding of the industry. I also had the opportunity to shadow senior executives, learning about leadership and different management styles. This diverse experience helped shape my perspective.*

Q You seem to be passionate about your company now more than when you first started. What changed?

A *Joining the board as an Executive Director and being appointed Chief Recycling Officer in 2019 was a turning point for me. This role gave me a sense of purpose. With increasing concerns about plastic waste and new regulations being implemented, I realized the importance of focusing on recycling and sustainability. Understanding the environmental benefits of PET bottles compared to alternatives, and the potential of recycled PET bottles, fueled my passion.*

Q **Tell us about your role as the Chairman of ESG.**

A *Leading IVL's ESG Council was initially daunting but fulfilling. I started by immersing myself in research and gaining a broad understanding of sustainability practices across various sectors. With a small, passionate team, we began our sustainability journey. Sustainability inherently generates passion and excitement because it involves helping the environment. We aim to make a positive impact and time will reveal the results.*

Q **How does Indorama Ventures contribute to sustainability and environmental stewardship?**

A *IVL is committed to sustainability and environmental stewardship in several ways. Firstly, we prioritize resource efficiency and waste reduction throughout our operations. We strive to minimize our environmental footprint by optimizing energy and water usage, reducing emissions, and implementing circular economy principles. Additionally, we invest in research and development to develop innovative and sustainable products that meet the evolving needs of our customers. Lastly, we actively engage with stakeholders, including governments, NGOs, and local communities, to collaborate on sustainable solutions and contribute to the well-being of society and the environment.*

Q **You seem to be passionate about your company now more than when you first started. What changed?**

A *Joining the board as an Executive Director and being appointed Chief Recycling Officer in 2019 was a turning point for me. This role gave me a sense of purpose. With increasing concerns about plastic waste and new regulations being implemented, I realized the importance of focusing on recycling and sustainability. Understanding the environmental benefits of PET bottles compared to alternatives, and the potential of recycled PET bottles, fueled my passion.*

Yash Lohia's vision for sustainability at IVL extends beyond the present, with a focus on resource efficiency, circularity, carbon neutrality, and stakeholder collaboration. By aligning business objectives with environmental aspirations, IVL is well-positioned to drive positive change within the petrochemical industry. Yash's dedication to sustainability and his leadership in the ESG Council demonstrate his commitment to shaping a more sustainable future for the company and the world.

Polyurethane Foam Waste - A Nanotechnology-driven Circular System Innovation

Plastics have become a part of our lifestyle due to its many desirable characteristics and its several practical applications, though the mismanagement of plastic products at the end of their lifetime is contributing to the global plastic pollution.

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Plastics are polymers that can occur naturally or be synthesized synthetically. They have several practical applications due to their many desirable characteristics, such as their ability to be easily modified to fit a wide range of technical and customer requirements, their high strength-to-weight ratio, their ability to save materials and fossil fuels over time, and their ability to keep food and water safe during transport. As a result, plastics become a part of our lifestyle and its global production in 2021 has reached more than 390 million metric tons. Based on the chemical structure of the polymer base and side chains, plastics can be classified into different types, such as polyethylene (PE), polyethylene terephthalate (PET), polypropylene

(PP), polystyrene (PS), acrylic, polyurethane (PU), polyvinyl chloride (PVC), polyester, and halogenated plastic. Bioplastics, in contrast to these traditional plastics made from nonrenewable petrochemical sources, are made mostly from plant-based ingredients like cellulose and starch. However, the area of bioplastics is relatively new and still expanding as one of the potential solutions to the problems of limiting petrochemical resources and the threat of global warming.

Polyurethane (PU): A multi-functional plastic

Invented in the year 1937 by Prof. Otto Bayer, polyurethane (PU) is a versatile thermoset-type polymer formed from diisocyanate and polyol monomers. Thermoset polymers are plastics that, when heated, undergo an irreversible chemical reaction and can only be melted and molded into any shape once. Thus, upon re-heating, PU decomposes rather than melting. Today, PU can be found in thousands of goods available to consumers. Automotive sealants and components, refrigerant insulation, shoe soles, paint and varnish sealants, foams upholstery, and soundproofing are just some of the many uses for PU. Being man-made, it can be altered to take on any shape or movement, from flexible to rigid, from fluid to solid. Flexible PU foams, typically found in our mattresses or sofa, are prepared by blowing a gas (e.g., CO_2) to make the foams softer and comfortable. Rigid foams, on the other hand, are prepared by trapping a gas (e.g., pentane) within the PU cells, increasing its heat-insulation properties. When no gas is used, PU takes a dense and hardwearing form useful to many applications.

PU, being very adaptable and a good insulator, provides multiple solutions to the problems of energy efficiency and environmentally friendly design. It is commonly used to lessen the demand for power in electronics and automobiles. It is also put to use with cooling systems like refrigerators, reducing domestic energy use. As a result, less resources are used, which can have a positive effect on the planet. Interestingly, 1 kg of PU creates 3.5 kg of CO_2 in production, but reduces 350 kg of emissions over a 50-

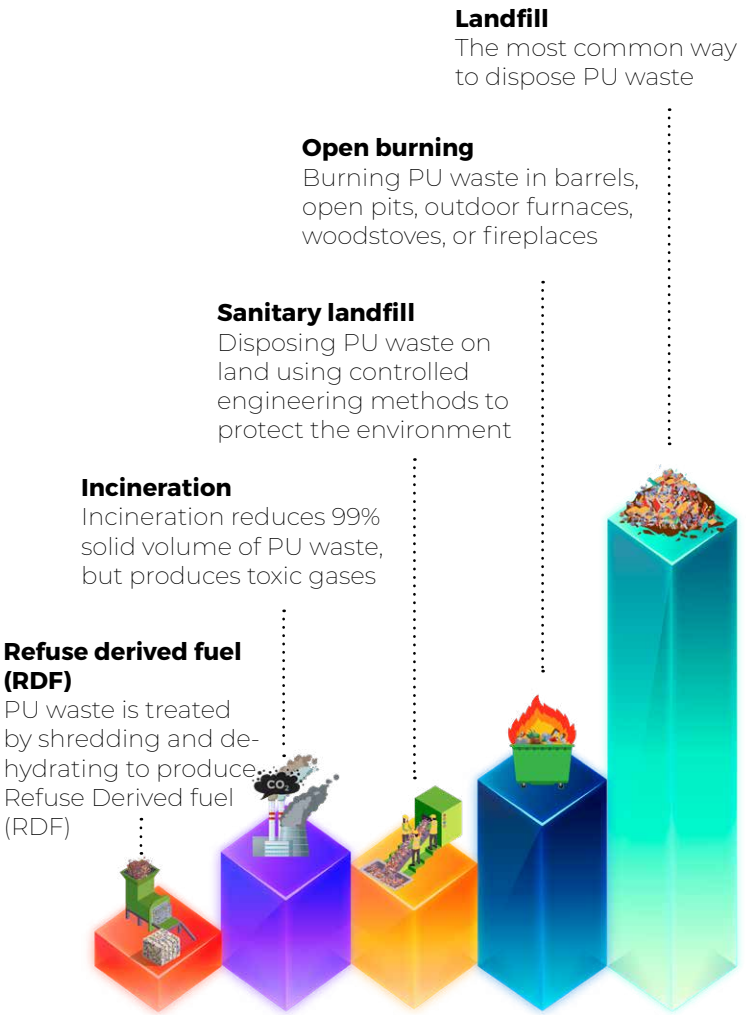

Figure 1: *The most common ways of disposing rigid PU foam waste in Thailand. [Source: Soraya Suwannafon (2018). An exploration and assessment of the environmental pollutants from rigid polyurethane foam waste disposal in Thailand. Thammasat University.]*

year lifetime making PU systems worth every penny. When treated properly and dried completely, PU products are considered as environmentally safe as they do not emit any gases and toxic compounds over time.

Problems with PU wastes

The biggest problem with PU wastes today is the mismanagement of its products at the end of their lifetime, which is contributing to the global plastic pollution issue. Like all other plastics, PU takes several hundreds of years to degrade naturally. Hence, when released to the environment, PU wastes can lead to environmental problems and human health issues. Today, the most common disposal method for flexible PU foam wastes is landfill or open burning, followed by incineration and recycling. Products made of polyurethane that are thrown away in landfills eventually disintegrate into compounds that are dangerous to humans and harmful to the environment. When burned or incinerated, a number of potentially harmful compounds, including isocyanates, hydrocyanic acid, and dioxins, are released into the atmosphere. This creates an issue for the environment. In addition to this, recycling PU is currently not so popular and quite challenging as they require a significant amount of energy. This is because the majority of polyurethanes are thermosetting polymers, which do not simply melt when heated.

Recycling of PU wastes

The Waste Framework Directive (WFD), prepared by the European Parliament & Council, provides a 5-steps approach to reduce waste generation and to use waste as resources . These five steps, as per their hierarchy from most preferred to least preferred, are: Prevention or Reduce, Reuse, Recycle, Recovery, and Disposal. In terms of PU wastes, recycling is therefore more preferred than disposal. Recycling PU's can be accomplished either mechanically or chemically, where the simplest and most fundamental way is with the use of mechanical processing. It entails transforming solid waste into flakes, grains, or powder in some form or another. They can either be utilized directly as stuffing for cushions, toys, and the like (referred to as Primary Mechanical Recycling), or they can be used as a substrate in future operations (referred to as Secondary Mechanical Recycling and Feedstock recycling). In the process of chemical recycling, long polymer chains are broken down into smaller units using some chemical processing. Hydrolysis, glycolysis, aminolysis, acidolysis, gasification, and many others fall under this category. Chemical recycling of PU is more difficult than mechanical recycling because of the higher expenses, higher applied temperature, and additional substrates. It facilitates the separation of polymers into constituent parts that can be used as either standalone raw materials or as building blocks in the synthesis of new polyurethanes.

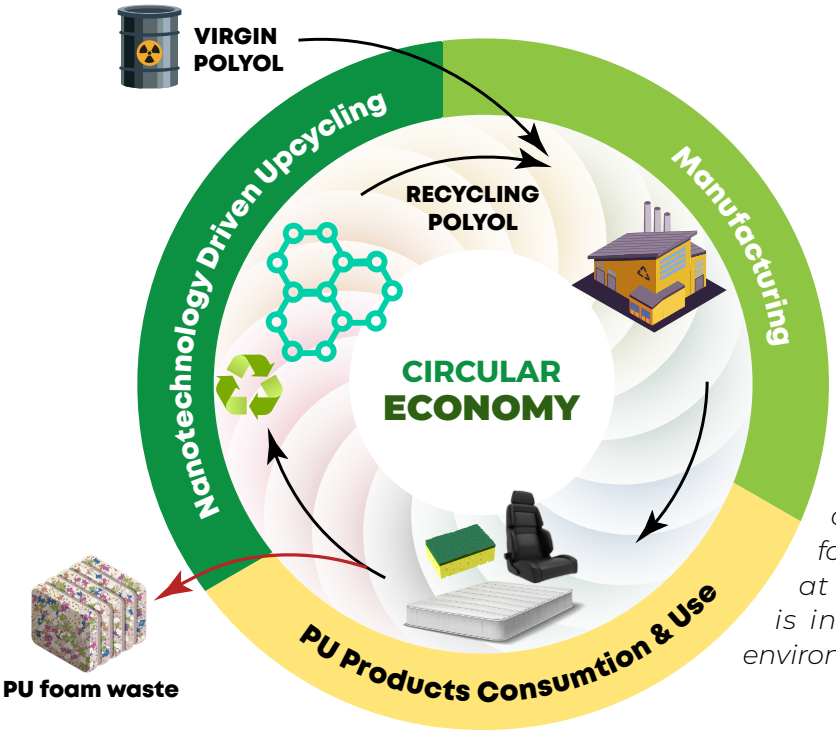

Figure 2: *Closing the loop on PU foam waste: a nanotechnology-driven circular approach for PU foam waste upcycling project at CoEN, AIT. The approach is innovative, economic and environmentally sustainable.*

Circular PU waste & Nanotechnology

Circular PU waste basically means innovations in PU waste handling and recycling to implement a circular economy based waste management system, which is essentially where we close the loop. Instead of letting trash pile up in landfills or harm the landscape, we should do everything in our power to put it to productive use again. Waste management is the final stage of resource conservation, which is vital to a circular economy. Research led by the Center of Excellence in Nanotechnology, Asian Institute of Technology, Thailand is currently working on an innovative circular approach to upcycle PU foam waste using a nanotechnology-driven hybrid method. Nanotechnology is the engineering of functional systems at the molecular scale. It involves the understanding and control of matter at the nanometer-scale which deals with dimensions between approximately 1 and 100 nanometers. A nanometer is one billionth of a meter, i.e., 0.000000001 or 10^{-9} meters. In order to reduce waste, the project aims to reverse the PU polymerization using a more sustainable way that will allow recovering the building blocks and upcycling the PU wastes to close the waste-to-resource loop. The project is in collaboration with the University of Cambridge, the UK and Circularity Co. Ltd., Thailand who are looking at the sustainable business model for this technology. It is funded by the Royal Academy of Engineering (RAE), the UK; the National Science and Technology Development Agency (NSTDA), Thailand; and Circularity Co. Ltd., Thailand.

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https://www.polyurethanes.org/what-is-it/

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Green Business and Circularity Technologies: Towards a Sustainable Future

Green business and circularity technologies have emerged as key strategies for advancing sustainable development, as they offer innovative solutions to some of the most pressing environmental challenges facing society.

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With growing concerns about climate change, resource depletion, and environmental degradation, businesses and policymakers are increasingly looking to green business and circularity technologies as possible solutions. Green business and circularity technologies have emerged as key strategies for advancing sustainable development, as they offer innovative solutions to some of the most pressing environmental challenges facing society. Green business involves adopting sustainable production and consumption practices, developing eco-innovative products and services, and promoting sustainable business models. Circularity technologies, on the other hand, focus on creating closed-loop systems where waste is minimized, resources are conserved, and materials are continually reused and recycled.

Green Business and Circularity Technologies

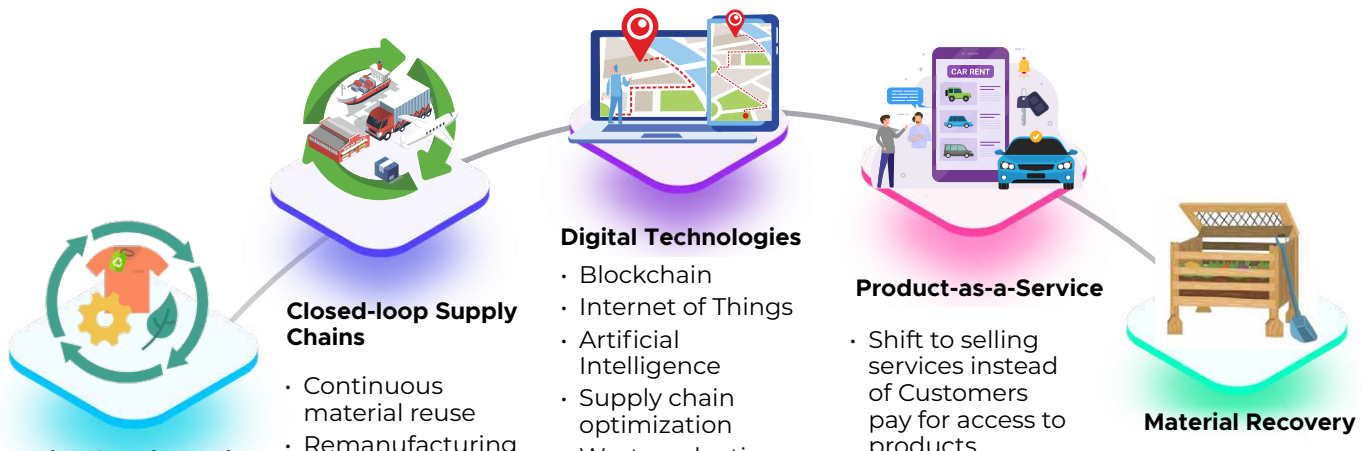
Green business encompasses a range of practices and strategies aimed at reducing the environmental impact of business activities. This can include adopting sustainable production processes, such as reducing energy consumption, using renewable energy sources, and minimizing waste. Green business can also involve developing eco-innovative products and services that minimize environmental impact throughout their life cycle, from raw material extraction to disposal.

It is a business model that is built on the principles of environmental sustainability, social responsibility, and economic profitability. This model recognizes that businesses can operate in a way that protects the environment, conserves natural resources, and promotes social well-being while generating profits. Green businesses can take many forms, including renewable energy companies, green construction firms, sustainable agriculture, and waste management firms.

Whereas, circularity technologies are a set of tools, practices, and strategies that aim to create a more circular economy. The circular economy is an economic system that aims to eliminate waste and promote the efficient use of resources. Circularity technologies enable businesses and organizations to achieve this goal by rethinking the way products and materials are used and managed throughout their lifecycle.

Circularity technologies can take many forms, including:

- **Design for circularity:** This involves designing products and materials that are reusable, repairable, and recyclable. It also involves designing products with the end-of-life in mind to ensure they can be easily disassembled and recycled.
- **Closed-loop supply chains:** This involves creating closed-loop supply chains where materials are continuously reused, remanufactured, or recycled.



CIRCULAR ECONOMY TECHNOLOGIES AND STRATEGIES

- **Material recovery:** This involves using technologies such as recycling, composting, and anaerobic digestion to recover materials and turn them into new products.
- **Digital technologies:** This involves using digital technologies such as blockchain, Internet of Things (IoT), and artificial intelligence (AI) to optimize supply chain operations, reduce waste, and track materials throughout their lifecycle.
- **Product-as-a-Service:** This involves shifting from selling products to selling services, where customers pay for access to a product rather than owning it. This can encourage manufacturers to design products that are more durable and easier to repair, as they will have to maintain them over their entire lifecycle.

Circularity technologies can enable businesses to create new revenue streams by adopting sharing and leasing models or by remanufacturing products.

Circulatory technologies provide a way to move away from the linear model of the traditional economy and towards a more circular and sustainable model.

Roles of Innovation, Technology, and Policy

Innovation, technology, and policy play a critical role in driving the growth of green businesses and promoting sustainability. Advances in technology, such as renewable energy and energy-efficient products, are creating new opportunities for green businesses to reduce their environmental impact and generate economic benefits. Policy and regulations, such as carbon pricing and renewable energy targets, can incentivize businesses to adopt sustainable practices and reduce their carbon footprint. Additionally, innovation in business models, such as the sharing economy and the circular economy, can promote sustainability by reducing waste and promoting resource efficiency.

One of the key drivers of circularity technologies is innovation. Advances in technology and design are enabling new solutions for reducing waste and promoting sustainable practices. For example, the development of sustainable materials, such as bio-based plastics or textiles made from recycled materials, can help reduce the environmental impact of products. Similarly, new design strategies can enable products to be designed for disassembly and remanufacturing, promoting circularity. Circularity technologies are also driving innovation in business models. For example, sharing and leasing models enable businesses to generate revenue from the use of products rather than the sale of products. This can create new opportunities for businesses while also reducing waste and promoting circularity.

Synergies between Green Business and Circularity Technologies

Green business and circularity technologies are not mutually exclusive, but rather complementary approaches to advancing sustainable development. They share a common goal: to promote sustainability and reduce waste. By combining the principles of green business with the tools and practices of circularity technologies, businesses can create synergies that enable them to reduce their environmental impact while also generating economic and social benefits.

One way that green business and circularity technologies can work together is through the adoption of sustainable materials. Green business emphasizes the use of sustainable and renewable resources, such as organic materials or materials sourced from sustainable forests. Circularity technologies can build on this by promoting the use of recycled or bio-based materials, reducing the reliance on virgin materials and minimizing waste.

Another area of synergy between green business and circularity technologies is in the development of new business models. Green business emphasizes the importance of creating value while minimizing negative environmental impact. Circularity technologies can enable businesses to create new revenue streams by adopting sharing and leasing models or by remanufacturing products. These models not only promote circularity but also generate economic benefits for businesses.

Circularity technologies can also help in achieving the principles of green business by promoting the adoption of sustainable practices throughout the supply chain. For example, circularity technologies can enable businesses to track and monitor the use of products, reducing waste and promoting sustainable practices. They can also create transparency and accountability in supply chains, enabling businesses to ensure that their suppliers adhere to sustainable practices.

Also, the adoption of circularity technologies can help businesses meet the increasing demand for sustainable products and services. Consumers are increasingly concerned about the environmental impact of the products they buy and are willing to pay a premium for products that are produced sustainably. By adopting circularity technologies, businesses can meet this demand and create a competitive advantage.

Consumers are increasingly concerned about the environmental impact of the products they buy and are willing to pay a premium for products that are produced sustainably.

By combining the principles of green business with the tools and practices of circularity technologies, businesses can create synergies that enable them to reduce their environmental impact while also generating economic and social benefits, and thereby achieving a more sustainable future.

Challenges

Green business and circularity technologies face a number of challenges that can hinder their adoption and impact. Some of the key challenges include:

- **Lack of awareness:** Many businesses and individuals may not be aware of the principles and benefits of green business and circularity technologies. This can lead to a lack of demand for sustainable products and services, and a reluctance to invest in circularity technologies.
- **Economic barriers:** Implementing circularity technologies can require significant investment in new infrastructure, technologies, and processes. This can be a barrier for small and medium-sized businesses that may not have the resources to make these investments.
- **Regulatory barriers:** Existing regulations and policies may not support the adoption of circularity technologies or green business practices. This can make it more difficult for businesses to transition to more sustainable models.
- **Lack of standardization:** There is a lack of standardization in the adoption of circularity technologies, which can create confusion and uncertainty for businesses. This can also make it difficult to measure and compare the environmental impact of different approaches.
- **Limited availability of sustainable materials:** Despite the growing demand for sustainable materials, there is still a limited supply of these materials in many markets. This can make it more difficult for businesses to source sustainable materials and adopt circularity technologies.
- **Cultural barriers:** Cultural attitudes towards waste and sustainability can vary across different regions and countries, which can make it more difficult to promote the adoption of green business and circularity technologies.
- **Resistance to change:** Resistance to change is a common challenge for any new technology or approach. Businesses may be resistant to change their existing practices or invest in new technologies, particularly if they perceive a risk to their bottom line.

Benefits

Green business and circularity technologies mutually support each other in promoting sustainable development. Through the implementation of sustainable production processes and the creation of eco-innovative products and services, companies can effectively minimize waste and preserve valuable resources, ultimately contributing to the advancement of circularity. On the other hand, by embracing circularity technologies, companies can improve their environmental performance and achieve cost savings, thus encouraging

- Reduction in the environmental impact of the businesses which in turn helps in addressing climate change, and protection of natural resources.
- Creation of more sustainable models that can help the businesses in accessing new markets and attract customers who prioritize sustainability.
- Promotion of social equity by providing access to sustainable products and services for all.
- Focus on innovation and creativity in order for businesses to look for new ways to improve their sustainability and competitiveness.
- Reduction in dependence on finite resources and promotion of sustainable practices.

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AIT towards Net Zero by 2030
A BOTANICAL GARDEN CAMPUS

The AIT campus has been described as one of the most verdant academic settings in Thailand, and South-East Asia more broadly. Its trademark is its lush, raw greenery enriched by exotic tropical flora and fauna that coexist harmoniously with the day-to-day intellectual pursuits of students, academics, and researchers from all around the world. To be truly sustainable campus, AIT aims to take the lead in practicing and promoting sustainability – by establishing an all encompassing botanical garden on its campus. This initiative builds on the previous campus plans, and it represents a significant leap forward toward making the entire AIT a fully-fledged botanical garden with a target to be Net Zero by 2030.

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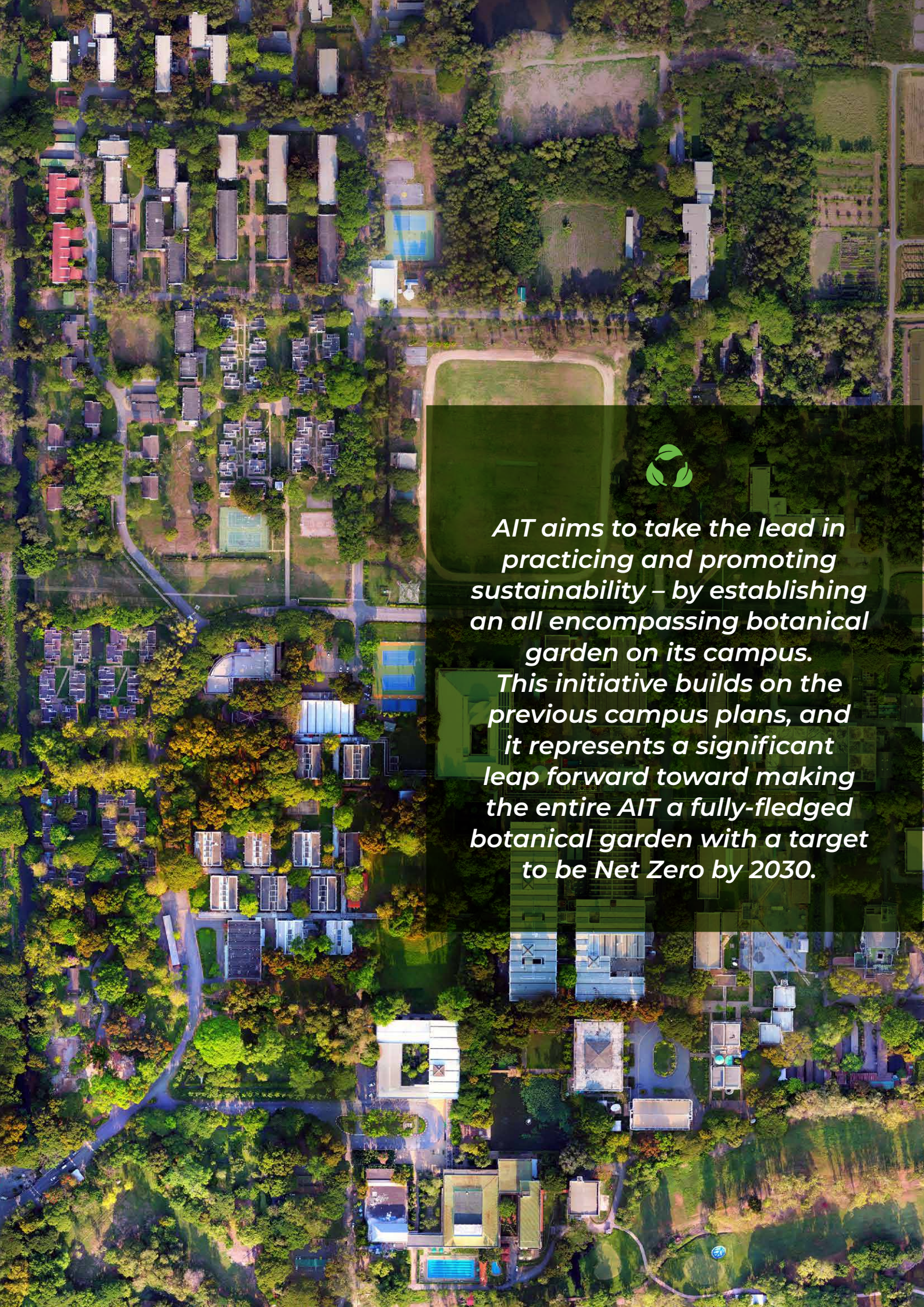

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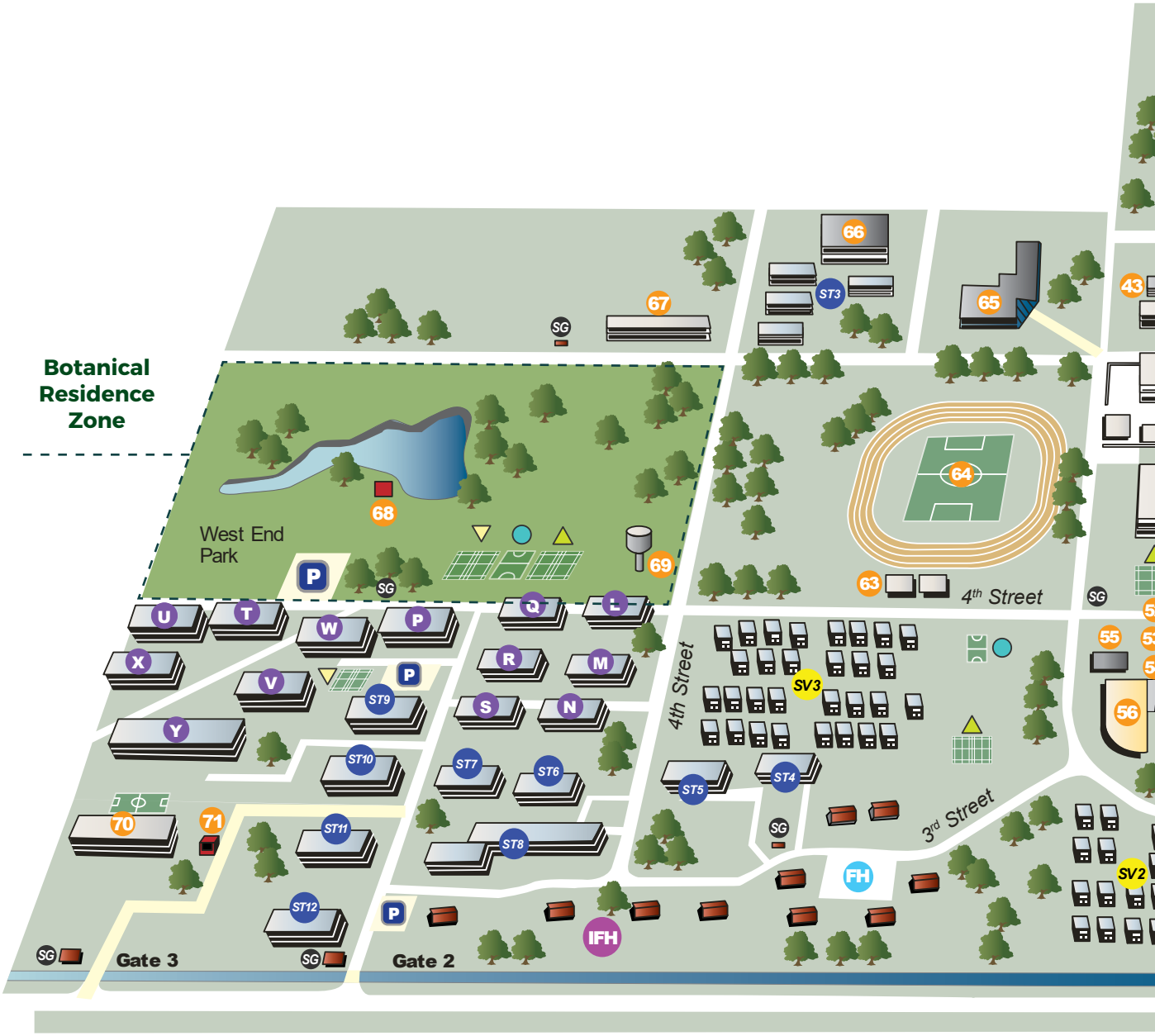

Academic and Reseach Buildings

25 Academic North Building
- ▷ School of Engineering and Technology (SET)

26 Academic South Building
- ▷ School of Environment, Resources and Development (SERD)

67 School of Management (SOM)
44 Agricultural Systems Engineering
70 AIT International School
43 Aqua Outreach
42 Aquaculture Laboratory
36 Biotechnology (BT)
65 Chalerm Prakiat Building
- ▷ Industrial Systems Engineering & Management (ISE)

29 Computer Science and Information Management (CSIM)
30 Distributed Education Center (DEC)
40 Entomology Laboratory
31 Energy (ET)
37 Environmental Research Station
41 Food Processing Laboratory
34 Geoinformatics Center
66 Habitech Park
60 Internet Education and Research Laboratory (intERLab)
47 Library
48 Language Center
32 Outreach Building
- ▷ AIT - UNEP RRC.AP
- ▷ Center of Excellence in Nanotechnology
- ▷ RIMES
- ▷ Télécoms Sans Frontières

35 Plant Nursery
39 Protected Cultivation Green Houses
33 Pulp and Paper Technology (PPT)
28 Telecommunications (TC)

Administration

12 Administration Building
- ▷ AIT Alumni Association
- ▷ Alumni Affairs Office
- ▷ Centre of Excellence on Sustainable Development in the context of Climate Change
- ▷ External Relations and Communications Office (ERCO)
- ▷ Fundraising Office
- ▷ Government Relations Unit (GRU)
- ▷ President's Office
- ▷ Registry Office
- ▷ The Wetlands Alliance

17 AIT Consulting
23 AIT Extension
- ▷ Milton E. Bender Jr. Audiorium
- ▷ Helpdesk

20 AIT Conference Center
- ▷ Asian Regional Center of Excellence in Millennium Development Goals (ARCMDG)
- ▷ CSR Asia at AIT
- ▷ UN AIT
- ▷ Yunus Center in AIT

49 Media and Communications Unit (MCU)
46 Sodexo
59 Student Union Office

Facilities

3, 55 108 Convenience Store
71 AITCS Kiosk
16 Arcade
51 Bicycle Repair Shop
15 Bookstore
56 Cafeteria
- ▷ SU Cafe'

45 Campus Mailing Office
50 Copying Service (S.Santi)
53 Copying Service (Thai Saguan)
58 Fitness Center
62 Grocery Shop
10 Hom Krun Coffee
54 Indy Cafe
4 Kasikorn Bank
5 Klong Luang Post Office
11 Klong Luang Post Office (AIT Branch)
2 Knowledge City Police Station
57 Korea House
61 Laundry Service
18 Medical Clinic
7 Queen Sirikit Arboretum Garden
24 SERD Kiosk
27 SET Coffee Shop

Housing
- Dorm
- Staff Houses
- Houses No. 1 - 8
- FH : Faculty Houses
- IFS : International Faculty and Staff Houses
- SV : Student Villages

- Badminton Court
- Basketball Court
- Tennis Court
- Volleyball Court
- SG : Security GuardHouse
- P Parking Area

Botanical Garden Campus Towards Net Zero will organize these numerous natural assets into an integrated and harmonized campus plan to achieve Net Zero Emissions and the Bio-CircularGreen (BCG) Economy. Put simply, Net Zero refers to reducing GHGs as much as possible. Our plan will be in-line with the BCG Economy direction of Thailand and the Asia-Pacific region through the implementation of two major activities to become a carbon neutral campus, where various types of ecosystems and biodiversity can be found, thereby providing a place for naturehuman harmonization in the center of one of Asia's most urbanized settings.

Three Key Principles underscore the vision to achieve Botanical Garden and Net Zero emissions: Connection to The Queen Sirikit Arboretum; Balance between Academia and Industry; and Open Access to the Public. The 130-hectare campus will include three distinct zones of specialized activities to be a carbon neutral campus. Academic and BOI Science and Technology Zone, Botanical Residence Zone and Botanical Public Space Zone will mutually reinforce each other to create a synergy of sustainable activities across the campus.

By leveraging its abundant natural biodiversity and capitalizing on its historical role as an international gateway to showcase technology and sustainability in higher education, Botanical Garden Campus Towards Net Zero is AIT's response to address the climate and biodiversity challenges of our time. Our campus can become a magnet to attract educationalist, researchers public and private sector partnerships, social enterprises, start-ups, responsible investment, carbon credits, and topclass prospective students and researchers. Botanical Garden Campus Towards Net Zero will be a prime example of a sustainable academic institution where people aspire to live, study and work carbon-free in the 21st century.

Urban Eco-innovation and Circular Economy: Plastic Recycling Innovation of Selected Cases in Thailand

The global call to action on sustainable development is a response to the existential threat to humanity caused by unsustainable human activities and lifestyle.

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Introduction

Due to rapid urbanization, cities experience limitations in resource consumption, waste generation, and environmental degradation. To address these challenges, the concepts of urban eco-innovation (EI) and circular economy (CE) have gained prominence. EI is an important driving force of high economic development while also ensuring ecological benefits through developing and implementing new innovation (Yang et al., 2022). CE is an economic system designed with the intention that maximum use is extracted from resources and minimum waste is generated for disposal. Both of these concepts share common ground by focusing on sustainability, resource efficiency and waste reduction. While EI applies

CE principles to address sustainability challenges, CE provides a framework that guides and supports EI efforts.

The article aims to illustrate the concepts of EI and CE and how these two concepts can be integrated in the planning process to achieve sustainability, by closing the loop. In addition, to understand the concepts and their applications, two case studies from Thailand are included, focusing on plastic recycling innovation of Pattaya City plastic waste management and Indorama Ventures Public Limited.

Concepts and Applications

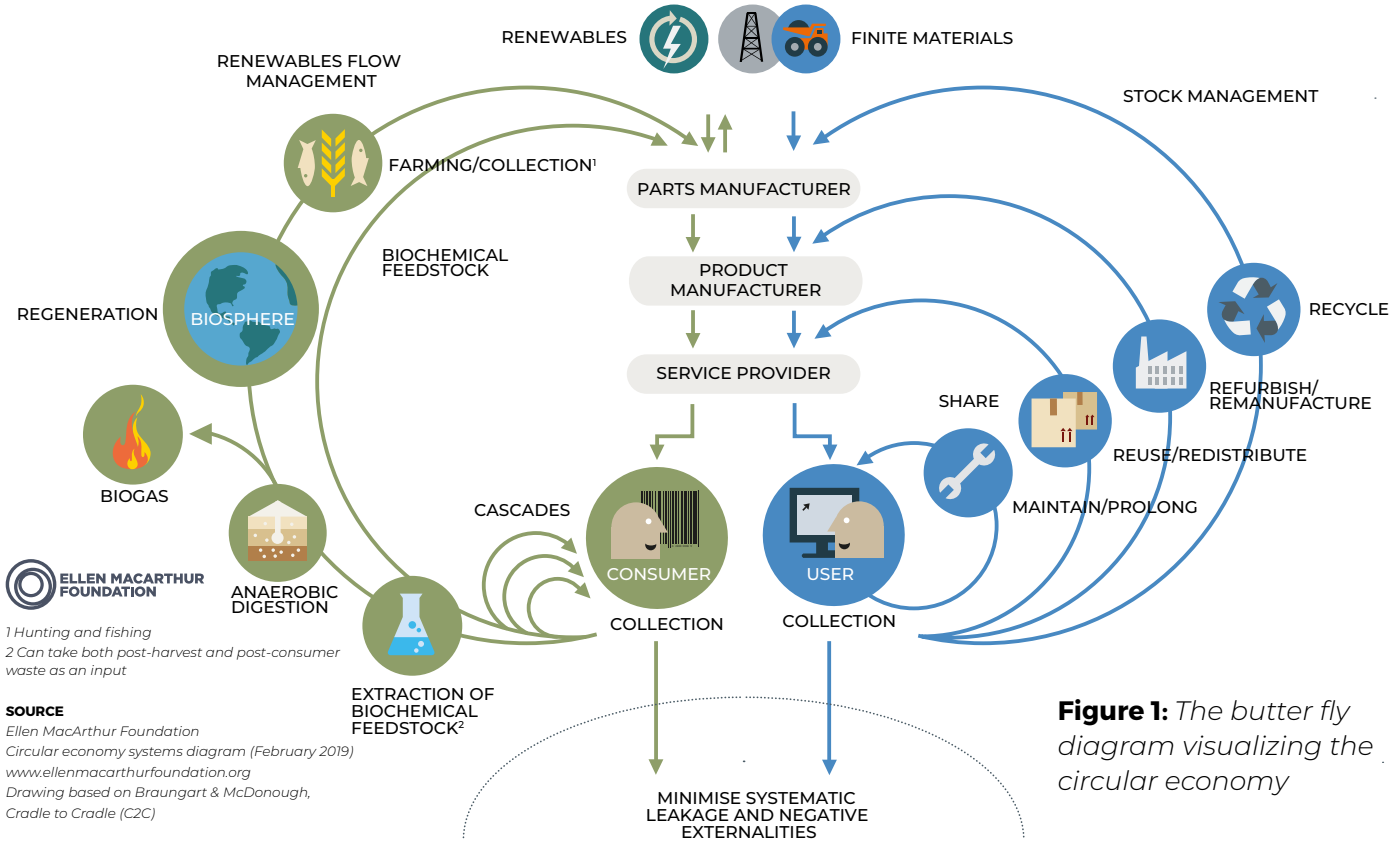
Eco-innovation

Fussler and James (den Hond, 1997) describe eco-innovation (EI) as the development of new products, processes, or services that offer value to both companies and consumers while significantly reducing harmful environmental impacts. It is worth noting that EIs yield environmental benefits, economic advantages and social well-being, (Reid & Miedzinski, 2008) and optimize use of natural resources (Sarkar, 2013).

By engaging in eco-innovative practices, companies establish a foundation for circular business models which drive pro-environmental changes in consumption patterns. Ultimately, this establishes a system where the economy, society, and the environment come together for sustainability (de Jesus & Mendonça, 2018; Kanda et al., 2021). This provides the small and medium – sized enterprises a competitive edge by enhancing operational efficiency, improving profitability throughout the value chain, and maintaining compliance with regulations and standards (UNEP, n.d.).

Circular Economy

The idea of CE is to move away from the traditional linear model, As shown in Figure 1, instead, CE aims to close the loop by reusing, repairing, recovering, and recycling materials to reduce waste



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input

SOURCE
Ellen MacArthur Foundation
Circular economy systems diagram (February 2019)
www.ellenmacarthurfoundation.org
Drawing based on Braungart & McDonough, Cradle to Cradle (C2C)

Figure 1: *The butter fly diagram visualizing the circular economy*

and maximize their value (Liu, 2012; Linder & Williander., 2015). The core principles of the CE can be summarized as the 3R principle: reduce, recycle, and reuse (Liu, 2012).

CE draws inspiration from various principles and approaches, such as industrial ecology, cradle to cradle theory, regenerative design, biomimicry, and the blue economy. These ideas help guide us towards a system that is restorative and regenerative, with a focus on resource efficiency.

By embracing the CE in micro context of the business models and the macro context of cities/countries, it is possible to make a more sustainable future where resources are used efficiently, and economic growth is balanced with environmental stewardship.

Applications of Circular Economy and Eco-innovation

EI and CE offer practical solutions to promote sustainable development and tackle environmental challenges. Here are some common applications:

1. Waste Management: Waste reduction, recycling, and resource recovery strategies; Innovative technologies such as waste-to-energy conversion, composting, and material recovery facilities for resource efficiency and waste reduction (Genovese et al, 2017).

2. Circular Built Environment: Designing buildings for longevity with recycled or renewable materials, and efficient energy and water management systems. Embracing

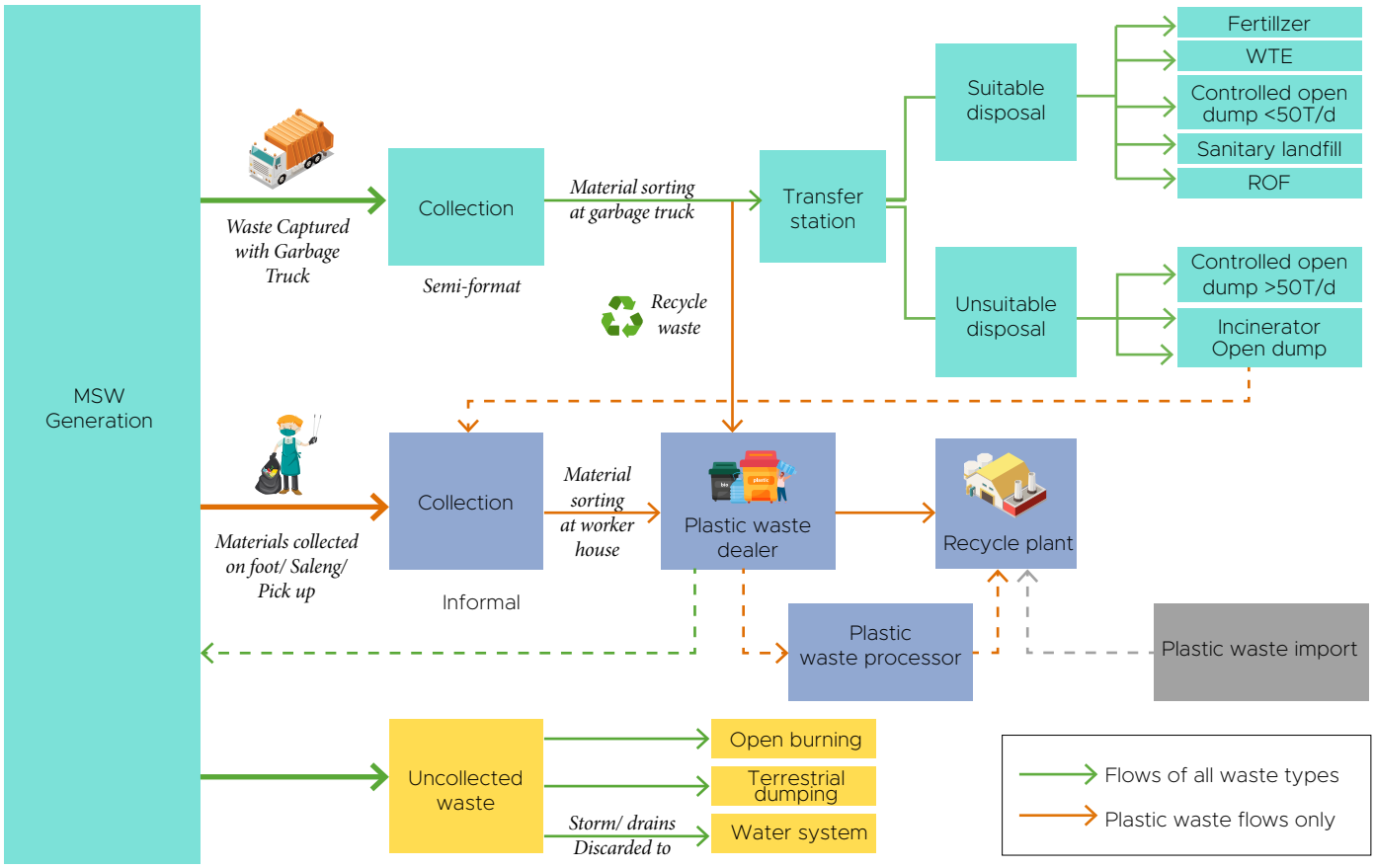


Figure 2: *Municipal solid waste and plastic waste flow of Pattaya City.*
Source: Own study based on field survey

Figure 3: *The plastic pellets production process. Source: Adapted from PCD (2021)*

CE principles in building renovation and retrofitting to minimize waste and optimize resource efficiency (Geng et al, 2012)

3. Sharing Economy: By promoting resource sharing, cities can reduce the demand for new products and optimize resource utilization. These models also foster community engagement and social cohesion (Tan & Ooi, 2017).

Case Studies

Circular Economy Approach in Plastic Waste Management of Pattaya City

With rapid urbanization and tourism, Pattaya City has generated a large number of plastic wastes. Therefore, the city is equipped with waste management facilities, including a landfill, incinerator, and composting facility. In terms of policies and regulations, the city has implemented a Waste Management Master Plan to improve the efficiency of waste management, increase public awareness, and reduce waste generation. The plan also promotes recycling and composting to reduce the use of single-use plastics.

As shown in Figure 2, mixed waste is transported to a transfer station for composing, landfilling, and waste energy plants where segregation occurs. Informal sector plays an important role in Pattaya City in CE as some waste flow is carried out by informal actors.

Informal waste collectors collect various plastic wastes from the landfill or transfer station and transfer to junkshops where plastic wastes are separated into types (e.g. PP, PE and PET). Then, they are packed in bulks and transferred to bigger recycling centers for grinding, melting and pelletizing for reuse in the economy either domestically or internationally, as shown in Figure 3.

Circular Eco-Innovation Solutions for Plastic Business of Indorama Ventures Public Company Limited

In the city, the informal sector works closely with the private sector in achieving circular economy despite the limited number of recycling centers and junk shops. However, these informal actors are poorly recognized by local government despite being an important actor in plastic recycling. Therefore, there is lack of support and guidelines for the informal sector; thus limited resources and health risks of the workers are some of the challenges the sector faces. On the other hand, this creates opportunities for the government to develop the guideline for the informal sector and plan a sustainable infrastructure development and innovative technology to attain objective of zero plastic waste.

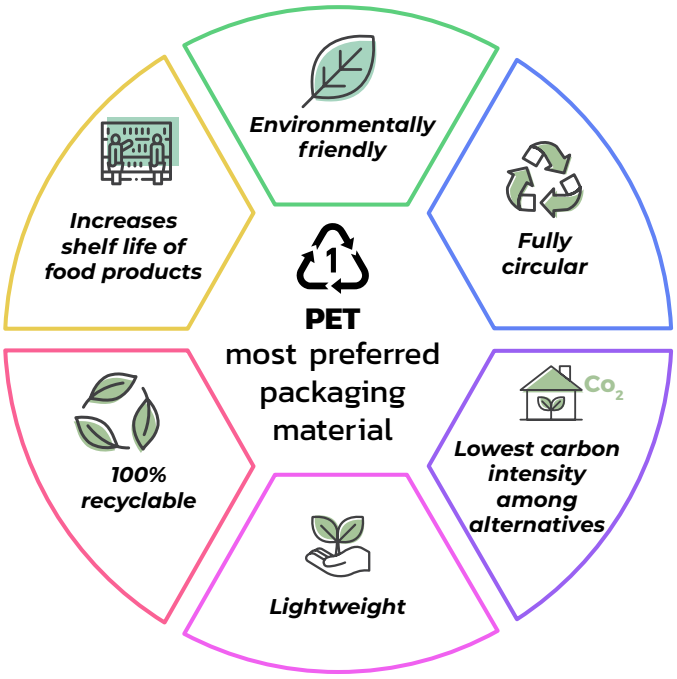


Figure 4: *Recycling of PET bottle. Source: IVL (2023)*

Post-consumer PET bale input per year	
0.75 million tons by 2025	1.5 million tons by 2030(a)
Post-consumer bottles recycled per year	
50 billion by 2025	100 billion by 2030(a)
Investment	
US$ 1.5 billion	(a) 3.13 million tons and 200 billion bottles per year

Recycling Facilities Worldwide Locations

IVL recycling operations in Asia and Europe (see Figure 5) help reduce the amount of PET waste sent to landfills. In Thailand, IVL is working closely with various key stakeholders particularly to persuade the Thai government to amend the current law prohibiting the use of recycled PET in the production of new food and beverage packaging.

This process illustrates the importance of recycling and circular economy for waste reduction. IVL recognizes that PET is the ticket to achieving "Zero Plastic Waste to Nature" due to its recyclability. In 2011, IVL began recycling PET bottles, producing clean PET flakes for use in fiber, sheet, and bottle applications. Since then, IVL has expanded its PET bottle recycling capacity in Mexico, the United States, and Thailand. They were also

among the first in the PET resin industry to incorporate recycled PET flake into virgin polymerization process, allowing to produce PET resin with up to 30% recycled content.

While plastic pollution imposes significant risk and ecological concern, it also represents a significant opportunity. IVL has been involved in PET recycling for many years, and it is constantly looking for ways to expand its recycled product offerings and grow the business. "PET - Recycling - The Renaissance to Reduce PET Plastic Waste Going to Nature and Preserve Natural Resources."

IVL Achievement

Recycling Education Program

IVL has also started a number of programs addressing environmental concerns such as educational initiatives and awareness programs of the 3R's. The initiative was launched in 2018 to raise awareness of the value of PET recycling. Additionally, IVL focuses on the general public and student audiences to meet its goal of having a good influence. To transfer knowledge and advantages to communities around the world, they have expanded their collaborations with various institutions.

Figure 5: *IVL Global Companies, Source: IVL (2023)*

The circular EI solutions in Indorama, as also depicted in Figure 6, include.

- IVL products are designed to be lightweight, high performance, and inclusion of sustainable and recycled materials which can be easily managed at the end of life.
- IVL operations aim to reduce GHG emissions with alternative raw materials and renewable energy for reduced resources consumption.
- IVL improving Logistics Management / GHG Scope 3 Accounting

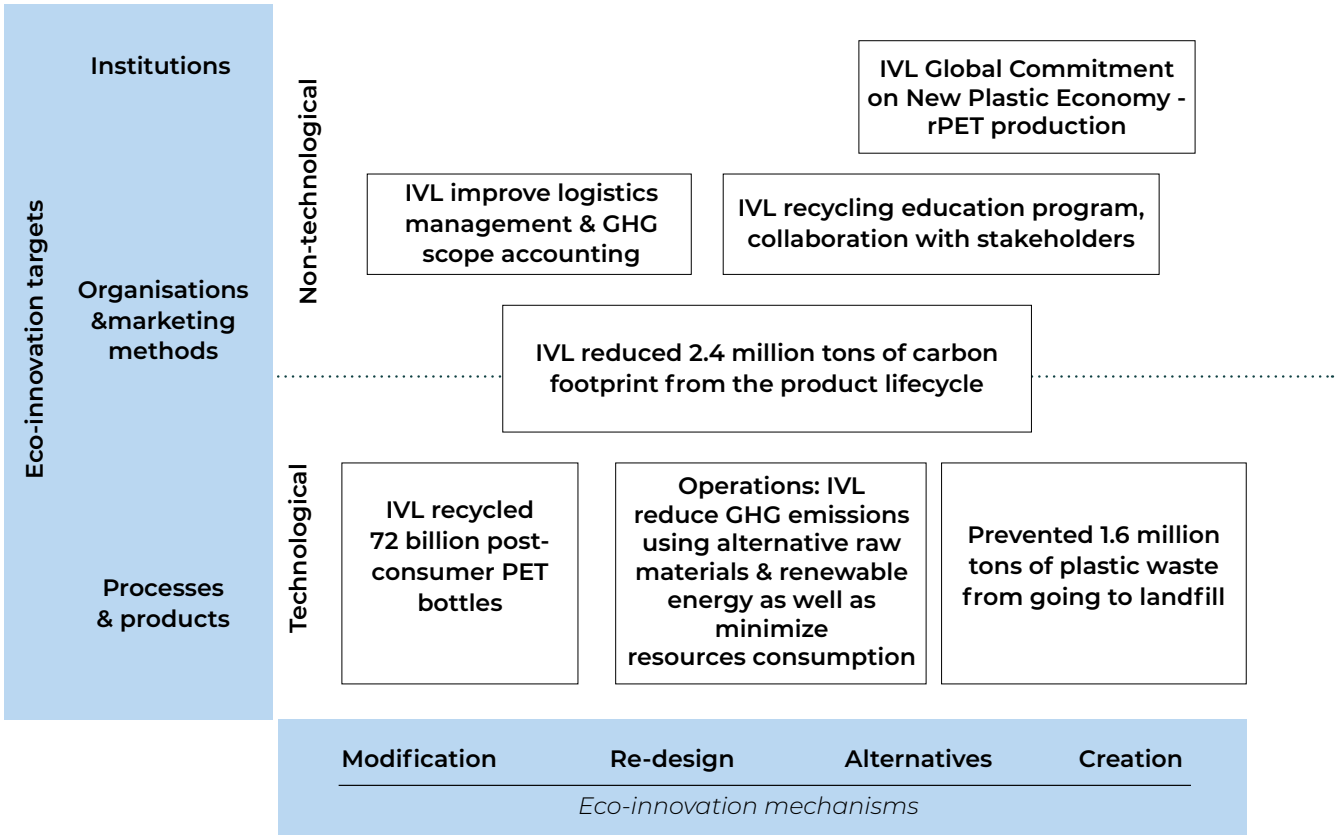


Figure 6: *Circular Eco-Innovation Solutions in Indorama. Source: Own analysis based on available data from IVL using OECD model*

- IVL advocating for Changes in Laws and Regulations by providing and promoting waste management and demand for rPET.
- IVL collaborating with Stakeholders for Recycling Education Awareness
- IVL recycling is the heart of a Sustainable and Future Global Economy

Conclusions and Ways Forward

Urban EI and CE concepts offer promising solutions for addressing the environmental challenges faced by cities. Integrating these principles, cities can transition towards sustainable and resilient cities. However, achieving widespread implementation requires collaborative efforts from various key stakeholders. As evident in the case of Pattaya city, informal sector and private recycling sector worked together well to fill the gap in plastic recycling. However, there is a lack of recognition and support from the local government which challenge the informal actors to expand their business in a safe and efficient way. Thus, governments also play a role to provide supportive policy frameworks and incentives for CI and CE practices. Businesses also should embrace sustainable business models and invest in research and development

for eco-innovative solutions. The case of Indorama illustrates the achievement of adopting the CE concept integrated with EI, focusing on the innovative technology for the PET recycling. However, there is an untapped market for other types of plastic where new business ventures should explore with better technology. In conclusion, urban EI and CE offer a pathway to transform cities into sustainable and resource-efficient urban ecosystems.

The way forward lies in fostering collaboration, innovation, and a shared commitment towards achieving sustainability. Further efforts should focus on sustainable technologies, materials and business models that can drive innovation and transition to a CE. Academic research should prioritize in areas such as renewable energy, waste management, sustainable agriculture and resource-efficient technologies. Governments need to promote policy and regulatory framework that support EI and CE such as extended producer responsibility, waste management regulations, eco-design standards, and green logistics. In addition, financial support and investment should be provided to new opportunities for EI and CE initiatives; i.e., grants, subsidies, and low-interest loans for sustainable projects.

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Bio-Circular-Green Economy Model: Thailand's Response for Inclusive and Sustainable Growth

The global call to action on sustainable development is a response to the existential threat to humanity caused by unsustainable human activities and lifestyle.

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Call to Action

It is a societal imperative to have a clear understanding of what sustainability is about and the transformation required in the development and knowledge sectors. In this regard, the circularity model, which is the circular flow and efficient use and reuse of resources, materials and products, which has many environmental, climate, social and economic benefits, is gaining attention, and as countries continue to experience economic and population growth, the problems of waste and resources entering soil, rivers and oceans that cause damage to environments and biota, can only magnify.

New Economic Model for Thailand

The Bio-Circular-Green Economy (BCG) model has been conceptualized to underpin Thailand 4.0 for inclusive and sustainable growth. It is an integration of bio-economy, circular economy and green economy. Bio-economy is the production of renewable biological resources and the conversion of these resources into value-added products. Circular economy aims at reusing and recycling resources. Green economy aims to keep economy, society and environment in balance, leading to sustainable development. The BCG model represents a strategy to drive the country's economic and social development and is expected to provide further impetus for implementation of the Sustainable Development Goals (SDGs). Thailand has demonstrated an active role on the BCG model implementation by raising it as an agendum at the 2022 Asia-Pacific Economic Cooperation (APEC) Ministerial Meeting chaired by Thailand.

The discussions delved into how the BCG model relates to each sector and shared various initiatives demonstrating actual and potential applications of BCG in Thailand.

The Royal Thai Government promotes the BCG model to the private sector, government officials and all relevant stakeholders. The National Research Council of Thailand supported Mahidol University, in collaboration with the United Nations Resident Coordinator's Office (UN Thailand), National Science and Technology Development Agency, Office of the National Economic and Social Development Council, Ministry of Foreign Affairs, and the Asian Institute of Technology to deliver a seminar series in 2022 on 'Thailand's Bio-Circular-Green Economy Model: Awareness Raising, Capacity Building and International Perspectives' covering four priority sectors: (i) BCG and the food and agriculture sector; (ii) BCG and the health and wellbeing sector; (iii) BCG and the bioenergy, biomaterial and biochemical sector; and (iv) BCG and the tourism and creative economy sector. The discussions delved into how the BCG model relates to each sector and shared various initiatives demonstrating actual and potential applications of BCG in Thailand. These events were followed by a national conference which shared the findings of the seminars and identified priority actions and opportunities for future application of the BCG model in Thailand and regionally in light of five areas – Governance, Human Resource, Science & Technology and Research & Innovation, Partnership and Collaboration, and Finance and Investment.

Governance

Since the Thai Cabinet included the BCG model in its national development agenda, the government aims at achieving three dimensions in growth, namely inclusiveness, balance and sustainability. To ensure success in implementation, all related sectors should work together, avoid working in silos by strengthening communication and cooperation across sectors. Policies that promote enhancement and dissemination of information available would be a good way to advance BCG implementation. Promotion of community-based services and development of civil society organizations could facilitate inclusive approach, especially in a country where the governance system is based on sectoral infrastructure. BCG implementation needs to be inclusive, to have no one left behind, and to link the UN Women guiding principles with the SDGs as well as on the gender responsiveness in circular economy and sustainable consumption and production and opportunities for women. The BCG model should be implemented through a whole-society approach and policymakers should establish BCG roundtables to serve as networking platforms for knowledge exchange and innovation.

Human Resource

BCG model implementation in Thailand faces challenges since the concept, by and large, is not yet well understood. There is lack of awareness across-the-board including within the small-and-medium enterprise (SME) sector. There are opportunities though to advance the BCG concept by connecting people, creating networks, and sharing good examples of BCG practices from around the world. There is a need for looking at how the BCG model empowers people, bringing the concept into reality. Raising awareness, building capacities and learning international perspectives on the BCG model at local, national, regional and global forums are essential in building infrastructure for BCG transformation.

Science & Technology and Research & Innovation

BCG transformation requires investments in green technological innovation, resource efficiency, sustainable production technology, and logistical infrastructure throughout the supply chain. These need to be stepped up through science, technology, research and innovation. Technological innovations from the academia and research institutions should be disseminated to private sector actors. Policy intervention from the government and sharing local frontier technology by international organizations are important. Raising awareness and encouraging more private sector personnel and individuals to participate would benefit the transformation for achieving the SDGs. Benefits from problem-oriented research from academia should be delivered to communities. Empowering people and enhancing information availability on science & technology, research & innovation are important in evidence-based policymaking. Technological innovations plus novel knowledge creation from academia and research institutions should be carefully selected and encouraged.

The process of BCG implementation would entail building capacities of human resources to be conversant and skillful of the BCG methodology and practice.

Partnership and Collaboration

Government agencies ought to work together with the communities to advance the BCG concept. In this regard, it is important to promote the 5P (Public-Private-Professional-People-Partnership) approach. Industry should partner with the various stakeholders to participate in pilot projects, explore new investments in BCG, mainstream BCG policies into company policies, and establish companywide commitments to BCG internally and externally. Strong partnerships between the academic and scientific community, business sector, government sector, civil society, international organizations, and a diversity of stakeholders are necessary to achieve the SDGs. As for international organizations, global knowledge and experience sharing should be a priority. The role of the UN through its various agencies as well as other international organizations are essential in upscaling pilot projects through sharing of best practices and policies. The need for interaction among sectors could benefit from support and facilitation of international organizations particularly in terms of sharing knowledge and in amplifying local technology.

Finance and Investment

Investment in research and innovation is, by far, rather low in Thailand. There needs a holistic approach and effective policy intervention to develop research & development and innovation. The process of BCG implementation would entail building capacities of human resources to be conversant and skillful of the BCG methodology and practice. This would require investments in science, technology, research, and innovation.

Moving Forward

Effective implementation of the BCG model hinges on multiple pillars - Governance, Human Resource, Science & Technology and Research & Innovation, Partnership and Collaboration, and Finance and Investment – and these need to be strengthened as Thailand transitions to BCG. The issues are similar across sectors. Hence, it would be feasible to adopt coherent BCG policies across all levels and sectors.

Performance-based Seismic Design

We provide PBD services to ensure the safety and performance of structures during earthquakes. We use advanced analytical methods to evaluate the design and achieve specific performance objectives, such as limiting damage or ensuring the safety of occupants. Over 150 buildings have been designed by our in-house experts in a span of 10 years.

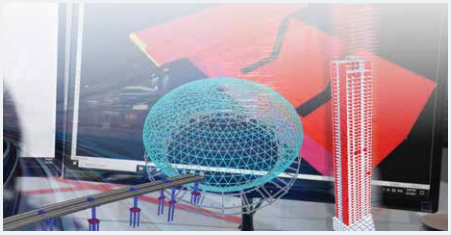
Wind Tunnel Testing

We provide wind tunnel testing services to evaluate the effects of wind on buildings and structures. Our testing is conducted in a controlled environment using an atmospheric boundary layer wind tunnel, with a working section of 2.5m x 2.5m x 23m. This service is essential for high-rise buildings, cable stayed and suspension bridges.

Structural Health Monitoring

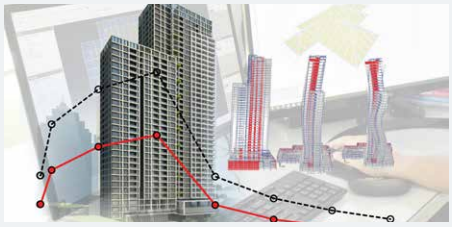
We offer this advanced analysis technique to ensure the safety and reliability of buildings and structures. Our expert team uses this technique to monitor the health of instrumented structures and assess their safety and reliability. This monitoring can detect damage, particularly after an earthquake, and the results can be shared with building managers, developers, engineers, and occupants for their peace of mind.

Computational Modeling and Analysis of Complex Structural Systems



Our expert team uses advanced techniques to develop and analyze complex structural systems, ensuring their safety and reliability. This service involves the use of state-of-the-art software and modeling techniques to simulate various scenarios and assess the performance of structural systems under different conditions.

Structural System Development and Code-based Design Review

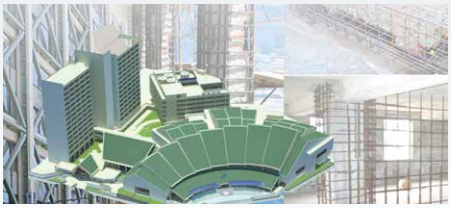


We understand that the safety and efficiency of a structure depend on its design. That's why we offer Structural System Development and Code-based Design Review services to ensure that our clients' structures are designed to meet their specific needs while being safe and compliant with local codes and regulations.

Software Development & IT

We specialize in software development and IT services, creating customized desktop, web, mobile, and cloud-based applications to meet the unique needs of our partners and clients in various fields, including structural engineering, mobile computing, knowledge products, construction monitoring and management, travel and leisure, and smart living. With our expertise in software development and IT services, we help businesses optimize their processes and enhance their productivity.

Structural Failure Investigations and Retrofit Design



Our expert team investigates and evaluates the causes of structural failures and develops retrofit designs to enhance the safety and reliability of existing structures. This service involves a thorough investigation of the structural system, including site inspection, testing, and analysis to determine the cause of the failure. Based on the findings, we develop retrofit designs to improve the performance of the structure, ensuring its safety and reliability.

GREEN STARTUP TOOLKIT: EMPOWERING SUSTAINABLE ENTREPRENEURS

Bringing the Sustainable Development Goals to Life

The Sustainable Development Goals (SDGs) provide a comprehensive framework for addressing global challenges and creating a better future for all.

In today's rapidly changing world, the need for sustainable solutions has never been more critical. The Sustainable Development Goals (SDGs) provide a comprehensive framework for addressing global challenges and creating a better future for all. Adopted by all United Nations Member States in 2015, these 17 interlinked goals aim to eradicate poverty, protect the planet, and foster peace and prosperity by 2030.

Among the SDGs, one goal stands out as particularly crucial for individuals and companies alike: SDG

Contributor
AIT Entrepreneurship Center Team

12 - Responsible Consumption and Production. As a linchpin connecting various other goals, it underscores the importance of sustainable consumption and production (SCP) in achieving global sustainable development.

Sustainable consumption and production go hand in hand with poverty eradication, natural resource management, and economic and social development. To build a sustainable future, fundamental changes are necessary in the way societies produce and consume goods and services. By embracing responsible practices, we can make a significant impact on the planet while fostering economic growth and societal well-being.

At the core of the Green Startup Toolkit lies the concept of Sustainable Consumption and Production (SCP).

With the world's population projected to reach 8.5 billion by 2030, the choices we make as individuals and communities will have far-reaching consequences. From our dietary habits to transportation choices, from housing to leisure activities, we must reimagine our consumption patterns to ensure a thriving planet for generations to come.

Alarming statistics reveal the urgency of this mission. Over the past four decades, global resource extraction has tripled, surpassing a staggering 70 billion tonnes in 2010 (UNEP). At the current rate, humanity will require the resources equivalent to two Earths to sustain itself by 2030. These figures highlight the need for innovative startups and initiatives that prioritize environmental, social, economic, and governance aspects of sustainable consumption and production.

Introducing the Green Startup Toolkit

In response to this pressing need, the Green Startup Toolkit has emerged as a comprehensive guide for environmentally-conscious startups and aspiring eco-entrepreneurs. This toolkit equips individuals with the knowledge, resources, and strategies to develop sustainable solutions and foster positive change. Whether you have a groundbreaking idea or a burning desire to make a difference, the Green Startup Toolkit will empower you to navigate the challenges and opportunities of the sustainability landscape.

A collaboration project between United Nations Environment Programme (UNEP), the Asian Institute of Technology (AIT) through Entrepreneurship Center, and startup founders, the Green Startup Toolkit is a comprehensive resource designed to support founders and their startups at every stage of development, empowering them to create sustainable businesses that contribute to the achievement of the Sustainable Development Goals (SDGs).

Understanding Sustainable Consumption and Production

At the core of the Green Startup Toolkit lies the concept of Sustainable Consumption and Production (SCP). We delve into the values and principles that underpin SCP, emphasizing its crucial role in building a more sustainable future. By exploring the requirements and opportunities of starting green businesses, we lay the foundation for eco-entrepreneurs to make a meaningful impact.

From Idea Generation to Acceleration: A Step-by-Step Approach

To guide aspiring green entrepreneurs on their journey, the Green Startup Toolkit presents a structured framework encompassing six key phases of the green startup implementation process:

6 Accelerate:
Propel your green startup to new heights through acceleration. Discover how to optimize operations, leverage emerging technologies, and seize opportunities for increased impact and market penetration.

5 Scaling up:
Unlock strategies for scaling your green startup while maintaining your sustainability goals. Explore avenues for growth, such as strategic partnerships, market expansion, and innovative funding models.

4 Pitching:
Master the art of pitching your green startup effectively. Learn how to craft a compelling story, communicate your vision, and attract investors and partners who share your commitment to sustainability.

3 Incubation:
Navigate the critical phase of incubating your green startup. Gain insights into establishing a supportive ecosystem, accessing mentorship, networking, and leveraging incubation programs to refine your business model and strategy.

2 Sustainable Business Model Canvas:
Dive into the Sustainable Business Model Canvas, a powerful tool for mapping out the essential elements of a green business. Explore key components such as value proposition, customer segments, revenue streams, and environmental impact.

1 Idea Generation:
Discover how to spark innovative ideas that address sustainability challenges. Learn techniques for identifying market gaps, analyzing trends, and conceptualizing environmentally conscious solutions.

Equipping Green Startups with Essential Business Tools

In addition to the step-by-step implementation process, the Green Startup Toolkit provides a wealth of essential business tools to support eco-entrepreneurs on their journey. From market research templates and financial planning guides to sustainability impact assessment frameworks and stakeholder engagement strategies, these resources are carefully curated to enable startups to thrive in the sustainability space.

Join the Green Startup Movement Today!

You are welcome to join the growing community of environmentally-conscious entrepreneurs who are reshaping industries, driving innovation, and creating a better future for all. Embrace the power of sustainable entrepreneurship, harness your ideas, and make a positive impact on the world. Together, let's build a greener and more prosperous tomorrow.

Note: *The Green Startup Toolkit is a dynamic resource that will continue to evolve, incorporating the latest insights and best practices from the sustainable entrepreneurship ecosystem.*

For feedback and comments
✉ ***ec@ait.ac.th***

For more info about the toolkit, visit:
🌐 ***http://ec.ait.ac.th/toolkit/***

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