# JURUTERA

The Monthly Bulletin of The Institution of Engineers, Malaysia

IEM
The Institution of Engineers, Malaysia

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# SOLID WASTE MANAGEMENT AND CIRCULAR ECONOMY

## Engineering a Sustainable Future for Malaysia

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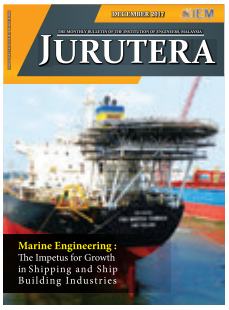





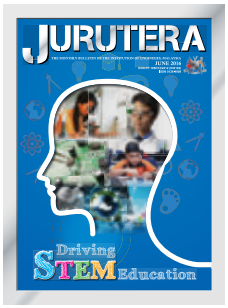


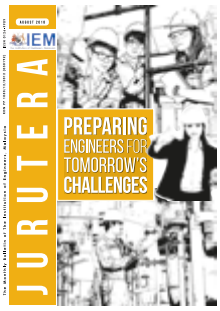


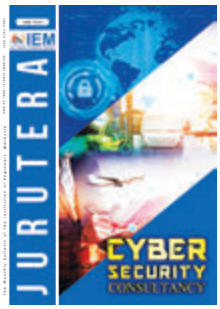


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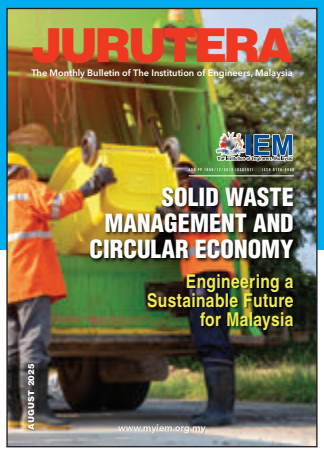


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# COVER *Note*

**by Ir. Ts. Jaya Chandar Poloha Nadan**
*Chairman, Environmental Engineering Technical Division (ENETD)*

## Engineering Waste Solutions

We are proud to present you the August 2025 edition of *JURUTERA*, with a theme that is both urgent and enduring: Solid Waste Management and Circular Economy.

In today's rapidly urbanising and consumer-driven society, the issue of solid waste is no longer confined to landfills or municipal responsibility. It has evolved into a complex engineering, social, and environmental challenge that calls for innovation, policy integration, and public engagement.

Over the years, solid waste management in Malaysia has seen positive developments such as enhanced regulatory frameworks, increased recycling awareness, and the rise of waste-to-energy initiatives. Nevertheless, persistent challenges remain in areas such as infrastructure development, enforcement mechanisms, and community involvement. Engineers have a key role in designing efficient systems, optimising resource recovery, and advocating for circular economy principles.

We hope to showcase the role engineers play in driving sustainable solutions with insightful articles, project spotlights, technical perspectives and interviews to provide a comprehensive look at the current state and future of Solid Waste Management and Circular Economy in Malaysia.

I would like to thank contributors, authors, editors, and reviewers for helping to make this publication a success. ■

# EDITOR'S *Note*

**by Ir. Ts. Wan Rizaluddin Abdullah Wan Ali**
*Principal Bulletin Editor*

## Sustainable Solutions for Solid Waste Management

Engineers stand at the forefront of solving one of humanity's most pressing challenges – solid waste management. Global waste generation is projected to double by 2050, so the need to find solutions has never been more urgent.

This month, we see how engineers are transforming trash into valuable resources with recycling technologies, waste-to-energy systems, circular economy principles and smart collection systems.

Read about real world case studies where data-driven designs, automation, and policy integration turn waste management into opportunities for sustainability and urban resilience. This issue emphasises the role of engineers as change agents, bridging the gap between technical solutions, regulatory frameworks, and public engagement.

Solid waste is no longer just an environmental issue; it is a platform for innovation, collaboration, and impact. Let us engineer solutions that don't just manage waste but also eliminate it at its source. ■

# National Solid Waste Management Reformation:

# Engineering a Sustainable Future for Malaysia

The growing urgency of solid waste management in Malaysia has prompted a full-scale national reformation, anchored in sustainability, modernisation, and technological innovation. Dato' Ir. Ts. Gs. Dr. Mohd Azhar Abd Hamid, the Director General of the Department of National Solid Waste Management, Ministry of Housing and Local Government (KPKT), tells us why reformation is urgent.

Engineering a cleaner tomorrow has now become more urgent for Malaysia due to rapid urbanisation and economic growth. One of the key approaches to take is to reform the national solid waste management system. The numbers alone are alarming. In 2024, Malaysia generated 14.5 million tonnes of solid waste, a figure projected to balloon to 17.03 million tonnes annually in the coming years.

**"Of Malaysia's 135 landfill site, only 23 are currently sanitary"** - page 10

"This reformation is no longer optional," says Dato' Azhar. "We are addressing not just a local issue, but a critical national agenda that intersects with health, sustainability, and economic resilience."

Malaysia's strategy revolves around four core objectives:

- Managing the increasing generation of solid waste annually using modern, sustainable, affordable, and proven technologies
- Standardising the quality and standards of solid waste and public cleansing management services through the enforcement of the Solid Waste and Public Cleansing Management Act (Act 672) nationwide
- Transforming the current linear solid waste management system into a circular economy-based approach in line with the Government's aspirations under the 12th Plan (RMKe-12) and
- Safely closing all open dumping sites and replacing them with more environmentally friendly facilities.

The Malaysian Solid Waste & Public Cleansing Management Act, 2007 (Act 672) spells out regulations and guidelines for the management of controlled solid waste and public cleansing in Malaysia. Its key objectives are to ensure adequate sanitation and to address related and necessary matters relating to solid waste and public cleansing. The Act grants executive authority to the Federal Government, giving the Director General the duty of implementation and requiring its approval for solid waste and public cleansing works and services including prescribed solid waste management facilities.

According to the Act, obtaining a licence is mandatory to provide solid waste or public cleansing management services. Licence holders are required to comply with the specified conditions. Violations of the Act, such as improper handling of controlled solid waste or damage to facilities, can result in fines, imprisonment, or both.

The Act also promotes reducing, reusing, and recycling of controlled solid waste. However, the Act has faced major challenges affecting its successful implementation.

## Challenges & Opportunities: Confronting the Solid Waste Crisis

The key drivers behind this reformation stem from persistent and escalating challenges:

- The high volume of daily waste generation.
- Rising costs of public waste services.
- Overcapacity across the country's 135 landfill sites.
- Slow adoption of technologies like AI and Waste-to-Energy (WtE).
- Low public participation in waste separation and recycling. Public awareness and participation in Reduce, Reuse, Recycle (3R) programmes and source segregation remain weak.

Nevertheless, the Department of National Solid Waste Management believes that these challenges can be effectively addressed through stronger collaboration between key stakeholders and the public, guided by the circular economy strategy based on the 9R principles which are Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, and Recycle.

This strategy builds upon and adds value to the existing 3R approach (Reduce, Reuse, Recycle), and is expected to drive a new direction for the circular economy across the entire solid waste management value chain in Malaysia. It is also in line with the new policy direction outlined in the Circular Economy Blueprint for Solid Waste Management in Malaysia (2025-2035).


*Front cover of RMK12*

According to Dato' Azhar, "we cannot depend on landfills forever. Their expansion comes at the cost of our environment. Modernising our disposal system is vital for our future".

## Strategic Roadmap: Engineering for Short-, Mid-, and Long-Term Impact

To achieve Malaysia's solid waste vision, Dato' Azhar says the government has outlined a three-tiered strategy.

**Short-Term Goals (0-5 years):**

- Upgrade and safely close unsanitary landfills.
- Increase the number of transfer stations to connect waste-producing zones with processing facilities.
- Build Waste-to-Energy (WtE) plants to reduce waste volumes and generate clean energy.
- Boost public engagement through educational campaigns.

**Mid-Term Objectives (5–10 years):**

- Expand the enforcement of Act 672 across all states and federal territories.

**Long-Term Vision (10+ years):**

- Enact a comprehensive circular economy law.
- The implementation of Extended Producer Responsibility (EPR) as key initiative to ensure that producers are held accountable for the entire life-cycle of their products, from production stage through to post-consumer use. This approach aligns with the 12th Malaysia Plan, the National Cleanliness Policy, the Circular Economy Blueprint for Solid Waste, and the decisions made during the National Circular Economy Council (NCEC).

"These strategies are aligned with global best practices and are tailored to our local landscape. There's no time to waste in driving sustainable progress," adds Dato' Azhar.

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*Dato' Ir. Ts. Gs. Dr. Mohd Azhar Abd Hamid*

## The Public: From Passive Bystanders to Active Stakeholders

Public co-operation is paramount. Reformation efforts cannot succeed without changing behaviour at household levels. Dato' Azhar urges Malaysians to:

- Discard the 'Not In My Backyard' (NIMBY) mindset
- Practise separation of solid waste at source
- Cut back on single-use plastics
- Expand the 3R concept to the 9R circular economy strategy.

"The public's involvement will determine the success of this transformation," he asserts. "We need the people to realise that solid waste is not just garbage — it's a resource waiting to be recovered."

## Closing the Landfill Chapter: Transition to Sanitary and Sustainable Systems

Of Malaysia's 135 landfill sites, only 23 are currently sanitary. The reformation plan proposes an overhaul:

- Reducing landfill sites in Peninsular Malaysia from 67 to 24 by 2050.
- Establishing 18 WtE facilities to treat waste thermally and to feed energy to the grid.
- Converting closed landfill sites into public parks or solar farms.

"These new facilities won't be traditional landfills," says Dato' Azhar. "They will be part of a modern solid waste management ecosystem."

## Transition to WtE: Harnessing Energy from Solid Waste

Under the National Cleanliness Policy Action Plan 4.1.6, Malaysia plans to construct 18 WtE plants which are expected to generate 600 MW of renewable energy, reduce carbon emissions by 45%, and incorporate new technologies alongside thermal methods.

Dato' Azhar says: "WtE will not only help us manage solid waste more efficiently, but will also support our renewable energy goals and climate commitments ensuring that there is no waste to waste."

## Legal & Regulatory Support: Building a Solid Foundation

Legislative tools and policies have also been sharpened to steer this transformation towards a modern eco-system. Key frameworks include:

1. **National Cleanliness Policy (NCP)**

Structured across five clusters and 91 action plans, DKN guides state and local authorities in improving waste management service quality and cleanliness level.

2. **Expansion of Solid Waste & Public Cleansing Management Act, 2007 (Act 672)**

This federal law covers solid waste collection, waste bin provision, cleansing, concession management, KPI monitoring, and enforcement. KPKT is responsible for solid waste collection, supply of waste bins, public cleansing, implementation by government-appointed concession companies, quality monitoring of services via Key Performance Index (KPI) by the Federal Statutory Body, planning and execution of solid waste management facilities and enforcement of laws under Act 672.

The Act is currently implemented in seven states (Johor, Melaka, Negeri Sembilan, Pahang, Kedah, Perlis) and two federal territories (Kuala Lumpur & Putrajaya).

"We encourage states not yet under Act 672 to do so in near future to ensure the success of this reformation," says Dato' Azhar.

3. **Circular Economy Blueprint for Solid Waste**

This blueprint advocates for cradle-to-cradle waste cycles and supports the MADANI vision of balanced, sustainable development. MADANI is a policy framework and the current government slogan aimed at building a more inclusive, participatory, and just civil society by emphasising values such as sustainability, well-being, creativity, respect, confidence, and courtesy. Setting a vision for Malaysia to achieve a circular economy transformation in solid waste management by 2050, maximises resource efficiency and minimises waste generation, while

simultaneously promoting economic growth, social well-being, and environmental sustainability.

4. **Communication, Education, and Public Awareness (CEPA) Programmes**

KPKT also strengthens efforts, key to long-term behavioural change. CEPA strategy is a tool to move towards understanding and adopting sustainable use of natural resources. It is aimed at raising the level of environmental awareness, knowledge and skills among the people through a range of education and training activities focused at supporting community action and behavioural change.

## Technology as a Catalyst: From AI to Drones

Innovation is a major lever in the reformation agenda. Dato' Azhar says: "We are not just modernising infrastructure, we're digitising operations."

Among key technologies for operational digitalisation are:

- **AI (Artificial Intelligence):** Used for data analysis, real-time monitoring, and decision-making at transfer stations.
- **IoT (Internet of Things):** Enabling smart bin systems and predictive waste tracking.
- **Drones:** Deployed for enforcement and environmental monitoring.

At the Kuala Lumpur 2 Solid Waste Transfer Station (TSKL2), AI manages traffic flow and vehicle registration, streamlining operations and reducing human error.

## Public-Private Synergy: Partnership for Progress

Malaysia's solid waste reform recognises that innovation often comes from outside the government. The Private Finance Initiative (PFI) is being promoted to introduce efficient technologies, to reduce dependency on public funds and to foster sustainable public-private partnerships.

"We invite private sector players to propose and co-develop modern facilities," says Dato' Azhar. Private sector participation is encouraged to introduce innovative solid waste management technologies to the government, while the PFI concept will be applied to ensure smooth services are delivered to the public through strategic public-private partnerships.

*Paya Kamunting Landfill Site, Kubang Pasu, Kedah has been safely closed*

## CEPA Mission: Changing Public Mindsets

Educating Malaysians on the value of waste is central to the reformation. Notable initiatives include:

- Drive-Through Recycling Centres (DTRC).
- Recycling facilities in residential and institutional zones.
- Community-based Zero Waste projects at PPRs (public housing).
- Waste to Wealth Innovation (WAWI) competitions.
- School Recycling Competition (PerKISS).
- The No Single-Use Plastic Bag campaign launched with the retail industry in 2024.

"These programmes are more than just creating awareness; they are culture builders," Dato' Azhar says.

## Environmental & Economic Rewards

Sustainability is not just about environmental preservation. It has real economic dividends in terms of environmental gains and economic benefits.

**Environmental Gains:**

Environmental gains expected from this reform are:

- No more polluting of rivers due to leachate discharge from solid waste facilities below stipulated standards set by relevant authority.
- Greenhouse Gas (GHG) emission from the solid waste sector is expected to reduce significantly and will help Malaysia achieve its commitments made in the Paris Agreement. Malaysia targets reduction of 45% of GHG of GDP intensity in 2030 as compared to 2005 level.
- No more land will be required to build landfills which require hundreds acre of lands and metres of buffer zones.

**Economic Benefits:**

- The tourism industry will flourish with cleaner cities and sustainable solid waste management.
- Implementation of clean and modern technology will expand green job opportunities and change the negative perception of the solid waste management sector.

*During the official visit of interview session*
*From left to right: Ir. Noor Iziddin Abdullah Haji Ghazali, Dato' Ir. Ts. Gs. Dr. Mohd Azhar Abd Hamid, Ir. Ts. Prof. Dr. Teo Fang Yenn, Ir. Muhammad Fadly Ahmad Usul*

- Domestic recycling and renewable manufacturing sectors will grow stronger and become a driver of Malaysia economy.

**Looking Ahead: Lessons and Inspirations**

To further accelerate progress, Malaysia is at other countries for inspiration.

- **Japan:** Known for discipline in its citizens and systematic solid waste management. Japan has excellent solid waste segregation systems at source and adopts modern solid waste management technology such as WtE plants. Japan also has systematic solid waste education and awareness, making citizen participation in solid waste management very high.
- **Sweden & China:** Known for widespread adoption of WtE. Citizen acceptance of modern technology is outstanding and there is a good blend of the surroundings and culture of the people. WtE is well accepted by the people.
- **South Korea & Singapore:** Known for their systematic and successful 'pay-as-you-throw' system which sustainably funds their solid waste management systems.

Dato' Azhar notes: "Learning from the world doesn't mean copying; it means adapting success stories to suit our context and learning from past mistakes so that we do not repeat it."

## IR4.0 Meets Waste Management

Digital transformation is a natural progression in this era. In alignment with Industrial Revolution 4.0 (IR4.0), Malaysia's waste strategy incorporates:

- AI and IoT integration.
- Smart monitoring systems.
- Predictive analytics to optimise logistics.

"Digital tools give us visibility and control over the entire value chain," says Dato' Azhar. "This is how we close the loop."

## Balancing Development with Public Sentiment

While WtE offers numerous benefits, there may be community resistance when these facilities are planned near residential areas. The solutions include building on existing landfill sites to avoid NIMBY objections, designing WtE plants with landscaped, park-like surroundings, real-time emissions monitoring and transparent reporting. Dato' Azhar says the goal is to build trust and to impress upon the people that the technology is safe, and that the benefits are shared.

On the public resistance to the construction of WtE facilities near residential and commercial areas, Dato' Azhar acknowledges that the government must balance national goals with environmental and public concerns. He points out that the following actions must be followed through:

- Careful site selection: Existing landfill locations are currently prioritised for WtE projects to minimise public objections.
- Adopting the latest eco-friendly technologies which emit no pollution and are designed as park-like, effective facilities.
- Continuous emission monitoring using online systems and public display.
- Conducting Environmental Impact Assessments (EIA) to minimise effects on communities and the environment.

## Conclusion: Reformation in Motion

Malaysia's National Solid Waste Management Reformation is an ambitious but necessary journey. Backed by sound engineering, robust policies, forward-thinking leadership, and collaborative partnerships, the initiative holds the promise of a cleaner, greener, and more sustainable Malaysia.

Dato' Azhar concludes: "This is not just a solid waste management plan. It's a national transformation strategy, one in which every Malaysian has a part to play." ■

Interviewer:

**Professor Ir. Ts. Dr. Teo Fang Yenn**
Deputy Chair of the Environmental Engineering Technical Division

**Interviewee's Profle**

**Dato' Ir. Ts. Gs. Dr. Mohd Azhar Abd Hamid** *is the Director General of the Department of National Solid Waste Management, Ministry of Housing and Local Government. With a solid foundation in engineering, he brings extensive experience in both public and private sectors in strategic planning, innovation, and governance. He previously served as Director of the Technology and Research Division at SWCorp, and holds a Ph.D. in Solid Waste Management from Universiti Sains Malaysia (USM).*


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# Solid Waste Solutions with CDS Technology in Advancing Urban Stormwater Management

by:

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Continuous Deflective Separation (CDS) technology significantly advances hydrodynamic separation systems of solid waste solutions for urban stormwater management. An extensive review of CDS technology, its working principles, and its advantages over conventional hydrodynamic separators are given in this paper. It emphasises how CDS systems are ideal for managing urban stormwater because they can achieve solid waste and high pollutant removal efficiency, especially when flow conditions are variable, making them highly suitable for urban stormwater management.

We also explore integrating the CDS system with green infrastructure and nature-based solutions to illustrate how a hybrid system can improve the resilience and sustainability of water management. The findings highlight the importance of implementing cutting-edge technology like CDS to handle the escalating solid waste problems associated with urban stormwater runoff in light of climate change and tightening environmental restrictions.

Continuous Deflective Separation (CDS) technology has emerged in recent years, as a frontrunner of solid waste solutions to improve stormwater quality in highly populated areas. CDS technology is now leading the way in stormwater treatment for urban areas. Managing stormwater effectively is a serious challenge in cities, where impervious surfaces and human activities generate significant runoff. This runoff often carries solid waste and pollutants, such as sediment, oils, grease, and debris, all of which can harm water quality and aquatic life.

Traditional solid waste solutions for urban stormwater management, such as gross pollutant traps (GPTs) and hydrodynamic separators, have been widely used. However, these often face limitations due to variable flow conditions, space constraints for installation, and the inability to capture smaller particles in stormwater.

In contrast, CDS technology has revolutionised how we treat stormwater. By using advanced hydrodynamic methods, CDS units can achieve solid waste and higher pollutant removal efficiencies than conventional systems while taking up less space and needing less maintenance. This paper dives into the operational principles, benefits, and applications of CDS technology, highlighting its essential role in modern stormwater management.

## Solid-Liquid Separation System

**Operating Principle:** CDS technology lies in its ability to use gravity and centrifugal force to separate solid wastes and pollutants from stormwater. This system optimises water flow to minimise retention time, allowing for efficient removal of heavy metals, sediments, and other contaminants. As stormwater flows through a CDS unit, a vortex increases water retention time and enhances sediment separation.

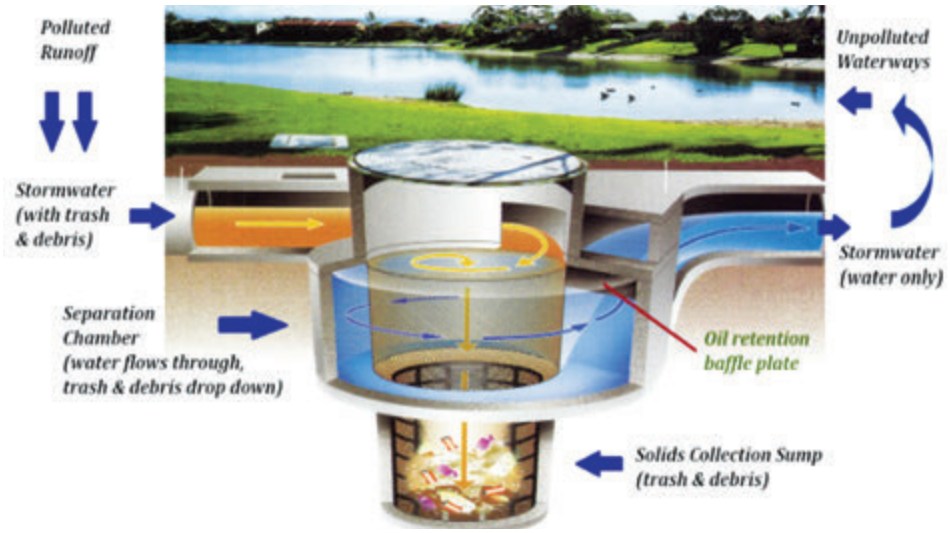


*Figure 1: CDS Operation System*

In this swirling motion, lighter materials float to the surface or remain suspended, while heavier sediments settle at the bottom. The design utilises advanced micro-hydrodynamics to facilitate effective filtration through a 3-dimensional static screen interacting with the induced flow. This specialised flow helps capture a broad range of particles.

CDS units also incorporate perforated screens and baffles to trap floating debris and oils, improving their ability to remove coarse and fine pollutants. Unlike traditional separators which rely solely on size or density for separation, CDS systems harness hydrodynamic forces to optimise sedimentation and filtration processes.

**Essential Elements:** One of the standout features of CDS technology is its small installation footprint, making it ideal for urban environments with limited land availability. As cities grow and land becomes more scarce, compact systems are critical. CDS units allow for continuous water flow across a diverse range of treated flows, meaning less water storage is necessary than large cell storage methods.

CDS systems extract significant amounts of contaminants, achieving over 85% removal for fine particles and 96% for coarse ones. Their flexibility allows them to function effectively across varying rainfall cycles and runoff levels. This adaptability makes CDS a reliable, space-efficient solution for managing urban stormwater in the face of changing weather patterns.

**Applications:** The application of CDS technology presents numerous benefits in urban stormwater management. These systems are particularly efficient at matching street and highway runoff, making them suitable for roadway drainage. This capability is invaluable to urban planners, helping minimise the environmental impacts often accompanying conventional drainage methods.

Industries can also use CDS systems to treat stormwater contaminated with oil, grease, and sediments. As urban areas face increasing regulatory scrutiny over stormwater discharges, adopting technologies such as CDS can ensure compliance while maintaining ecological integrity. Additionally, CDS systems provide reliable runoff control in densely populated residential areas, effectively reducing localised pollution levels and flash flooding risks.

CDS technology fits seamlessly into green infrastructure projects. This integration is essential in contemporary urban design, especially as cities seek to embrace sustainability principles.

## Competitive Advantages of CDS Technology

**Conventional Hydrodynamic Separators (HDS):** Traditional HDS systems rely on size or density-based methods to filter contaminants from stormwater. While effective for capturing larger particles, it is often a struggle with finer sediments and dissolved pollutants. High flow rates can create turbulence, resuspending settled sediments and significantly diminishing their overall performance in handling variable flow conditions.

**Gross Pollutant Traps (GPTs):** Building on conventional HDS technology, proprietary hydrodynamic separators have evolved into what we now refer to as GPTs. These systems frequently capture large debris and coarse pollutants, e.g. leaves and litter, before reaching water bodies. Typically, GPTs consist of chambers where stormwater passes through screens or meshes that trap larger particles while allowing water to flow through. However, GPTs become less efficient for capturing finer particles, requiring complementary treatment technologies to achieve the desired water quality.

**Hydrodynamic Vortex Separators (HDVS):** HDVS are an improvement over traditional HDS systems, utilising vortex movement to enhance sedimentation. These systems can maintain better removal efficiencies under moderate flow conditions, capturing smaller particles more effectively than older systems. However, their design typically demands larger footprints than CDS units, and their performance may decline during significant flow fluctuations, limiting their applicability in highly variable stormwater conditions.

**Continuous Deflective Separation (CDS):** Drawing inspiration from HDVS principles, CDS technology incorporates the latest design innovations to enhance solid waste and pollution removal. The stability of CDS systems makes them reliable options for urban stormwater treatment, mainly due to controlled vortex flow and their ability to handle changing flow conditions. Furthermore, CDS solutions are often economically viable for urban developers looking to upgrade their stormwater treatment capabilities while minimising space and maintenance needs.

CDS technology addresses the shortcomings associated with HDS, GPT, and HDVS by capturing a wider range of pollutants, including coarse and fine sediments and oils. The vortex flow in CDS creates optimal sedimentation conditions, allowing heavier particles to settle effectively. Meanwhile, the perforated screens and baffles ensure that floating debris and oils are contained and trapped without bypassing the system. This holistic treatment approach results in high efficiency for urban stormwater management.

**CDS Benefits & Performance:** Table 1 shows the key aspects such as pollutant removal efficiency, operational mechanisms, and cost considerations and illustrating the advantages of CDS for modern urban water management.

*Table 1: Comparison between conventional separator, HDVS and CDS*

| Attributes | Conventional HDS & GPT | HDVS | CDS |
|---|---|---|---|
| Pollutant Removal Efficiency | Moderate (20-30%) | High (70-80%) | Very High (85-98%) |
| Mechanism of Operation | Size/density-based | Vortex flow with size-based | Controlled vortex with deflection |
| Performance Under Variable Flow | Reduced efficiency | Improved, but may struggle | Maintains high efficiency |
| Space Requirements | Large footprint | Compact design | Very compact |
| Maintenance Requirements | Moderate, clog-prone | Lower maintenance | Low; designed to minimise clogging |
| Initial Investment Cost | Typically, lower | Moderate | Potentially higher, but cost-effective over time |
| Integration with Existing Systems | May require significant modifications | Can be retrofitted into some systems | Easily integrated with minimal disruption |
| Environmental Impact | Limited scope | Good for fine sediment | Comprehensive approach |

CDS technology offers a variety of advantages, including higher pollutant removal rates and consistent performance even under variable flow conditions. These features make CDS an appealing choice for urban stormwater management, particularly in areas with limited space, and where water quality is a critical concern.

A key feature of CDS technology is its patented non-blocking design which ensures constant flow rates through the screens. This self-cleansing ability makes CDS a more effective option than standard trash screens. According to the Law of Diminishing Returns, when the flow is obvious, the filtration efficiency reaches maximum levels, while a completely blocked screen results in zero efficiency. Therefore, traditional GPTs yield a maximum efficiency of only about 50%. Moreover, in systems where screens double as storage sumps, only 50% of that storage is typically utilised, reducing the average efficiency to 25%. Comparatively, the performance of CDS units can be estimated to be four times more effective under similar treatment conditions.

CDS units are designed to capture pollutants below the screen chamber in a separate sump. These units are primarily installed offline, set up to capture and treat a specified flow rate of 95% for an Average Recurrence Interval (ARI) of three months while allowing for bypass when total flow exceeds that. The bypass flow is engineered to correspond with the maximum drainage flow rate, preventing upstream impact and flash flooding risks compared to in-line GPTs.

Notably, CDS is the only technology analysed using established hydraulic formulas related to the sizing of diversion chambers and culvert considerations. This allows for effective design of the weir length without causing disruptions to drainage infrastructure.

Independent laboratory tests conducted in various countries show that CDS technology captures nearly all sediments down to a size of 0.25 mm. Field data over 20 weeks reveal that almost 30% of the particles are larger than 0.075 mm. In Malaysia, CDS units sold since the inception of Putrajaya Holding have consistently met the Total Suspended Solids (TSS) removal standard of a minimum of 60%. Later revisions to the Malaysian Urban Stormwater Manual (MSMA2) established this minimum TSS standard. CDS has demonstrated its ability to trap over 85% of particles at a size of 0.1 mm.

## Integrating Natural and Technological Solutions

**Opportunities for Integration:** Merging natural and technical approaches in stormwater management presents immense potential for improved treatment and sustainability outcomes. Nature-based solutions (NbS) include constructed wetlands, vegetated swales, and permeable pavements. For example, integrating natural adsorbents such as biochar and/or media bed, and biofilm can boost pollutant removal rates when used alongside traditional stormwater solutions and CDS technology.

**Case Studies:** Several eye-opening case studies highlight the effectiveness of hybrid systems which CDS technology with natural treatments. In 2016, a project was carried out to improve water quality in Port Dickson's historical area, from a Water Quality Index (WQI) of Class 5 to Class 3 without electricity. This initiative utilised four CDS units for filtration. This process allowed the effluent to undergo further polishing through multiple stages of biofilm and media bed treatment, ultimately achieving the desired improvement in water quality.

In addition, the implementation of an underground sullage water treatment plant in Kuala Lumpur as part of the KL River of Life Phase 2 Project was targeted to achieve Class 2B water quality but it exceeded expectations by reaching Class 2A. A new generation of Hybrid CDS-Lamella clarifiers was incorporated into this project, marking a significant evolution in the final treatment stage.

More recently, a pilot study exploring the synergies between a CDS filtration system, wetland grass and biochar, indicated that stormwater could be treated to meet Class 2B standards by relying solely on kinetic energy sources instead of using electricity. These achievements underscore the potential of hybrid systems to tackle complex urban stormwater management challenges.

## Conclusion

CDS technology significantly advances hydrodynamic separation methods of solid waste solutions for urban stormwater treatment. It provides practical solutions to urban pollution problems. While GPTs and traditional separators have limitations, CDS units offer a comprehensive treatment package that captures a wide range of pollutants while requiring minimal footprint and maintenance.

The integration of CDS technology with natural treatment systems and green infrastructure enhances its ability to meet the challenges posed by urban stormwater management. Innovative solutions such as CDS will be key to making urban water management more sustainable and resilient as cities grow amidst climate change. By effectively improving water quality and reducing environmental impacts, CDS technology aligns with broader ecological goals of minimising pollutant discharges to waterways and protecting vital aquatic ecosystems. ■

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# From Scheduled Waste to Strategic Resource: Ultrasound-Assisted Leaching for Malaysia's Spent Catalysts

by:

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Malaysia is experiencing rapid economic growth and urbanisation, both of which have resulted in an increase in solid waste generation. According to various sources including the International Trade Administration (ITA), KDEB Waste Management and the Malaysian Investment Development Authority (MIDA), we produce approximately 39,000 tonnes of solid waste daily and this figure is projected to rise beyond 55,000 tonnes per day by 2030. This surge is driven by population growth, expanding industrial activities, and rising consumption patterns. Consequently, managing solid waste effectively and sustainably has become an urgent national priority.

The solid waste stream in Malaysia comprises municipal solid waste (MSW), industrial waste, construction and demolition debris, and scheduled wastes. While MSW management has received considerable attention, with initiatives such as waste segregation, recycling programmes, and improved landfill technologies, the management of scheduled wastes — which encompass hazardous and potentially dangerous industrial by-products — remains a challenging area.

Scheduled wastes are regulated under the Environmental Quality (Scheduled Wastes) Regulations 2005, which classify certain wastes based on their hazardous properties. Among these, SW202 refers to waste catalysts that have been used extensively in industries such as petrochemical, hydrogenation, and oleochemical processing. These spent catalysts contain valuable metals, primarily nickel, but also cobalt, molybdenum, and sometimes precious metals including platinum and palladium.

Recent data from the Department of Environment Malaysia indicate that we generate over 15,000 MT of SW202 annually. This substantial volume of hazardous waste not only poses environmental and safety risks but also represents a largely untapped resource. Currently, many spent catalysts are either stockpiled, disposed of in hazardous landfills, or exported overseas for metal recovery, often at significant economic and environmental costs.

## SWM System: Progress & Persistent Challenges

In the past two decades, Malaysia has made considerable progress in its waste management infrastructure. Urban centres are equipped with sanitary landfills, waste sorting facilities, and increasingly effective recycling programmes. However, the industrial sector still faces substantial obstacles in managing hazardous wastes like SW202. Scheduled wastes require specialised handling, transportation, and disposal facilities which comply with strict environmental regulations.

The current management practices primarily involve stabilisation or neutralisation of hazardous wastes, followed by disposal in secure landfills. Alternatively, some industries opt to export spent catalysts to countries with advanced metallurgical recovery facilities. Both approaches have significant drawbacks.

Landfilling, even when conducted under regulatory supervision, poses risks of soil and groundwater contamination due to potential leachate seepage. It also represents the permanent loss of valuable metal resources embedded in the wastes. Exporting hazardous wastes, on the other hand, involves high transportation costs, logistical complexities, and the risk of regulatory or political barriers. Furthermore, reliance on overseas recovery perpetuates dependency on foreign processing capabilities, which may fluctuate due to market or policy changes.

In addition, the chemical and metallurgical methods currently used to recover metals from spent catalysts often involve harsh chemicals, high energy inputs, and multi-step processes that limit operational efficiency and environmental performance. Such inefficiencies discourage widespread implementation of domestic metal recovery solutions, particularly for small and medium-sized enterprises (SMEs). These challenges reflect a broader issue: Malaysia's waste management framework has yet to fully embrace the principles of the circular economy, which emphasise resource recovery, waste minimisation, and sustainable consumption.

## Circular Economy & Sustainable Waste Management

Malaysia's commitment to sustainable development and resource efficiency is reflected in national policy documents such as the 12th Malaysia Plan (2021-2025) and the

Circular Economy Roadmap Malaysia (2021-2030). These initiatives call for the integration of circular economy concepts into industrial practices, waste management, and environmental conservation. The circular economy model encourages industries to rethink waste as a resource, promoting technologies that enable material recovery, reuse, and recycling. Within this framework, scheduled wastes, such as spent catalysts, represent a strategic opportunity. Rather than viewing these materials solely as hazardous liabilities, they can be transformed into valuable secondary raw materials, supporting domestic manufacturing and reducing dependence on virgin resources.

For Malaysia, adopting circular economy principles in the management of SW204 and other scheduled wastes aligns with national goals to reduce environmental impact, foster green industrial growth, and enhance economic resilience.

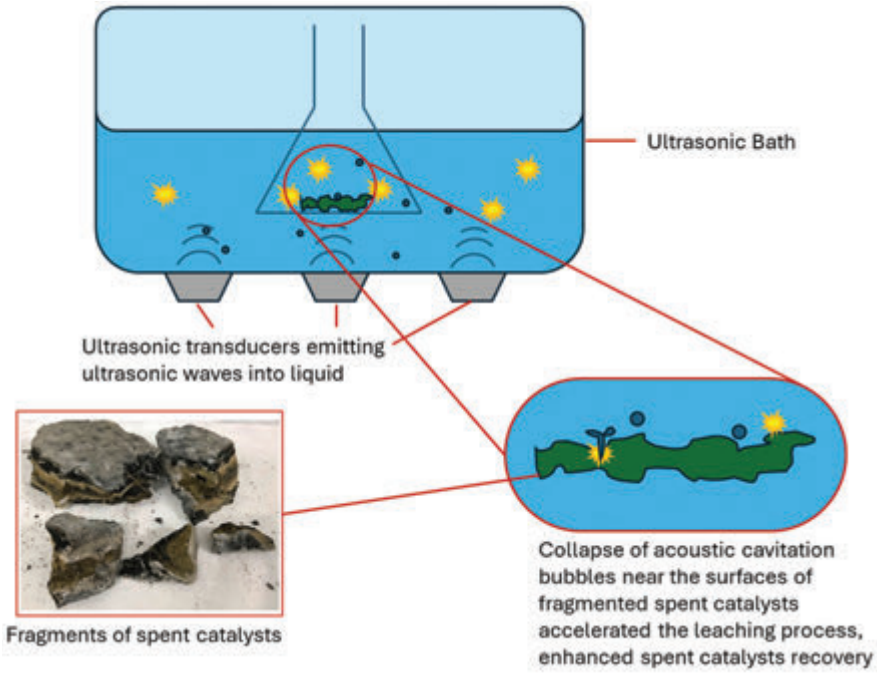


*Figure 1: Illustration on the effects of ultrasonication in accelerating the recovery of spent catalysts*

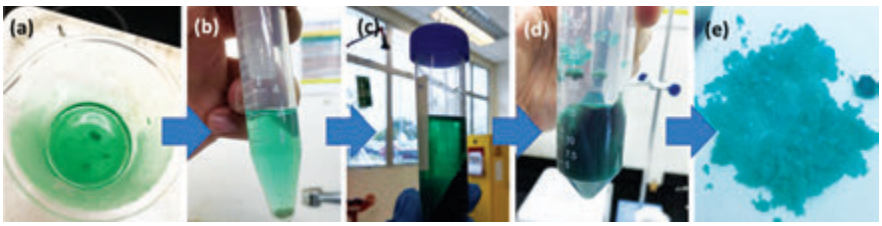


*Figure 2: (a) Ni solution recovered from spent catalysts, with the presence of some additional impurities. (b) Separation of solvent and precipitates after centrifugation. (c) Concentrated Ni solution. (d) Post drying and crystallisation. (e) Nickel sulphate crystals.*

## Ultrasound-Assisted Leaching: Cutting-Edge Approach to Metal Recovery

One of the most promising recent developments in metal recovery from solid wastes is the application of ultrasound-assisted leaching technology. Ultrasound, which involves sound waves at frequencies above 20kHz, generates acoustic cavitation when applied to liquids. Cavitation entails the formation, growth, and violent collapse of microbubbles, producing localised “hot spots” with extremely high temperatures and pressures. This unique phenomenon enhances chemical reactions and accelerates mass transfer processes, making ultrasound an effective tool for intensifying leaching (the process of dissolving solid metals into liquid form). See Figure 1.

The research team at the University of Nottingham Malaysia has pioneered the use of ultrasound-assisted leaching with dilute nitric acid solutions to extract nickel from spent catalysts. Compared to conventional mechanical stirring, the ultrasound method achieved a nickel recovery rate of 99.4% in just two hours. Figure 2 illustrates the steps of recovering Ni salts.

Notably, this high efficiency was obtained under mild conditions: Low acid concentration and moderate temperature, reducing chemical consumption and energy use. This technology represents a game changer for several reasons:

1. It dramatically improves extraction efficiency and speed, making metal recovery more economically viable.
2. It lowers environmental risks by minimising chemical and energy inputs.
3. The modular and scalable nature of ultrasonic equipment enables flexible deployment in diverse industrial settings, including smaller facilities.

## Advantages of Ultrasound Technology

Beyond the recovery of nickel from spent catalysts, ultrasound-assisted leaching holds broader potential for managing a variety of industrial wastes containing critical metals. These include electronic waste (e-waste), automotive catalytic converters, battery scraps, mining tailings, and fly ash.

Conventional extraction methods for these wastes often face limitations such as slow kinetics, incomplete metal recovery, and reliance on aggressive reagents. The ability of ultrasound to disrupt solid structures, enhance mass transfer, and create reactive species can overcome these issues. For example, it can facilitate the breakdown of complex waste matrices, enabling a more thorough extraction of metals under environmentally friendlier conditions. By improving recovery yields and lowering processing times and chemical usage, ultrasound-assisted leaching contributes to the circular economy by enabling

the sustainable extraction of metals critical for emerging technologies such as electric vehicles, renewable energy systems, and electronics manufacturing.

## Environmental & Economic Benefits

The application of ultrasound-assisted leaching in Malaysia's scheduled waste management sector offers multiple environmental and economic advantages. Environment-wise, this technology can reduce hazardous waste volumes requiring disposal, thus decreasing landfill use and associated pollution risks. By operating under milder chemical and thermal conditions, it lowers the carbon footprint and minimises the generation of secondary pollutants. Moreover, onsite or near-source treatment can reduce transportation distances and emissions linked to waste movement.

Economy-wise, recovering valuable metals from spent catalysts and other wastes provides industries with a new source of raw materials, lowering dependency on costly imports and exposure to global commodity price volatility. The relatively short processing times improve throughput and operational efficiency, further enhancing cost-effectiveness. For Malaysia, a country aspiring to position itself as a green industrial hub in South-East Asia, the integration of such innovative recovery methods aligns with strategic objectives to build a resilient, sustainable industrial sector.

## Industrial Scalability & Deployment in Malaysia

Ultrasound-assisted leaching is highly adaptable and scalable. Industrial ultrasonic units can be designed as modular systems, facilitating integration into existing production lines or mobile platforms. With this flexibility, the technology can be used to serve various industrial scales, from large petrochemical plants to smaller manufacturers.

This modularity is particularly beneficial for the local industrial landscape, characterised by a large number of SMEs that may otherwise lack the resources to invest in large-scale waste processing infrastructure. By deploying compact ultrasonic leaching units, SMEs can participate actively in circular economy initiatives, recovering metals and reducing hazardous waste in cost-effective ways.

## Challenges & The Path Forward

While ultrasound-assisted leaching offers great promise, several challenges remain for its widespread adoption in Malaysia. Firstly, scaling from laboratory experiments to industrial volumes requires careful engineering to maintain consistent cavitation and treatment efficacy. Design considerations include ultrasound frequency, power density, reactor geometry, and handling of solid wastes in slurry form.

Secondly, initial capital investment may be a barrier, particularly for smaller companies. This highlights the importance of government incentives, subsidies, or the development of shared treatment facilities to promote adoption.

Thirdly, awareness and technical expertise in ultrasound technology are still limited in Malaysia. Capacity building through training, pilot projects, and collaborations between academia and industry are crucial to overcome these gaps.

Finally, regulatory frameworks must evolve to recognise and facilitate the use of novel technologies like ultrasound-assisted leaching. Clear guidelines and standards will help industries comply while encouraging innovation in waste management.

## Aligning with Sustainability & Circular Economy Goals

The ultrasound-assisted leaching technology directly supports Malaysia's environmental and industrial policies. The 12th Malaysia Plan emphasises resource efficiency, green technology adoption, and sustainable industrial development, while the Circular Economy Roadmap Malaysia 2021-2030 calls for zero waste initiatives and improved waste valorisation.

By enabling near-complete metal recovery from hazardous scheduled wastes under mild and environmentally friendly conditions, ultrasound-assisted leaching embodies these policy goals. It helps transform waste management from a cost centre into a value-generating activity, contributing to Malaysia's vision to become a sustainable, innovation-driven economy.

## Conclusion

Malaysia is at a critical juncture in its waste management journey. Traditional methods of handling hazardous scheduled wastes like spent catalysts are no longer sufficient in the face of growing environmental and economic pressures. Ultrasound-assisted leaching (UAL) offers a transformative solution, enabling near-complete metal recovery under mild, sustainable conditions. Its scalability, efficiency, and alignment with national circular economy goals make it a compelling pathway forward. Realising its full potential will require coordinated action among researchers, industries, and policymakers. With the right support, Malaysia can shift from viewing scheduled waste as a liability to recognising it as a strategic resource, paving the way for a greener, more resilient industrial future. ■

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# From Waste to Worth: Role of Agricultural Wastes in Circular Economy with Two Green Product Examples

by:

**Assoc. Prof. Dr. Suchithra Thangalazhy-Gopakumar**

*Associate Professor, Department of Chemical & Environmental Engineering, University of Nottingham Malaysia.*

Circular economy (CE) is a rapidly maturing economic concept aimed at maximising the use of resources while minimising the waste and environmental impact. The concept started in the 1960s during the rise of the modern environmental movement, but the CE approach gained clearer definition and global recognition only through publications by the Ellen McArthur Foundation. The organisation introduced the influential Butterfly Diagram, which visually represented the continuous flow of materials in a circular system with two major cycles:

1. The technical cycle focuses on the flow of materials through processes like reuse, repair, remanufacture, and recycling of non-biodegradable materials.
2. The biological cycle involves returning biodegradable materials to the earth through processes like composting and anaerobic digestion.

CE is a framework based on restorative and regenerative by design. The principles of CE are eliminating waste and pollution, circulating materials and products at their highest value, and rejuvenating nature. This is achieved through strategies like reusing, recycling, and remanufacturing of materials into new valuable products, in contrast to the traditional linear economy model of take-make-dispose.

Through the implementation of circular practices, humans can reduce environmental impacts through waste minimisation, reduction in the emission of greenhouse gases (GHG), conservation of raw materials and preserving our biodiversity. Instead of depending on global supply chains and finite resources, CE strengthens economic stability and community engagement through local resources. Therefore, this model also brings more job opportunities for local societies.

In spite of these benefits, the transition to CE is not without challenges. As this business model often utilises waste as a resource, consumer acceptance is a major hurdle. Therefore, comprehensive education, awareness campaigns, and incentives to encourage sustainable choices are required to overcome this hurdle.

Another major challenge is the economic viability. The market demand for secondary materials is often limited, so the financial returns may be uncertain, making it difficult for businesses to invest confidently. Therefore, new policy frameworks, incentives, and product standards are required for circular products. Additionally, circular businesses require advanced recycling facilities, reverse logistics networks, and digital technologies for tracking and monitoring. Without this infrastructure and technology, scaling circular practices remains a challenge.

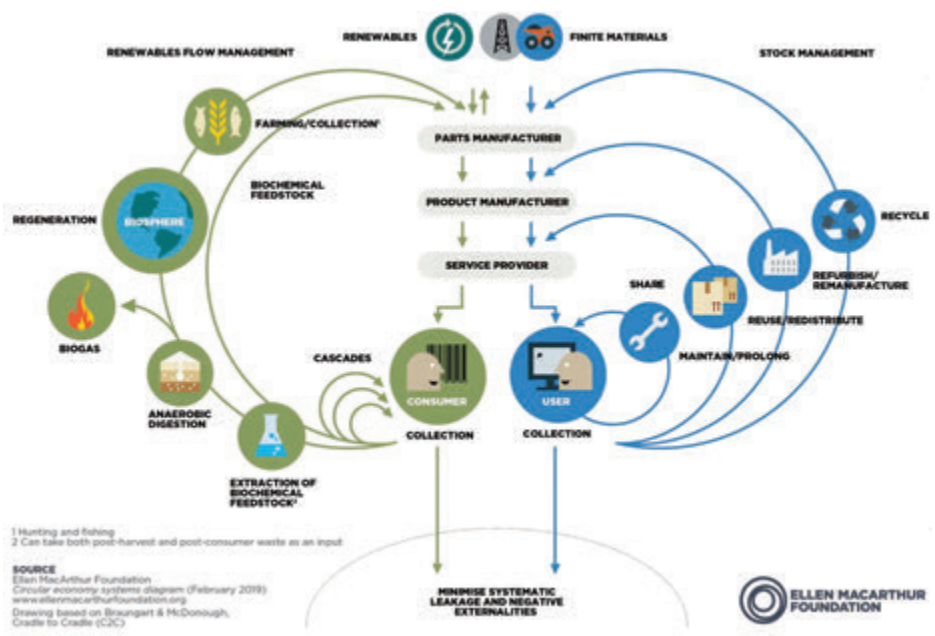


*Figure 1: Ellen McArthur Foundation's Circular Economy Systems diagram (Feb 2019). (Adopted from https://www.ellenmacarthurfoundation.org)*

Encouragingly, many companies are adapting the CE concept. Here are two successful stories of circular products that can be adopted by any agriculture-based country. Aakar Innovations produces Anandi pads and Kaffeform manufactures reusable cups (Weducer cups), demonstrating the opportunity to make a profit utilising waste as raw materials. These enterprises exemplify the potential of circular models to drive innovation, sustainability, and economic opportunity.

*Figure 2: Hand pressing the sanitary pads (Adopted from https://www.aakarinnovations.com/mini-factories)*

Anandi pads are eco-friendly sanitary napkins made entirely from compostable natural materials, designed to biodegrade safely in the environment. Given the essential role sanitary pads play in the lives of menstruating women, they must be both user-friendly and environmentally sustainable. Conventional sanitary pads are typically composed of plastics and synthetic polymers, which are non-compostable and can take many years to decompose. Moreover, when incinerated, these materials release harmful fumes, posing serious environmental and health risks.

Agricultural waste materials such as water hyacinth, banana fibre, bagasse, and bamboo pulp sheets serve as the primary raw materials for the napkin. These are pre-treated, shredded, and pulverised to make a soft, fluffed material which is then weighed and made into pad moulds to form the absorbent core. Next, a bio-adhesive is sprayed onto a corn starch-based bio-plastic backsheet, followed by another adhesive layer to attach a bio-nonwoven top sheet. Plant cellulose-based super absorbents are added between layers to improve fluid retention and skin safety. Pads are sealed, then sterilised with UV light for 30 minutes.

Reusable coffee cups are made from an innovative material, which blends biopolymers with upcycled coffee grounds and beechwood fibre. While reusable coffee cups are commonly made from materials such as plastic, glass, ceramic, and stainless steel, plastic remains the dominant material in the market. However, the most widely used plastic (polylactic acid or PLA) is not truly biodegradable, resulting in reusable plastic cups ending up in landfills.

The collected coffee grounds go through pre-treatment such as cleaning and drying. After drying, coffee grounds are blended with other materials such as plant fibre, beechwood grain, and natural resins in a blender


*Figure 3: (a) Collecting the coffee grounds from cafes (b) The weducer cups (Adopted from from https://www.kaffeeform.com/en)*

compounder at high temperatures. This mixture is then transformed into granules, which are fed into an injection moulding machine. Inside the machine, the granules are heated to turn into a fluid state and then injected under high pressure into moulds that shape the final product, eco-conscious coffee cups.

These two projects are examples of the implementation of circular aspects for long-term sustainable economic advantages. They not only provide job opportunities for the local community, but they also create user and environmentally friendly necessities by using local waste. Napkin and coffee cup manufacturers work with local farmers or small businesses and workshops to collect and process the raw materials, emphasising community engagement and sustainability.

However, companies still face several challenges in growing with circular products. Circular industries have to ensure a consistent supply of raw materials from local farmers and other suppliers and this can sometimes limit their production scale. Therefore, scaling up circular products is a significant challenge.

Moreover, industries need to raise public awareness among the community to spread word on the use of these environmentally friendly products and to set the market price of the products at a lower value.

In spite of the challenges, there are successful stories for the transformative potential of circular economy models. Repurposing local waste materials into valuable, eco-friendly products not only reduces environmental impact but also fosters inclusive economic growth.

## Acknowledgment

The author would like to thank her students, Agnes Toh Jia Yue, Chang Lee Shin, Wong Shu Yao, and Yan Shaet Jing, for collecting the information on these projects and for their contributions. ■


## CAFEO 43 (28-30 OCTOBER 2025, PHILIPPINES)

43rd Conference of the ASEAN Federation of Engineering Organizations (CAFEO 43), hosted by The Philippine Technological Council (PTC) is scheduled to take place from **28 to 30 October 2025**, at the SMX Convention Center Clark in Mabalacat City, Pampanga, Philippines. This year's conference will revolve around the theme, "ASEAN Engineers: Beacons of Prosperity, Inclusivity, Equity, Resilience, and Sustainability." IEM is currently inviting interested members to participate as speakers. Interested IEM Members are encouraged to submit their details using the link below:

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# Waste-to-Energy: Success or Failure?

by:

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Waste-to-Energy (WtE), also known as energy-from-waste, is the process where energy (typically heat and electricity) is generated using waste as a fuel source. This is often done through direct combustion using waste incinerators (burning) or producing a combustible fuel from a gas such as methane. The latter method is less common and requires processes such as gasification or anaerobic digestion.

WtE solutions are now recognised as a preferred waste treatment option for residual waste and a sustainable waste management approach in the country. Recognising this, the Housing & Local Government Ministry is planning to establish six WtE plants in the country by the end of 2025. This is in line with the nation's move towards the zero-waste status.

Malaysia is actively playing a pivotal role in strengthening waste management and transforming environmental governance to better manage its environment and natural resources, including reducing its economic impacts. These inititatives are highlighted in the 12th Malaysia Plan 2021-2025 as part of the country's commitment to achieving net-zero carbon emissions by 2050. The blueprint also highlights the importance of establishing a circular economy as well as achieving a National Recycling Rate target of 40% by 2025.

## Problem with WtE

Like many developing nations, Malaysia is grappling with increasing volumes of municipal solid waste (MSW). While WtE technology has been promoted as a potential solution to the landfill crisis, the approach is not without challenges. One of the primary criticisms of WtE is its potential to undermine recycling efforts. By burning waste which includes recoverable and recyclable materials, WtE facilities reduce the incentive to implement effective source segregation and recycling programmes. This can slow down the transition toward a circular economy.

According to a joint statement by Greenpeace Malaysia and over 30 environmental groups, the proposed development of 18 WtE plants may jeopardise national efforts to improve recycling and waste minimisation, as these facilities can lock in long-term demand for mixed waste as fuel, thereby discouraging upstream initiatives such as packaging reduction and composting (Greenpeace Malaysia, 2024).


*Rawang residents and other protestors demonstrating against the proposed incinerator in Batu Arang*
*(Photo by: Jaringan Rawang Tolak Incinerator (JRTI) Facebook)*

Environmental concerns are also at the forefront. Incineration-based WtE systems produce greenhouse gases (GHG) such as carbon dioxide ($CO_2$), and pollutants such as dioxins, furans, and heavy metals; all these pose risks to both environmental and public health. For example, the planned incinerator in Batu Arang, Selangor, sparked protests from residents who were worried about air quality and toxic ash residues (The Straits Times, 2024). Such concerns are exacerbated by weak enforcement of emissions standards and limited public access to environmental impact assessments (EIA).

Governance and transparency issues further complicate the adoption of WtE in Malaysia. Civil society organisations have criticised the lack of proper stakeholder engagement, including the absence of social impact assessments in large-scale WtE projects (Greenpeace

Malaysia, 2024). Public distrust is magnified when projects are fast-tracked without sufficient environmental oversight or consultation.

Moreover, Malaysia's position as a global hub for plastic waste imports has raised the alarm. According to reports, imported waste often ends up in unregulated facilities or is co-processed in WtE plants, posing additional threats to environmental sustainability and public health (*Bernama, 2023*). If not tightly regulated, WtE may inadvertently support the continuation of illegal or unethical waste trading practices.

## Pros of WtE

- Avoiding Landfilling: Roughly 80% of Malaysia's municipal solid waste is still landfilled, posing long-term risks such as groundwater contamination, methane emissions, and land degradation. With many landfills nearing full capacity and closure costs estimated at RM20 million per site (The Star, 2024), alternatives are urgently needed. WtE offers a sustainable solution by reducing waste volume by up to 90%, greatly reducing landfill demand. This is particularly valuable in urban regions where land for new disposal sites is limited. Incorporating WtE into the national strategy can extend landfill lifespans and mitigate methane emissions, which have a global warming potential 25 times higher than carbon dioxide.
- Resource Recovery: WtE facilities also enable the recovery of valuable materials. Metals can be extracted from bottom ash and recycled, while stabilised ash can be repurposed for road construction or bricks. This reduces reliance on virgin materials and thus, supports circular economy principles. More advanced technologies such as pyrolysis and gasification further enhance value by transforming organic waste into syngas, biochar, and bio-oil, useful for energy, agriculture, and industry (Petronas, 2024).

## Contrast of WtE

It is expected that the adoption of WtE in Malaysia will contribute to large amounts of $CO_2$ and other GHG emission, particularly in the south-east peninsula region. The plan to install three WtE plants in Negeri Sembilan, Johor, and Melaka to tackle landfill shortages and pollution may ultimately backfire, marking a significant setback to our climate goals. Such a move jeopardises Malaysia's commitment to cut GHG emissions intensity by 45% by 2030 under the Paris Agreement. Data from the Solid Waste Management & Public Cleansing Corporation (SWCorp) shows that our domestic waste stream is dominated by food waste (Table 1). With a high proportion of plastic and other flammable materials, incineration at WtE facilities can become a major source of carbon emissions, at times exceeding even coal-fired power plants in $CO_2$ emissions per unit of energy generated.

The national recycling rate has yet to surpass 40%, but it shows a commendable upward trend, increasing from 33.2% in 2022 to 35.4% in 2023. This steady progress

*Table 1: Composition of Malaysia's domestic waste stream*

| Waste Type | Percentage (%) |
|---|---|
| Food Waste | 30.6 |
| Plastics | 21.9 |
| Paper | 15.3 |
| Disposable Diapers | 8.2 |
| Hazardous Household Waste | 4.2 |
| Others | 19.8 |
| Total | 100.0 |

*Source: Solid Waste Management and Public Cleansing Corporation (SWCorp), 2024*

reflects the country's growing commitment to sustainable waste management and achieving SDG 12.5.1. (Table 2). However, the introduction of WtE can divert recyclable and compostable materials such as paper, metals, food waste, and plastics, away from recovery streams and into incinerators. Once burnt, these materials are lost forever, along with their economic value. This undermines the concept of a circular economy and goes against national efforts to improve resource efficiency through recycling and composting. While some plastics are non-recyclable due to contamination or complexity, incineration still poses significant risks, including the release of toxic pollutants that filtration systems alone cannot fully eliminate.

*Table 2: Malaysia's national recycling rate under SDG indicator 12.5.1*

| Year | National Recycling Rate (%) |
|---|---|
| 2022 | 33.2 |
| 2023 | 35.4 |

*Source: Ministry of Housing & Local Government and Solid Waste & Public Cleansing Management Corporation, 2023*

To be financially viable, WtE plants require a constant input of burnable waste. This demand discourages waste separation and recycling, particularly in Malaysia where public participation is limited and enforcement is still in progress. The need to "feed the fire" may reduce incentives for local governments to invest in recycling infrastructure or community awareness programmes. Furthermore, WtE may inadvertently reopen Malaysia to the global waste trade.

WtE plants carry not only high financial costs but also serious health and environmental risks. Beyond $CO_2$, they emit toxic pollutants such as dioxins and heavy metals. Without strict regulation and monitoring, especially in vulnerable communities, these facilities can worsen air pollution and endanger public health.

WtE is often marketed as a silver bullet, but for Malaysia, it may create more problems than it solves. The high $CO_2$ emissions, destruction of valuable materials, discouragement of recycling, and risks associated with the waste trade raise serious red flags. Rather than rushing into WtE, Malaysia should strengthen its focus on waste reduction, recycling, and composting, alongside public education and policy enforcement. WtE should only be a last resort and not a replacement for better, more sustainable waste solutions.

## WtE Technologies

Incineration, the direct combustion of waste at high temperatures, is the most common WtE technology and the most commercially viable. However, there are other energy recovery methods such as:

**Anaerobic digestion (AD).** Besides composting, anaerobic digestion is a controlled, oxygen-absent process that encourages the decomposition of organic solid wastes by using microorganisms. While it can occur naturally, AD is also used in residential or industrial settings to produce a biogas consisting mainly methane and $CO_2$ and is considered a renewable energy source.

**Pyrolysis.** As a thermochemical treatment, pyrolysis exposes organic waste to high temperatures without oxygen present. This initiates decomposition and disintegration. The byproducts are commonly carbon-rich char (biochar) and combustible gases. Some of the gases can then be condensed into a combustible liquid called bio-oil or bio-crude.

**Landfill gas (LFG) recovery.** The decomposition of organic material in landfills creates a natural byproduct called landfill gas. LFG consists of methane, carbon dioxide and a small percentage of non-methane compounds. It can be collected, treated and used as fuel for industrial uses, vehicles and more. LFG recovery is one method for reducing landfill methane emissions.

**Gasification.** Gasification is a thermochemical treatment which converts organic waste (biomass) into combustible gas by using high temperatures and a controlled amount of oxygen or steam or both. The result is a combustible natural gas called syngas or producer gas that is used to make ammonia and methyl alcohol (methanol). It can also replace gasoline as a biofuel alternative.

## Conclusion

WtE facilities can contribute substantially toward Malaysia becoming a zero-waste nation due to its hygienisation processing of waste. To accelerate the transition of SWM from a linear economy to a circular economy, Malaysia is banking on WtE solutions. Additionally, the establishment of waste eco-parks, development of waste management technologies and closure of all open landfills are encouraged in line with its commitment to becoming a net-zero carbon emission country by 2050. According to the World Bank report, What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050, global waste generation is expected to grow roughly by 3.4 billion tonnes per year by 2050. This has sparked extensive discussions on the various aspects of waste management for the sustainable development of the global economy, environment and society. ■

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*On behalf of The Institution of Engineers, Malaysia (IEM), we extend our heartfelt condolences to the bereaved family of* ***Ir. Khoo Choong Keow*** *on his passing.*

*We honour and deeply appreciate his long-standing contributions to IEM since becoming a member in 1978. Ir. CK Khoo served as a Council Member during the 1985/1986 session and was a Fellow Member of the Institution. His dedication and service to the engineering community will be fondly remembered.*

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# National Solid Waste Management Reformation Symposium 2025

by:

**Ir. Assoc. Prof. Dr. Ngien Su Kong**

On 6 May 2025, the National Solid Waste Management Department, under the Ministry of Housing & Local Government, organised the National Solid Waste Management Reformation Symposium 2025, in collaboration with the Waste Management Association of Malaysia and the Housing & Local Government Training Institute (I-KPKT).

The day-long programme, held in the compound of I-KPKT in Bukit Tinggi, Pahang, attracted more than 500 participants from federal and state government agencies, waste-related industries and institutions of higher learning. These included four members from the Environmental Engineering Technical Division of IEM: Professor Ir. Ts. Dr. Teo Fang Yenn, Associate Professor Ir. Dr. Ngien Su Kong, Associate Professor Ts. Dr. Anurita Selvarajoo and Associate Professor Dr. Suchitra Thangalazhy Gopakumar.

The symposium, with the aptly-worded theme, No Time to Waste, was aimed at increasing the awareness of timely and efficient solid waste management as well as the use of AI in sustainable solid waste management. To this end, the organisers arranged a series of talks and presentations on smart waste management and solutions in a forum centred on the application of artificial intelligence (AI) in managing solid waste.

*Participants at the symposium*

The Deputy Minister of Housing & Local Government, Y.B. Datuk Hajah Aiman Athirah Sabu officiated at the symposium. In her speech, she stressed on the importance of policy updates, use of green technology and the involvement of the community in ensuring that the national solid waste management system was in line with the aspirations of the government. She said Malaysia was moving towards 15% reduction of waste sent to disposal sites by 2030 and was committed to achieving net-zero greenhouse gas emissions by 2050. This was followed by the launching of I-KPKT's new training system, e-MAS I-KPKT.

The series of talks started with a presentation on smart solutions for recovery and recycling by Mr. Nicholas Kolesch, founder and director of NK Circular Economy Consulting Pte. Ltd. He said that although there are many technical and economic challenges in collecting and processing lower value plastic waste, the tide is turning. However, innovative, high-impact solutions being commercialised will drive demand and create value from materials previously destined for disposal.

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The second talk was by Mr. Raymond Lee, Team Lead at Ramboll Energy, who presented an overview of smart waste management in Denmark and outlined the key policy frameworks which underpinned Denmark's commitment to a circular economy. The lessons learnt here could become a valuable framework to explore pathways towards more resilient and circular waste management solutions in Malaysia.

Then Mr. Lovish Ahuja, Vice-President of Public Affairs (Asia & South Africa) at TOMRA Systems ASA, talked about the use of AI in material recovery. He showcased the Holistic Resource Systems integrated model which combined deposit return systems, separate collections, and mixed waste sorting to maximise material recovery and reduce environmental impact.

The fourth speaker, Ms. Joanne Lee, Vice-President of Orkel Asia Region (Orkel AS), focused on optimised smart baling. This method is adaptable for use with diverse materials, making it a versatile tool in achieving circular economy objectives and supporting landfill reduction strategies.

The last speaker for the day was Mr. Qairul Reeza Othman, Senior Project Engineer at Fichtner GmbH & Co. KG. His talk was on comprehensive waste facilities and how smart solutions were required for these in decentralised, rural areas.


*Some of the exhibition booths at the symposium*

After the talks, the forum on AI Adaptation in Solid Waste Management started. The moderator was Ts. Dr. Pramila Tamunaidu from Universiti Teknologi Malaysia. The panellists were the Deputy Director of the National Solid Waste Management Department, Mr. Ahmad Zuhairi Muzakir, an expert representative from Centre of Excellence for Waste Germany, Ir. Ts. Intan Nor Zuliana Baharuddin, and Senior Manager for Overseas Environmental Business Unit of Kanadevia Corporation Japan, Mr. Taiyo Miyagi. The main takeaway from the forum was that Malaysia had the talent and support to adopt AI in solid waste management, but needed a central driving force, a shift in mindset toward landfills as regenerative assets, and consistent data collection to fully realise its potential.


*Environmental Engineering Technical Division members at the symposium. (From left: Dr. Anurita, Prof. Teo, Dr. Suchitra and Dr. Ngien)*

Aside from the talks and forum, the symposium also attracted 24 exhibitors dealing with solid waste from government-linked agencies, solution providers and institutions of higher learning which displayed their products, services and research at their respective booths.

In conclusion, the symposium was a fruitful gathering of like-minded professionals interested in and concerned about the direction of the nation's solid waste management and who wished to increase their knowledge in the various aspects relevant to solid waste. ■

## NOTICE OF IEM (KEDAH-PERLIS BRANCH) OFFICE BEARERS FOR SESSION 2025/2026

The Institution of Engineers, Malaysia (IEM) Kedah-Perlis Branch had its 23rd Annual General Meeting on 6th July 2025 and we are pleased to introduce the new office bearers for session 2025/2026:

| IEM (Negeri Sembilan Branch) Office Bearers 2025/2026 | |
|---|---|
| Chairman | Ir. Jamaluddin Abdullah |
| Vice Chairman | Ir. Abdur Rahman Azzam Che Sobry<br>Ir. Rosafizawati Suib |
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# Kuching Urban Transport System (KUTS): Engineering Innovations and Challenges

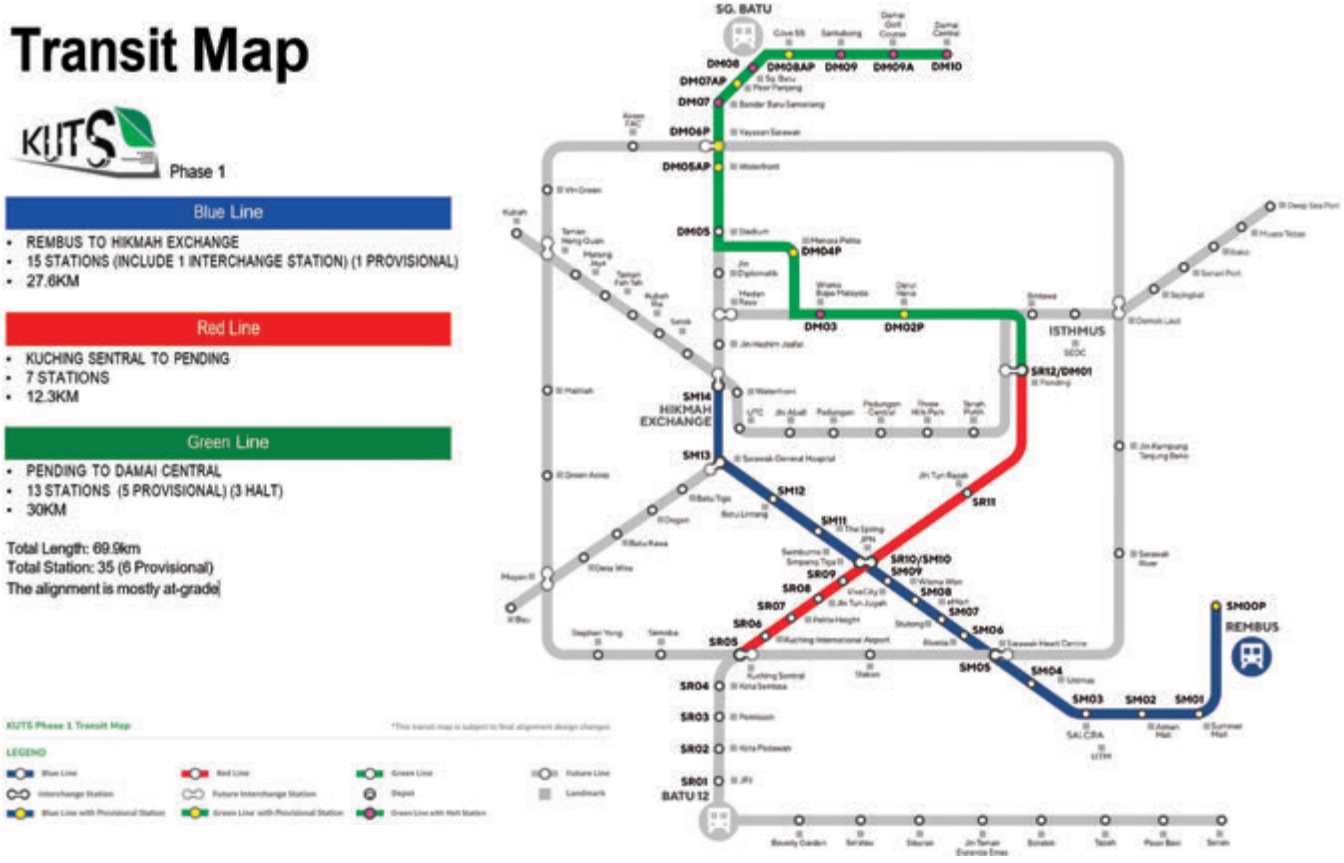
by:

**Mr. Mark Omar Mohsen**

On 6 May 2025, the Highway & Transportation Engineering Technical Division (HTETD) of the Institution of Engineers, Malaysia (IEM) hosted a technical talk titled Kuching Urban Transport System (KUTS): Engineering Innovations & Challenges. Held at the Auditorium Malakoff, Wisma IEM, Petaling Jaya, the session brought together professionals, students, and industry experts eager to learn about the latest developments in urban transport for Sarawak.

The talk was delivered by Mr. Chew Yueh Chin, Head of Department for Interface & Integration at Sarawak Metro. With over 22 years' experience in the railway and engineering industry across Malaysia, Brunei, and Singapore, Mr. Chew provided a comprehensive overview of the KUTS project, which represented Sarawak's bold vision for sustainable urban mobility.


*Presentation by Mr. Chew Yueh Chin*




*KUTS alignment map*

He began with an overview of Sarawak Metro, a wholly owned subsidiary of the Sarawak Economic Development Corporation (SEDC), responsible for implementing, operating, and maintaining the KUTS project. He highlighted the vision of KUTS, which is to provide efficient, sustainable, and low-emission public transport for Kuching through the deployment of the Autonomous Rapid Transit (ART) system.

## Key Components and Engineering Innovations

The presentation covered the major elements of KUTS, including the following:

1. Autonomous Rapid Transit: A state-of-the-art system combining the features of a bus, train, and tram, the ART operated on rubber tyres with dedicated lanes and used hydrogen fuel, making it a zero-emission solution for urban mobility.
2. Hydrogen-Powered Vehicles: The adoption of hydrogen as a clean energy source for ART and other public transport vehicles supported Sarawak's commitment to green energy.
3. Dedicated Infrastructure: This included both at-grade and elevated lanes, hydrogen refuelling stations, and a state-of-the-art Operation Control Centre (OCC).
4. Advanced Signalling and Control Systems.
5. Transit Signal Priority (TSP): An innovative system that gave ART vehicles priority at traffic signals, improving punctuality and travel times.

Mr. Chew highlighted that KUTS was not just a transportation project but also a significant step towards sustainable urban mobility. The use of hydrogen fuel for ART aligned with Sarawak's green energy goals, reducing carbon emissions and promoting energy diversification. The presentation also addressed the practical challenges of implementing KUTS, such as managing the complexities of constructing at-grade and elevated ART lanes, ensuring safe and efficient hydrogen refuelling operations and engaging with local authorities, utility providers, and regulatory agencies.

Mr. Chew also introduced the Sarawak Metro Socio-Economic Enhancement Development (SEED) Programme, an initiative aimed at developing local expertise, creating job opportunities, and establishing Sarawak as a leader in sustainable transport solutions. He emphasised that KUTS was not only about providing efficient public transport but also about building local capacity and expertise in green technology.

The session concluded with an engaging Q&A segment, where participants actively inquired about the technical aspects of ART, the hydrogen fuel system, and the future expansion of KUTS. Mr. Chew's practical insights and candid responses provided valuable clarity to attendees.

IEM and HTETD extended sincere thanks to Mr. Chew for delivering an inspiring and detailed presentation, and to all participants for making the event a success. ■

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The Trigonometrical Station at the highest point of Pulau Jerejak

# Pulau Jerejak Heritage Talk + Hike 2025

*by:*

**Ir. Ong Sheng How**

*Deputy Chairman, Highway & Transportation Engineering Technical Division (HTETD).*

## Digital Content

**SCAN ME!**

*https://bit.ly/46xIY5b*

Pulau Jerejak, off the south-eastern shore of Penang, has always captured the interest and imagination of people with an archaeological and adventurous heart. In a partnership between Orange Ong, IEM HTETD, IEM Penang Branch, GCF and RUAM, the back-to-back events of the Jerejak Heritage Talk & Hike (9 & 10 May 2025 respectively) became a reality, thanks to Orange's determination and persistence to track down Mike Gibby, the author of the book, *Jerejak: Penang's Untold Story*.

On that Friday night, 42 people attended the Jerejak Heritage Talk held at COEX Kilang Besi, George Town, where Gibby recounted the captivating story of the island. He traced its history, layer by layer, in its time, which he likened to kuih lapis.

Pulau Jerejak has a fascinating though somewhat dark history. A leper colony was established there in 1868 and it housed thousands of leprosy patients until the 1960s. It also served as a quarantine station for newly arrived immigrants in 1875 and as a tuberculosis sanatorium after World War II due to an increase in the number of tuberculosis patients.

In 1969, it became a penal colony and the Jerejak Rehabilitation Centre was set up as a high-security detention centre and a maximum-security prison, earning the island the moniker, the Alcatraz of Malaysia. The centre was eventually closed in August 1993.

In more recent times a shipyard and a holiday resort were built on its shores. Despite its somber past, Pulau Jerejak is preserving its rich history while offering a destination for hiking, exploration and adventure.

The morning after the talk, 50 participants and 2 guides took a boat ride to Pulau Jerejak to hike and explore the island. After listening to Gibby's talk, we learnt to appreciate the history of the abandoned buildings that we came across on our hike. Among the historical ruins and significant heritage sites we visited were the Russian Memorial, the Christian Cemetery, the 1930 Jail & Detention Camp, the 1921 Eurasian Camp, the 1896 Catholic Church, the Trigonometrical Station at the peak, the 1911 Quarantine Camp, and the Assembly & Briefing Hall near the jetty.

After spending the day hiking and walking around, we returned to Penang Island, glad to have had the opportunity to rediscover the Pulau Jerejak heritage. ■

*Mike Gibby giving his talk on Pulau Jerejak on 9 May 2025*

*Mike Gibby's book Jerejak: Penang's Untold Story*

*Participants eager to go hiking and exploring Pulau Jerejak on 10 May 2025*

*The participants exploring one of the historical ruin sites*

# Guidelines for JURUTERA Authors

## Overview

The primary objective of JURUTERA is to publish articles of general interest to IEM members. JURUTERA provides reports and news on professional activities, branch activities, and current issues of interest. It also serves as one of the medium of communication between the Institution and its members, providing notices and announcements of IEM.

Articles submitted for publication in JURUTERA must be original, light reading material, unpublished elsewhere, and of interest to IEM members. Technical content should be presented in a readable and accessible style. JURUTERA is published Monthly, and can be viewed in the IEM website.

## Technical Articles

1. Since JURUTERA is not a peer-reviewed publication, research articles can be forwarded to the Editor of IEM Journal. However, articles based on research conducted are welcome.
2. A technical article are limited to **2,400 words**. The word count must be reduced appropriately with each additional figure or diagram or photo.
3. The author may be requested to modify the article or to clarify certain points in the article. The Editorial Board reserves the right to edit manuscripts for clarity, readability, length and content.
4. An article should communicate information efficiently and effectively to readers. The prose should follow a coherent line of thought. Sidebars, tables and figures may be used where appropriate. All mathematical equations must be properly checked by the authors themselves, using MS Excel formulae format. It is suggested that all articles have a summary or conclusion. Technical or formal articles may list the references cited using the IEE style.
5. The actual publication of an article is at the sole discretion of the Editorial Board.

## Reports on Activities

1. **Each report shall be limited to 800 words:** All reports should be concise and precise in view of the limited publication space. The word count must be reduced appropriately with each additional figure or diagram or photo. As the sizes of such insertions affect their word-countequivalent, it will be left to the judgement of the authors on the number of words to cut. The Bulletin Editor retains the right to edit or further reduce the number of words.
2. **All reports are subjected to selection for publication by the Editorial Board:** To better determine themselves on the suitability of the reports, the Editorial Board is free to seek further advice from parties deemed fit to do so, while avoiding conflict of interest such as asking the same Technical Division to vet their own reports.
3. **Reports on activities should be value-adding to the readership:** For example, reports on talks should be akin to an extended abstract from which readers could get the gist of the talk and the subsequent Q&A. Reports on visits, forums and others shall serve a similar purpose, e.g. highlighting critical observations, issues, resolutions that will be of interest to the readers. Other than the basic information such as title, venue, name and affiliation of the speaker, details which are of little interest to most readers (such as the time of arrival at a destination, presentation of a token of souvenir etc) should be excluded.
4. **A report should preferably be submitted within a month from the date of activity:** Considering that some Technical Divisions have internal vetting process prior to submission, the Editorial Board will not be unreasonably strict with this requirement.
5. Although the Editorial Board will strive to publish the reports in a timely manner, the Editorial Board reserves the right to Schedule to a later date, e.g. to provide room to clear the backlog, or to better fit the theme of the month. Until the backlog is cleared, each issue of JURUTERA will contain a mix of earlier submitted and relatively current reports.
6. It is also the discretion of the Bulletin Editor to decide on the reports to be uploaded in the IEM webportal "Jurutera Online".

## Writing Style

1. It is recommended that authors peruse published articles in past issues of JURUTERA to get a feel for the style, format and nature of the articles. A technical article may use a formal style, while an opinion piece may be written in a very casual style. The Editorial Board prefers to refrain from imposing particular styles.
2. Articles should be in U.K. English. Submitted material is expected to be of a high standard.
3. Since articles submitted for JURUTERA are not peer-reviewed, the onus is on the author to ensure that the article is factually correct and the arguments are sound.
4. An article should be written in a clear and direct style. Paragraphs and sentences should be short and easily digestible. Long-winded and tedious technical writing styles must be avoided. Writing is a two-way street; remember that you are writing for an audience that consists largely of both technically-minded trained professionals and budding engineers. The reader should be moved along briskly; reading JURUTERA ought to be an enjoyable and satisfying activity.

## Authors

Authors are requested to submit a recent passport-sized photograph together with a brief profile of themselves. Authors are also encouraged to provide keywords for articles submitted.

## Submission of Materials

Electronic copies of articles may be sent as attachments to the following e-mail address: *pub@iem.org.my*. Your documents should have meaningful and unambiguous names. Large documents may be sent compressed using the ZIP archive format and should be sent as separate attachments.

## Photographs and Illustrations

All photographs should be of high quality, ready for typesetting. Image files should be in JPG/JPEG format, and of a high resolution (at least 300 DPI.) Drawn illustrations must be of high quality, as they will be used "as is". All figures, tables, graphs and photographs must be rightly captioned.

## Fair Use of Copyrighted Material

It is necessary to adopt a conservative policy on the fair use of copyrighted material. The Editorial Board reserves the right to reject articles that exercises the doctrine of fair use in an excessive manner. It is up to the author to obtain permission, if necessary, for the use of copyrighted material.

## Use of Proprietary Material

An article must not overtly promote a proprietary or commercial product. Such articles will be immediately rejected. Proprietary material such as trade names and proprietary terms should be avoided. Prose that seems advertorial in nature is unwelcome. An objective and balanced technical discussion involving commercial products is acceptable.

*IEM JURUTERA Editorial Board*
*Rev 3 June 2006, June 2011*
*Rev 4 September 2013*
*Rev 5 February 2021*
*Rev 6 January 2025*


*The Taipei 101 660-ton damper ball*

# Taipei 101: Where Culture Meets Engineering

Formerly known as the Taipei World Financial Centre, Taipei 101 stands at 508 metres and 101 storeys tall. It held the title of the world's tallest building from its opening on 31 December 2004 until it was surpassed by Dubai's Burj Khalifa in 2010.

Shaped like a bamboo stalk, Taipei 101 rises in eight stacked sections, which is symbolic of prosperity in Chinese culture. However, the design is more than aesthetic. It reflects values like strength and resilience, both essential in a region prone to typhoons and earthquakes.

At the core of its structural innovation is a 660-ton tuned mass damper, a giant steel pendulum suspended between the 88th and 92nd floors. Measuring 5.5 metres in diameter and built from 41 stacked steel plates, it reduces the building's movement by up to 40% by counteracting sway. Two smaller dampers, each 6 metric tons, are installed at the spire to further reduce wind-induced vibration. On 8 August 2015, Typhoon Soudelor caused the main damper to sway a record 1 metre, showcasing its vital role in maintaining stability.

Unlike that of most skyscrapers, the Taipei 101 damper is proudly displayed to the public, complete with cartoon mascots, making advanced engineering not only functional but also educational and engaging. ■

***Photography by:***

**Ir. Prof. Dr. Zuhaina Zakaria**

Date: 22 July 2025

To all Members,

## LIST OF CANDIDATES ELIGIBLE TO SIT FOR THE PROFESSIONAL INTERVIEW FOR THE YEAR 2025

The following is a list of candidates who are eligible to sit for the Professional Interview for the year 2025.

According to the IEM Bylaws, Section 3.8, the names listed below are published as eligible candidates to become Insitution Members, provided that they pass the Professional Interview in 2025.

If there are any Corporate Members who have objections against any candidate deemed unsuitable to sit for the Professional Interview, a letter of objection can be submitted to the Honorary Secretary, IEM. A letter of objection must be submitted within one month from the date of publication.

**Ir. Chen Harn Shean**
*IEM Honorary Secretary*

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| **ELECTRICAL ENGINEERING** | | |
| 116155 | AMRI BIN MISRI | BE HONS (UiTM) (ELECTRICAL, 2018) |
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| 39274 | SITI ZULAIKHA BINTI ZAINAL | BE HONS (UiTM) (MECHANICAL - MANUFACTURING, 2012) |
| **MECHANICAL ENGINEERING** | | |
| 69360 | SIM WEE SIANG, SIMON | BE (SWINBURNE) (MECHANICAL, 2014) |
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| 58733 | PREMA A/P SIVANATHAN | BE (UniMAP) (METALLURGICAL, 2012) |

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| 128352 | NINA SAKINA BINTI KAMARUDDIN | BE HONS (UiTM) (CIVIL, 2016) |
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| 105925 | POH AIK CHONG | BE HONS (MMU) (MECHANICAL, 2011) |
| 112732 | SUFFIAN BIN ADNAN | BE HONS (UiTM) (MECHANICAL, 2008) |
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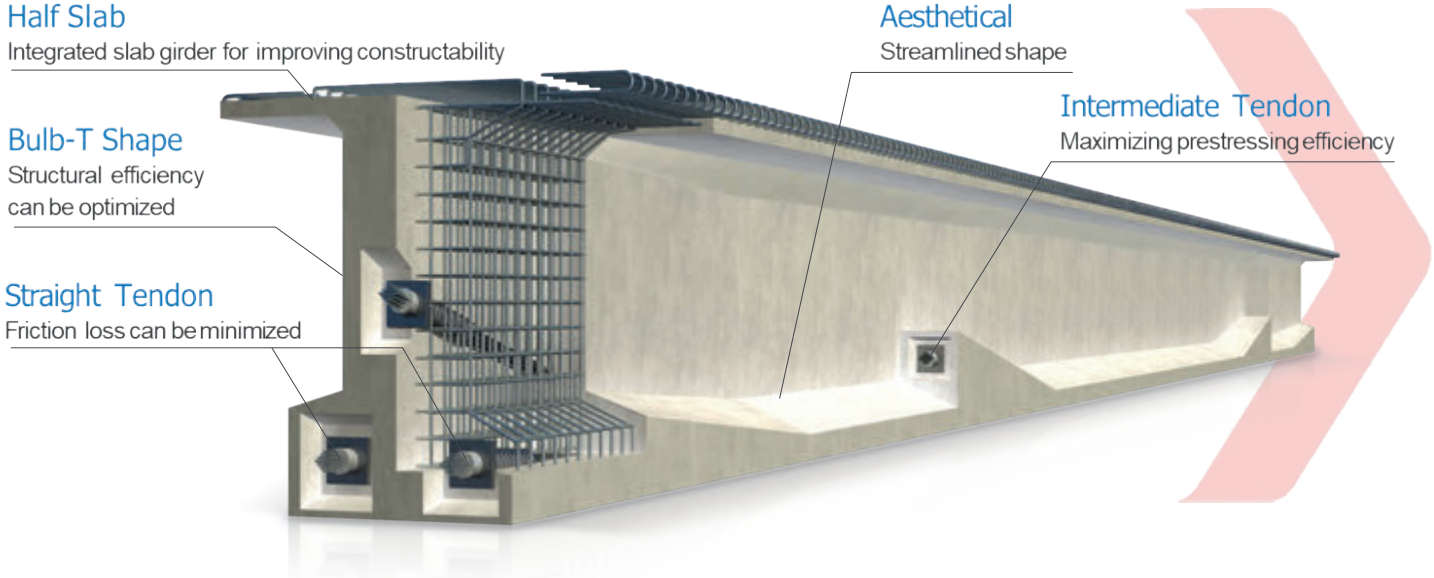


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