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## From bin to biogas

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**A**S Malaysia scales its adoption of waste-to-energy (WtE) solutions, the research and innovation arm of Tenaga Nasional Bhd (TNB) is running a pilot project to convert food waste into biogas and other by-products.

Since 2018, TNB Research Sdn Bhd has been operating an anaerobic digestion facility in Kajang for organic waste research and technology validation. A torrefaction system was added in 2020.

Food waste used in these pilot systems is sourced from nearby hotels, local eateries and food service facilities within TNB premises, providing a realistic representation of urban food waste streams, said TNB Research head of research centre (decarbonisation and renewable energy) Noraziah Muda @ Omar.

Among the key milestones are the conversion of biogas into renewable natural gas and the production of pyrolysis oil from

the torrefaction system.

"These outcomes demonstrate TNB's ability to move up the value chain by converting waste into higher-value energy products, while strengthening readiness for future scale-up."

Anaerobic digestion is a process through which bacteria break down organic matter in the absence of oxygen. It produces two outputs: biogas (composed of methane, carbon dioxide, hydrogen sulfide, water vapour

and other gases) and digestate, referring to the residual liquid and solid materials left after the digestion process.

TNB Research's anaerobic digestion system is designed to process up to 500kg of food waste daily, although operational experience indicates an optimum feed rate of 300kg to 350kg a day.

"At this operating range, the system produces around 50 to 60 normal cubic metres (Nm<sup>3</sup>) of biogas a day, with a methane content of 60% to 65%, which is higher than initially expected for mixed food waste," Noraziah said.

The process also recovers 80% to 90% of the input material as digestate, which can be used as biofertiliser.

The torrefaction system, which heats biomass in a low-oxygen environment to produce a charcoal-like material, can process up to 100 litres of food and organic waste per cycle.

Depending on the feedstock type and moisture content, it yields 20% to 30% biochar by weight, equivalent to 10kg to 30kg per cycle.

The biochar produced is currently used for research, testing and validation, including studies on its suitability for solid fuel enhancement, soil improvement and carbon material applications.

The pilot-scale operation allows TNB to assess biochar quality and consistency, while generating data to support future scale-up or integration into broader WtE and carbon management initiatives.

Noraziah said TNB is satisfied with the performance of both systems, which promote circular economy principles through offering an alternative treatment pathway for food waste.

It helps to reduce landfill dependency, minimise odour and environmental pollution, and encourage better waste segregation and recycling practices at source, she added.

For TNB, the project demonstrates that WtE solutions are viable beyond traditional palm biomass feedstock. Nonetheless, it has no immediate plans for a large-scale rollout.

"While the systems are operated primarily for research and technology validation, the technical knowledge, operational experience and positive community engagement generated support future scale-up and commercial potential."

Insights from these pilot-scale systems will guide decisions on whether similar models can be replicated or adapted at other suitable TNB facilities.

It is also working with SWCorp and Alam Flora Environmental Solution to explore opportunities in food and organic waste management, technology validation and potential WtE integration.

"Although these efforts remain at an exploratory stage, they reflect TNB's intention to assess scalable, practical WtE pathways aligned with national sustainability priorities and TNB's ESG strategy," Noraziah said.



Food waste goes through a pre-treatment process to ensure suitable feedstock quality for waste-to-energy conversion. (Photo: Handout)