IRENA
International Renewable Energy Agency

Case Study

Lessons from turning palm waste into power

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UNFCCC Climate Week, Yeosu, South Korea

22 April 2026

Malaysia turned palm waste into power, what made it investable

- This presentation covers how Malaysia converted a palm oil waste problem into a clean energy asset, and what made the projects financeable.
- We look at two cases: TNB with IHI, and Malakoff's Tanjung Bin plant. Both trace their roots to a 2022 IRENA case study.
- The question we are answering today is not whether the technology works, it does. The question is what made it investable, what financing architecture supported it, and what other countries can learn from this.

Palm oil waste was an environmental liability before it became a fuel

EFB waste: from environmental liability to power fuel

- Malaysia and Indonesia produce 65 million tonnes of oil palm biomass annually.
- Felled trunks and empty fruit bunches (EFB) were left to rot on plantations, releasing methane, a greenhouse gas 25 times more potent than CO2
- Sugar-rich liquid in felled trunks generated further emissions.
- The density of dried trunks is too low (0.35 g/cm3) for efficient transport, making the waste a cost burden, not a resource.
- **The 2022 IRENA case study documented the challenge: finding an economically viable path from agricultural waste to power-sector fuel.**

Source: IRENA, Scaling Up Biomass for the Energy Transition, 2022

A pre-treatment process removed the barrier to burning EFB in power plants

The potassium problem and how IHI solved it

- Raw EFB contains high levels of potassium and chlorine, compounds that melt at relatively low temperatures, causing slag and agglomeration in boiler furnaces.
- IHI Corporation developed a three-stage pre-treatment process: drying, crushing, and granulation followed by decalcification to remove low-melting-point compounds.
- Combustion tests demonstrated that treated EFB pellets could be co-fired without furnace damage.
- EFB can be a boiler-compatible biomass fuel if pre-treated.

Source: IRENA, Scaling Up Biomass for the Energy Transition, 2022

TNB and Malakoff both reached commercial co-firing, at different scales and timelines

TNB-IHI (2023-2026) and Malakoff (2024-2025)

- TNB and IHI completed a trial burn at the Tuanku Mukhriz power plant in September 2023, one week at 1% EFB pellet co-firing, within regulatory emission limits. The project then entered FEED (Front-End Engineering Design) and is now in plant modification phase targeting initial co-firing by Q3 2026, scaling to 1% ammonia and 2% biomass.
- Malakoff launched its pilot at the 2,100 MW Tanjung Bin plant in May 2024, 2% biomass mix using wood and EFB pellets, reducing an estimated 755,000 tonnes of CO2 per year. In September 2025, Malakoff received a Merit Award at Malaysia's National Energy Awards.

Source: TNB-IHI, February 2024; Malakoff, September 2025

Three structural conditions made EFB co-firing investable in Malaysia

Policy signal, zero-cost feedstock, integrated utility

- Malaysia's National Energy Transition Roadmap (NETR) identified co-firing as a Flagship initiative, with TNB designated as champion. The framework gave developers a clear signal and a counterpart for project development.
- Malaysia's palm oil industry generates 65 million tonnes of biomass annually at zero or negative disposal cost, the raw material has no market alternative, which kept fuel procurement costs predictable.
- TNB's wholly-owned fuel subsidiary (TNBF) handled procurement, removing a market risk that has undermined biomass projects elsewhere.

Source: IRENA, NETR Malaysia, TNB

Financing success combined a utility anchor, technology partnership & public support

Anchor utility, technology partner, FEED de-risking

- TNB brought the anchor demand, a 2,100 MW portfolio requiring continuous fuel supply, making the offtake case for co-firing credible to investors. IHI brought validated technology and a track record in Japan and Malaysia, reducing lender uncertainty on technical performance.
- The FEED phase served as a structured de-risking tool: by completing front-end engineering before committing construction capital, the project moved from concept to bankable evidence.
- Public co-funding for the FEED phase, aligned with Malaysia's NETR, reduced the pre-investment cost burden that typically kills biomass projects at the planning stage.
- For Malakoff, the award recognition functioned differently: it shifted perception from experimental to recognised, reducing the reputational risk that utilities face when piloting unproven blends at scale.

Source: TNB-IHI FEED, February 2024; NETR Malaysia

EFB co-firing is replicable where biomass waste is avail & policy signals are credible

Three conditions, two cautions, and the timing question

- The replicability case is strong in countries with large palm oil or agricultural waste sectors, Indonesia, Thailand, Vietnam all generate comparable volumes.
- The three enabling conditions are: a utility or generation company willing to champion the project, a waste stream with no alternative market (which controls fuel cost), and a policy framework that names co-firing explicitly.
- The two cautions are: pre-treatment adds capital cost that must be absorbed in the fuel price, and the greenhouse gas accounting for biomass combustion depends on how residues are credited, carbon neutrality claims require transparent methodological foundation.

Source: IRENA