

Renewable Energy

An ESG Take On Managing End-of-life Solar PV Assets

Highlights

- A significant wave of solar PV waste is on the horizon for Malaysia, with 229,500 tonnes of end-of-life solar panel volumes by 2050.
- Malaysia is currently working on a regulatory framework to address solar PV waste management. The proposed E-Waste Management Mechanism is expected to provide greater clarity by establishing a comprehensive framework for end-of-life solar panel management.
- Maintain OVERWEIGHT. Our sector top picks are Solarvest, Pekat Group and Northern Solar.

Analysis

- First wave of solar PV decommissioning by 2034, we opine.** Based on projections by the International Renewable Energy Agency (IRENA) and other industry studies, crystalline silicon (c-Si) solar photovoltaic (PV) modules generally have an operational lifespan of 25-30 years. Nevertheless, some asset owners may elect to retire solar installations upon the expiry of their Power Purchase Agreements (PPA), depending on the economics of continued operation. In Malaysia, the first significant wave of solar PV decommissioning could emerge as early as 2034, driven primarily by the expiry of the 21-year PPAs awarded under the maiden FiT programme. This could result in the retirement and disposal of at least 345 MW of solar PV capacity by 2040.
- Navigating the lifespan vs PPA mismatch.** Developers may choose to extend the operational life of their assets by repowering existing facilities, securing PPA extensions, or entering into new offtake arrangements with corporate buyers. The decision will largely depend on module performance, maintenance costs, and prevailing electricity market conditions. Extending module lifespans through second-life applications is generally considered more environmentally friendly than immediate recycling.
- Solar panel waste concerns.** The environmental risks associated with solar PV waste are largely concentrated in the improper disposal of panels containing trace amounts of hazardous materials, including lead (Pb) and cadmium (Cd). Without effective collection and recycling systems, these substances could contaminate soil and water resources, potentially affecting ecosystems and public health. For perspective, Tenaga's TNB Sepang Solar (50MWac/79.2MWp) commissioned under LSS1, consists of 243,712 double-glass polycrystalline modules, each weighing around 25kg with a footprint of 1.94m², translating into a future waste stream of approximately 6,100 tonnes of solar panel material when the project reaches the end of its operating life.

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**OVERWEIGHT
(Maintained)**

Segmental Rating

Segment	Rating
Renewable Energy	OVERWEIGHT (Maintained)

Source: UOB Kay Hian

Sector Picks

Company	Ticker	Rec	Share Price (RM)	Target Price (RM)
Solarvest	SOLAR MK	BUY	3.14	3.50
Pekat Group	PEKAT MK	BUY	1.85	2.00
Northern Solar	NORTHERN MK	BUY	0.685	1.00

Source: Bloomberg, UOB Kay Hian

Malaysia's Solar PV Installations

Programme	2025 Capacity (MW)
LSS (including CGPP)	2684.4
FiT	345.41
NEM	2,747.92
Total	5,777.73

Source: IEA PVPS, SEDA

Peer Comparison

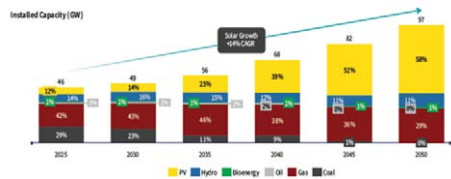
			Price	Target	Last	----- PE -----		----- EV/EBITDA -----		Yield	ROE	Market	Price/
Company	Ticker	Rec	10 Aug 26	Price	Year	2026F/27F	2027F/28F	2026F/27F	2027F/28F	2026F/27F	2026F/27F	Cap.	NAV
			(RM)	(RM)	End	(RM)	(RM)	(RM)	(RM)	(%)	(%)	(RMm)	(x)
Solarvest Holdings	SOLAR MK	BUY	3.14	3.50	3/26	26.7*	22.5**	15.4*	12.7**	-	12.0*	3,035.1	3.2
Pekat Group	PEKAT MK	BUY	1.85	2.00	12/25	24.1	20.4	9.1	7.5	0.5	10.8	1,311.7	2.6
Northern Solar	NORTHERN MK	BUY	0.685	1.00	3/26	12.1*	7.2**	6.7*	3.6**	-	21.3*	271.0	2.6

* Data for 2027F; ** Data for 2028F

Source: Bloomberg, UOB Kay Hian

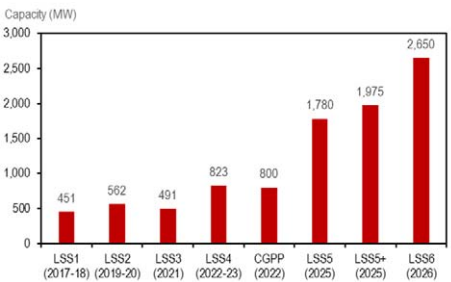
- **Around 229,500 tonnes of solar panel waste to be generated by 2050.** According to the Korea Institute of Energy Research, solar PV modules manufactured after 2011 have an average weight of approximately 73.3kg/kW. Based on this estimate, Malaysia could generate approximately 25,500 tonnes of end-of-life (EOL) solar panel waste by 2040. The volume of solar PV waste is expected to increase significantly thereafter and could rise by more than nine-fold by 2050 as successive generations of solar assets approach the end of their operational lives.
- **Recycling comes at a cost premium relative to landfilling.** IEA-PVPS notes that the cost of recycling solar PV modules often exceeds that of landfill disposal. This is due to the relatively small proportion of high-value materials such as silver (~0.04% by weight) and silicon (~2.7%) within a solar panel, and the substantial capital, logistics and processing costs associated with recycling operations. Transportation costs further compound the challenge. For example, the disposal of approximately 5,000 solar panels (equivalent to around 2.5-3.6MWp) would require roughly five 40-foot lorries, excluding the additional costs associated with long-distance transportation to licensed recycling facilities, given that utility-scale solar farms are often located in remote areas away from major economic and industrial centres.
- **Regulation of solar PV waste is still a novelty in Malaysia.** Currently, solar PV waste is not explicitly recognised as a distinct category of e-waste under the Environmental Quality (Scheduled Wastes) Regulations 2005. This regulatory ambiguity has contributed to licensed e-waste recyclers being reluctant to accept solar panels, citing a lack of regulatory clarity and specialised processing capabilities.
- **A comprehensive e-waste management framework in the pipeline.** To address existing gaps in e-waste regulation, Malaysia is in the process of developing an enhanced legal framework under the proposed E-Waste Management Mechanism. As noted by the acting Minister of Natural Resources and Environmental Sustainability, Datuk Seri Johari Abdul Ghani, the framework will adopt a lifecycle-based approach, regulating electrical and electronic products from the point of entry into the market through to their eventual disposal as e-waste. The government is currently undertaking further studies and stakeholder consultations to support the introduction of an extended producer responsibility (EPR) system. Once implemented, the EPR framework is expected to establish a shared responsibility model involving manufacturers, importers, consumers, collection centres, and recovery facilities, moving Malaysia closer to international best practices in e-waste management.
- **Tenaga's effort in adopting a circular economy.** As Malaysia's largest solar asset owner (>1.3GW), Tenaga has already adopted a circular economy approach to the EOL management of solar panels. Damaged solar panels are entrusted to Department of Environment-licensed vendors for storage, dismantling and treatment. During the recycling process, glass and metal components are separated, with glass disposed of at designated industrial landfills and metal frames recycled through third-party recyclers. For residential, commercial and utility-scale installations, Tenaga also evaluates whether decommissioned modules remain suitable for second-life applications, prioritising their reuse at other internal facilities where technically feasible and still under warranty. In parallel, **TNB Research** is developing an in-house pilot photovoltaic recycling system employing thermal treatment with an optimised heat recovery process to recover high-quality glass, silicon wafers, metals and other recyclable materials, with the aim of improving recycling efficiency and strengthening Malaysia's domestic solar PV circular economy ecosystem.

NETR: Projected Power Capacity Mix By 2050



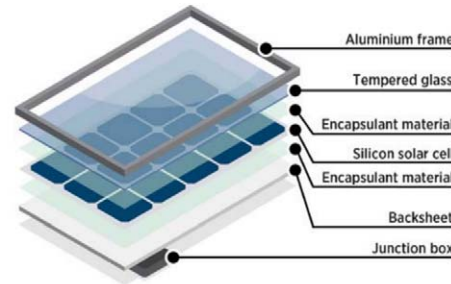
Source: NETR

LSS Projects In Malaysia



Source: PETRA, EC, UOB Kay Hian

Solar Panel Structure



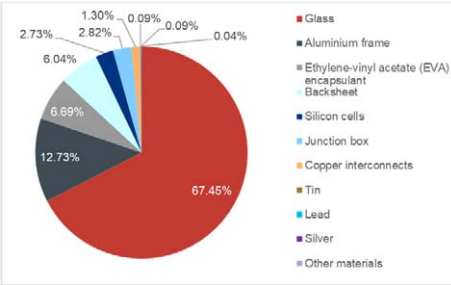
Source: IRENA

Solar Panel Components

Aluminium frame	Supports the structure and protects PV cells
Glass cover	Protects PV cells and allows maximum sunlight to pass through.
Encapsulant	Provides insulation and protection
Solar cell	Converts sunlight to electricity
Backsheet	Provides insulation and protection
Junction box	Connects with cable

Source: IRENA

Solar PV Module Materials And Components By Weight (%)



Source: IRENA

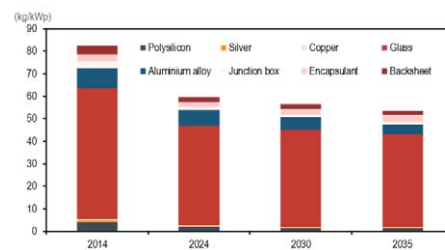
- **Solar PV recycling in other countries.**

- Within the **European Union (EU)**, the disposal of solar PV modules is regulated under the Waste Electrical and Electronic Equipment Directive 2012/19/EU, which classifies PV modules as electronic waste and subjects them to mandatory collection and treatment requirements. Under the Directive, manufacturers and importers are responsible for financing the collection, recovery, reuse and recycling of end-of-life modules under an EPR framework.
- China** has adopted a differentiated EPR approach embedded within its broader PV supply chain framework, primarily governed under the Solid Waste Pollution Prevention and Control Law of the People's Republic of China. Utility-scale solar PV project owners are responsible for ensuring the proper collection and treatment of decommissioned modules, typically through certified waste treatment and recycling companies.
- Singapore** adopts a producer-led approach to managing end-of-life solar PV panels through the Resource Sustainability Act 2019. Solar PV panels are classified as regulated non-consumer e-waste and fall within the scope of the country's EPR framework. Under this framework, manufacturers are legally and financially responsible for the collection, transportation, treatment, recycling, and reporting of end-of-life panels. Manufacturers are furthermore required to provide free take-back services to customers and channel collected panels to licensed waste management and recycling facilities. This approach effectively transfers end-of-life management responsibilities from solar system owners to producers, ensuring environmentally sound disposal and recycling practices.

Valuation/Recommendation

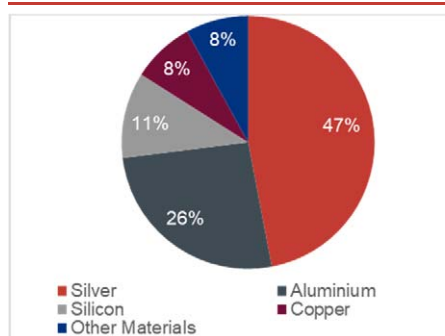
- **Maintain OVERWEIGHT; elevated orderbook driven by over 6.5GW of solar plant-ups.** We expect total solar PV capacity to exceed 6.5GW over 2026-29 as the government calls for tenders for the LSS6 and the take-off of CRESS projects. Assuming a construction cost of RM2.0m-3.5m per MW, total EPCC replenishment opportunities are estimated at a staggering RM13b-23b in the next four years. **Our sector top picks are Solarvest, Pekat Group and Northern Solar.**

Future Progression Of Solar PV Module Materials And Components By Weight



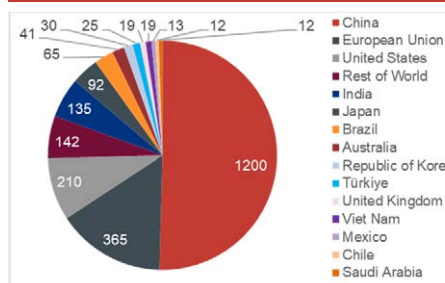
Source: IRENA

Solar PV Module Materials And Components By Value (%)



Source: IRENA

2025 Global Cumulative Solar PV Installations (GW)



Source: IRENA

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