# Revolutionising solar panel recycling to secure critical mineral supply through silver recovery



Solar energy has firmly established itself as a vital part of the global transition to renewable power, with over four million Australian homes and businesses now benefiting from rooftop photovoltaic (PV) panels. However, this rapid adoption brings a burgeoning waste challenge: by 2050, global solar panel waste could reach an unprecedented 78 million tonnes. In Australia alone, around one million tonnes of decommissioned panels—containing recoverable materials valued at approximately $1 billion—risk landfill disposal by 2035 unless recycling infrastructure undergoes significant expansion.

The recycling of solar panels is emerging as more than a matter of waste management; it represents a strategic avenue for securing critical minerals. Currently, China dominates much of the global refining and recycling market for strategic minerals, controlling two-thirds of battery recycling growth since 2020 and leading the refining of 19 out of 20 key minerals. Recent export restrictions on essential materials such as gallium, indium, and rare earth elements have underscored the geopolitical vulnerabilities inherent in current supply chains. Solar panel recycling can reduce reliance on traditional mining, providing a faster route to diversify critical mineral supplies and buffer against global market volatilities. Notably, silver recycling from solar waste represents one of the most promising opportunities for rapid supply diversification compared to the long timelines required for new mining projects.

Silver is especially valuable within solar panels. Each typical PV panel contains roughly 20 grams of silver, primarily used in conductive elements like fingers and busbars. Aggregated across Australia's installed capacity, this embedded silver rivals national silver mine outputs. The demand for industrial silver surged to 680 million ounces in 2024, driven largely by photovoltaic technology and artificial intelligence hardware manufacturing. This demand has created a market supply deficit of 118 million ounces, pushing silver prices up over 150% since 2018—from around US$15 to roughly US$38 per ounce.

Unlike many industrial metals, silver’s unique electrical conductivity underpins its irreplaceable role in high-performance solar cells. Despite ongoing research, substitutes have yet to match silver’s technical properties, elevating the importance of recycling to maintain steady supply.

Conventional solar panel recycling methods, typically involving mechanical shredding, thermal processes, and chemical acid treatments, present considerable limitations: high energy consumption, poor recovery rates (often below 70% for silver), production of low-grade outputs, and environmental hazards from chemical runoff. These methods often destroy valuable silicon wafers and pulverize glass, resulting in materials with diminished reuse potential.

Innovative technologies are transforming this landscape. For instance, Macquarie University pioneered Jet Electrochemical Silver Extraction (JESE), a technology that directs a gentle stream of weak acid onto silver deposits, dissolving the metal rapidly while preserving other panel components such as silicon wafers and glass sheets. This process achieves silver recovery rates exceeding 95%, surpassing traditional methods significantly, and yields material pure enough for immediate reuse in solar cell manufacturing and semiconductor industries. Coupled with Microwave Joule Heating Technology (MJHT), which enables controlled, layer-by-layer panel delamination at room temperature without harsh chemicals, these advances preserve component integrity, allowing silicon wafers and glass to be recovered intact and reused.

Such advanced recycling techniques achieve three to four times the economic value of traditional processes, reflecting in much higher material purity and reuse potential. Additionally, by eschewing acid leaching and high-temperature treatments, these methods considerably reduce carbon emissions and chemical waste associated with solar panel recycling.

The economic environment increasingly favours solar waste silver recycling, especially in light of volatile lithium markets; lithium carbonate prices, for example, have plummeted by over 80% since 2022. Meanwhile, silver’s value and tightening supply-deficit ratio make recovery from solar waste a compelling diversification strategy for mineral processing firms. For companies with existing refining expertise, expanding into silver recycling offers strategic hedging across multiple critical minerals supply chains. Importantly, panels installed during the early 2000s solar boom are now nearing their 20- to 25-year operational life, creating a timely wave of recyclable materials aligned with rising silver prices.

Governmental policies worldwide increasingly recognise recycling as an essential complement to primary mineral production. Developing recycling infrastructure offers a faster, lower-impact route to resource security compared to the often prolonged and complex process of opening new mines. Australia, with its leading rooftop solar adoption, faces an imminent surge in panel retirements, presenting a significant opportunity to establish domestic recycling capabilities that can convert potential waste liabilities into strategic resource advantages.

Efforts by industry and advocacy groups, such as the Australian Clean Energy Council’s call for a mandatory national stewardship framework, underline the importance of policy interventions. Such measures could prevent solar panels from entering landfills, secure jobs through burgeoning recycling industries, and reduce dependency on imported materials. Extended producer responsibility models, which hold manufacturers accountable for end-of-life panel management, are seen as key to overcoming challenges—including the dispersed nature of solar installations, which complicates product collection.

Advanced recycling is not only an economic opportunity but also aligns with broader sustainability goals. It embodies circular economy principles by preserving the full lifecycle value of materials—silver, silicon, glass, and others—thus reducing environmental impacts and resource depletion stemming from mining activities. The solar panel recycling model provides a template applicable to other clean energy technologies nearing end-of-life, such as wind turbines and energy storage systems.

Yet challenges remain. Scaling efficient recycling requires development of streamlined collection infrastructure, coherent regulatory frameworks, market creation for recovered materials, and widespread consumer education. Technological scaling from laboratory breakthroughs to commercial operations is also necessary to meet growing material flows.

Future prospects are optimistic. As new panel designs incorporate easier recyclability and recycling technologies integrate automation and AI-driven disassembly methods, processing efficiencies and recovery rates should improve further. Industry collaborations and government policies fostering recycling innovation promise a future where nearly all components of solar panels can be recovered and reintegrated, ensuring that today's clean energy solutions do not translate into tomorrow's waste crises. This evolving landscape demonstrates that recycling solar panel silver is not merely an environmental imperative—it is a critical component of a sustainable, secure, and economically viable clean energy future.

### 📌 Reference Map:

* Paragraph 1 – [[1]](https://discoveryalert.com.au/news/solar-panel-recycling-silver-supply-chain-2025/), [[7]](https://www.acap.org.au/post/a-truly-sustainable-solar-panel-recycling-industry)
* Paragraph 2 – [[1]](https://discoveryalert.com.au/news/solar-panel-recycling-silver-supply-chain-2025/), [[4]](https://www.sciencedirect.com/science/article/abs/pii/S1364032124009316)
* Paragraph 3 – [[1]](https://discoveryalert.com.au/news/solar-panel-recycling-silver-supply-chain-2025/), [[4]](https://www.sciencedirect.com/science/article/abs/pii/S1364032124009316)
* Paragraph 4 – [[1]](https://discoveryalert.com.au/news/solar-panel-recycling-silver-supply-chain-2025/), [[3]](https://www.pv-magazine-australia.com/2025/08/15/breakthrough-extraction-technology-a-silver-bullet-for-solar-panel-recycling/), [[6]](https://thewest.com.au/business/bulls-n-bears/lithium-universe-targets-silver-through-solar-panel-recycling-c-19353890)
* Paragraph 5 – [[1]](https://discoveryalert.com.au/news/solar-panel-recycling-silver-supply-chain-2025/), [[3]](https://www.pv-magazine-australia.com/2025/08/15/breakthrough-extraction-technology-a-silver-bullet-for-solar-panel-recycling/), [[6]](https://thewest.com.au/business/bulls-n-bears/lithium-universe-targets-silver-through-solar-panel-recycling-c-19353890)
* Paragraph 6 – [[1]](https://discoveryalert.com.au/news/solar-panel-recycling-silver-supply-chain-2025/), [[6]](https://thewest.com.au/business/bulls-n-bears/lithium-universe-targets-silver-through-solar-panel-recycling-c-19353890), [[7]](https://www.acap.org.au/post/a-truly-sustainable-solar-panel-recycling-industry)
* Paragraph 7 – [[1]](https://discoveryalert.com.au/news/solar-panel-recycling-silver-supply-chain-2025/), [[7]](https://www.acap.org.au/post/a-truly-sustainable-solar-panel-recycling-industry)
* Paragraph 8 – [[1]](https://discoveryalert.com.au/news/solar-panel-recycling-silver-supply-chain-2025/), [[7]](https://www.acap.org.au/post/a-truly-sustainable-solar-panel-recycling-industry)
* Paragraph 9 – [[1]](https://discoveryalert.com.au/news/solar-panel-recycling-silver-supply-chain-2025/), [[2]](https://www.unsw.edu.au/newsroom/news/2023/07/new-environmentally-friendly-solar-panel-recycling-process-recovers-valuable-silver), [[3]](https://www.pv-magazine-australia.com/2025/08/15/breakthrough-extraction-technology-a-silver-bullet-for-solar-panel-recycling/), [[6]](https://thewest.com.au/business/bulls-n-bears/lithium-universe-targets-silver-through-solar-panel-recycling-c-19353890)
* Paragraph 10 – [[1]](https://discoveryalert.com.au/news/solar-panel-recycling-silver-supply-chain-2025/), [[7]](https://www.acap.org.au/post/a-truly-sustainable-solar-panel-recycling-industry)

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## Bibliography

1. <https://discoveryalert.com.au/news/solar-panel-recycling-silver-supply-chain-2025/> - Please view link - unable to able to access data
2. <https://www.unsw.edu.au/newsroom/news/2023/07/new-environmentally-friendly-solar-panel-recycling-process-recovers-valuable-silver> - Researchers at UNSW Sydney have developed a patented sieving process that significantly improves the separation and extraction of valuable materials, particularly silver, from photovoltaic panels. This innovative method addresses the challenges of recycling solar panels by efficiently sorting components like glass, silicon, metals, wiring, and plastic, which are typically integrated in a way that makes them hard to separate. The new process enables the recovery of 99% of silver from solar cells, facilitating the reuse of materials and reducing environmental impact. The technology also offers a more environmentally friendly approach compared to traditional methods, which often involve high heat and toxic chemicals. This advancement is crucial as the first generation of solar panels installed in the 1990s approaches the end of their 20-25 year lifespan, highlighting the need for effective recycling solutions to manage the growing volume of solar panel waste.
3. <https://www.pv-magazine-australia.com/2025/08/15/breakthrough-extraction-technology-a-silver-bullet-for-solar-panel-recycling/> - Macquarie University researchers have developed a breakthrough technology called Jet Electrochemical Silver Extraction (JESE) to efficiently extract silver from decommissioned solar panels. This method directs a thin stream of weak acid onto the silver in solar panels, dissolving the metal in seconds while leaving other components untouched. Unlike traditional recycling methods that grind panels into powder and use harsh chemicals, the JESE technology preserves glass sheets and silicon wafers, making them suitable for reuse in semiconductor manufacturing. This innovation addresses the challenges of recycling solar panels by enabling the recovery of valuable materials with minimal environmental impact, aligning with the growing need for sustainable resource management in the renewable energy sector.
4. <https://www.sciencedirect.com/science/article/abs/pii/S1364032124009316> - A review published in the journal Renewable and Sustainable Energy Reviews discusses the potential of recycling silver from end-of-life photovoltaic (PV) panels. The study highlights that silver is a critical component in PV cells, and as the global demand for silver increases, recycling from PV panels presents a viable solution to meet this demand. The review examines various recycling techniques, including mechanical, chemical, and thermal methods, and emphasizes the importance of developing efficient processes to recover silver and other valuable materials from PV waste. It also discusses the economic and environmental benefits of recycling, such as reducing the need for mining and minimizing environmental pollution. The study underscores the need for further research and development to optimize recycling methods and enhance the sustainability of the PV industry.
5. <https://www.solarcycle.us/resources/powering-the-us-manufacturing-renaissance-with-recycled-solar-panels> - Solarcycle, a company specializing in solar panel recycling, has been actively contributing to the U.S. manufacturing renaissance by recycling retired solar panels and returning valuable materials to the supply chain. In 2024, Solarcycle recycled nearly 500,000 panels from over 80 partners, recovering more than 3.5 million pounds of aluminum and over 365,000 pounds of solar metals, including silver, copper, and silicon. These materials are reintegrated into domestic manufacturing, reducing dependence on foreign sources and strengthening the domestic supply chain. Solarcycle's efforts align with the growing emphasis on sustainable practices and the circular economy, highlighting the importance of recycling in the renewable energy sector to support manufacturing and reduce environmental impact.
6. <https://thewest.com.au/business/bulls-n-bears/lithium-universe-targets-silver-through-solar-panel-recycling-c-19353890> - Lithium Universe Limited has initiated a project to extract silver from discarded photovoltaic (PV) solar panels, leveraging technology developed by scientists at Macquarie University in Sydney. The company secured exclusive global rights to Macquarie University's microwave joule heating technology (MJHT), which uses microwaves to soften the plastic encapsulant in solar panels, enabling efficient delamination at room temperature. This process facilitates cleaner material separation compared to traditional mechanical crushing and recycling methods, which often result in lower recovery rates. The project aims to address the growing volume of solar panel waste, projected to reach 78 million tonnes by 2050, by recovering valuable materials like silver, silicon, gallium, and indium, thereby strengthening supply chains and reducing dependence on new mining operations.
7. <https://www.acap.org.au/post/a-truly-sustainable-solar-panel-recycling-industry> - The Australian Clean Energy Council (ACAP) emphasizes the importance of developing a sustainable solar panel recycling industry to address the challenges posed by the increasing volume of end-of-life photovoltaic (PV) panels. With projections indicating that Australia will face 2 to 3 million tonnes of solar panels at the end of their working life by 2050, the ACAP advocates for a mandatory national stewardship scheme to maximize reuse and recycling, preventing panels from ending up in landfills. Recycling solar panels offers multiple benefits, including preventing depletion of silver reserves, avoiding environmental pollution from hazardous materials, creating revenue through the resale of valuable materials like aluminum, copper, silver, and silicon, and reducing the environmental impact associated with producing raw materials for new panels. The ACAP calls for coordinated efforts to establish a truly sustainable recycling industry that supports the growth of renewable energy while minimizing environmental impact.