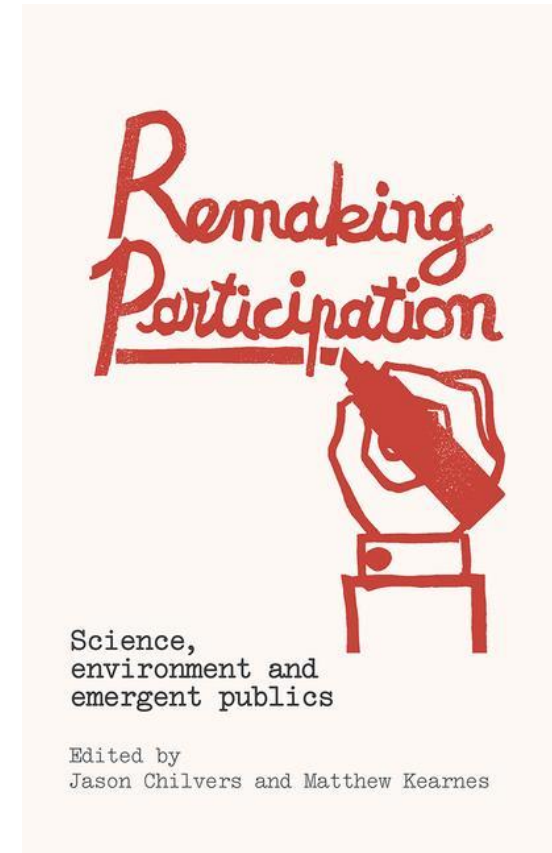
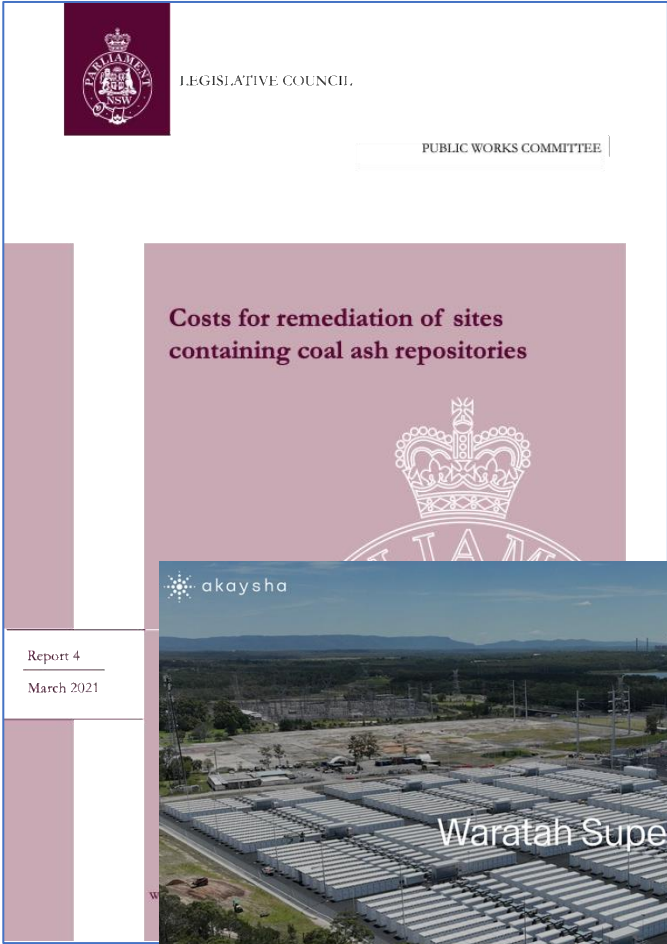
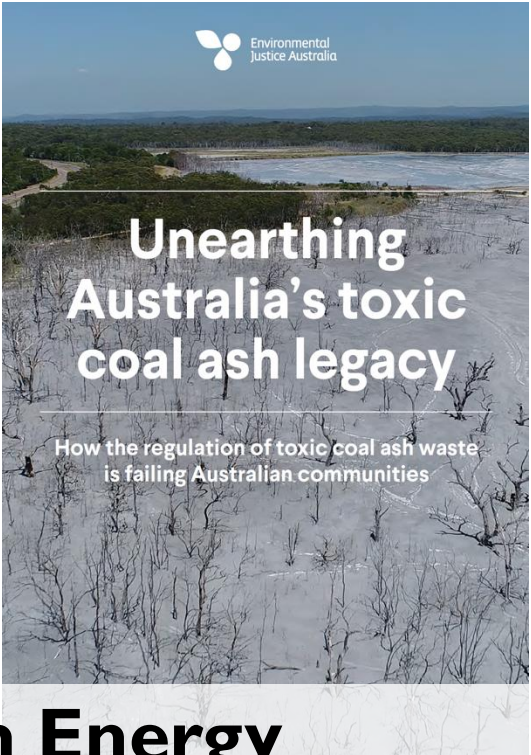
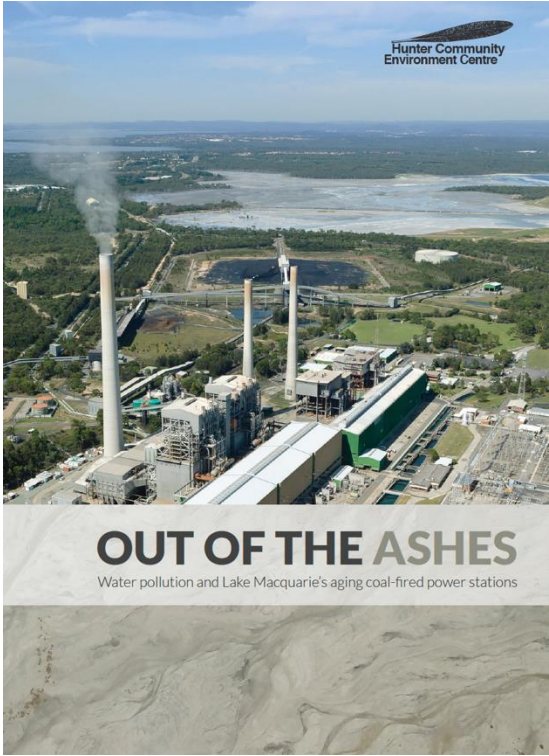


# Waste to and from energy

Matthew Kearnes, UNSW





Continuous active power capacity

**+700** MW

Useable energy storage capacity

**+1400** MWh

Square Metre site

**+138,000** m<sup>2</sup>

# Act I: Waste from Energy



# Towards a repair research agenda for off-grid solar e-waste in the Global South

Paul G. Munro<sup>1</sup>✉, Shanil Samarakoon<sup>1</sup>, Ulrich E. Hansen<sup>2</sup>, Matthew Kearnes<sup>1</sup>, Anna Bruce<sup>1</sup>, Jamie Cross<sup>4</sup>, Sarah Walker<sup>5</sup> and Collen Zalengera<sup>6</sup>

**There has been a boom in the sale of small-scale off-grid solar products across the Global South over the past decade. A substantial portion of this boom has been driven by international investment in off-grid solar start-up companies, and a formalized off-grid solar sector has been established, with the Global Off-Grid Lighting Association acting as a key representative body. Although this boom has aided in extending electricity access to many energy-poor households and businesses, an emerging concern is the short (three to four years) working life that these off-grid solar products typically have. This has led to a growing issue of solar e-waste. Here we examine how the structure of the off-grid solar sector results in substantial barriers to addressing solar e-waste in the Global South. We consider how practices of repair might contribute to addressing the issue, and set out a research agenda to facilitate new approaches to the issues of solar e-waste.**

The sale of off-grid solar (OGS) products—in the forms of solar lanterns and small solar home systems (SHSs)—has experienced an unprecedented boom in the Global South over the past decade. In 2019 alone, more than 35 million solar products were sold (equating to around US\$1.75 billion in sales), a precipitous rise from the 200,000 products sold in 2010 (Fig. 1)<sup>1</sup>. In part, this boom has been driven by the rapid and substantial decrease in the price of components for these systems, which has led to the establishment of an OGS private-sector industry in the Global South<sup>2</sup>, and the emergence of an OGS industry that has attracted more than US\$2 billion in investment (equity and debt) since 2010<sup>3,4</sup>.

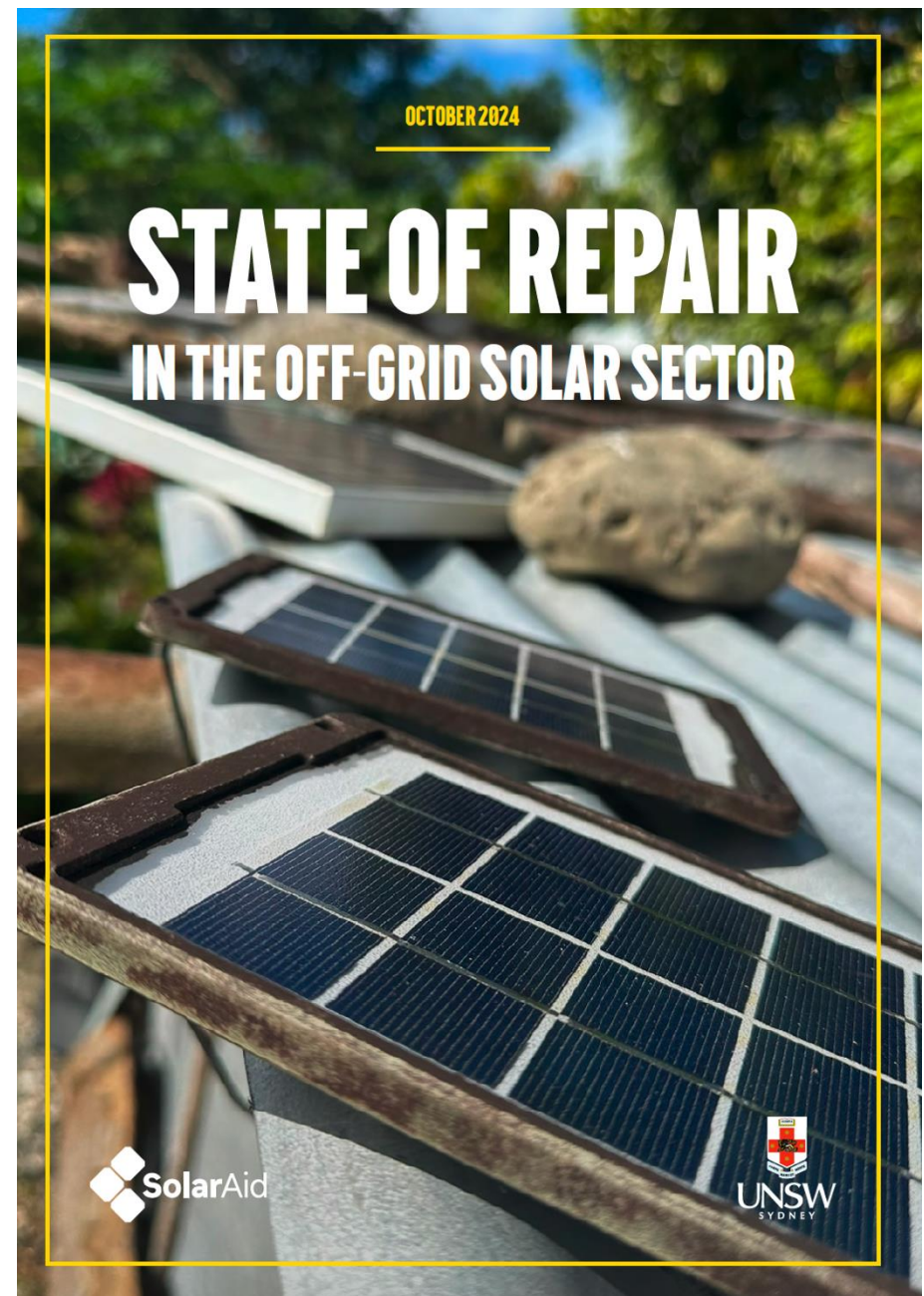
Established predominantly in East Africa, a range of OGS start-up companies in this sector are increasingly expanding their operations to other regions in the Global South experiencing energy poverty, including broader sub-Saharan Africa, South Asia, South-East Asia, the South Pacific and Latin America<sup>5,6</sup>. These companies tend to use a range of financial and technology innovations to facilitate the ‘last-mile distribution’ of solar products across the Global South. Solar lanterns initially dominated sales in this sector (comprising an estimated 160 million of the 200 million OGS products sold since 2010); however, pre-packaged SHSs are becoming increasingly prominent (40 million sold since 2010)<sup>7</sup>. Early on, these SHSs were basic—comprising a few lights and a plug for mobile phone charging. Since 2016, however, they have become more sophisticated and often include radios, television sets and fans.

A striking dimension of what Munro terms the private-sector-driven ‘photovoltaic turn’ in the Global South<sup>8</sup> is the way in which OGS is celebrated as a key means to address the overlapping challenges of energy poverty as encoded by the United Nations Sustainable Development Goal 7 (SDG7) alongside adaptation to climate change and decarbonization<sup>9</sup>. As Paterson and Strippel argue, in the case of carbon offset markets, the virtuous qualities of ‘green’ technologies have been critical in the construction of novel environmental markets<sup>10</sup>. In a similar way, solar technologies generally, and OGS technologies more specifically, are often

encoded as unambiguously morally good<sup>11</sup>. However, in the wake of this triumphalist story of off-grid electricity roll-out and access, the altogether murkier story of solar waste has become apparent<sup>12,13</sup>. As Cross and Murray note<sup>12</sup>, an overlooked socio-cultural and political dimension of the OGS market in Africa in recent years is the question of what happens to these solar technologies when they break down.

Accentuating this issue is that many, perhaps even the majority, of solar products sold in the Global South are described as being ‘generic, copycat and counterfeit (photovoltaic) products’<sup>13</sup>, and often only have working lives of a couple of years. Even branded, small-scale solar products usually only have one-year warranties, with an expected working life of three to four years<sup>12,14</sup>. Thus, the expected increase in the disposal of off-grid solar e-waste (SEW) in the Global South ‘is potentially the dark side of a promising innovation’<sup>2</sup>, a problem that was predicted several years ago<sup>15</sup>.

In the shadow of the 200 million products (and associated appliances) sold since 2010, is a wave of waste that much of the Global South is poorly equipped to deal with due to the decentralized nature of OGS products<sup>16</sup>. Although solar suppliers and investors in the Global North have only recently started to take action on managing e-waste, they tend to sell much larger and more expensive solar systems with working lives of about 25 years, and operate in contexts with comparatively stronger regulatory frameworks, including quality standards and waste management infrastructure. OGS products sold in the Global South, including photovoltaics (PV), batteries (lead-acid and lithium) and lights, contain ‘various hazardous materials, such as lead, cadmium, mercury and sulfuric acid, which may cause serious adverse effects to humans and the environment’<sup>2</sup>. Given that hazardous waste geographies disproportionately affect poor and marginalized communities<sup>17</sup>, if solar waste issues are left unaddressed, they could play a role in undermining SDG10 (reducing inequality) and SDG12 (responsible consumption), as well as goals relating to health and water.



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## Mission 300 is Powering Africa

Connecting 300 million People to Electricity

FACTSHEET



Mission 300 is an ambitious effort by The World Bank Group and the African Development Bank, with the support of partners like The Rockefeller Foundation, to connect 300 million people to electricity in Sub-Saharan Africa by 2030. Mission 300 will accelerate the pace of electrification in Sub-Saharan Africa while ensuring that the transition to more diversified and cleaner sources of energy meets growing demand, brings economic growth, and creates jobs.

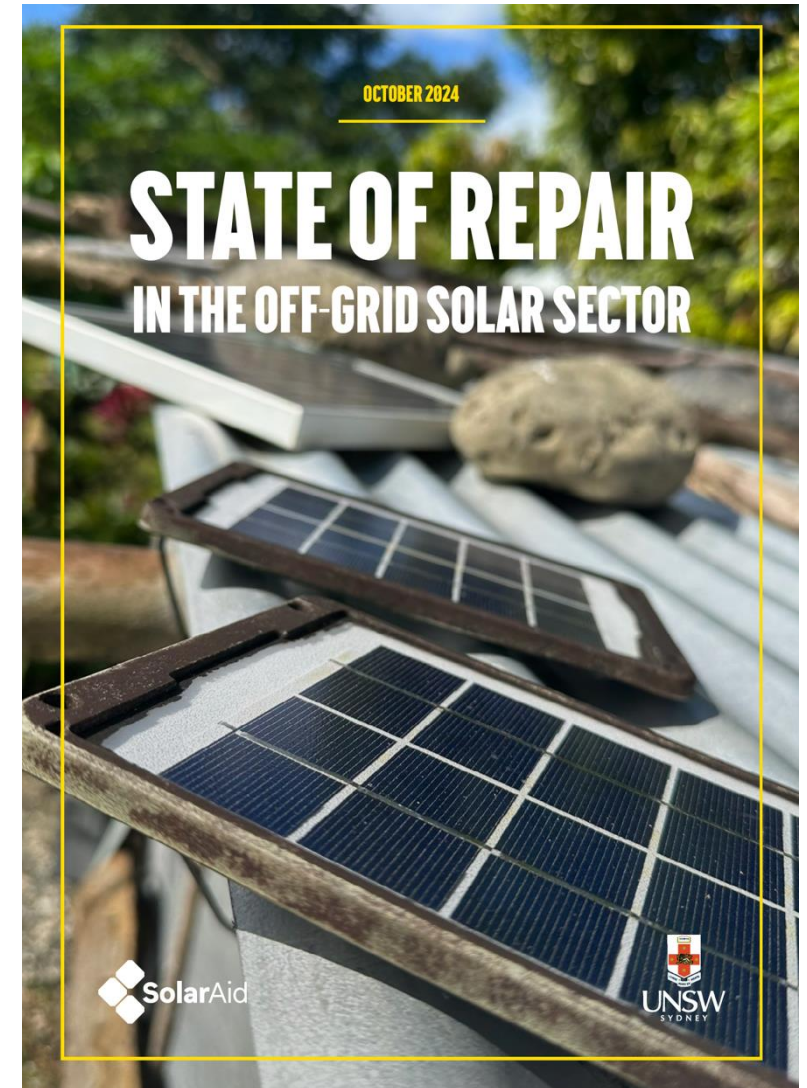
## Act 2: Repairable energy

#### Key insights from the survey include:

- 90% of all off-grid distributors are already delivering some kind of repair service as a part of their operations (most of the other 10% expressed a desire to deliver these services, but were early-stage firms that were not yet in financial position to do so).
- Batteries are by far the most likely failure point in off-grid solar products, sometimes causing a product to become obsolescent even when all other components are perfectly functional.
- Access to spare parts is a major logistical challenge for off-grid solar distributors across the Global South.
- New, replicable, business models are needed to increase repair services to the last mile.
- There are differing perspectives between manufacturers and distributors in terms of how repair is currently operating, and who should be conducting repairs – this has resulted in some tensions.
- There is an increasing interest in repairable design as a core approach for the sector.

#### Key recommendations emerging from the survey include:

1. Strategies are needed to ensure there is better access to spare parts;
2. Integrate more repairable design across the sector and enhanced consumer protection; and
3. Business model testing, training and sharing for a range of different repair approaches.



## Act 2: Repairable energy



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3 October 2024

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Kennedy Gondwe  
BBC News, Kariba Dam



Kariba Dam was built in a gorge between Zambia and Zimbabwe holding back the Zambezi River to create a man-made lake

# Act 2: Repairable energy

# Modern waste-to-energy plants claim to be safe but these Melbourne residents aren't convinced

By Norman Hermant 7.30 Recycling and Waste Management

Posted 8 Jun 2026 at 4:33pm



Sunbury has hosted landfill for more than two decades, now with plans for a waste-to-energy incinerator. (ABC News: Norman Hermant)

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## Parkes Shire Council formally opposes controversial waste incinerator

By Joanna Woodburn ABC Central West Recycling and Waste Management

Posted Wed 18 Feb 2026 at 8:04am, updated Wed 18 Feb 2026 at 9:19am



The Parkes Shire Council has formally objected to plans for a waste to energy plant on the edge of town. (Supplied: Parkes Clean Future Alliance)



Legislative Council  
Economy and  
Infrastructure Committee

### The development and expansion of waste-to-energy (WtE) infrastructure in Victoria

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Inquiry  
August 2026

Published by order, or under the authority, of the Parliament of Victoria  
August 2026

ISBN 978 0 908262 96 0 (print version)  
ISBN 978 0 908262 97 7 (PDF version)  
This report is available on the Committee's website:  
[parliament.vic.gov.au/elic](http://parliament.vic.gov.au/elic)

# Act 3: Energy from waste

# The promise of circularity?

## The Sydney Morning Herald

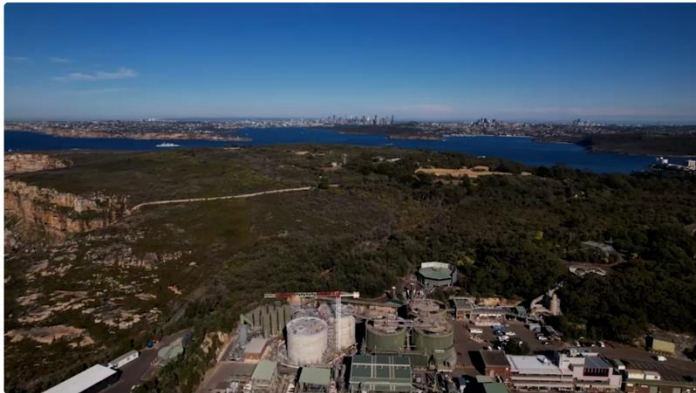
### How sewage from a million Sydneysiders helps grow the wheat we eat



Angus Dalton  
August 15, 2023 – 8:30am

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For more than two decades, solids recovered from wastewater have been processed and transported to the Central Tablelands to nourish crop fields and pastures.



Now Sydney Water is appealing for farms on the outskirts of the city to consider using fertiliser from human waste, called biosolids, to grow the crops that end up as products in our pantries. But the concept doesn't always sit easily.

Australia produces about one and half million tonnes of wet biosolids each year and the proportion of the product used in agriculture has jumped from 55 per cent to 73 per cent since 2010.

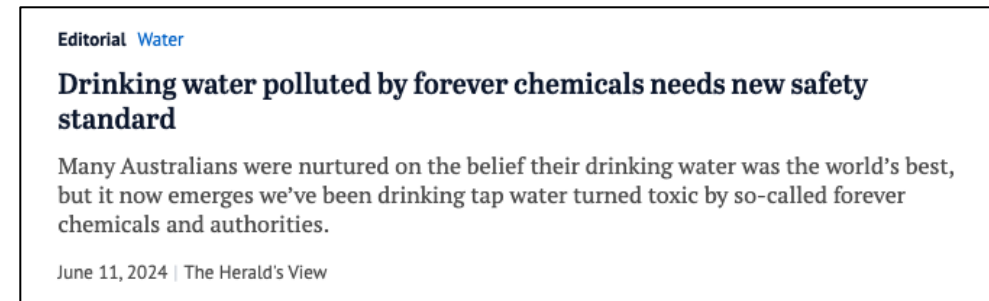
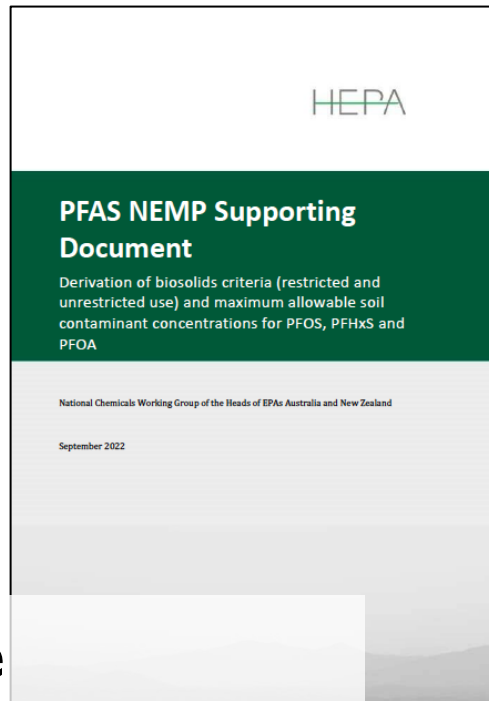
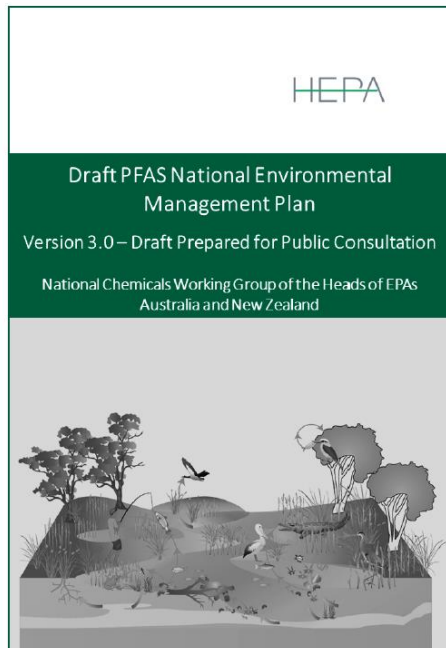
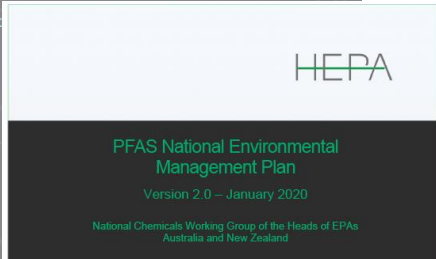
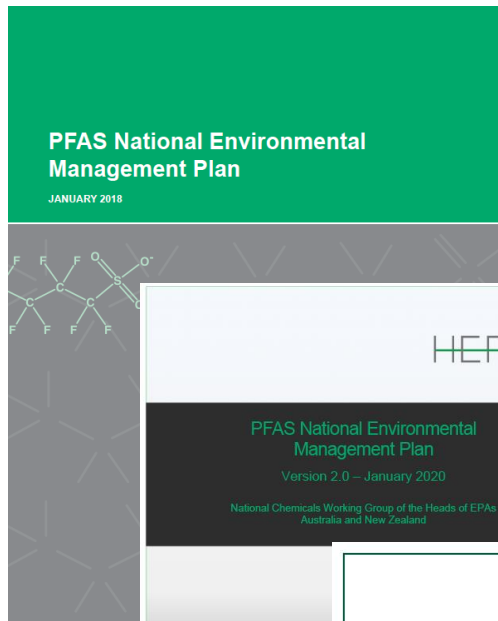
The digesters contain anaerobic bacteria that consume sewage sludge, the solids left over once the liquid effluent is pumped out to sea. Once digested for at least 30 days, centrifuged and dried, sludge turns into biosolids, a more stable, useful product with a texture compared to plasticine.

“There’s still a taboo,” Professor Andy Ball, director of the ARC Training Centre for the Transformation of Australia’s Biosolids Resource at RMIT University, said. “Everybody puts chicken manure or cattle manure on the garden, but the very thought of putting on human manure is repulsive.

The centre is also researching ways to address concerns about pollutants in biosolids. Because they’re derived from humans, everything that flushes down toilets and into drains – pharmaceuticals, detergent, microplastics and PFAS chemicals – can end up in biosolids too.

“We’ve got a glut of biosolids, so we have to find more uses,” Ball said. “There’s more production than demand at the moment.”

## Act 3: Energy from waste



Act 3: Energy from waste

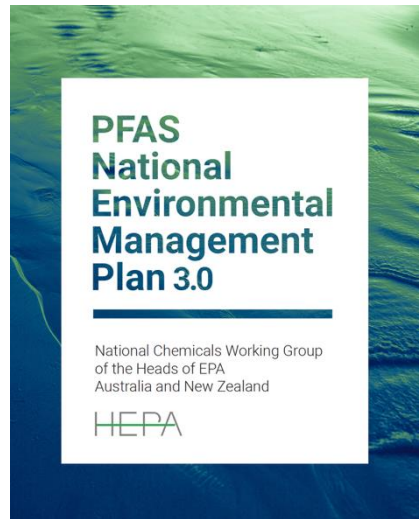
## 'Forever chemicals' found in Sydney sewage by-products used in food production

By Xanthe Gregory By Joanna Woodburn Stateline Environmental Health

Tue 17 Dec 2024

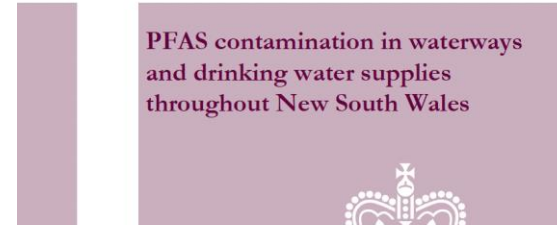


Biosolids contaminated with PFAS found in food production.



LEGISLATIVE COUNCIL

SELECT COMMITTEE ON PFAS CONTAMINATION IN WATERWAYS AND DRINKING WATER SUPPLIES THROUGHOUT NEW SOUTH WALES



### Finding 15

180

There is a lack of transparency and adequate regulation around the historical application of biosolids in New South Wales. This includes insufficient monitoring of downstream impacts on soil and water quality, despite evidence linking biosolid use to PFAS contamination in waterways such as the Belubula River.

### Finding 16

180

The revised standards under the PFAS National Environmental Management Plan Version 3.0 could render a significant proportion of biosolids produced by New South Wales water utilities unsuitable for agricultural reuse. This highlights the urgent need for phasing out PFAS chemicals, investment in treatment technologies and improved monitoring and compliance systems.

### Recommendation 29

181

That the NSW Government urgently undertake a comprehensive, state-wide audit of past and current sites where biosolids have been applied, including agricultural land, forests, mine remediation sites and composting facilities, to identify and monitor potential PFAS contamination.

### Recommendation 30

181

That the NSW Government expand the PFAS Investigation Program to specifically include biosolids as a focus area, and ensure monitoring occurs downstream from biosolid application sites, including testing of soil, groundwater, and adjacent waterways.

# Act 3: Energy from waste

# Acknowledgements

Biosolids – Pat Bonney & Lauren Rickards

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**Australian Research Council**



**Sustainable  
Communities  
and Waste**

**National Environmental Science Program**