New South Wales Government
Independent Planning Commission

IVAN ROBERT KENNEDY		**OBJECT**	Submission ID: 240002
Organisation:	*N/A*	Key issues:	*Land Use Compatibility/Conflict,Biodiversity*
Location:	*New South Wales 2113*		
Attachment:	*Attached overleaf*		

Submission date: 18/02/2025 20:44

See attachment

Muswellbrook Solar Electricity Generating + BESS – Independent Planning Commission NSW

'Development of a 135 megawatt (MW) solar farm including a battery storage facility and associated infrastructure. Reference number: SSD-46543209

Risk Management Research is Needed, Now

My interest in this Solar Farm stems from my professional expertise developed at the University of Sydney, managing chemical risk for farmers. Our expertise has been commissioned on many occasions in the past 40 years by official organisations (e.g. APVMA, NFF, CRDC, Qld Canegrowers, etc).

I will discuss just one of the heavy metal usually embedded in solar panels and its potential risks - silver. Silver is preferred because it speeds up electron transport from sunlight in a voltage gradient, for better efficiency. Unlike gold, silver can be reactive. Another area for which I claim more recent published expertise is in meteorology. A solar farm may pose cross-disciplinary environmental risks, even including storms, interacting with each other.

Each solar panel rated for 400 W would contain about 10-20 g of dispersed silver (Ag) (Rout et al., 2025), as well as copper and cadmium. A 135 MW facility could contain up to 7 tonnes of silver, dispersed in the glass panels. Silver may be the major metal component in these solar cells. Even a small lifetime leaching rate of less than 1% could lead to serious 'forever' contamination of soil, preventing plant growth. .

i) My first question is whether the risks of toxic contamination of soil have been scientifically assessed. The response given below by the Department of Planning referring to new panels, many of which are rated faulty at installation, is inadequate. Misadventure such as thunderstorms with large hail destroyed much of a functioning Houston solar farm in Texas, USA, in March, 2024, two years after commission. This is not an isolated incident. This toxic metal in panels can without doubt be oxidised in runoff water to an ionic form (Ag+) and then bound by organic matter or clays in soil. Silver ions are at the high scale of heavy metal toxicity just below mercury (Tsepina et al. 2022); they bind in ionic form to essential components of living systems like enzymes and rank next after chromium on the list of mutagenic substances, potential carcinogens.

ii) According to available information, a concentration of silver in soil considered toxic generally falls within the range of 1-10 mg/kg depending on the soil type and the form of silver present in soil (Tsipina et al., 2024); however, concentrations as low as 0.1 mg/kg may show detrimental effects on soil microbial communities in certain situations. Such a low concentration might be reached with as little as 0.1% lifetime leaching of silver from panels.

iii) An accurate calculation is not possible without exact solar farm specifications, but for soil density of 1.3 or around 1,300 kg per cubic metre, and for a mid-range toxicity 5 mg/kg (5 ppm by weight), then a total release of only 1.3% or 650 mg of silver per metre square from a panel supporting 50 g of silver could contaminate 130 kg of soil to a depth of 10 cm, enough to prevent all surface plant life. However, even low concentrations of Ag from leaching near one part per billion in water and soil can be expected to show some toxicity to soil bacteria and other organisms.

Sterilisation of drinking water from *Legionella* is commonly achieved by electrolytic formation of very dilute silver ions (Ag^+). Once released as leachate, all metal ions will then bind firmly to surface soil irreversibly and the contaminated area lost to agriculture as a hazardous site, probably forever.

iv) The Western Downs Green Power Hub in Queensland is Australia's largest operating solar farm. It has a capacity of 460 megawatts (MWp) and is made up of over one million solar panels on 1,500 hectares of land. So 460 MW has an estimated 23,000 kg of silver with an overall toxic coverage of about 1,500 mg per square metre, or 11.5 ppm (mg/kg) if restricted to the top 10 cm.

v) A monitoring program for leakage from storm and hail damage should be a requirement for operation of solar farms. This leaching is expected to increase with time as the pure metal gradually diffuses as a result of the gradient in its activity.

Risk research for the probability of toxic impacts is needed.

vi) My second question regards meteorology over solar farms. My question is what is the likelihood of major hailstorms in the 20-year life cycle of solar panels. The 350 MW Fighting Jays solar farm's lifetime for many of the panels was reduced to less than 2 years from July 2022. If these cells include heavy metals like silver, there would be irreversible loss of much of the soil under the panels. Research is needed to determine the risk of leaching under such circumstances. Is it possible that the low albedo of solar panels absorbing solar panel to a warmer temperature could even increase the likelihood of thunderstorms, as a focus for convection (Branch et al., 2024). A warmer surface on solar farms will cause more evaporation, providing the huge latent heat energy that of water vapour that at 5% of air can power major major storms.

Risk research and management is needed here too. There may be ways of reducing damage, such as protection from storm or hail damage, such as orientation.

Professor Penelope Crossley [redacted], to my knowledge has already advised NSW Parliament on this matter of inadequate faulty or end-of-life panel disposal, provided as expert legal opinion; it is my understanding that no legal methods of disposal for used solar panels are currently available in Australia. This clearly confirms their hazardous toxic nature.

My brief analysis concludes with the following recommendations:

(i) A lifetime risk analysis be performed for this solar farm before proceeding, including clear responsibility for safe methods of panel disposal, given chemical recycling in Australia is not economic. We cannot accept a high probability for losing any of our productive soils, either from future agriculture or the natural environment.

(ii) A condition for approval for construction of solar farms, long term leaching rates of heavy metals from modules like silver and cadmium must be measured on site as due diligence. This submission has focussed on silver, which is about 0.1% of the weight of each solar panel, similar to that of equally toxic cadmium; the latter is often associated with zinc coating made to protect metal sheeting, or low quality phosphate fertiliser, a problem farmers already experience.

Who will be responsible? Properly conducted periodic analyses of soil under solar installations should be performed annually to help ensure environmental safety is guaranteed. Such soil and water analysis is readily available commercially, or in government departments. If serious leaching is detected, who will enforce replacement with non-leaching panels.

(iii) I dispute the short-term conclusion made without chemical research by Nicole Brewer of the Department of planning and Environment below that "*the use of metals in solar panels has not been found to pose a risk to the environment. To readily release contaminants into the environment, solar panels would need to be ground to a fine dust*". On the contrary, despite being embedded in glass or plastic when made, pure silver atoms and molecules such as sulfides will always diffuse away at a measurable rate, given sufficient time and high temperature, because of the large thermodynamic gradient and increasing entropy, an area of my expertise. This corrosion and dispersion is natural, recognised by many publications as significantly diminishing the efficiency of solar modules containing silver or protective plastic; attempts to generate more durable solar cells exist (Li et al. 2020; Jeffries et al. 2021; Fairbrother et al. 2022), which should be considered.

Nover et al. (2021) have confirmed leaching using photovoltaic modules focussing on cadmium for 1.5 year leaching experiments, only one-tenth the expected module lifetime. Short- term experiments with crushed PV modules are irrelevant, given the absence of disruptive environmental variables of oscillating temperature, leaching by acid rain water with pH value less than 7 and significant ultraviolet radiation, stressing the glass modules, causing their structural deterioration by separating their layers and increasingly exposing metals to leaching and reaction of silver with natural products in poorly drained soils such as H_2S. Shown in my analysis above in (iii), even 1% of average leaching would permanently poison the surface soil beneath each panel.

(iv) The cumulative likelihood of destructive meteorological events, particularly including hail in thunderstorms, should be estimated by modelling. Amongst the questions that could arise, whether the low albedo of solar panels of under 0.05, meaning almost no reflection of sunlight, could raise the probability of convective storm events by local warming, increasing the likelihood of thunderstorms even breaking photovoltaic structures.

Meteorologists have even proposed recently that very large blackened panels could be used to increase precipitation from convective rainfall (Branch et al. 2024); this would not apply to a 380 ha low albedo site. Hail damage might be minimised by orientation of panels, and protective shielding in storm prone areas of higher humidity. Such measures should be investigated as risk mitigation by proprietors for insurance.

I make this submission citing my references that supported my 5-minute verbal presentation to the IPCN on February 12. I am grateful for that opportunity, requesting that risk management

and research are employed as far as possible, with clear guidance for responsibility of action, to minimise the likelihood of serious unintended consequences.

Yours sincerely,

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Submissions DUE - 19th February 2025

https://www.planning.nsw.gov.au/sites/default/files/2024-11/renewable-energy-planning-framework-faq.pdf

https://www.planning.nsw.gov.au/sites/default/files/2023-03/large-scale-solar-energy-guideline-faq.pdf

Appendix; Do solar panels contaminate soil?

The metals in solar panels (including lead, cadmium, copper, indium, gallium and nickel) cannot be easily released into the environment. This is because metals such as cadmium telluride (CdTe) or cadmium sulfide (CdS) are enclosed in thin layers between sheets of glass or plastic within the solar panel. **Because of this, the use of metals in solar panels has not been found to pose a risk to the environment.**

To readily release contaminants into the environment, solar panels would need to be ground to a fine dust.

Begin forwarded message:

From: Nicole Brewer [redacted]

Date: 15 August 2022 at 8:04:07 AM AEST

To: [redacted]

Subject: Response to enquiry

Dear [redacted]

I understand you have spoken with Damien Griffin of the Water Enquiries Team and requested follow up on the issue of contamination risk from developments in the Riverina and that you considered there was a perceived conflict of interest with a former Department staff member now working for the Walla Walla Solar Farm.

In regard to your query regarding the issue of contamination, the metals in solar panels cannot be easily released into the environment. This is because the metals are enclosed in thin layers between sheets of glass or plastic within the solar panel. **Because of this, the use of metals in**

solar panels has not been found to pose a risk to the environment. To readily release contaminants into the environment, solar panels would need to be ground to a fine dust.

In addition, the conditions of consent require applicants to avoid causing any water pollution, as defined under Section 120 of the *Protection of the Environment Operations Act 1997*.

In regard to your query about former Department staff being employed by an applicant, I can confirm that his employment with the applicant commenced post approval of the Walla Walla Solar Farm and there was no overlap in his employment with the applicant and the Department.

In addition, I note that the Walla Walla Solar Farm was subject to a detailed assessment by the Department in accordance with relevant policies and guidelines and in consultation with government agencies and Council. The final decision was made by the Independent Planning Commission (IPC). The IPC assessment process included a site inspection and a public meeting.

Regards

Nicole

Nicole Brewer
Director, Energy Assessments
Planning and Assessment
Department of Planning and Environment
[redacted]
www.dpie.nsw.gov.au, 4 Parramatta Square, 12 Darcy Street Parramatta NSW 2150
Locked Bag 5022, Parramatta NSW 2124

References

Branch, O., Jach, L., Schwitalla, T., Warrach-Sagi, K., Wulfmeyer, V. (2024) Scaling artificial heat islands too enhance precipitation in the United Arab Emirates. *Earth Syst. Dynam*. 15, 109-129. https://doi.org/10.5194/esd-15-109-2024.

Meteorological scale for inducing rainfall

Fairbrother, A., Gnocchi, L., Ballif, C., Virtuani, A. (2022). Corrosion testing of solar cells: Wear-out degradation behaviour. *Sol. Ener. Mater. Solar Cells* 248, 111974.htpps://doi.org/10.1016/j.solmat.2022.111974.

Jeffries, A.M., Nietzold, T., Schelhas, L.T., Bertoni, M.I. (2021) Corrosion of novel reactive silver ink and commercial silver-based metallizations in diluted acetic acid. *Sol. Ener. Mat. Sol. Cells* 223, 110900. https://doi.org/10.1016/j.solmat.2020.110900.

Li, X., Fu, S., Zhang, W., Ke, S., Song, W., Fang, J. (2020) Chemical anti-corrosion strategy for stable inverted perovskite solar cells. *Sci. Adv.* 6: eabd1580.

Nover, J., Zapf-Gottwick, Feifel, C., Koch, M., Werner, J.H. (2021) Leaching via weak spots in photovoltaic modules. Energies, 14, 692 https://doi.org/10.3390/en14030692.

Long term experiments show "it is possible to leach out all … of the toxic elements from the photvoltaic modules".

Rout, S., Jana, P., Borra, C.R., Önola, M.A.R. (2025) Unlocking silver from end-of-life pholovoltaic panels: A concise review. *Ren. Sustain. Ener. Rev.* 210, 115205. https://doi.org/10.1016/jrser.2024.115205.

This article reviews existing recycling technologies, with acidic solutions among the most popular for extracting silver from solar panels.

Tsepina, N., Kolesnokov, S., Minnikova, T., Timoshenko, A., Kazeev, K. (2022) Soil contamination by silver and assessment of its ecotoxicity. *Rev. Agric. Sci.* 10, 186-205. https://doi.org/10.7831/ras.10.0_186.

Negative effects of silver greater than 0.5 ppm decrease plant growth, suppress growth of earthworms, decrease soil bacteria and inhibit soil enzymes Silver is the second most toxic substance after mercury. As for mutagenic properties, this reactivity series is somewhat different from the toxicity series Cr6+ >> Ag > Hg > Cd, > Mo6+, Pb > W6+ > Cu.