IPCN Presentation on Dinawan Solar Energy Hub + BESS – Spark Renewables Development of a 800 MW Solar Hub SSD-50725959. 1.2 GW of Wind Power and 300 MW BESS Included in the Total Hub

Complete Lack of Diligent Field & Environmental Risk Research Prior to This Development

An Expert Opinion Submitted by Professor Emeritus Ivan Kennedy to Independent Planning Commission NSW on Mar 4, 2026

Focussing on Solar Power, Attention is Drawn to Several Issues Lacking Diligent Prior Research for Environmental Risk and Its Mitigation.

I. **The Environmental Toxicity of the Solar Panels Employed to Soil and Livestock Subject to Slow Leaching or Its Acceleration by Hail Storm Damage; Recycling at End of Life Cycle is No Solution.**
II. **Possible Interaction Between Grazing Ruminants and rate of Degradation of Solar Panels; New Information Needing Research**
III. **Several Specific Questions Require Answers as Responses to These Issues**

Due diligence should be exercised in assessing risks to farmlands and environment when introducing renewable Solar or Wind Energy. The Independent Panel should justify its independence by ruling whether the gaps in diligence to be revealed here are valid, defining who is responsible. In my professional opinion based on years developing expertise in risk analysis, if the IPCN was truly diligent it could settle concerns I raise in my submission by requesting quality-controlled analyses of soil and ground water under existing solar facilities subject to more than 10 years of slow corrosion, as well as at sites where serious storm damage has occurred as I will foreshadow. However, no such analyses have been commissioned anywhere by Authorities, I assume for fear scientific results from these could halt development of solar power.

Negligent or legally culpable failure by authorities, proposers or planners to conduct risk research under Australian environmental conditions for solar farms can justify a class action for damages for loss of productivity in farmlands and the environment. While climate change is characterised by uncertainty in causes and remedies, lacking necessary prior research, this risk must loom larger. Unintended consequences become more likely.

From professional expertise developed in research on environmental and climate science at the University of Sydney, managing risks to agricultural productivity and toxicity for farmers,

my research group opposes this development. It is likely to damage productive farmland irreversibly and fails to diminish climate risks. For a previous submission on heavy metal toxicity from solar panels see Kennedy (2025, Submission 240002 Muswellbrook Solar Farm).

I: The Inherent Environmental Toxicity of the 800 MW of Solar Panels Employed

About 30 tonnes of metallic silver is embedded in the monocrystalline silicon solar panels at Dinawan (Balji et al. 2024), just under 0.1% of the weight of the installation. Crystalline silicon photovoltaic modules contain approximately 75% of the total weight from the surface of the module (glass), 10% polymer (polyvinylidene difluoride (organofluorine PVDF) & ethylene vinyl acetate (EVA)), 8% aluminum as framing, 5% silicon (solar cell), 1% copper (interconnectors) and 0.1% silver contact lines, with other metals like tin and lead. The cells are electrically interconnected by copper, creating a string of cells in series.

New solar panels have no immediate toxic effect, with heavy metals contained in glass, unless cells are broken. However, if only 1% of this chemical silver becomes leachate in the Dinawan solar panel lifetime of 20 years, because of extreme environmental conditions in temperature, ultraviolet radiation or impulsive pressures in meteorological hailstorms, then prime land needed for agriculture could be lost forever. Remediation of the top layer of soil from bound silver or other heavy metals will be economically impossible. Faulty solar panels are usually prohibited by government from disposal in landfill because of their heavy metal content, although the risk of contamination of groundwater is real, particularly if soil texture is low in organic-clay content with poor metal binding capacity. Silver is well known to be highly toxic to microorganisms (Levard et al., 2013).

II: Possible Harmful Interaction Between Grazing Ruminants and Degradation of the Solar Panels

Although grazing sheep under solar panels is even recommended, combining such a practice in close proximity to solar panels is probably incompatible. Hydrogen sulfide (H_2S) may be produced in anaerobic conditions deeper in soil, increased by deposition of manure and flooding by rainfall. Furthermore, sheep may exhale H_2S produced in the rumen and another sulphur-containing compound, dimethyl sulphide (DMS), is also exhaled by ruminants near ppm in eructed breath. DMS from breath of ruminants has been identified as contributing 10% of sulphur to the global atmosphere which was estimated to be between 2.1 and 5.5 Tg S yr^{-1} (Hobbs et al., 2001) There has been no recognition of beneficial contributions from livestock to DMS that regulates global climate by inducing cloud formation. Both of these gaseous sulfur compounds readily form sulfides with silver, particularly with a high surface area to weight ratio as in solar panels. The effect of these reactions on corrosion of silver in solar panels is unknown. Although Ag_2S is insoluble, the effect of flowing electricity in silver wires, daily variations in temperature near 100 ^oC and even mild acidity in rainfall has not been examined experimentally. Even low rates of corrosion over many years may have

a cumulative effect of leaching rates, potentially contaminating wool or meat of livestock and rendering them unsaleable. The risk of such accelerated corrosion and soil contamination cannot be ignored.

III. Specific questions addressed to Spark Renewables the IPCN

Q.1: What monitoring of leachate from solar panels will be conducted? Livestock such as sheep may be impacted by such leachate and quality regulations may prohibit marketing of such livestock as is normal for toxic constituents. This is explained in more detail below.

Q2: In case of major damage to solar panels, such as severe hail storms, hail damage shattering panels or bushfire possibly making silver and other metals volatile, what measures will be taken to mitigate accelerated release of toxic metals or PFAS or other constituents released to air from the panels?

Q.3: How will such responses and reports investigating such issues be regulated? Who will be responsible?

I. Monitoring risks of soil and groundwater contamination from toxic heavy metals

For crystalline photovoltaic cells, silver paste is applied to silicon solar cells of panels to speed up electron transport from sunlight in a voltage gradient, for better electrical output efficiency. Silver can be reactive, particularly with hydrogen sulphide (Mukherjee et al., 2025) formed by plant metabolism from photosynthesis and slowly in soils under anaerobic conditions of respiration. The ubiquitous blackening of silver-plated vessels is evidence of this process, allowing surface leaching as ionic silver sulphide. Thin-film panels containing cadmium telluride rather than silver contain about 7 tonnes of heavy metal per 100 MW of power (Zapf-Gottwick, 2021). Field research by Yousuf et al. (2024) showed rice field solar panels experienced an increase in Cd levels from 0.47 mg/ kg in 2022 to 1.55 mg/kg in 2023, although other metal concentrations decreased, probably a result of field surface variations and sampling challenges. In obtaining field data under solar panels, questions arise as to soil type and depth of infiltration of leachate from panels and the age of solar installations affecting the extent of corrosion.

Each solar panel rated for 400 W could contain about 10-20 g of dispersed silver wire (Ag) (Rout et al., 2025), as well as copper and other minor metals. A 500 MW facility could contain up to 20-30 tonnes of silver, dispersed in the glass panels, to improve flow of electricity. Even a small lifetime leaching rate of less than 1-5% could lead to serious 'forever' contamination of soil, preventing plant growth.

The specific heavy metal composition of the bifacial solar panel modules used at the Dinawan Solar Farm is not publicly detailed, so these literature values are assumed as approximate. The International Energy Agency Report for the Technology Collaboration Programme gives Figure 4 as one example of bifacial PERT solar cell scheme invented at UNSW, showing front and rear metal grid material of aluminium and silver (Ag). See https://iea-pvps.org/wp-

content/uploads/2021/04/IEA-PVPS-T13-14_2021-Bifacial-Photovoltaic-Modules-and-Systems-report. And

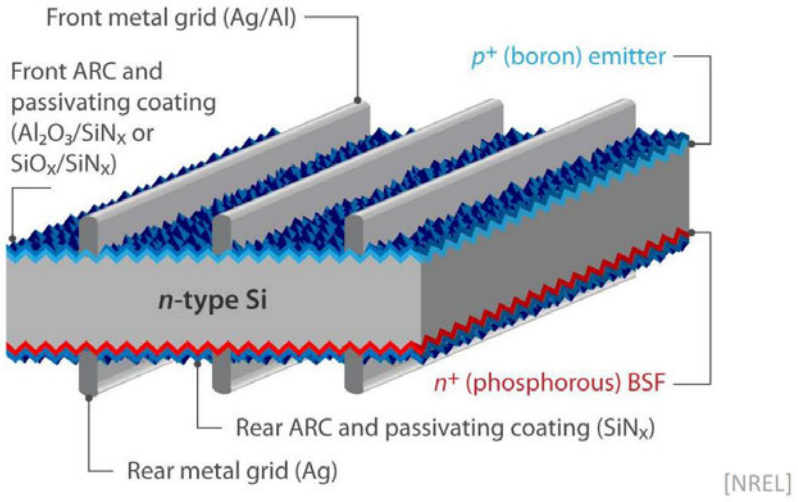

Figure 4: Typical bifacial n-PERT cell scheme.

More recently, shown as Figure 5 in the above reference, more efficient hetero-junction solar cells (HJT) that specify silver (Ag) only for front and rear metal grids have been developed and may be employed in the Dinawan depending on cost.

i) **Recommendation for immediate soil testing and future monitoring of current solar farms and urban panels sites.** Have risks of toxic contamination of soil been scientifically assessed by accurate monitoring under Australian conditions? Such a programme would require prolonged collection of runoff from panels and precision analysis after concentration of liquid samples. Short-term laboratory testing overseas has confirmed leaching of broken cells (Nover et al. 2021), but not for testing in solar panels after environmental stressing for years. In Australia, no peer-reviewed long-term statistically valid quality-controlled analyses of soil under solar panels have been conducted after 20 years maturing, despite some current retirement of solar farm sites, possibly for fear of positive results and lack of funding.

ii) **Likelihood of thunderstorms panel-shattering hail greater than 25 mm.** Misadventure such as thunderstorms with large hail destroyed much of a functioning Houston solar farm in Texas, USA, in March, 2024, just two years after its commission. This is not an isolated incident. Raupach et al. (2023) reviewed evidence for hailstorm damage in Australia. This July, Raupach and Aldridge (2025) published their modelled prediction that risk from hailstorms is increasing with warming, expected to increase hail size in the 21st century, potentially exceeding 100 mm in diameter. For eample, Kalgoorlie showed increases in both giant hail (from ~12% to ~21%) and 100 mm hail (from ~1% to ~2%). Even more common 25 mm hail stones can shatter glass-enclosed solar cells. Fragments from shattered panels will certainly be leachable to soil, with mildly acid rain. At least one such major hailstorm event is probable during the operation cycle of each solar farms of 20-30 years, a period claimed by manufacturers for operation retaining at

least 80% efficiency. Slightly thinner glass used in bifacial panels as proposed for Dinawan solar farm are reported to fragment more easily into smaller sizes (Solar Choice data) than monofacial cells. Once shattered on soil corrosion would be rapid by oxidation, leaching into runoff water as an ionic form (Ag^+), binding firmly with organic matter complexes with clays in soil. Silver ions are at the highest 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.

iii) **Estimating toxic concentrations in soil underneath panels.** According to available information, a concentration of silver in soil considered toxic generally falls within the range of 1-10 mg/kg (1-10 ppm by weight) depending on the soil type and the form of silver present in soil (Tsipina et al., 2024); however, even 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 to soil. Sterilisation of drinking water at risk from *Legionella* is achieved by electrolytic formation of silver ions (Ag^+). 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 out of 50 g silver would contaminate 130 kg of soil to a depth of 10 cm, enough to prevent all surface plant life. Alternatively, considering there is 50 g of heavy metal toxin in every kW of solar panels, 0.5 g or 1% would contaminate 130 kg of soil to 10 cm depth to 3.8 ppm by weight of soil. Once released as leachate from panels, heavy metal ions may bind firmly to surface soil and the contaminated area lost to agriculture as a hazardous site, possibly forever.

iv) **Need for risk research for the probability of toxic impacts**. A legitimate question regards chaotic meteorology (Raupach and Aldridge, 2025) that may be further induced over solar farms with low albedo. A warmer surface on solar farms will cause more evaporation, providing the huge latent heat energy of water vapour that at 5% of air powers major storms. What is the likelihood of major hailstorms in the 20-30 year life cycle of solar panels? The 350 MW "Fighting Jays" solar farm's lifetime for many of the panels was reduced to zero less than 2 years from July 2022. Research is needed to determine the risk of leaching under such circumstances, as conducted by Sharma et al. (2021) for solar panel waste, indicating USEPA toxicity characteristic leaching procedure (TCLP) leachate levels in ppm in water. This research study indicates that solar panels should not be disposed of at end-of-life in land fill, because of toxicity in ground water, particularly if at acidic pH values.

v) **Benefits of risk research and management of solar panels.** There may be ways of reducing damage, such as protection from storm or hail damage, such as orientation of panels, use of monofacial panels or avoidance of leachable sandy soils. Professor Penelope Crossley of the University of Sydney advised NSW Parliament on this matter of inadequate faulty or end-of-life solar panel disposal, provided as expert legal opinion; she stated that no legal methods of disposal for

used solar panels are currently available in Australia. This practice confirms their hazardous toxic nature, at variance with the Safe Energy Council. Dismantling and transport costs for the major components would be uneconomic and the quantities of silver involved from 30 million tonnes of super structure such as aluminium at Dinawan make recycling practically impossible.

This analysis makes the following recommendations:

(i) A life cycle risk analysis for the Dinawan site should first be performed, including clear responsibility for funding safe methods of panel disposal, given chemical recycling in Australia is not economic nor likely to be. We cannot accept a high probability of losing such an area of our productive soils, either from future agriculture or the natural environment.

(ii) Nover et al. (2021) have confirmed ease of leaching from photovoltaic modules focussing on cadmium for 1.5 year leaching experiments, less than one-twentieth the expected module lifetime. Short- term experiments with crushed PV modules are irrelevant, given the naturally more disruptive environmental variables of oscillating temperature, leaching by acid rainwater 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. Poddar et al. (2024) point to the greater rate of solar panel deterioration with warming. Meteorologists have even proposed recently that very large, blackened panels could be used to increase precipitation from convective rainfall (Branch et al. 2024); this could apply to a 15,000-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, as recommended by Raupach and Aldridge (2025).

(iii) Who is responsible for monitoring? Properly conducted periodic analyses of runoff and soil under solar installations should be performed at least annually to help ensure environmental safety is guaranteed. No long-term leaching experiments have been performed, suggesting too much confidence by the SEC and IPCN regarding safety because of the noble purpose of combating climate change. By contrast, trials including simulated hail damaged panels are needed. Such soil and water analysis is readily available commercially, or in government departments. If serious leaching is detected, who will enforce the process of replacement with non-leaching panels?

In the Muswellbrook Solar SSD 46543209 (27th May 2025), risks from solar panels (Kennedy, Submission 240002) were disregarded casually without counter evidence in the following statement:

The Large-scale Solar Energy Guidelines, Frequently Asked Questions (Guideline FAQ) states the following in relation to the potential for solar panels to cause contamination (pages 4-5): "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 or cadmium sulfide 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." The Commission acknowledges the community's concerns on contamination, however, accepts the advice of the Department as outlined in the Guidelines FAQ.

On the contrary, the potential for longer term toxic effects in soil is easily established by previous research elsewhere for the solar farm's anticipated 30-year term, including risks from storms. From other research this is beyond dispute. Nor has any diligent research on these risks been performed for the locality of Dinawan by IPCN. A moratorium on installation could be regarded as legally warranted, implying defence for operators of Dinawan Solar Farm, and the IPCN, in case of future class actions lack of diligence and losses of land productivity. Evidence that this detriment has occurred will be easily obtained, simply by comparisons with well separated control soils nearby not exposed to solar panels.

Our review shows that there are serious unanswered question regarding solar panel toxicity that could in future amount to local catastrophic consequences. No definitive research has been conducted globally. It also seems that silver is assumed as benign and often not even mentioned, So studies on its environmental toxicity have been almost completely neglected.

Clean Energy Council Has No Evidence and Recycling can Only be Post-Solar

A pamphlet (August, 2025) from the Clean Energy Council entitled *Debunking Myths about Solar Panel Toxicity* unwisely discounts longer term toxic risks from panels, claiming all metal contents can be successfully recycled, ignores the previous toxic life cycle. The Clean Energy Council has no evidence to guarantee such a costly requirement, given accountibility is not clearly allocated. Reliable evidence to the contrary is presented below of recycling's ineffectiveness, because it assumes all panels will survive for processing. The CEC has ignored the fact that only traces of heavy metal content, such as silver, cadmium, selenium, lithium, copper and even silica itself are needed to express lethal toxicity to living organisms. Silver ions are the second most toxic after mercury. The long life cycle of solar farms up to 30 years invalidates short term leaching tests on panels, unstressed by physical and chemical corrosion, including in turbulent storms, hailstorms and temperature extremes. The recycling concerns have very recently been taken up by researchers at Macquarie University in a patented Jet Electrochemical Silver Extraction (JESE) process, a "pressure washer" method using strong nitric acid to selectively dissolve and extract silver from discarded solar panels while leaving other components intact, including silicon wafers and glass. Their publicity confirms that standard solar panels contain 20 g of silver making the process possibly worthwhile since 630 g per tonne of solar panels, this is similar in content to average silver ores (Balaji et al. 2024). However, such recycling is only possible "after the event" with respect to possible soil and groundwater contamination.

Concern Regarding 1.2 GW of Wind Turbine Wakes at Dinawan

There is also legally culpable neglect of environmental risk research on introducing renewable wind energy. Does this lack of due diligence ignore potential loss of agricultural productivity and increased bushfire risk?

Key points regarding wind facilities:

- Complete lack of diligent research on potential landscape drying effect of wind turbine wake turbulence. None has been commissioned nor funded by government regulators.
- This lack of environmental research is negligent because of the scale of government plans to introduce some 7000 turbines by 2050, each similar in height to the Eiffel Tower or Crown Casino Barangaroo, like building 70 new skyscraper cities. This must change local weather.
- Our published research below [7](https://doi.org/10.47852/bonviewAAES32021330) predicts turbulent heating of wake air, increasing evaporation by disturbing the boundary layer.
- Case studies concerning necessary expansion of (i) Gingin Fire & Rescue, north of Perth after wind turbines were installed in 2019 (ii) the Lahaina Maui fire of August 2023 when 102 people died in the wake of Maui's largest windfarm (iii) many other wildfires in areas with wind turbines probably made more intense by magnified ignition and heat release from extra drying of combustible litter. Climate change has been blamed, without evidence.

For detailed reviews of these cases see:

(i) Senate Committee of Inquiry on Energy Planning and Regulation, Submission 55 Kennedy 2024; see also 55.1 recommending 9 million ha Casuarinas as wood to replace coal. https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Energy_Planning_and_Regulation_in_Australia/EnergyPlanning

(ii) Select Committee on Information Integrity on Climate Change and Energy Submission 223 Kennedy 2025

Concluding With A Strong Recommendation to Pause Renewable Energy Introduction

Given uncertainty in causes of climate change and the probable futility of reaching zero carbon because of falling surface seawater pH values with warming calcification, emissions of CO_2 will continue (Kennedy et al., 2022; Kennedy et al., 2025a, 2025b). It is for this reason I object to these unnecessary developments that are scientifically futile. I predict that IPCN members will know that truth in the not too distant future. There is no urgency as Australia's renewables will only have a minor effect, if any, well after 2050.

We therefore recommend a pause for several years halt in renewable energy developments until benefits for managing climate change are proven. Risk management and quality controlled research should be employed to give clear scientific guidance for responsible

action. This will minimise the likelihood of the serious unintended consequences that we predict.

Yours sincerely,

[redacted]

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