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EIA CONSISTENCY AND THE POTENTIAL MICRO-CLIMATE IMPACTS OF SOLAR FARMS

1.0 INTRODUCTION

Solar energy is the most abundant of all renewable energy assets (1), with high levels of solar radiation and suitable land-mass making Australia an ideal location for large-scale solar developments (2). The growth of large-scale solar farms is a recent phenomenon for which best-practice environmental planning and assessment processes are still to be established. A solar farm is basically an area of land on which large arrays of interconnected solar panels are used to capture light from the sun and convert it into electricity with minimal air or noise emissions (1). Individual solar panels are made from toughened glass and are mounted on aluminium and steel frames in long arrays. The frames are inclined at an angle above the ground to minimise shading and maximise solar efficiency (1). As with the development of any major project, concepts of 'best-practice' and the 'precautionary principle' dictate that any potential impacts resulting from development should be fully assessed and mitigated prior to the project's approval. The difficulty with large-scale solar farms however, has been a lack of consistent assessment guidelines and a lack of knowledge concerning some of the more 'intangible' impacts of large-scale solar deployment.

2.0 ENVIRONMENTAL IMPACT ASSESSMENT AND CONSISTENCY

Consistency in Environmental Impact Assessment (EIA) has been a subject of debate ever since the adoption of formal EIA procedures around the world (3). EIA involves the identification, prediction and mitigation of the environmental impacts associated with proposed developments. In his paper on best-practice EIA within an Australian context; Macintosh (2010) describes the following principles as integral to achieving improved outcomes in Australia.

Table 1: Best-Practice EIA Principles

Best-practice principles for achieving improved EIA outcomes in Australia	
Purposive	EIA should aim to improve environmental outcomes
Cost-effective	EIA benefits should be at least cost to stakeholders
High level	EIA should be undertaken at the highest policy and planning level, rather than project level
Integrated	EIA should be integrated with other regulatory processes
Focused	EIA should employ a risk-based approach
Certain	EIA should provide certainty in all aspects of requirement and outcome
Timely	EIA should be conducted in a timely manner
Flexible	EIA should have sufficient flexibility to assess different projects and issues
Participative	EIA should include requirements for engaging with all stakeholders; including the community
Transparent	EIA should ensure that proponents and stakeholders have access to information and decision-making
Consistent	EIA should require and promote consistency across and within jurisdictions
Adaptive	EIA should promote adaptive environmental management
Precautionary	EIA should promote and implement the precautionary principle

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3.0 ASSESSMENT OF SOLAR FARMS

Australian jurisdictions see some industries, such as mining, heavily regulated. Others, such as the solar industry, are not regulated to the same extent. The environmental impacts and planning approval requirements of energy infrastructure projects in Australia tend to be assessed *primarily* at the state or territory level. In some states, large-scale solar projects may even be assessed by local councils. Approval pathways and EIA requirements therefore vary for large-scale solar developments in different jurisdictions; in other words; assessment and approval processes required in New South Wales, may not be the same as those required in South Australia. Further; what might be required in one region of a state, might not be required in the adjoining region. To understand the implications of this issue, it is necessary to consider the planning and policy frameworks required for solar farm development around Australia.

3.1 SOLAR FARM GUIDELINES

Australia does not have national guidelines that govern the development of large-scale solar farms, and in fact, most states of Australia have only recently prepared state guidelines.

The *Guide to Commercial Scale Solar Development in South Australia* was produced in 2014 at a time when the state's renewable energy investment was predominantly targeted to the wind industry. The guidelines identify the different development approval considerations for solar farms under the *Development Act 1993* and provide an overview of the types of technical studies required to support solar farm Development Applications, but do not provide detailed scopes for technical studies. The Relevant Authority is generally always State Government through the public infrastructure approval pathway (4).

Victoria's *Draft Solar Energy Facilities Design and Development Guidelines* were prepared in 2018 in response to community demand for a more integrated and coordinated approach to solar farm development (5). This was necessary as although all planning applications are assessed under the *Planning and Environmental Act* 1987, there is no central decision-making authority for solar farm proposals in Victoria; where local councils are often the Relevant Authority.

New South Wales' 2018 *Large-Scale Solar Energy Guideline for State Significant Development*, outline that solar projects that have a capital value of more than $30 million, or solar projects worth at least $10 million that are also situated in an environmentally sensitive area of state significance, are classified as State Significant Developments under the *Environmental Planning and Assessment Act 1979* and require the proponent to prepare an Environmental Impact Statement. (6).

Under the 2018 *Queensland Solar Farm Guidelines*, proposals are assessed by local councils through Development Applications lodged under the *Planning Act 2016*. Solar farms in Queensland generally fall into one of two categories of assessment: 1) Code Assessed, or 2) Impact Assessed (7).

At the Commonwealth level, the national EPBC Act is only relevant to solar farm approvals if the proposed development potentially impacts a defined matter of national environmental significance (usually a threatened or migratory flora or fauna species). Most proposed solar farm developments are not referred to the Commonwealth government for assessment under the EPBC Act.

4.0 POTENTIAL MICRO-CLIMATE AFFECTS OF SOLAR FARMS

An issue that has recently become of concern to the community is the potential micro-climate impacts of large-scale solar farms. Solar panels are made of dark-coloured glass and cover large areas of land; and in doing so they potentially alter the solar reflectivity of the ground surface (8). Albedo is a measure of the reflectivity of the earth's surface; it is the fraction of solar energy being reflected from the Earth back into space. Generally, dark surfaces have a low albedo and light surfaces have a high albedo. Whilst the 'heat-island' affect has traditionally been referred to in an urban context, the concept is now being considered in relation to the potential of large-scale soar farms to heat up an area or 'micro-climate' through solar panels reducing surface albedo, and hence potentially increasing temperatures (9).Very little information on this topic exists, which is not surprising given the recent development of the solar industry and the significant number of parameters involved in attempting to directly attribute the heating-up of an area to an adjacent solar farm development. What is certain is that the potential climatic effects of one solar farm would not be the same as those of another solar farm in a different location.

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To try and understand the potential impacts of solar farms on surrounding areas a literature review of academic research papers was undertaken. Only ten published papers were identified, and the locations, methodologies and outcomes of these studies all differ; however, several common findings have emerged (10,11,12,13):

- Temperatures in the centre of a solar farm may be slightly higher than ambient
- Temperatures return to ambient several metres above a solar farm
- Temperatures may be slightly warmer directly adjacent a solar farm
- Temperatures gradually return to ambient with distance away from the solar farm
- Air temperatures at ground level underneath panels may be slightly cooler during summer months
- Air temperatures directly above solar arrays may be slightly warmer at night and during warmer months

4.1 THE IMPORTANCE OF EIA CONSISTENCY IN AUSTRALIA

Best-practice EIA advocates for consistency across and within jurisdictions; and nowhere is this more important than for those issues for which there is a lack of understanding. Consistency does not only apply to approach and methodology; it also applies to the application of EIA across similar projects, consistency in assessment procedures, consistency in mitigation, and importantly; consistency in decision-making. This applies to national and cross-jurisdictional decision-making; particularly where different approval authorities are involved. As outlined above, large-scale solar farms may create a heat-island affect, which could heat up the local micro-climate directly above and adjacent to the solar farm. This may not be considered a major issue where a single solar farm is constructed in an area of low-agricultural value; but what about where a solar farm is developed in an area of high-value and sensitive agricultural production? What about where several solar farms are proposed for an area of high-value agricultural production? And what if these projects are subject to several different Relevant Authorities?

To review the EIA consistency of planning approval documents across Australia, a review was undertaken of development applications, planning permit reports and EIS's for proposed solar farm developments in South Australia, Victoria, New South Wales, Queensland and Western Australia. The approach involved reviewing publicly available planning approval documentation to determine statutory approval pathways, Relevant Authority and EIA issues. Of specific interest was whether the planning approval documentation involved consideration of the potential micro-climate impacts of solar farms. The results are outlined in the table below.

Table 2: Selected Solar Farm Approvals in Australia

	South Australia	**Victoria**	**New South Wales**	**Queensland**	**Western Australia**
Solar Farms Approval Documents Reviewed (in planning, construction or operation)	14	14*	15	54*	7*
Approval Pathway	Section 49 (Public Infrastructure)	General Scheme	State Significant Development (EIS)	General Scheme	General Scheme
Relevant Legislation	*Development Act 1993*	*Planning and Environment Act 1987*	*Environmental Planning and Assessment Act 1979*	*Planning Act 2016*	*Planning and Development Act 2005*
Relevant Authority	State Government	Local Councils	State Government	Local Councils	Local Councils
Environmental impact assessment	Yes	Yes	Yes	Partial	Yes
EPBC Referral Required	1	5	12	24	5
Consideration of micro-climate impacts	1	0	0	0	0
Consideration of mitigation for heat-island affects	No	No	No	No	No
Comments	Practically all renewable energy infrastructure projects sponsored under Section 49	Majority, but not all, of renewable energy projects assessed by individual local councils	All solar farm projects over $30 million deemed State Significant Developments and require an EIS	Majority, but not all, of renewable energy projects assessed by individual local councils	Solar projects assessed by local shire councils

* Not all approval documents available to review in detail. Stakeholder engagement material and council notifications may have been reviewed as an alternative.

Table 3 demonstrates the lack of consistency not only across Australia, but also within individual states. This in turn outlines the importance of consistent solar farm guidelines, although there are currently no national Australian solar farm development guidelines and little uniformity between existing state and territory solar farm guidelines. This is an issue not only for typical solar farm impacts such as ecological issues, visual amenity issues and loss of agricultural land, but particularly for poorly-understood issues such as potential micro-climate impacts.

5.0 MITIGATION OF THE POTENTIAL HEAT ISLAND AFFECT AND IMPLICATIONS FOR PLANNING AND POLICY

Environmental practitioners are bound by the precautionary principle, and for environmental practitioners who work in the field of planning and environmental approvals, this means that where the potential impacts of a proposed project are not definitively understood, management and mitigation measures should be applied as if the impact is *known* to exist.

The cooling effect of plants has traditionally been researched in relation to urban areas (14,15,16); where trees and parks have long been demonstrated to reduce local temperatures (15, 16). Tree species differ in their ability to both increase humidity and decrease air temperatures, with trees that have a high leaf area density and a high rate of transpiration being the most effective at cooling the environment (17). Attempting to determine the cooling effect of vegetation is complex and site-specific, with the cooling effect of plants varying with space, time and plant-specific properties (15). A recent study out of Denmark found that the cooling effect of parks and vegetated areas was determined by species group, canopy cover, size and shape of vegetated area. The study found that in an urban park scenario in Turkey, temperatures decreased with every percentage increase in tree canopy cover. Interestingly, *Eucalyptus*, *Acacia*, and *Olea* species were found to be more effective at cooling the local environment than several other selected species (15).

The implications of this cursory overview for large-scale solar farm planning are clear. With literature indicating that large-scale solar farms have the potential to heat up a local area; and with proposals for solar farms in Australia not necessarily considering the cumulative effects of other proposals in neighbouring areas, there is scope to incorporate existing knowledge relating to the heat-island mitigating effect of trees and vegetated areas into both planning policy, site-selection and design principles for major solar farms. Specifically, the following high-level concepts are worth further consideration:

- Updating existing solar farm site-selection factors to mitigate for the potential micro-climate impacts of solar farms through the inclusion of vegetated buffer-areas.
- Incorporating treated buffer-areas around solar arrays and undertaking modelling to ensure that species selection and planting density do not impact upon the operating efficiency of the solar farm through shading.
- Incorporating requirements for treated buffer zones (i.e. vegetated with appropriate species) into development approval conditions.
- Investigating the value, applicability and statutory capacity for comprehensive and integrated national solar farm guidelines in Australia.

6.0 SUMMARY

The growing Australian solar farm industry provides clean energy to communities, helps reduce greenhouse gas emissions and contributes to state and national sustainability targets. As an increasing number of solar farms are developed, land-use conflict will inevitably intensify; particularly in regions of sensitive agricultural production. This paper discusses the lack of EIA and development approval consistency across Australia, and occasionally within individual states. It further outlines the risks associated with this lack of consistency through the consideration of a single issue; that of potential micro-climate impacts. Through updating existing state guidelines to improve consistency, and by adopting the precautionary principle through the incorporation of potential mitigation measures into site selection and design, it is argued that heat-island effects may be reduced.

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