SOLAR ENERGY IN ARID SOUTH AUSTRALIA

With exceptional irradiance levels, South Australia is a leading state for solar projects in Australia. Projects from operational (Bungala Solar PV Project, Tailem Bend Solar Project) to various development stages (Crystal Brook Energy Park, Cultana Solar Farm, Port Augusta Renewable Energy Park, Pallamana Solar Farm, Riverland Solar Storage, Solar River Project) will generate over 1,900 MW for the state.

These projects are in areas with hot and persistently dry climates; their arid and semi-arid landscapes have extensive native chenopod shrublands, open woodlands, grasslands and desert. The soils are old and weathered, and categorised for their low nutrient availability, poor biological activity, fine particle size, and high levels of alkalinity, salinity and sodicity. Thick mats of soil crust have important functions in these systems, they bind soil, minimise erosion, fix nitrogen and carbon, and absorb rainfall.

CLEARING ARID VEGETATION

Typically, construction zones of solar projects are completely cleared of vegetation and debris, including soil crusts, and then graded. These flat, open areas facilitate machine and plant movement on site and efficient construction activities. However, this approach also creates dust pollution (Fig. 1) and operational problems that will be experienced over the life of the solar project, including:

- Reduced panel efficiency and profit
- Increased operational costs (panel washing)
- Panel deterioration from abrasion
- Human health and community concerns
- Weed and vegetation management issues
- Poor restoration outcomes

Figure 1: PV panel with dust soiling

DUST AND PV PANELS

Dust scattered in the atmosphere and deposited on the PV panel surface creates a significant reduction in the output of solar projects. Research in this field has increased and matured in recent years, such that the nature of dust movement and deposition and the associated effects on panel temperatures, partial shading and abrasion are relatively well understood. A dust accumulation rate of 20 g per m^2 will reduce efficiency by 15–35%, for example, but the impacts will vary with geolocation and other factors such as air pollution and humidity (see Table 1).

Dust with fine particle size is also problematic, it has greater impact on the performance of PV panels than coarser particles of the same type. A greater relative surface area means fine particles experience greater adhesion forces with the panel's surface than larger dust particles do. Fine particles are less likely to be removed by wind or rainfall.

Table1: Efficiency loss from dust accumulation (Costa et al. 2018)

Country	Efficiency loss recorded
Ghana	After 4 months of dust accumulation, power output decreased by 29% and panel efficiency by 6%
Qatar	After 1 month of harsh temperature and dust conditions, energy yield decreased by 15%
Qatar	Fine dust particles (2 µm) caused transmission to drop by 26%
India	Efficiency of uncleaned modules with tracking decreased by 50%
Oman	After 4 months, dust cover caused 30–40% power losses, the average daily loss in PV performance was 0.05%
Indonesia	After 2 weeks, PV power output declined by 11%

Figure 2: Low stature shrubland with soil crust.

AMBIENT TEMPERATURE AND PV PANELS

Dust affects the thermal profile of a panel, increasing temperatures and decreasing power; ambient temperature also interacts with panel functions, affecting operational efficiency. With increasing temperatures panel outputs reduce by 10–25%. Given the hot climates of South Australia, including record-breaking temperatures in January 2019, it seems prudent to factor in measures for regulating temperature and mitigating extreme conditions. The cooling effect of transpiring plants in integrated PV-green roof systems is well documented (outputs increase by up to 8%; Lamnatou & Chemisana 2015). Maintaining low stature plants beneath panels and promoting biological soil crusts (Fig. 2) will provide passive thermal benefits, as well as capture dust.

ENVIRONMENTAL MANAGEMENT OF SOLAR PROJECTS

A range of key natural processes can be applied to project design, site preparation and ongoing management to reduce the impact of dust and reduce ambient temperatures. These include:

Increase panel functions

- Using low-stature vegetation and vegetation buffers to reduce erosion and dust pollution
- Using plants and biological soil crusts to reduce ambient temperatures and capture dust

Reduce maintenance costs

- Changing clearing practices to reduce dust issues in the short- and long-term (Fig. 3)
- Using vegetation species that do not impact on panel function via shading and excessive growth; particularly with changes in rainfall capture and drip zones (Fig. 4)
- Using vegetation to compete with weeds and reduce weed outbreaks

Figure 3: Vegetation flattening instead of clearing.

SUCCESSION ECOLOGY

Succession Ecology is a multi-faceted environmental consulting business that has a particular interest in dust mitigation and the use of ecological principals to improve site outcomes.

Services includes:

- Vegetation management plans for solar projects
- Alternative site preparation for reducing offsets
- Arid and semi-arid botanical and ecological expertise
- Plant-based soil stabilisation and dust suppression services
- Soil and seedbank tests
- Biodiversity services, including weed management
- Site restoration

Figure 4: Vegetation growth increases on leeward side of fixed panels with increased rainfall in these zones.

CONTACT

Glenn Christie: Glenn@successionecology.com.au 0409 282 296

Dr Briony Horner: Briony@successionecology.com.au 0410 526 210

References

Australian Government (2019). Map of Climate Zones of Australia, Bureau of Meteorology.

Australian Government (2019). Australian Soil Resources Information System, CSIRO Land and Water, Canberra.

Australian Government (2018). Australian Lichens. Australian National Botanic Gardens.

Costa S.C.S., Diniz, A.S.A.C., Kazmerski L.L. (2018). Solar energy dust and soiling R & D progress: literature review update for 2016. *Renewable and Sustainable Energy Reviews* **82**, 2504–2536.

Government of South Australia (2019). RenewablesSA.

Lamnatou C. and Chemisana D. (2015). A critical analysis of factors affecting photovoltaic-green roof performance. *Renewable and Sustainable Energy Reviews* **43**, 264–280.

Succession Ecology (2019). Cultana: Seedbank and Soil Testing. Succession Ecology report ES019-02 prepared for SIMEC Energy Australia.

Zaihidee F.M., Mekhilef S., Seyedmahmoudian M., Horan B. (2016). Dust as an unalterable deteriorative factor affecting PV panel's efficiency: why and how. *Renewable and Sustainable Energy Reviews* **65**, 1267–1278.