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To: Solar PV Rulemaking Advisory Committee (RAC)

From: Christopher M. Clark, Rules Coordinator, Siting Division
Todd Cornett, Assistant Director, Siting Division

Subject: RAC #3 Staff Report

Background

One goal of the current rulemaking is to identify issues specific to solar PV facilities and determine whether specific standards may be required to address them. In preparation for this rulemaking, the Department researched four potential issues related to solar PV facilities:

- Toxicity and disposal of solar panels
- Impacts to wildlife and wildlife habitat
- Impacts related to glare from panels and system components
- Impacts related to changes in microclimate near solar facilities (e.g. the heat island effect)

The first two issues were discussed at the Nov. 8, 2018, RAC meeting. An audio recording and notes of the meeting are available on the Department's website. A brief summary of the department's findings on the two remaining issues is provided below.

At this time, the department is not proposing specific rules or standards related to any of the above issues; rather, these findings are presented for discussion at the third RAC meeting on Jan. 30, 2019. In particular, the Department is seeking input on the scope of the concerns, how potential impacts are currently being addressed by the development community, and suggestions for how to best mitigate or avoid adverse impacts.

Impacts related to glare from panels and system components.

One commonly cited concern about solar facilities is the visual impacts of glare from solar panels and other facility components.[1] For example, a project in Pendleton received a number of complaints about the impact of glare on drivers on a nearby highway (Sierra, 2018.) Visual impacts to aviation and nearby residences have also been identified as potential areas of concern (FAA, 2018; Rose & Wollert, 2013.)

The literature suggests some potential for impacts.

Solar panels are designed to absorb light; however, some light is still reflected from their surface. With an anti-reflective coating, the most commonly used solar panels reflect between approximately two and seven percent of incoming sunlight depending on the relative angle of the sun to the panel, similar to the reflectivity of smooth water like a pond (Anurag et al., 2017; FAA, 2018; Ho, 2016; Riley & Olsen, 2011; Rose & Wollert, 2013.) While the potential for permanent eye damage is minimal, this level of

[1] For this overview, "glare" refers to both brief flashes (e.g. "glint") and prolonged flashes (e.g. "glare") of reflected light.

reflectivity may cause discomfort and may have the potential to induce a brief loss of vision (i.e. flash blindness) under certain conditions (Ho, 2016; Paudel & Hirsch, 2015; Riley & Olsen, 2011; Rose & Wollert, 2013.) Other system components, including array frames and inverters can also create visual impacts which may distract or discomfort an observer (Sullivan et al., 2012.)

Glare analysis may help identify potential impacts

The evidence suggests that conducting a glare analysis during the design phase can help identify most of the potential impacts related to glare from solar PV facilities so that they can be avoided (FAA, 2018; Paudel & Hirsch, 2015; Rose & Wollert, 2013; Sánchez-Pantoja, Vidal, & Pastor, 2018)

Several programs in Oregon, the U.S., Europe, and Australia have successfully sited solar PV facilities on highway right-of-ways without increase in safety incidents (ODOT, 2016; Paudel & Hirsch, 2015; Poe et al., 2017.) These programs have incorporated glare analysis into their siting process and have used practices such as panel surface texturing, setbacks from roadways, and proper angling to minimize glare (Paudel & Hirsch, 2015; Poe et al., 2017.)

Solar PV facilities have also been sited at a number of airports (Zhu, 2018), including PDX. While most of these facilities have not resulted in impacts to aviation, at least one airport was forced to reposition panels after complaints about glare from air traffic controllers (Solomon, 2014.) The Federal Aviation Administration (FAA) requires U.S. airports to complete a glare analysis to demonstrate that glare or glint will not affect traffic control towers or flight approach paths. Prior FAA guidance required airports to use the Solar Glare Hazard Analysis Tool (SGHAT) developed by the Sandia National Laboratories for the analysis, but this tool has only been available for commercial licensees since 2016. Guidance published in 2018 allows airports to develop an analysis based on site specific conditions which may include consultation with air traffic controllers, pilots, and airport officials; field testing; or geometric analysis (FAA, 2018.)

Some impacts may be addressed by current standards.

Council could address impacts associated with glare from solar PV facilities though the Public Service Standard (OAR 345-022-0110.) This standard requires Council to find that construction and operation of the facility, taking into account mitigation, are not likely to result in significant adverse impact to the provision of public services, including traffic safety. Historically, Council has interpreted “traffic safety” to also include “air traffic safety.” Other visual impacts may also be addressed by the standards for Recreation (OAR 345-022-0100) and Scenic Resources (OAR 345-022-0080) and Protected Areas (OAR 345-022-0040). These standards do not apply to potential impacts to private residences or landowners.

<u>Impacts related to changes in microclimate near solar facilities.</u>

The Department is aware of public concerns about the impact changes in microclimate near solar PV facilities may have on agriculture. While empirical evidence is limited, there is some evidence to suggest that the physical changes associated with large-scale solar PV facilities have the potential to effect local air temperatures, humidity, pressure, and wind speed (Paudel & Hirsch, 2015.)

Evidence of impacts to agriculture is limited.

The direction and magnitude of microclimate changes depend on overall changes in the way that incoming solar energy is reflected, absorbed, stored, and reradiated during construction and operation of a solar facility. These changes are influenced by changes in surface reflectivity (albedo), shading, and roughness, as well as changes in vegetation (Barron-Gifford et al., 2016.)

As discussed in the section on glare, a solar panel absorbs the majority of the solar energy reaching its surface. Some of this energy is converted to useable electricity, however, a portion is also re-radiated from the panel over time as sensible heat which may increase local ambient air temperatures. (Barron-Gifford et al., 2016.) The elevated smooth surfaces of solar arrays may also effect local wind speed and pattern (Barron-Gifford et al., 2016; Millstein & Menon, 2011.)

Decreased vegetation in a site may also increase local temperatures and decrease moisture. Vegetation generally reduces local ambient temperatures by shading soils and dissipating solar energy through transpiration of water vapor. While most solar PV facilities include revegetation of the majority of disturbed areas, the capacity for heat dissipation may still be reduced (Barron-Gifford et al., 2016.)

Several studies have shown that rooftop solar arrays and utility scale PV facilities in urban environments have minimal impacts on microclimate, and in some cases may even decrease ambient temperatures (Barron-Gifford et al., 2016; Hernandez et al., 2013; Masson et al., 2014; Millstein & Menon, 2011, Taha, 2013.) Fewer studies have examined the microclimate impacts of large scale solar PV facilities in rural areas, where most EFSC jurisdictional projects are likely to be sited. One study modelling the impacts of a simulated desert array found converting land to a solar PV facility could increase local temperatures up to 0.4 °C (Millstein & Menon, 2011.) A widely cited empirical study of a solar PV facility on desert lands in Arizona found that temperatures in its immediate vicinity were 3-4 °C warmer at night than nearby unaffected desert lands (Barron-Gifford et al., 2016.) Another study of a large solar PV facility in North America found that day-time air temperatures were elevated within a solar facility, but that the temperature differences were no longer noticeable 300 m away from the facility perimeter (Fthenakis & Yu, 2014.)

A recent study of a dual-use solar facility and sheep pasture near the OSU campus in Corvallis found small (less than 1 °C), but statistically significant, increases in air temperature near panels. The study also found changes in local wind speed and patterns, and increases in soil moisture under the solar panels (Adeh, Selker & Higgins, 2018.) These findings are similar to those in an earlier study which found no significant differences in the daily average air temperatures on land under a solar array on grassland in the UK and a control plot (Armstrong et al., 2016.)

Some practices may minimize adverse impacts.
Despite the uncertainty around the size and direction of impacts, the literature does suggest some practices that may minimize potential adverse impacts. These include setbacks from temperature sensitive areas and limiting vegetation losses during construction and operation of the facility (Barron-Gifford et al., 2016.)

The department is not aware of any specific regulations related to microclimate impacts of solar PV facilities; however, Currituck County in North Carolina has imposed a condition related to avoiding heat transference to adjacent lands in a recent solar facility project (Currituck County, 2016.)

Some impacts may be addressed by current standards.
It is possible that some potential impacts to agriculture could be addressed through application of the Land Use Standard. Under OAR 345-022-0030(4)(c)(C), in order to approve a goal exception, the Council must find that a facility is compatible with other adjacent uses or will be made compatible through measures designed to reduce adverse impacts.

Sources

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