Utility Scale Solar: Dual Purpose Land Usage Opportunities

Recent months have seen the approval of many landmark developments of utility scale solar farms, such as the 2GW proposal in Bulli Creek, NSW and the 130MW proposal in Clair, QLD. These developments will take up vast amounts of land: the 130MW solar farm will take up 340 hectares of cane sugar fields, and the 2GW site over 5000 hectares of primarily cattle grazing land.

As the number of these large scale greenfield developments increase, so too arises the argument that that these developments are encroaching on existing, land use. Solar developments occupy large tracts of valuable land that may otherwise be used for agricultural activities. Solar farms can be compared favorably to alternative uses such as mining. Not only can solar farm sites be easily rehabilitated at the end of their project life, but it is also possible for solar farms to offer dual purpose land activities, providing land owners with an opportunity to diversify their land use and increase the overall value and productivity.

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While solar farms have large land footprints, not all of the land is actively taken up by solar panels or related infrastructure. Typically, modules in solar farms are installed on framing system mounted on piles or concrete ballasts. Disturbance to the ground is usually less than 5% of the area used, and only around 40% of the surface is over-sailed by solar modules (BRE, 2014). As solar modules are tilted and raised on posts to avoid shading, the land beneath the module, as well as unshaded land between rows is still available for plant growth, allowing for agricultural activities such as grazing and cropping.

Livestock Grazing

Grazing of livestock within solar farms is the most popular dual use option, especially since this practice also has the additional benefit of controlling vegetation growth. The presence of solar modules does not affect stock density, and provides shelter to grazing livestock. However consideration needs to be given to the choice of livestock. Sheep are common (Figure 1) as they are small enough to easily pass between rows of modules and do not damage equipment. For similar reasons poultry such as chicken and geese are also common choices. Grazing of larger livestock such as cattle and horses in solar farms has been attempted, however the mounting system will need to be designed to accommodate their greater size.

Figure 1: *Sheep grazing at a solar farm in Wychwood*

Crop Production

Solar farms can also be combined with crop production. Planting of vegetables or non-food crops can occur underneath the solar arrays. This practice is also referred to as solar sharing or ‘agrivoltaics’.

In Japan, the practice known as 'solar sharing' is allowed on farmlands, where small typically 100W solar modules, are mounted 3 to 5 meters above ground and installed at regular, spaced intervals with shading rate of up to 32% to allow sufficient irradiation for the ground crop (Figure 2). The mounting structures are designed to allow space for tractors and other farming equipment, allowing farmers to receive a feed-in tariff from electricity generated while being able to continue farming without modification to their normal practices. As Japanese regulations require the removal of these systems if they reduce the yield from farmlands by more than 20%, the packing density of these solar farms is much lower than conventional solar farms (Movellan, 2013).

A study has been done in southern France with a set-up similar to 'solar sharing', but with varying packing density of modules. The result shows that the density of PV will affect not only the amount of irradiance available, but also the micro-climate underneath the array. Array orientation is also an important factor, as orientation will affect the shading pattern on the area below (Marrou et al, 2013). However, there is still much research to be done on the exact effects of partial shading of crops from PV arrays, as well as adaptability of different crops to these conditions.

Figure 2: *Solar array and crop at the 34.4kW Kazusatsurumai Solar Sharing Project*

Another way for integrating crops into solar farms is via strip cropping of high-value vegetables or non-food crops under or in between rows of the solar array. An example is the planting of hardy crops such as agave or jojoba under the drip lines of solar arrays in arid locations. This takes advantage of water run-off from rain and cleaning solar modules. Planting in this way will require careful layout of the solar array with regard to the proposed size of farming machinery required and the expected height of crop.

Enhancing biodiversity

Solar farms also present the opportunity to enhance the biodiversity of the site, especially if the site previously supported monocrops. Native wildflower and bird seeds mixes can be sown between and around rows of modules, which provide food and habitat for local birds, small mammals and invertebrates. Planting of species that have high pollen and nectar yields also presents beekeeping as an additional revenue option (Figure 3).

Figure 3: *"Sunny Honey" produced from bees at solar farms operated by BELETRIC*

Constraints from dual purpose land use

During design and construction of the solar farm, consideration must be given to the intended agricultural activity and its requirements. For example, soil compaction and damage to watercourses during the construction phase should be avoided to maintain the site's capacity to support vegetation. The layout of rows of solar array and field margin will need to anticipate future maintenance requirements, taking into account the size, reach, and turning circle of machinery that might be used to maintain grazing pasture or tend to crops. Securing and protection of exposed cables, as well as the depth of buried cables, must also be taken into consideration where agricultural machinery and livestock will be present.

Conclusion

Dual use of land for agriculture and solar farming can add attractive revenue streams for land owners and plant operators. In the case of grazing livestock, dual use of land can also have a positive impact on the operation costs of the solar farm. Incorporating solar farms with livestock grazing, cropping, or biodiversity enhancement does however introduce more complexity into the design, operation and maintenance of a solar farm, and the costs of this must be considered. In addition to the positive impacts outlined above, the benefit of increased utilisation of available space for agriculture is felt not only by the land owner, but also by communities as the land retains, or creates a new identity and purpose for itself.

References:

- BRE, 2014, Agricultural Good Practice Guidance for Solar Farms. Ed J Scurlock
- Marrou et al, Aug 2013, Microclimate under agrivoltaic systems: Is crop growth rate affected in the partial shade of solar panels?, Agricultural and Forest Meteorology (Impact Factor: 3.76). 08/2013; 177:117-132. DOI: 10.1016/j.agrformet.2013.04.012
- Movellan, J., 10 Oct 2013, Japan Next-Generation Farmers Cultivate Crops and Solar Energy, Renewable Energy World, Available from <http://www.renewableenergyworld.com/articles/2013/10/japan-next-generation-farmers-cultivate-agriculture-and-solar-energy.html> [Accessed: 11 Aug 2015]

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