ZENAPA

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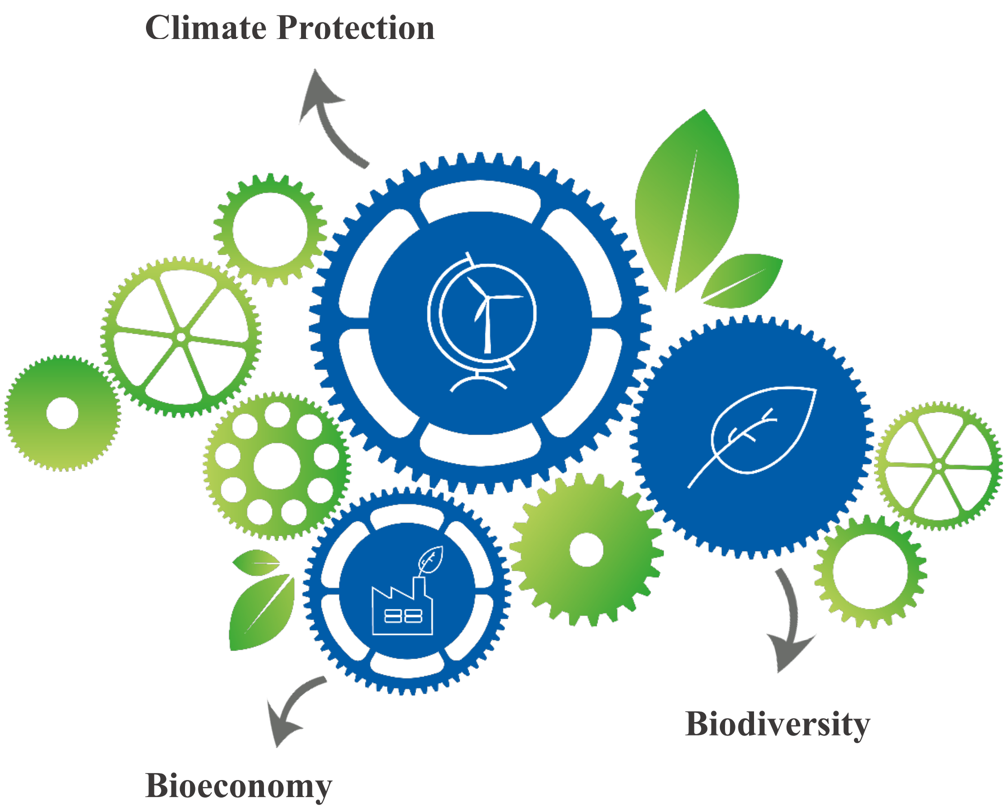
EFFECTS OF SOLAR FARMS ON BIODIVERSITY



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Institut für angewandtes Stoffstrommanagement
Hochschule Trier
Umwelt-Campus Birkenfeld
Postfach 1380
55761 Birkenfeld
www.stoffstrom.org

Contact Person:
Thomas Anton
Phone: +049 (0) 6782 17 – 1571
E-mail: t.anton@umwelt-campus.de

Scientific management:
Prof. Dr. Peter Heck (Geschäftsführender Direktor IfaS)

Financial project management:
Markus Blim

Technical project management:
Thomas Anton

Project work and editorial staff:
Christoph Dohm, Jacob Bußmann

Layout:
Jacob Bußmann

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ZENAPA stands for “Zero Emission Nature Protection Areas” and already expresses the project goal of CO_2e-neutral large-scale protected areas in the project name. ZENAPA aims not only to make a measurable contribution to climate, nature and species protection, but also to demonstrate that these protection goals are not conflicting with each other and can be achieved in a cooperative manner.

Large solar farms play a vital role in converting our energy production from fossil fuels to renewables. Climate change is one of the biggest threats to biodiversity in the near future. Currently, habitat loss has the biggest impact on species loss.

So how do solar farms affect biodiversity, which on the one hand might be able to reduce the impact of climate change but on the other hand seemingly occupy vast amounts of area? A closer look on solar farms reveals that the impact of habitat loss is, in fact, fairly low. Modern solar farms use pile-driven or screw foundations instead of concrete foundations. These are easy to dismantle after usage and have very little soil disturbance. Only around 2 % of the area of a modern solar farm is actually sealed. The remaining area is still available for a second type of usage such as nature conservation. However, there is also the area that is not sealed but is impacted by the solar farm in the form of shading. As photovoltaic modules have a certain degree of transparency (i.e. depending on the type, a certain amount of light passes through) and diffuse light can enter from the sides to illuminate the area below the modules, these areas receive enough light for plant growth. Typically, there is no lack of water availability below the solar array that prevents plant growth because of expansion gaps between each module coupled with the dispersion of water within the soil and because of the lower evaporation due to lower irradiance. Also, the solar array creates a different microclimate with gradients in water and light availability that might promote plant diversity. Generally, within the area of a solar farm, three different categories of impacted areas can be distinguished: 1. Sealed areas 2. Shaded areas 3. Non-shaded areas.

Sealed areas are used for foundations, inverters and grid connections. They have a noticeable negative impact on biodiversity and should be reduced to a minimum. Measures that increase solar production slightly but enlarge the sealed area greatly (such as reflective foils) should be avoided as their environmental costs far outweigh the production gains.

Figure 1: East-West mounted solar system

Advancements in technology have led to a more efficient use of areas. While solar farms used to have a power to area ratio of around 0.3 MWp/ha, this number increased to around 0.9 MWp/ha. This is partly through advancements in module efficiency, which nowadays produce more energy per area, but also due to a denser mounting within the solar farm. Better shade management and lower prices allow for more mounting options. Modules are nowadays flatter mounted and therefore the distance between the rows can be lowered. Also, East-West mounting systems become more common in solar farms. While this trend increases the percentage of shaded area within the farm, it also enhances land-use efficiency and lowers therefore the total amount of land needed for energy generation.

Figure 2: Plant growth below East-West mounted solar system

The impact of shaded areas is somewhat more complicated. They do limit plant growth and therefore they lack stratification, which can limit biodiversity in that area. However, they offer different conditions than the surrounding area and thus can benefit biodiversity of the total area (lower alpha diversity but higher beta diversity). Non-shaded areas are not impacted by the solar farm itself. Shaded areas and non-shaded areas are still available as a habitat for flora and fauna and their value for conservation can be greatly increased by additional measures such as bushes, dry stone walls, ponds and an adapted maintenance concept to enhance biodiversity. However, high bushes and shrubs should be avoided, because shading the PV modules reduces the power output of the solar farm. Depending on the location, regular mowing and removal of the cuttings can be used to convert the area with few types of grass to a 'neglected grassland' rich in biodiversity. In addition to increasing biodiversity, this also has the advantage that the area will require less maintenance in the future. With regard to plant diversity, extensive mowing and extensive grazing have similar effects. On 'neglected grassland' the mowing should be carried out late in the year to give the flowering plants the opportunity to form the seeds. Grazing should only occur through portion or rotational grazing, to avoid a build-up in parasites and keep selective impact of grazers on the plant community low. This extensive use increases the species richness of the area further due to the excrement-utilising insects and the resulting increment in food supply.

Many studies have found positive impacts of solar farms on biodiversity. Main driving forces are often the changes in land use from before e.g. intensive agricultural use with fertiliser and pesticide employment to an extensive use within the solar farm.

While biodiversity within the area might benefit from the land use change, fences pose a possible threat to ecosystem connectivity, as these might create barriers that separate populations. In order to minimise the impacts of fences on biodiversity, these should be permeable for smaller animals and, in the case of larger solar farms, corridors should be planned to allow larger animals to cross the area.

Figure 3 shows a solar park where the operator has implemented measures to increase biodiversity. The fence is permeable to small mammals, reptiles and amphibians, which find small wetlands in front of and behind the fence. The stone pile serves as a refuge for the animals. It would have been possible to increase the biodiversity of this area further by installing nesting boxes on some of the fence posts.

Figure 3: Large solar farm with biodiversity measures

With vertically mounted bifacial modules, another option is available, which can be used especially in the case of high area competition.

Due to the non-ideal alignment, the modules achieve only 50-60 % solar yield per side compared to optimally aligned modules, but as both sides are used the total yield is about 10-15 % higher compared to an optimal alignment where only one side can be used. Another advantage is the better distribution of energy production throughout the day. Disadvantages are the more expensive modules and the more stable posts due to the high wind load. To avoid shading, the distance between the module rows is comparatively large. Due to this large distance, more area is required, which in turn, however, is very little affected. The module rows create strip-shaped structures with many possibilities to create biodiversity hotspots (e.g. uncut grass, flowering strips, stone piles, dead-wood islands etc.)

Figure 4: Vertically mounted bifacial modules (source: Next2Sun)

These modules also allow agricultural use of the area, especially grazing and planting of vegetables (if they do not shade the modules). Due to this type of elevation, the water distribution in the area is very little influenced. Less than 1 % of the area of the solar farm is sealed. And since the sun shines exactly between the module rows at midday, the influence of shading is limited to 10 – 15 %, which has very little influence on plant growth as vegetation would be more likely to be limited by water or nutrient availability in such circumstances. Since no snow can accumulate on the module surfaces, there is no reduction in yield during the winter months. Yield values have even shown that the system can achieve a yield increase of up to 38 % on a sunny snow day compared to a sunny day without snow.

While the main purpose of solar farms is energy generation, their area can still be used for other purposes. Compared to other land use forms, they have very limited impact on their surroundings and even without further measures, they offer a protected area for the local flora and fauna. Biodiversity can greatly benefit from additional measures that can be adopted to improve habitat variability, nesting sites and ecosystem connectivity. Nevertheless, land efficiency should not be underestimated. The higher the solar yield per hectare, the lower the land consumption. Using an unnecessarily large area for a solar park to ensure more species protection is not purposeful in most cases, and it is better to create targeted nature conservation areas.