HARMONIZING RENEWABLE ENERGY WITH CONSERVATION: EXPLORING OPPORTUNITIES THROUGH SOLAR FARM DESIGNS

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ABSTRACT

Competition among land uses is making it increasingly difficult to set aside adequate space for wildlife and nature conservation, so it is imperative that opportunities that simultaneously achieve commercial and conservation outcomes be identified and seized. Such opportunities exist in the renewable energy industry. It is widely recognized that renewable energy generation benefits the ecosphere through reduced carbon emissions, but currently, further opportunities for realizing direct and indirect conservation benefits through the design of solar farms are less well known. Among other opportunities, solar farm designs that deliver environmental credits through carbon sequestration and biodiversity improvements can deliver higher financial returns. Other opportunities to improve local hydrology, pollination, and pest control services could be available depending on site-specific characteristics where solar farms are built and the other land use practices that exist or are possible in the immediate vicinity.

Keywords: Renewable energy, Solar farms, Conservation, Biodiversity, Urban green spaces, Energy mix, Public and media relations, Sustainable development.

INTRODUCTION

As countries face the need to reduce exposure to volatile fossil fuel energy prices and greenhouse gas emissions and improve the security of energy supplies, renewable energy sources are becoming increasingly important. The European Renewable Energy Council (2010) has set out a 100% renewable energy vision for The European Union and has analyzed 'the economic, environmental and social benefits likely to accompany such a transition.' Arguably more realistically, if less ambitiously, the U.K. Government is committed to meeting 15% of the nation's energy needs from renewable sources by 2020 as part of its strategy to reduce greenhouse gas emissions and reduce dependency on imported energy supplies. Looking further ahead, the U.K. government has suggested that 'renewables will also have a crucial role to play in the U.K. energy mix in the decades beyond, making the most of the U.K.'s abundant natural resources' (Gov. UK 2013). One of the core principles within the National Planning Policy Framework (NPPF) is that 'planning should.....support the transition to a low carbon future in a changing climate' by, inter alia, 'the development of renewable energy' (Department for Communities and Local Government 2012). More specifically, the NPPF stresses the need 'to help increase the supply of renewable and low carbon energy, local authorities should recognize the responsibility on all communities to contribute to energy generation from renewable and low carbon sources' The development of energy resources has traditionally had a wide range of contested impacts on the economy, the environment and everyday life, focused for example, on nuclear power and the reprocessing of nuclear fuels, major oil spills in marine environments, the closure of coal mines and the effect on coalfield communities and more recently on the fracking of oil shales. Many of the leading public and media relations firms have been working on fossil fuel energy issues for many years, and this work has often been managed in an atmosphere of intense and occasionally hostile public and media scrutiny. The mix of renewable energy resources currently includes wind, hydro-electric, tidal, biomass, and solar power, but a recent study of communication best practices for renewable energy suggested that 'although numerous examples of good practice in communications for renewables were observed in the process of undertaking this study, rigorous, well planned and adequately evaluated communication strategies were not the norm' (Collings, Cottrell, and Leopold 2013). In a similar vein, research undertaken by the CC Group (2012) concluded that 'investing in communication activity is becoming of increasing importance to the success of renewable energy businesses.' The continuing development of both onshore and offshore wind farms within the U.K., particularly in northern and western regions, has stirred considerable public, political, and media controversy. That said, solar energy is the most abundant of all the sources within this mix, and PricewaterhouseCoopers (2010) has suggested that solar power 'shows increasing potential as an alternative to existing fossil fuel sources.' With this in mind, this paper outlines the characteristics of solar farms, describes their development within the U.K., examines some of the issues raised by these developments, and offers a concluding discussion of the contributions that public and media relations firms can make to the development of solar farms. (Department for Communities and Local Government 2012).

Human population growth continues to exert increasing pressure on the land resources upon which we rely for diverse ecosystem services. Setting aside natural areas for wildlife and nature conservation, land sparing (Box 1; Fischer et al. 2008) has an important role in maintaining natural resources and the services they provide. Given the often large and widely distributed areas required to conserve biodiversity and the necessity of ensuring that such areas are properly managed and protection is enforced (Phalan et al., 2011), resources available for nature conservation are seldom sufficient. Consequently, approaches other than land sparing to conserve biodiversity have gained more attention in recent years, especially in urban landscapes (Ives et al., 2016; Wolch et al., 2014). Urban green spaces, public parks and gardens, and green roofs and walls support increased biodiversity in patches across anthropogenic landscapes (Goddard et al.,2010). Further, many of these urban green spaces are multi-functional, supporting biodiversity, food production (e.g., public gardens and green roofs), and recreation (e.g., parks and golf courses). Such spaces can also provide additional benefits of improved air quality (Nowak et al., 2006), better physical and mental health (Ward Thompson et al., 2012; Wolch et al., 2014), and reduced heat-island effects (Tsilini et al., 2015). By leveraging these effects, urban designs can contribute to the achievement of the United Nations' Sustainability and Development Goals (United Nations, 2015). Beyond urban limits, the emergence of regenerative agriculture is another example of attempts to simultaneously achieve financial and conservation benefits. In such landscapes, the construction of solar farms presents an additional opportunity to codesign facilities that focus on achieving better commercial returns for agriculture and renewable energy businesses while improving conservation outcomes. Here, we examine the influence of spatial pairing of agricultural and solar assets and agrivoltaic systems (Dinesh and Pearce, 2016; Dupraz et al., 2011a) on the achievement of simultaneous benefits across agriculture, industry, and conservation (Fig. 1; Semeraro et al. 2018).

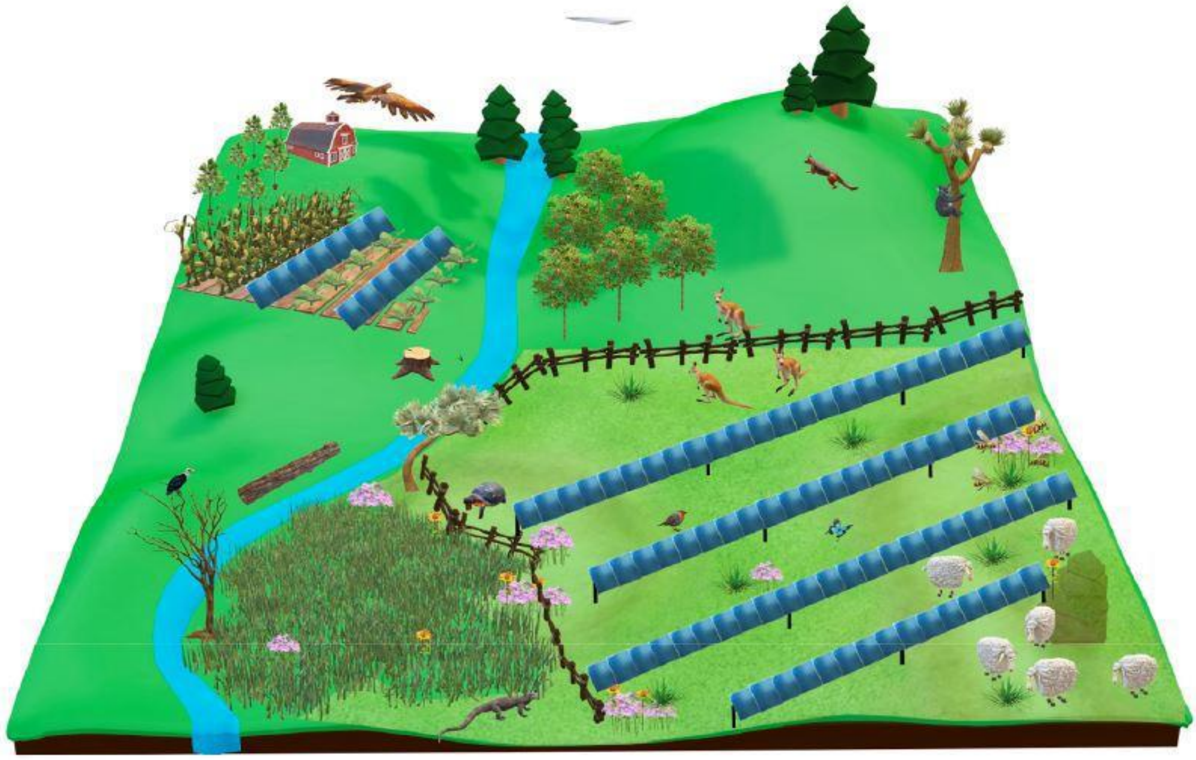

Fig. 1. A hypothetical agrivoltaic system in Australia. Solar panels are co-located within croplands and on existing grazing land. (Semeraro et al. 2018).

Solar Farms

While there is no official definition of a solar farm, it is essentially an area of land on which a large number of solar panels are deployed to generate electricity, producing very little noise, having no moving parts, and no harmful emissions. More specifically, solar farms are large arrays of interconnected solar panels that work together to capture sunlight and convert it directly into electricity. The active elements within the solar panels are silicon solar cells, which have at least two layers with positive and negative charges. The electric field across the junction between the two layers causes electricity to flow when the semiconductor absorbs photons of light and releases electrons. The electricity so generated is cabled to one or more (depending on the size of the solar farm) inverters, electrical power converters that change direct current into alternating current electricity. The output can be connected to both local users and the national grid. Solar energy generation is at its strongest during the daytime when the demand for electricity is high, and when the solar farm produces more electricity than is required locally, then the surplus is fed into the national grid, and when there is a shortfall, extra power can be drawn from the grid.

Globally, the geography of solar farms reflects a number of factors, including operational economics, global solar energy potential, and access to the national grid. The operational economics, more particularly consistently advantageous fiscal financial support and grid parity, has been particularly important in influencing the distribution of solar farms. In the future, the geographical pattern of solar farms may change as different regions achieve grid parity. Worldwide solar energy potential is at its lowest in high latitudes and at its highest in desert areas of Africa and Australia. That said, most of the world's densely populated areas, including large areas of Africa, Australia, the Middle East, the Indian subcontinent, the southern United States, and Mexico, large areas in South America, and much of southern and western Europe, offer suitable levels of solar energy potential. Access to national electricity grids, more particularly proximity to electricity substations or power connectors, is important because power losses from cables increase with distance.

The Development of Solar Farms in the U.K.

While there is no national register, and hence no definitive information on the number of solar farms in the U.K. per se, the use of solar power has increased rapidly, albeit from a low base level, in recent years, and anecdotal and trade evidence clearly suggests that the number of solar farms is rapidly increasing. Solar Voltaic Energy (2013), for example, listed 91 major *'solar energy schemes'* as having been commissioned by April 2013, with a further 56 being classed as approved or under construction and a further 32 proposed or going through the planning process. The global irradiation and solar energy potential within the U.K. varies from 980 kilowatt hours per meter squared in the far north of Scotland to 1240 kilowatt hours per meter squared in the southwest of England, and it is the southwest and southeast of England where the development pressure, as evidenced by the number and the scale of solar farm projects, is greatest. While some solar farms have been developed on brownfield sites, for example, on disused airfields or former landfill sites, many have been proposed and developed on agricultural land. The Wheal Jane solar farm was the first to be commissioned in Cornwall. It is on the site of a disused tin mine, and the farm's 5,700 solar panels yield a generating capacity of 1.5 MW, it can provide electricity for up to 430 homes and saves over 700 tonnes of carbon dioxide emissions per annum. Somerset's first solar farm on a 4-hectare site at

Sandhill Park, near Bishops Lydeard, has been providing electricity to some 600 homes since 2011. The U.K.'s largest solar farm, which had a capacity of 34 M.W., was developed at a cost of £35 million on a former military airfield at Wymeswold near Loughborough in Leicestershire and became operational early in 2013. In April 2013, solar farm developers were paying farmers up to £50,000 per annum for a 20-hectare site in the South East and South West of the U.K. and up to £40,000 in the Midlands and East of England, but precise figures reflect annual sunlight levels and other factors including access and topography.

Solar farm developers typically look for sites offering between 10 and 20 hectares, and they normally take on the planning costs and risks in funding projects through commissioning. More specifically, a number of development criteria can be identified in that potential solar farm sites should:

- offer between 10-20 hectares of land of low-grade agricultural land, though there is no upper limit on size
- Ground that is flat or gently sloping and south-facing
- not be overlooked from public vantage points or neighboring houses
- offer easy access for construction and maintenance work
- be free from surrounding buildings or trees that would cast a shadow
- not prone to flooding
- be free of rights of way
- have no underground pipes crossing the land
- be in proximity to a major overhead power line
- not be in environmentally sensitive areas, areas of archaeological significance, or areas of significant landscape value
- be available to lease for at least 20 years

Potential commercial and environmental returns from agrivoltaic systems

The Opportunities Presented By Designing Land Sharing Schemes That Incorporate Renewable Energy Production, Agriculture, And Nature Conservation Are Just Starting To Be Understood And, In A Very Limited Number Of Cases, Realised (Dupraz et al., 2011a; Hernandez Et Al., 2015; Kiesecker Et Al., 2011; Semeraro Et Al., 2018). Such Opportunities Should Be Vast Given The Very Considerable Land Areas Globally Being Committed To Renewable Energy Generation (REN21, 2019; Trainor et al., 2016) And The Extensive Application Of Land To Agriculture (E.G., 48.6 Million Km2 [37.4% Of Global Land Area]; World Bank Group 2016). Indeed, The Co-Location Of Photovoltaic (P.V.) Solar Facilities Within Agricultural Landscapes Can Increase Productivity Of Crops Under Solar Panels (Dupraz et al., 2011b; Marrou et al., 2013c), Increase Soil Carbon, And Reduce Water Evaporation (Armstrong et al., 2014; Hassanpour Adeh Et Al., 2018; Marrou Et Al., 2013a).

Understanding the potential benefits and limitations of agrivoltaic systems

P.V. solar farm performance

Solar farms require ongoing maintenance. This maintenance can include keeping the solar panels free of debris (e.g., dust, leaves, bird droppings), which can reduce panel efficiency by up to 7% over extended periods without rain or panel cleaning (Goossens and Van Kerschaever, 1999; 8

Jaszczur et al., 2019; Mejia et al., 2014). Therefore, panels need cleaning periodically to maintain high levels of energy production (Fig. 2a; Mani & Pillai, 2010; Lovich & Ennen, 2011).

In addition, large-scale P.V. solar farms increase local ambient temperatures and act as heat islands (Armstrong et al., 2016; Barron-Gafford et al., 2016; Edalat, 2017; Zhang & Xu, 2020) which can reduce the efficiency and performance of solar panels (Fesharaki et al., 2011; Kande et al., 2016; Popovici et al., 2016) and have negative impacts on plants and wildlife (Yow, 2007). Vegetation cover around and under solar panels can reduce this heat-island effect and help maintain solar panel efficiency (Kande et al., 2016; Tsilini et al., 2015). For example, vegetative ground cover can reduce the degradation of solar panel backsheets (the protective layer on the backside of the solar panel). Backsheets protect the internal electrical components from weathering and act as insolation for the solar panel (Gambogi et al., 2013; Oreski & Wallner, 2005; Voronko et al., 2015).

Through such design considerations, solar farms have the potential to increase their financial returns by using grazing livestock for vegetation management to suppress vegetation from over-shading solar panels. Further, in some systems, native herbivores could be encouraged to occupy and forage within solar facilities (e.g., kangaroos or wallabies in Australia, pronghorn antelope in the USA), providing biodiversity benefits, as well as 9 low-cost vegetation management that may also, in some cases, provide additional income through biodiversity offsets (Fig. 2c, d).

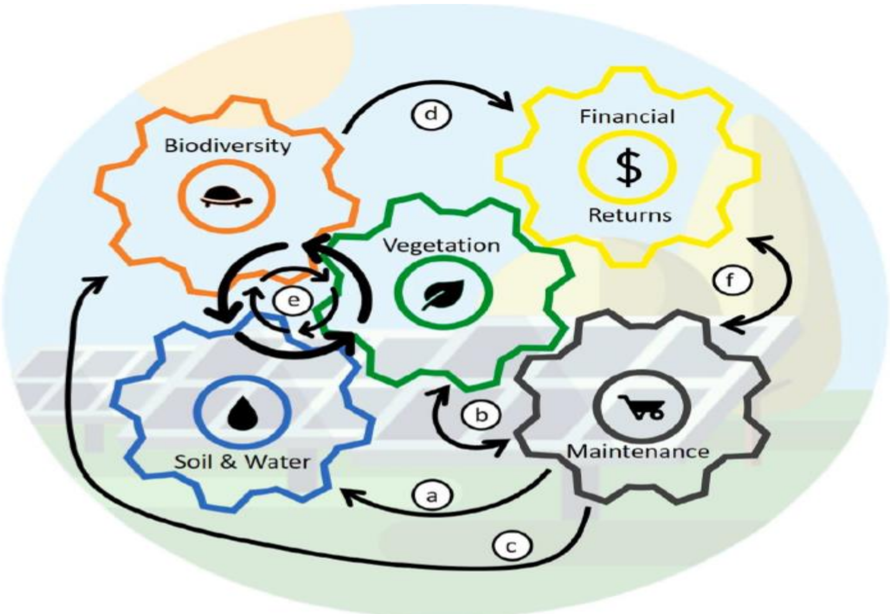

Fig. 2. Conceptual model of components and interactions that influence land condition in agrivoltaic systems.

Five major components are summarized through their interactions (represented by a – f and described in the text): Biodiversity (wildlife habitat, species diversity, refugia and cover, pollinator and predators, and ecosystem services); Soil and Water (run-off, erosion, soil moisture, soil compaction, dust accumulation, nutrients, fertilizers); Vegetation (ground cover, vegetation complexity, weeds, food production); Maintenance (clearing, infrastructure, mowing, herbicide use, pesticide use, livestock health, cultivation, and harvest); Financial returns (carbon credits, electricity production, jobs, site maintenance, pest control, profit through livestock/crop yields, supplemental feeding for livestock).

Design and placement of solar farms

The installation of solar farms can disturb landscapes through large-scale clearing and site preparation. The construction of any solar farm will cause some level of disturbance to natural habitats. The net benefits of building a new farm will depend on at least two factors: the original quality of the land prior to its current use and its current state. For example, high-quality habitats that have been degraded in recent years through intense cropping, overgrazing, or other damaging agricultural or industrial practices have the most to gain from regenerative approaches available to agrivoltaic systems. Regenerative agriculture coupled with P.V. solar capacity can help improve the economic profitability and environmental and ecological values of a site. Degraded landscapes of historically high quality that are selected for regenerative agrivoltaic sites have the potential to experience the lowest relative degradation and benefit most over the long term, given their current poor land condition. Of course, many agricultural properties are well-managed and not degraded. In these cases, landowners may be able to improve low-productivity areas (perhaps with poor soil nutrients, rocky or undulating land, etc.) through land-sparing patches or co-planting alongside solar panels. Generally, the design and potential outcomes from agrivoltaic installations will be site-specific. For example, landscapes that support burrowing species, such as desert tortoises (*Gopherus agassizii)* or burrowing owls (*Athene cunicularia*), may be adversely affected if burrows are collapsed by machinery during solar farm construction (Gibson et al., 2017; Lovich & Ennen, 2011). Ideally, such negative impacts could be minimized by using existing low-quality habitats and or low-productivity agricultural areas or improving solar farm design and construction. Many factors determine the suitability of sites for P.V. solar farms, including the quality of the solar resource (Hernandez et al., 2014; Lovich & Ennen, 2011; Moore-O'Leary et al., 2017)

Research priorities and recommendations

Typically, solar farms are designed and managed only to produce renewable electricity. Therefore, it is reasonable for solar farm developers to target locations with the highest quality solar resources that can easily be connected to electricity grids or local loads. There are, however, greater financial returns possible by coupling solar farm returns with agricultural production and environmental restoration and conservation. Agricultural markets are well developed and understood and can easily be modeled in combination with power production to create agrivoltic designs that generate greater returns. Environmental markets for carbon and biodiversity credits and natural capital are much less well-known and are changing rapidly. Currently, carbon credits, perhaps the best known of these markets, vary by more than an order of magnitude in price, and it is reasonable to assume the value of these credits will increase substantially as more carbon reduction targets are legislated and the demand from the voluntary market continues to expand. Moreover, the opportunity for landholders to access debt and equity to support their businesses by leveraging their natural capital is only just starting to emerge as a financial instrument. Clearly, much more research will be required to understand and capture these emerging market opportunities. These additional returns can be realized not just by accessing these additional revenue streams but also by realizing available synergies among different land uses in close proximity. For example, appropriate ground cover under and in the vicinity of solar panels could lower running costs for solar facilities while producing carbon and other environmental credits, such as access to run-off mediation funds, while providing pollination and pest control services to adjacent horticultural production (Delaney et al., 2020; Li & Waller, 2015). Consequently, rather than simply focusing only on existing priorities, such as optimizing the design, placement, and maintenance of solar facilities (Peschel, 2010; Sinha et al., 2018), considerable opportunities exist to consider how landscapes can be improved, rehabilitated, or both, through the production of multiple products from a mosaic of land uses in more sustainable ways. These opportunities exist in a variety of combinations that could include energy production, shade-tolerant crops, feed for livestock, and wildlife refuges, among others. While the potential to apply such design principles for simultaneous and improved conservation, sustainability, and commercial returns clearly exists, understanding how to design for such synergistic outcomes is in its infancy. A better understanding of these opportunities will arise from research directed to address specific questions regarding how to determine the most appropriate mix of scales and patterns of deployment of various land uses. The opportunities for codesign will be complex and location-specific, depending on a combination of ambient environmental conditions, the agricultural land uses possible and practiced at that location, the regulatory frameworks under which such a facility will operate in terms of the environmental costs and credits available, and the types of technology deployed. Decision support tools will also need to be developed to optimize these choices in different circumstances. We suggest that future solar projects should initially explore multiple uses of their sites to achieve better environmental and commercial outcomes. In its simplest form, an agrivoltaic system might support both energy production and under-panel crop production. Such a design would reduce the land required for both uses (i.e., increase the LER) while supporting at least some biodiversity. Alternatively, an agrivoltaic system that uses livestock for vegetation management could reduce labor costs for staff to mow or spray vegetation, support local graziers via leasing solar farmland to feedstock, and incidentally provide habitat for plant and animal diversity. These co-benefits may be further increased by incorporating inter-panel vegetation buffers and tree and shrub buffers around solar facilities, especially in mosaics of other land use systems. As our knowledge of the opportunities in this space increases, agrivoltaic solar facilities have the potential to contribute to the rehabilitation, and possibly improvement, of biodiversity on degraded landscapes of poor ecological and economic value and increasing the economic returns to solar farms and agriculture while improving land condition and conservation outcomes. Rather than constructing new facilities on undisturbed native vegetation or green-field sites, even areas of low biodiversity value, developers could focus instead on reusing degraded landscapes for solar farm development (Cameron et al., 2012; Milbrandt et al., 2014). Degraded landscapes, overgrazed land, low-productivity croplands, and sites disturbed by anthropogenic practices are plentiful, and many could potentially be repurposed. These degraded landscapes are generally under-used, have poor yield potential, are difficult to cultivate, or have low economic value that makes them comparatively inexpensive to acquire. However, some regions may be constrained by access and proximity to electricity grid connections and access roads for construction. Alternatively, site selection for solar energy projects may raise local real-estate prices with the promise of better access to grid power in the vicinity of solar farm installations, thereby increasing property values or commercial development potential. The reuse of degraded or lower-quality agricultural land, already modified from its original state, provides an opportunity to rehabilitate or improve land in support of better agrivoltaic system revenues and improved biodiversity (Hernandez et al., 2016; Kiesecker et al., 2011). Such modification of existing landscapes into agricultural, environmental, and energy-generating mosaics will undoubtedly produce trade-offs whereby one use of the space is compromised in favor of another. Such trade-offs should be reduced to some extent through careful design and management that minimizes negative effects and enhances the positive ones (Neilly et al., 2018). P.V. solar farm facilities have generally conformed to standard designs, with panels situated in rows, generally mounted 1–3 m off the ground, depending on the racking and mounting system used. Other designs for solar panel deployment could mitigate, to some extent, the ongoing need for vegetation management (Fig. 2b,f) or allow grazing livestock to access vegetation under panels (Guerin, 2017). Rather than solar panels sitting close to the ground, if panels were situated at least 2 m above the ground at their lowest point, many grasses and shrubs would not grow tall enough to block the panels from sunlight. Further, this may allow additional vegetation types to be incorporated into solar facilities (e.g., shrubs and low woody vegetation), which could provide more habitat structural complexity, leading to increased biodiversity (Neilly et al., 2018; Nordberg & Schwarzkopf, 2019). Yet, to our knowledge, no solar facilities have experimented with the structural design of solar panels in this manner. Clearly, the additional costs of materials to place solar panels further above ground on solar farms would need to be offset by savings on vegetation management (mowing, spraying, etc.), dust control, and income from available environmental credits, and other revenue streams from producing food or fiber on the same sites. Conversely, on-ground solar arrays are now available to reduce the costs of deployment while minimizing ground disturbance. These low-profile placements may provide a better habitat for some kinds of biodiversity but may lead to increased panel fouling or may interact with other processes in ways we do not yet understand. Irrespective of the designs deployed, such costs and benefits will need to be considered to optimize system performance. Again, independent of the solar technology deployed, system designs and solar panel arrangements could be improved by adding vegetation buffers, shrub and tree rows, and other patchy vegetation clusters to increase habitat and connectivity for wildlife, production of livestock and crops, and reduce run-off and erosion. What is certain is that leaving intact or restoring vegetation clusters and corridors can increase biodiversity and have positive impacts on species richness and diversity around agricultural landscapes (Burel, 1996; Nordberg et al., 2021).

Summary and future directions

Increasing the generation of renewable energy has the potential to greatly reduce carbon emissions and diminish reliance on fossil fuels, but little is yet known about the effect of this expanding industry on the landscapes on which generation facilities are built or the biodiversity associated with these sites and the ecosystem services they provide. We are similarly ignorant of how to minimize these impacts or access the potential for better environmental and commercial returns that could be realized through better design of solar facilities in association with other land uses such as agriculture or conservation. It is clear, however, that the potential exists for increased net returns from co-locating power generation, agricultural production, and land restoration and conservation. To understand the size of this potential opportunity, studies quantifying the direct and indirect effects of solar farms on biodiversity and agricultural production, and vice versa, are needed. There is urgency in this need for greater understanding, especially given the current rapid growth of solar farm construction. As our knowledge of how to access these opportunities expands, the placement of new solar farms should be carefully considered to minimize negative effects on ecological communities, as should the co-location of new facilities within existing disturbed agricultural landscapes. Designing mosaics of land uses that provide multiple economic benefits to multiple industries will reduce the negative effects of multiple land uses and provide enhanced revenue for multiple industries, both through reduced maintenance costs and increased production. By designing future solar farms in partnerships with solar farm developers, agriculturalists, economists, and conservation ecologists, we can achieve more sustainable and regenerative outcomes for environmental, agricultural, and power generation.

Discussion

A growing number of public and media relations companies are working on solar farm developments and proposals for a range of clients, and this work embraces managing communication activities, community engagement, awareness-raising campaigns, informing and shaping public opinion, working with farmers and land owners to help them realize the potential of solar farm development, helping to position local authorities as leaders in the renewable energy sector, working to attract investment into solar farms, and overcoming community opposition to specific developments. A few simple illustrative examples give some impression of the nature of this work. Collings and Money, for example, claims to offer a full marketing and communication service to solar farm developers, including marketing and communications strategy and planning, copywriting and the dissemination of press releases, securing editorial opportunities in the trade press, negotiating and implementing advertisement campaigns, managing advertisement schedules, securing speaking engagements at conferences, managing participation at exhibitions and designing and managing print and online marketing materials Athene Communications worked with Lark Energy on community engagement for the large solar farm development at Wymeswold mentioned earlier. In reporting on this project, Athene Communications (2013) emphasized that Lark Energy's belief that *'with the solar industry under continuing time pressure because of frequent changes in clean energy support rates….a proactive approach to community engagement and stakeholder management made all the difference to ensure smoother planning process.'* Athene's approach to the project included community audits, a statement of community engagement, the delivery of a preplanning application engagement and consultation program, feedback to the community, and a troubleshooting service. The community audits, for example, focused on research designed to help demonstrate an understanding of local people's opinions and align engagement with their interests, while troubleshooting involved providing mediation services to proactively manage objectors within a community.

Within the US, Solargen Energy has worked with a strategic communications company, Passantino Andersen, to help overcome community opposition to the development of a solar farm in the remote Panoche Valley in San Benito County in northern California. The site of the proposed development was a traditional haven for bird watchers and a few kilometers from a number of small organic farms. Local farmers and wildlife and environmental groups campaigned against the proposal, and the developers and Solargen engaged Passantino Andersen to address the campaigners' concerns, build alliances, and mobilize supporters to overcome opposition influence and create a political climate that would favor timely government approval. The communications company conducted public opinion research designed to identify likely supporters and opponents and the issues of importance to both audiences, looked to develop compelling messages that would help to foster a sense of ownership for the solar farm amongst the target audiences, offer something of value to the area that it would not otherwise receive and to keep communications constant and consistent in order to maintain control over the debate. In devising its messaging, for example, given the high unemployment rate within the county,

Passantino Andersen stressed the importance of the economic benefits the solar farm would generate and the developer's commitment to provide $10 million to offset property tax exemption. At the same time, government decision-makers were fully briefed on opinion poll research results, the benefits of the proposed development, stakeholder engagement, and levels of public support in an attempt to build and maintain their confidence.

More specifically, Collings, Cottrell, and Leopold (2013) made seven recommendations for communications strategies in the renewable energy sector, namely that:

• development of renewable energy campaigns should be approached as a process with clearly defined stages

• partnering and pooling resources should be undertaken more often to increase funding for renewable energy communication campaigns

• pre-campaign research in renewable energy communications should be more thorough and aimed at getting a better understanding of public opinion about renewable energy

• behavioral economics findings should be applied to the development of renewable energy communications

• more innovative and emotive messaging of renewable energy communications would elicit more positive responses

• ongoing and post-campaign evaluation should be consistently applied for quality control at all stages of renewable energy communication processes

• communication strategies should be more proactive in responding to negative media coverage of renewable energy.'

In Concluding Their Study, Collings, Cottrell, And Leopold (2013) Suggest That An International Survey Designed To 'Identify Specific Misconceptions Held By A Range Of Population Segments' And The Development Of 'A Communications Knowledge Platform For Renewable Energy To Pool Information And Knowledge From A Number Of Stakeholders' Would 'Have The

Potential To Bring Significant Practical And Theoretical Contributions To Overcoming Current Renewable Energy Communication Challenges.

CONCLUSION

The aim of such type of township (solar farm) is to become self-independent on electricity requirements along with distribution of it and also to learn optimum usage of energy of daily requirements in terms of electricity, water, food, land, and proper distribution of work. In the future, It will help the group (or society) to be energy-independent, financially independent, and food-independent, improve eating habits and work culture, make life simple and better, and improve the standard of living in a hygienic condition.

REFERENCES

1. Abbasi, S.A., Abbasi, N., 2000. The likely adverse environmental impacts of renewable energy sources. Appl. Energy 65, 121–144. https://doi.org/10.1016/s0140-6701 (00)92689-4.

2. Armstrong, A., Ostle, N.J., Whitaker, J., 2016. Solar park microclimate and vegetation management effects on grassland carbon cycling. Environ. Res. Lett. 11 (7), 074016. https://doi.org/10.1088/1748-9326/11/7/074016

3. Armstrong, A., Waldron, S., Whitaker, J., Ostle, N.J., 2014. Wind farm and solar park effects on plant-soil carbon cycling: Uncertain

impacts of changes in ground-level microclimate. Glob. Chang. Biol. 20 (6), 1699–1706. https://doi.org/10.1111/ gcb.12437.
4. Barron-Gafford, G.A., Minor, R.L., Allen, N.A., Cronin, A.D., Brooks, A.E., Pavao-Zuckerman, M.A., 2016. The photovoltaic heat island effect: Larger solar power plants increase local temperatures. Sci. Rep. 6, 1–7. https://doi.org/10.1038/ srep35070.
5. Bridle, R., Leopold, A., Collings, J., & Cottrell, J. (2013). RE-COMMUNICATE: Communication Best-Practices for Renewable Energies. Scoping Study.
6. Burel, F., 1996. Hedgerows and Their Role in Agricultural Landscapes. CRC. Crit. Rev. Plant Sci. 15 (2), 169–190. https://doi.org/10.1080/07352689.1996.10393185
7. Cameron, D.R., Cohen, B.S., Morrison, S.A., 2012. An approach to enhance the conservation-compatibility of solar energy development. PLoS One 7. https://doi. org/10.1371/journal.pone.0038437
8. Connor, R. (2015). *The United Nations world water development report 2015: water for a sustainable world* (Vol. 1). UNESCO publishing.
9. Cypher, B.L., Westall, T.L., Spencer, K.A., Meade, D.E., Kelly, E.C., Dart, J., Job, C.L.V.H., 2019. Response of San Joaquin kit foxes to the Topaz solar farms: Implications for conservation of kit foxes
10. Dawson, S., Gritsan, A., Logan, H., Qian, J., Tully, C., & Van Kooten, R. (2013). *Working group report: Higgs boson* (No. arXiv: 1310.8361; FERMILAB-CONF-13-671-T). Fermi National Accelerator Lab.(FNAL), Batavia, IL (United States).
11. Delaney, A., Dembele, A., Nombr´e, I., Gnane Lirasse, F., Marshall, E., Nana, A., Vickery, J., Tayleur, C., Stout, J.C., Requier, F., 2020. Local-scale tree and shrub diversity improves pollination services to shea trees in tropical West African parklands. J. Appl. Ecol. 57.