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THE DEVELOPMENT OF SOLAR FARMS IN THE UK

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Abstract

The UK Government, for example, is committed to meeting 15% of the nation's energy needs from a mixture of renewable sources by 2020. Solar power is the most abundant of all the renewable sources and the recent development of solar farms is seen to have a part on helping to achieve this target. This paper outlines the characteristics of solar farms, outlines their general geographical pattern and locational development criteria within the UK and examines the planning issues raised by these developments. The findings reveal that the development pressures for solar farm are greatest in the south east and south west of England and that proposals to develop solar farms have raised wide range of environmental, social and economic issues. While obtaining planning permission has not been a major constraint on solar farm development to date a study of planning issues they raise provides a valuable lens through which society's changing relationship to energy can be viewed.

Keywords Solar farm, Planning, UK

Introduction

In exploring the current practices and resources for teaching energy issues within Geography, Bridge (2012) argued that *'the manner in which energy is captured and transformed lies at the heart of society's relationship with the natural world'* and while the centrality of this relationship has long been recognised when studying the traditional stock of physical energy sources it is equally valid for the renewable sources that may eventually replace them. As countries become increasingly faced with the need to reduce exposure to volatile energy prices and greenhouse gas emissions and improve the security of energy supplies so renewable energy sources will become increasingly important. Bradshaw (2010), for example, has argued that *'we now face a global energy dilemma created by concerns about future availability of fossil fuels and the impact of their exploitation on the planetary ecosystem.'* Bradshaw (2010) further suggested that within the *'developed market economies'* the solution to this energy dilemma *'is being sought through increased energy efficiency, carbon trading, the development of technologies to de-carbonise fossil fuel use and electricity generation and the promotion of renewable energy and nuclear power.'*

As part of its strategy to reduce greenhouse gas emissions and reduce dependency on imported energy supplies the UK Government, for example, is committed to meeting 15% of the nation's energy needs from renewable sources by 2020. Looking further ahead the Government has suggested *'renewables will also have a crucial role to play in the UK energy mix in the decades beyond, making the most of the UK's abundant natural resources'* (Gov. UK 2013). This mix currently includes wind, hydro-electric, tidal, biomass and solar power. 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.'* That said the UK Government's *'Renewable Energy Roadmap*' recognises that *'there are different approaches to energy policy in* *different parts of the UK'* (Department of Energy and Climate Change 2011). More specifically Bridge (2012) in identifying distinctive geographical contributions to *'the range of contemporary energy dilemmas–such as determining whether, how and for whom particular landscapes should be valued for their energy generating potential, or deciding on the geographical scale at which trade-offs between energy security and environmental impact should be made.'* With this in mind this paper outlines the characteristics of solar farms, describes their general geographical distribution and locational development criteria within the UK and examines some of the planning issues raised by these developments. The paper is based on information drawn from the Internet, principally solar panel development and management companies and local authority planning departments, on personal communication with a limited number of individuals within local authority planning departments and solar farm development companies and on field visits to solar farms in Gloucestershire and Cornwall.

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 a positive and negative charge. The electric field across the junction between the two layers causes electricity to flow when the semi-conductor 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 day time 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.

A typical solar farm generates some 5 mega-watt peak (MWp) which would provide electricity for up to 1,200 houses with a carbon dioxide saving of 500 grams per kilo-watt hour (g/kWh). Such a solar farm would require 15 hectares of land with about 30% of the total area being covered by up to 20,000 solar panels. The individual solar panels measure 1.6 by 1.0 metres and their upward facing surfaces are made from toughened glass with an anti-reflective coating to maximize the light captured by the solar cells. The solar panels are mounted in arrays on aluminum and steel frames and inclined at an angle of 25% between 1.0 and 2.65 metres above the ground, thus providing clearance for habitats and plants to remain in situ, and they are usually laid out in rows and interspaced to facilitate access and to minimise shading. Solar farms usually have a secure perimeter fence and are often sited behind existing or new hedges planted to screen them. Maintenance is normally straightforward and relatively minimal involving performance monitoring; defects analysis, diagnosis and replacement; landscape maintenance; annual inspections; and security. The theft of solar panels has been reported as an issue, particularly on large solar farms in relatively remote areas, and a growing number of operators are installing sophisticated closed circuit surveillance systems. Solar farms are generally thought to have a lifespan of 20-25 years and in many ways they can be seen as a temporary land use and there are no legacy issues in that the entire installation can be removed relatively easily and sites can, if appropriate, be restored to their original use.

The world's first small solar farms were built in California in the early 1980's but development was slow until 2004 when changes in the financial incentives for solar power generation were introduced in Germany which led to the development of a new generation of solar power plants. Within the last decade increasingly large solar farms have been developed in a number of countries including China, United States, Mexico, Spain, Germany, Portugal, Italy, France and the UK are currently the countries with the largest solar farm capacity. The solar farm developed on a former military airfield at Neuhardenberg in Germany and opened early in 2013 is the world's largest installation and has a generating capacity of 145 MW and it provides power to some 48,000 homes. Spain also has substantial solar power generating capacity and it largest development at Olmedilla, in *Castille-La* Mancha, has a generating capacity of 50 MW, provides electricity for 40, 000 homes and will displace 2 million tonnes of carbon dioxide during its 25 year life span.

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. Looking to 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 sub stations or power connectors, is important because power losses from cables increase with distance.

The Solar Farm Development in the UK

While there is no national register, and hence no definitive information on the number of solar farms in the UK 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 UK varies from 980 kilowatt hours per metre squared in the far north of Scotland to 1240 kilowatt hours per metre squared in the south west of England and it is the south west and south east 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 and 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 UK's largest solar farm with a capacity of 34 MW developed at a cost of £35 million on a former military airfield at Wymeswold near Loughborough in Leicestershire 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 UK and up to £40,000 in the midland and east of England but precise figures reflect annual sunlight levels and other factors including access and topography. Solar farm developers are typically looking for sites offering between 10 and 20 hectares and they will normally take on the planning cost and risks in funding projects through to 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 neighbouring 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 or areas of archaeological significance or areas of significant landscape value
- be available to lease for at least 20 years

The growth in solar farm development reflects a number of factors. On the one hand the UK governments' positive approach to renewable energy and more specifically solar-specific Power Purchase Agreements (PPAs) and the government-mandated Renewables Obligation (RO) have been important in providing the initial impetus for solar power development. Solar farm operators sell electricity to utilities at a fixed price under the PPAs for every megawatt hour generated. The RO is the main support mechanism for renewable electricity projects in the UK and it places an obligation on UK electricity suppliers to source an increasing proportion of electricity they supply to customers from renewable sources. RO Certificates (ROCs) are issued to operators of accredited renewable generating stations for the eligible renewable electricity they generate. Operators can then trade the ROCs with other parties, with the ROCs ultimately being used by suppliers to demonstrate that they have met their obligation. On the other hand as the price of solar panels and system installation costs have fallen and the cost of electricity generation by traditional methods has increased so solar power has increasingly achieved so called 'grid parity' where electricity generated from solar sources becomes equal in cost, or less than, purchasing power from grid power, so this would seem to favour a continuing shift in generation patterns to solar sources.

Planning Policies and Issues

One of the twelve 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). While the NPPF makes no explicit reference to solar energy or solar farms it does stress the need *'to help increase the supply of renewable and low carbon energy, local authorities should recognise the responsibility on all communities to contribute to energy generation from renewable and low carbon sources'* (Department for Communities and Local Government 2012). At the same time the NPPF also emphasizes that *'planning policies should....promote the development and diversification of agricultural and other land based businesses'* (Department for Communities and Local Government 2012).

At the local authority level planning policies generally reflect the spirit of this national guidance but there is little specific reference to solar farms per se. That said development proposals for solar farms have raised a wide range of issues. These include impacts on land, landscape and visual amenity; ecology and nature conservation: cultural heritage and historic environment; construction traffic and highways; security; economic benefits; and potential economic and social impacts within the community. Although many local planning authorities clearly support solar energy developments in principle they have often emphasised the importance of giving full consideration, where appropriate, to many of the issues listed above. In providing strategic planning observations to Newark and Sherwood District Council on a proposed solar farm at Bilsthorpe in Nottinghamshire in February 2013, for example, the County Council expressed concerns over *'the potential impact of the proposal on the ecology, historic environment and landscape of the County'* but reported that they could not make a formal recommendation until significant work had been undertaken and relevant information has been provided by the developers (Nottinghamshire county Council 2013).

More generally issues concerning land, landscape and visual amenity have focused, for example, on the impact on landscapes and agricultural land. In a report on a proposed solar farm at Great Glenham, presented to Suffolk Coastal District Council by the Head of Planning and Coastal Management in March 2013, it was argued that *'landscape impact is likely to be the most critical issue'* (Suffolk Coastal District Council 2013). While the report stressed that a Landscape and Visual Assessment Impact concluded that although the area of land covered by the solar farm was significant the structural form of the solar panel arrays would be low level and that the landscape impact would be limited and that the local pattern of topography, vegetation and development would limit the extent to which the proposed development would be more generally visible within the surrounding area. A number of objections to the proposed solar farm at Great Glenham focused on the loss of what was seen to be productive agricultural land but the report to the District Council emphasised that the development proposal was reversible and did not destroy the fundamental agricultural qualities of the land which could eventually be returned to full agricultural production. At the same time local planning authorities have expressed concerns about the cumulative impact of solar farms in areas where development pressure are strong and South Somerset District Council, for example, has emphasised that it does not support the prospect of a regular spread of solar farms across the whole of its jurisdiction.

In addressing ecology and nature conservation local planning authorities have generally looked to recognise that solar farms could have implications for habitat loss, fragmentation and modification and displacement of species. The nature and scale of any such impacts will clearly depend on the ecological features and the characteristics of proposed sites. On the one hand solar farms may reduce habitats but on the other hand they may also allow the integration of land uses and produce environmental benefits. Here a number of local authorities have employed ecology consultants and advisers in an attempt to mitigate adverse impacts and to maximise possible biodiversity enhancement. Solar farms can have impacts on a range of heritage assets, including sites, monuments, buildings and landscape, both above and below ground, though here the impact of solar farms will generally be site specific. However in Cornwall, a county where development pressures for solar farms are possibly greater than anywhere else in the UK, the County Council expects all development proposals to be informed by a consultation with the Historic Environment

Record (HER) and has made arrangements for a priority service with the HER for proposed solar farm developments. An Archaeological Assessment of a proposed solar farm at Crantock in Cornwall conducted by HER in 2011, for example, provided a chronological summary of the site and its landscape and an inventory of sites within and adjacent to the proposed development area and reported that a number of the sites were considered to be of high significance and of national importance. That said the report concluded that the impact of the proposed solar farm on the archaeological resource was assessed to be minimal if recommended mitigation measures were undertaken. These measures included a geophysical survey prior to any construction work to allow the identification of any buried sites, careful design of the proposed works to reduce the impact on field systems and any documented archaeological sites, controlled soil stripping and the analysis of mitigating archaeological recording should be compiled , analysed and published.

While some concerns have been expressed about increased traffic flows and vehicle movements and more general disruption during the construction phase this is generally seen to have a very limited impact. Generally developers stress that it would be unlikely that any exceptional large or bulky loads would be delivered to solar farm development sites during the construction phase and they are always willing to agree traffic routing with local highway authorities and the police to minimise the impact of construction activity on local road networks. Many local planning authorities usually advise applicants submitting solar farm development proposals that they must provide full details and specifications of all security installations. More specifically the Devon and Cornwall Police Authority have provided advice on perimeter fencing, electronic security, closed circuit television surveillance and landscaping techniques designed to deter unwanted vehicle access .The Authority further suggests that thought should also be given to the wider issue of access around any site and it suggests that where land surrounding a solar farm site is under the same ownership, thought should be given to improving gates so as to provide layers of difficulty for potential criminals to overcome.

Within planning applications for solar farms a number of local economic gains have sometimes been claimed. The construction phase, which might last up to three months, can bring a number of short term benefits including increased demand for accommodation in local hotels and guest houses, increased patronage of local shops, restaurants and public houses by workers and contracts for plant hire companies, hauliers, electrical, groundwork, drainage and fencing contractors. In the longer term while the development of a solar farm might result in a fractional reduction in employment, ongoing site maintenance and management, environmental stewardship and the introduction of schools visits programmes may produce a small net gain in employment. More generally some developers have argued that the development of solar farms in rural areas will have a long term multiplier effect not only in terms of new employment opportunities but also in that workers will be exploring new opportunities outside traditional agricultural employment.

Some residents living close to proposed solar farms have expressed concerns that such developments will reduce neighbouring residential property values. While there have been press claims that properties have been, and will be, devalued by the development of solar farms a number of local planning authorities have dismissed such claims. In recommending approval for a solar farm on 65 hectares of agricultural land at Hundon in Suffolk, St. Edmundsbury Borough Council (2012), for example, noted that *'concerns have been expressed over the impact on neighbouring property values from the proposed solar farm'* but stressed *'these are not considered to be material to the assessment of this* *application.'* More generally, if perhaps more predictably, a leading trade source has argued that *'to date there is no evidence to suggest that solar farms negatively affect property prices'* (The Solar Trade Association 2013).

A number of local planning authorities have been keen to suggest that community engagement should be seen as an integral part of the development process. Developers have often reported recognising the need for accessible and inclusive public consultation in order to allow people in the area surrounding proposed solar farms to express their opinions and ask questions within a timeframe that allows for a constructive dialogue and appropriate response but the level of public involvement has often been low and sporadic. An e-petition launched on the Cornwall Council website in November 2012 (Cornwall Council 2012) argued that *'the cumulative impact of solar farm development is having a damaging effect on Cornwall's landscape and rural economy, and should be suspended immediately until a coherent policy based on the wishes of the people of Cornwall is put in place'* and that solar farm development *'should be directed towards previously developed land or brownfield sites.'* The petition which called on *'Cornwall Council to suspend the development of solar farms on greenfield sites with immediate effect'* had attracted some 660 (0.12% of the population of Cornish) by early May 2013.

Conclusion

The UK Government has argued that solar power has the potential to form a significant part of the renewable energy generation mix and thus to meet its target of achieving 15% of the nation's electricity generation by 2020. While the UK government recognises that it faces uncertainties in delivering its renewable energy targets for 2020, not least in estimating future energy demands, the cost of renewable technologies and the level of renewable deployment the industry believes can be achieved, the continuing development of solar farms certainly seems likely to be an important element in achieving these targets. The development pressures for solar farm development are likely to continue to be greatest in the south east and the south west of England. While obtaining planning permission has not been a major constraint on development in these regions to date, the National Farmers Union of England and Wales (Farming Futures 2012) has suggested that up to 25% of the UK's sustainable energy needs could be met from the land and thus the cumulative impact of continuing solar farm development may become an increasingly contentious planning issue. Looking to the future the development of solar farms is just one of the many pressures currently facing the UK countryside. These pressures include developing more integrated approaches to land use, developing closer engagement between urban and rural populations, increasing the focus on ecosystem and biodiversity and delivering ecosystem services and harnessing and providing greater access to continuing technological innovation. However Bradshaw (2010) has suggested that *'re-defining society's relationship to energy is one of the great challenges of the twenty-first century'* and the continuing planning issues raised by the development of solar farms may provide a valuable lens through which these changing relationships may be viewed within the countryside, which may in turn provide some clues as to how wider and contested pressures for change and development will be received and reconciled.

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