The countryside charity
Gloucestershire

Rooftop solar: investigating Gloucestershire's industrial spaces

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Introduction

Climate change

Gloucestershire County Council, and all other Gloucestershire authorities, declared a climate emergency in 2019.

As part of Gloucestershire County Council's renewed climate change strategy, they committing to becoming a carbon-neutral county by 2045.

Climate change poses significant threats to the countryside and rural landscapes. Changing temperatures and weather patterns will increase pressure on rural ecosystems and influence biodiversity and increase flooding rates, for example. Therefore, climate change mitigation through reducing carbon emissions is essential for protecting rural areas.

According to the International Energy Agency, energy is thought to be responsible for more than 75 percent of all global greenhouse gas emissions. In the UK, the Department for Business, Energy and Industrial Strategy estimated that energy supply contributed to 20% of UK greenhouse gas emissions in 2021. Therefore, a shift towards renewable energy supply, and hence a reduction in greenhouse gas emissions from energy will have a substantial impact on enabling Gloucestershire to achieve its carbon-neutral targets

Solar power

Gloucestershire has therefore seen a significant increase in the number of solar farms, to utilise renewable energy sources.

Since 2011, there have been 104 planning applications for solar photovoltaics (Renewable Energy Planning Database, 2023). Of these applications, 70 (67%) were for ground solar farms. 57% of these applications were approved and are now operational or awaiting construction, 16% are awaiting approval and 27% have been abandoned/refused/withdrawn.

This is elaborated in Figure 1 below:

		REJECTED – 57%			PENDING – 16%	APPROVED – 57%		
		Abandoned/Planning expired/revised	Application Refused	Application withdrawn	Application Submitted	Awaiting Construction	Under construction	Operational
Total	70	8	9	2	11	11	1	28
		11%	13%	3%	16%	16%	1%	40%

Figure 1: A table showing the status of ground-mounted solar PV applications in Gloucestershire

Traditional agricultural areas have been transformed into spaces for solar power generation. This is presented as an attractive future for farmers, as it allows them to diversify their income and generate more profit than they would from crops. On a national scale, solar power not only enables the UK to achieve net zero targets but also increases the country's energy security. The UK can maintain independent energy production, as opposed to relying on importing energy, which may be problematic due to geopolitical events. Therefore, solar power and solar farms are seen to be incredibly advantageous locally and nationally.

However, recent installations of solar panel farms have come under controversy and contestation. The growth of solar power within Gloucestershire is a particularly contentious topic.

To name one example, there was controversy over the approval of a 160-acre solar panel farm in Clapton, near Berkeley in July 2023. Local councillors and residents disproved of the proposal, concerned about the impact on the landscape. Similarly, proposals such as the Maisemore Solar Farm (a 16 hectare, 49.9MW project) and one in Frampton Cotteral threaten wetlands and greenfield sites. Furthermore, CPRE is concerned with the impacts of solar farm construction on British agriculture and food production, biodiversity, and green spaces.

We welcome the many advantages of UK solar power, yet also want to minimise the threat to the rural landscape.

Therefore instead, CPRE National have launched a rooftop solar campaign.

The aim is to highlight the currently underestimated potential of rooftops for solar power generation to the national and regional government. They aim to encourage change in planning policies and regulations to protect green spaces and prioritise brownfield land.

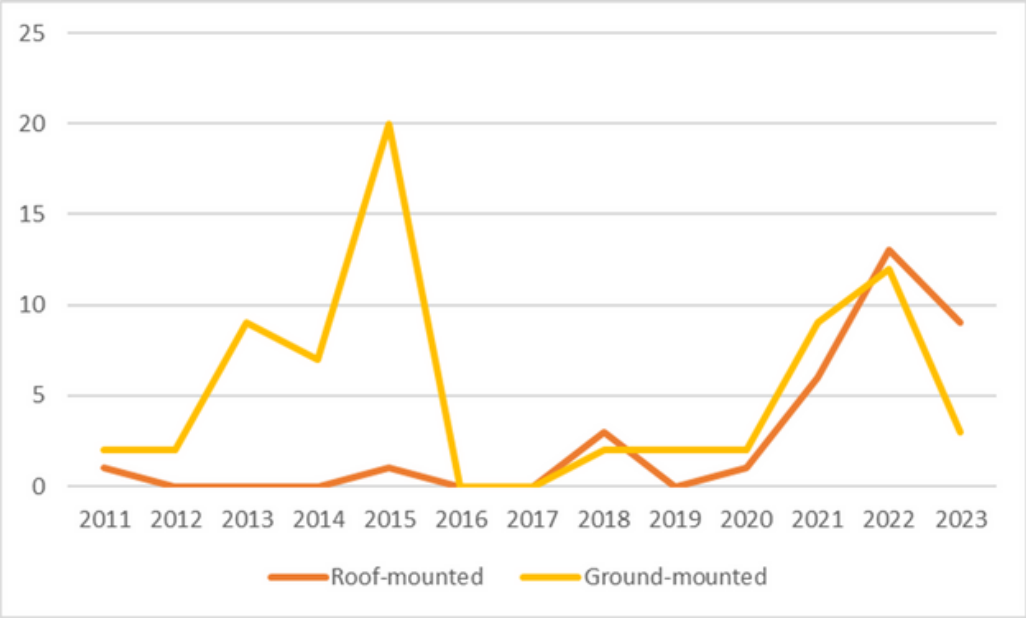

Figure 2: Solar PV applications in Gloucestershire by type

CPRE Gloucestershire has investigated the potential for installing solar panels on existing industrial infrastructure in the county.

Advocating for the use of these sites will hopefully protect Gloucestershire's green spaces and agricultural land. Furthermore, it will enable the county to achieve renewable energy generation in a way that will garner increased levels of public support. The installation of solar panels on the roof of 1000-year-old Gloucester Cathedral in 2016 demonstrates that the county and its residents are open to changing the agricultural site norm.

Furthermore, data from the Renewable Energy Planning Database 2023 illustrates that although planning applications for ground-mounted solar PV remains popular, there has been a recent increasing trend of roof-mounted solar panels.

Methods

This report will outline the GIS techniques adopted to establish the potential solar panel area in Gloucestershire, our findings, and conclusions. The aim of the research is to highlight the scale in Gloucestershire for rooftop solar power, by calling attention to the opportunities these sites present, and challenge the solar farm norm.

Although the CPRE National Campaign considers a variety of roof types, this research specifically wanted to investigate the available area of non-domestic, industrial rooftops.

We chose to focus on the city of Gloucester as our central location but extended our research to surrounding communities in Gloucestershire. These included Ashchurch, Hardwicke and Quedgeley. We also looked at areas connecting with Cheltenham, those being Brockworth and Swindon Village, to help provide a larger scope. These specific areas were located through preliminary scouting using satellite imagery to find areas of dense industrial land.

Therefore, when the findings were gathered, locations with small roof areas or residential buildings were disregarded. We recognise that these areas do not represent or include all industrial areas within Gloucestershire that could be used for solar panels, and that domestic rooftops also provide available rooftops. This therefore signifies that there may be an even greater area of space that could be used that is yet to be researched or identified.

As a consequence of our studies or work, we live in different areas of the UK. Therefore, we communicated and planned our research through numerous Zoom video calls. On these calls we deduced which area each person would collect data from and what technology would be used to collect and collate the findings. Our research was conducted using Google Earth software and its associated tools.

After identifying the sites of interest, these were divided amongst the group to map. The polygon tool was used to map the corners and points of the buildings to produce an overlay of the roof area (see Figure 1). This tool also produces a data point for the area of this overlay in m². This data was recorded in an excel spreadsheet to allow for data collection and analysis.

This data was recorded in an excel spreadsheet to allow for data collection and analysis. The tables we created also included columns that detailed if there were existing solar panels on the roof, and if there was, this area was taken away from the total roof area of that particular building. An example of the layout of our data collection table can be seen in Figure 3.

ID Number	Description of location	Size of roof	Solar (y/n)	Area of solar	Area avalible
TST001	Window Widgets	2927	N		2927
TST002	Downton	12445			12445
TST003	Gardiner Bros	2958			2958
TST004	Qued West Business Park	3126	2143	2143	983
TST005	Cotswold Shoes	2965			2965
TST006	Left of Downton	2675			2675
TST007	Vision Profiles	3451			3451
TST008	CCF Gloucester	3751	2152	2152	1599

Figure 3: Example of our data collection table

After each of us finished measuring the industrial space in our area, we had another Zoom meeting where we discussed what went well about the project, what could possibly be improved upon and how this information would be useful for the future of solar projects in Gloucester.

Limitations

The primary limitation of this approach is that it did not include assessments on the suitability of the buildings.

The base assumption of this research is that any industrial roof top is physically suitable, economically viable and available for use. It would have been beneficial to visit Gloucester and the surroundings areas in order to check that all the suitable buildings had been recorded.

Furthermore, if site visits had taken place, then unsuitable roof space could also have been removed from the data collection. Therefore, more precise information could be published. This could help save time for the companies that are looking to reduce the construction of solar farms on green spaces.

Also, there was an assumption made that solar panels could cover the entire roof space, when in reality this is not the case. For example, the solar panels will not necessarily spread across the whole extent from edge to edge.

Therefore, it is key to recognise that this research only identifies the available area, not the possible area. It's essential to consider factors like rooftop obstructions, HVAC systems, and maintenance access points when estimating the usable area for solar panels. As previously outlined, the sample acts as a limiting factor. This project did not evaluate all industrial areas in Gloucestershire

In addition, there is also the potential of non-domestic, non-industrial rooftops, such as schools, as well as domestic rooftops. This therefore means that this project cannot and does not claim to have the final figure for available rooftops for solar panels. Instead, this presents scope and opportunity for future project and development.

While we used the most recent satellite imagery from Google Earth, it's important to note that changes to the area/buildings may have occurred since then. Lastly, as this was conducted by people, there is always space for human error. In this case, the specific locations of the polygon corners may be slightly inaccurate by a few meters, for example.

Gloucester (east of the railway line), Swindon Village & Brockworth

In this section, research and data collection was undertaken at three separate locations, those being the east of Gloucester railway line, Swindon Village and Brockworth.

These locations are illustrated in the figure below:

Figure 4: Google Earth depiction of research locations

The table below shows the totals of existing solar panels and potential available roof space of each locational area. It clearly demonstrates that from the data that was gathered, the area of Brockworth has considerably more available roof space. It is also significant to note that overall, between the locations, so few of these industrial buildings have had solar panels fitted. This could provide huge opportunity for a greater supply of renewable energy in optimising as much of the existing roof space as possible.

Location	Existing solar panels (m^2)	Available roof area (m^2)
East of Gloucester Railway	4,464	14,9137
Brockworth	619	23,2281
Swindon Village	228	16,3520

Figure 5: Table comparing existing solar panels and available roof area between the locations

Hardwicke, Quedegley and the city of Gloucester (west of the M5)

The towns of Hardwicke and Quedegely have great transport links with major roads such as the M5 and the A38 running through or alongside them. Furthermore, the proximity of these towns to Gloucester has enticed the construction of industrial infrastructure.

Using the city boundary shown on Google maps, it can be deduced that 86 buildings on the western side of the M5 can be used for the construction of solar panels. There is already 6345.7m^2 of solar panels on these industrial buildings, thus there is 222,371.3m^2 available.

Figure 6: A screenshot, from Google Earth, showing the industrial roof space in the surrounding areas of Gloucester

Carrying on in a northern direction from these suburban towns, the city of Gloucester itself also has buildings that could be used to place solar panels upon. There is 309,265.7m² of industrial roof space that might be used for solar panels spread among 91 buildings in this city.

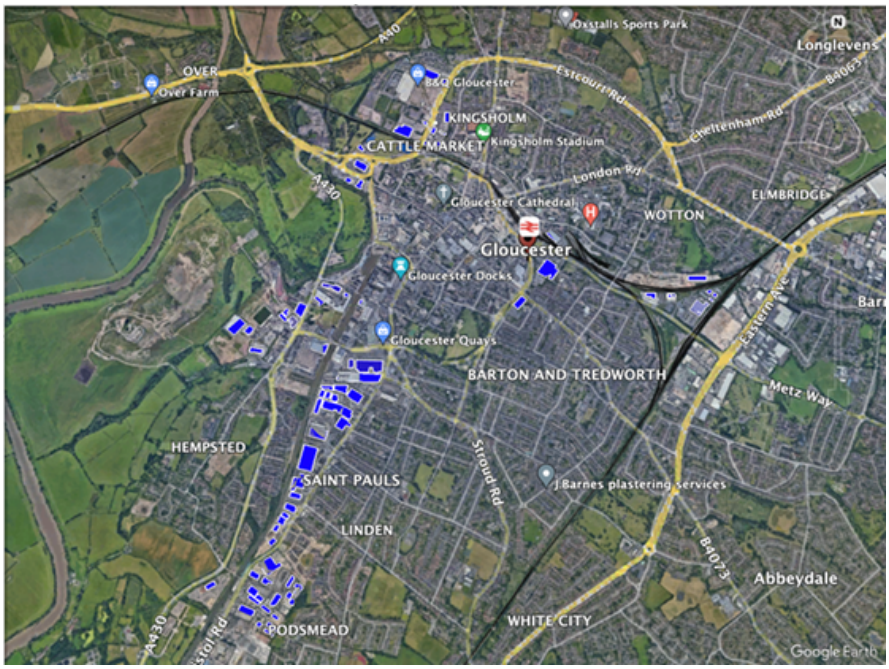

Figure 7: The industrial roof space in the city of Gloucester, as shown on Google Earth

Ashchurch, Tewkesbury

Ashchurch is located to the northeast of Tewkesbury, in the north of Gloucestershire. Although several buildings in this industrial area already feature solar panels, this research identified this only makes up 1% of the potential rooftops that could be utilised. Existing solar panel coverage is 3053.5 m2. However, the total area of available rooftops for solar panels is 312.775.5m², across 131 buildings as seen in Figure 3. The red overlays represent available rooftop spaces. This therefore represents a significant opportunity for solar panel expansion in the Ashchurch area by 100 times the current energy output.

Figure 8: Satellite imagery of Ashchurch with an overlay of avaliable rooftops for solar panels

Conclusions

Overall, this research project proposes that there is 1,392,351m² of solar panel potential area at these sites across Gloucestershire. This is significant increase of 85 times of what is currently being utilised.

	East Gloucester	West Gloucester	Ashchurch	Total
Total roof space (m²)	550,250	542,638	315,829	1,407,717
Existing (m²)	5,311.2	8,001	3,053.5	16,365.7
Available (m²)	544,938.8	534,637	312,775.5	1,392,351.3

Figure 9: Example of our data collection table

This has the possibility to produce a considerable amount of renewable solar energy and minimises the need for agricultural solar farms.

The implementation of initiatives like this project would be beneficial not only in Gloucestershire but also across the UK, as protecting greenfield land is crucial for the future of our nation. Renewable energy sources are believed and promoted to be how we can help combat the negative effects of greenhouse gases and climate change; however, it is important that the negative impacts of renewable energy sources are evaluated too

Future research could consider economic factors, such as the cost-effectiveness of installing solar panels on these rooftops and potential return on investment. This would be valuable for decision-makers and stakeholders.

Continued...

The proliferation of ground solar farms in Gloucestershire has not been without controversy, as concerns about their impact on the local landscape and ecosystems have surfaced. It is in this context that CPRE Gloucestershire embarked on a campaign to explore the possibilities of utilizing existing industrial infrastructure for solar power generation. This approach aims to protect green spaces, agricultural land, and biodiversity while still achieving renewable energy targets.

However, it is important to recognise that this research has limitations, as outlined in this report. Not all the roof space will be viable for solar panel projects, due to the shape of the roof, the disapproval of building owners, or difficulty in installing the panels and energy collectors. Additionally, reliance on satellite imagery and potential human error may affect the precision of the findings.

Nonetheless, this project serves as a starting point, offering a glimpse into the vast potential for rooftop solar power in Gloucestershire. This project hopes to encourage a mindset shift whereby rooftop spaces are prioritised for solar panels, and agricultural and green spaces are preserved and protected.

The data from the Renewable Energy Planning Database indicates that rooftop spaces are increasingly starting to be considered and prioritised for solar panels, and this project hopes to encourage and facilitate this mindset shift to preserve Gloucestershire's green spaces.

Moving forward, it is imperative to consider the broader implications of this research.

Encouraging collaboration between public and private sectors and investing in renewable energy infrastructure on industrial rooftops can pave the way for a sustainable and resilient energy future in Gloucestershire.

By harnessing the power of rooftops, we can make substantial progress toward achieving carbon neutrality, while also preserving the beauty and vitality of our rural landscapes for generations to come.

Thanks

We sincerely thank Tim Andrews and Matilda Jones at CPRE Gloucestershire for their valuable support, guidance in critically evaluating renewable energy's future, and for involving us in this significant project.

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