Proposed Solar Farm at Stock Green, Wychavon Planning application W/23/00270/FUL submitted to Wychavon District Council

Technical Review

Client: **Farrer & Co**

Status: Final
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LHW Partnership LLP, 31 Birds Hill, Heath & Reach, Leighton Buzzard, Beds LU7 0AQ
T: 01525 237030 • E: enquiries@lhwp.co.uk • W: www.lhwp.co.uk



LHW Partnership LLP
31 Birds Hill
Heath & Reach
Leighton Buzzard
Beds LU7 0AQ
www.lhwp.co.uk
enquiries@lhwp.co.uk

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Name	James Hoare CEng FIET FEI
Signature	
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EXECUTIVE SUMMARY

The summary identifies the key technical issues following a review undertaken of the proposed PV/BESS project on Land east of Stock Green, Wychavon that is the subject of planning application W/23/00270/FUL submitted to Wychavon District Council by JBM Solar.

- The key issue for the proposed PV/BESS (Battery Energy Storage System) project on Land east of Stock Green, Wychavon, is whether it is the most appropriate or necessary location for a project of this size, or whether there is another brownfield location that may be more suitable?

- There are some misleading claims in the applicant's planning statement, in particular CO_2 savings have in error been calculated against a coal power station offset value of 0.527 kg CO2 / kWh, and not the UK Government stated value of 0.19338 kg CO_2 / kWh which is more representative of the UK energy mix including interconnectors from mainland Europe. This is relevant because since 2019, coal power plants have generally not been operational in the summer period when the PV generation outputs are largest, and in 2022, coal only generated 1.5% of UK energy mix. Consequently, the applicant's stated CO_2 savings calculations are wrong, and misleading.

- The proposed battery chemistry technology selection for the 20 BESS containers has not been detailed, and this should be decided prior to the determination of the planning application and made the subject of a planning condition as necessary, as there are major variances in the risks and fire safety management requirements of the differing technologies. Currently, UK BESS technical standards and regulations are not sufficiently developed to deliver robust fire safety for the 20 batteries that form part of the proposed solar farm. Notably, fire safety is particularly important for this planning application given the rural location of the site. The nearest fire service is located 8 miles from the site, the roads leading to the site are narrow rural roads and the site is directly adjacent to Roundhill Wood.

- "Target 4: Treble renewable energy generation in the district by 2030" of the Wychavon District Council Intelligently Green Plan 2020 - 2030 has already been exceeded, without the requirement for the PV/BESS project that is the subject of this planning application. This is because of existing renewable energy generation and the grant of planning permission for 3 solar farms in the Wychavon District in 2022 and 2023.

- National Grid have stated that there have been over 300GW of new generation/BESS connection applications in the UK, and currently any new connection application with greater than 1MW of potential export is unlikely to have a grid connection before 2030 at the earliest, and in some instances a connection date of 2037 has been quoted. This is because major transmission network upgrade work is now required. Additional large scale generation projects within the District, including the proposed solar farm, are likely to limit the ability of local stakeholders within the District to undertake their own renewable projects.

- The proposed PV/BESS system will directly connect via a 66kV cable connection to Feckenham substation, in the Borough of Redditch, outside Wychavon District Council's administrative area. The applicant has submitted a separate planning application to Redditch Borough Council for the cable connection and associated works (23/00192/FUL). Feckenham substation will distribute electricity to a geographic area that is approximately double the area of Wychavon District. The planning statements and technical reports submitted with the Wychavon planning application claim that the generated energy will provide equivalent power for 18,186 Wychavon homes. This is not correct as the electricity distribution area that the Feckenham substation serves (as illustrated in Figure 3.1.4-A) is significantly larger than the

Wychavon area and the electricity is directed to where the demand/need is greatest. As a result, it is likely that the electricity will be directed to Redditch and other urban areas. In March 2023, RWE (a major utility company) purchased JBM Solar and it is likely that the generated green energy will be supplied to RWE customers and not necessarily Wychavon stakeholders.

- It is likely that a PV/BESS system of the size indicated in the planning application will generate annual revenues in excess of £9 million per annum with additional revenues for the BESS system. A proposed community benefit fund of £180,000 from JBM Solar to support local sustainable initiatives is considered to be disproportionately low, when there are likely to be generation connection impacts in the district that may prevent local stakeholders from connecting their own renewable energy systems that could reduce energy bills for local residents and businesses.

- The applicant's technical statement on BESS, alludes to the use of long duration storage batteries which could store the energy generated in June (which typically has longer sunnier days) for use in higher demand periods such as December and January. However, long duration storage is a R&D technology area that is very unlikely to be commercially proven and available within the construction timescales of the proposed scheme. To suggest that energy generated in June can be stored and released in the winter months is wholly misleading.

1 Introduction

1.1 Background

1.1.1 James Hoare of LHW Partnership has been instructed by Farrer & Co, on behalf of local residents to undertake an independent review of the relative merits of the technical and energy aspects of planning application W/23/00270/FUL submitted to Wychavon District Council ('the planning application") in relation to the proposed solar farm development at Land east of Stock Green, Wychavon (the "site")

1.1.2 This report provides a technical and impartial review of the planning application with a focus on the relative merits and drawbacks of the proposed scheme.

1.1.3 The review has been undertaken by James Hoare, a Chartered Engineer and Fellow of both the Institution of Engineering Technology and Energy Institute who has 38 years of energy engineering experience in power generation, transmission and distribution of electricity, of which the last 23 years have been heavily focused on PV and battery systems both grid and off grid from small to utility scale.

2 The project

2.1.1 The proposed project is described in document "R001v3 Planning Statement 310123 Final lr"

"Construction of a Solar Farm and battery energy storage system (BESS) facility together with all associated works, equipment and necessary infrastructure

The Proposed Development would have an export capacity of up to 49.9MW and will provide a reliable source of clean renewable energy which will be supplied to domestic and commercial consumers via the District Network Operator (DNO) grid network.

The main element of the Proposed Development comprises the construction, operation, management and decommissioning of a grid connected solar farm and BESS with associated infrastructure.

The Proposed Development also includes the underground cable route from the solar site into the existing National Grid Feckenham Substation which is located to the north of the Site. The total length of the cable route proposed is approximately 4.1km. This cable route has been assessed as part of this planning application.

3 Grid Connection and energy distribution

3.1.1 The PV farm / BESS system will connect to Feckenham a bulk supply point for the local distribution network connecting the local region via a 66/11kV substation owned by National Grid Distribution (formerly western Power Distribution, and Midlands Electricity). It is owned by National Grid Distribution and adjoins the National Grid 400kV transmission substation also at Feckenham.

3.1.2 Though the proposed PV/BESS installation is located in the Wychavon District, it connects to the grid and the point of connection is at Feckenham Substation 4.1 km to the north, which is located in the area of Redditch Borough Council, and not Wychavon.

3.1.3 Feckenham substation is part of the National Grid 400kV Transmission system and connects at 400kV to Seven Springs 400 kV substation in Gloucestershire, Hams Hall 400 kV substation in Warwickshire and Penn 400 kV substation in the West Midlands.

3.1.4 The National Grid Network Capacity Map outlines the following information for Feckenham 66/11kV substation which will provide demand electricity, and reverse power generation in the shaded area outlined in the map.

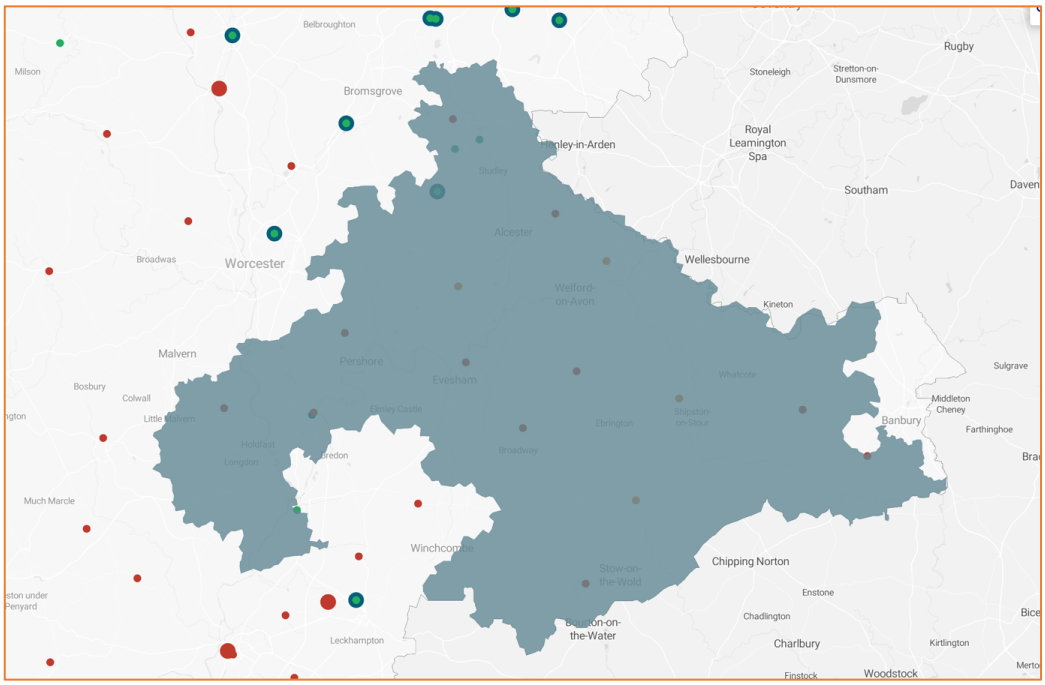

Figure 3.1.4-A Feckenham 66kV substation geographic distribution region

3.1.5 The National Grid capacity map outlines that within this area there is -

- 356.41MW of connected generation capacity (i.e., connected capacity that is in use and no longer available for new connections)
- 301.53 MW of accepted connection offers but not connected capacity (not a guaranteed connection depending on various factors including the progress of the project).
- 4.55 MW of yet to be accepted connection offers.

3.1.6 It is not known how much of the 301.53 MW of accepted connection offers, have been approved or are yet to be approved by National Grid Transmission.

3.1.7 It is known that the PV/BESS Project at the site has been approved by Western Power Distribution but is not known if the project has been approved by a National Grid Transmission Statement of works process.

3.1.8 The Feckenham 66kV connection at the substation will provide energy to the area outlined in the NGC map at Figure 3.1.4-A. 100% of the energy generated at the proposed solar farm will travel to Feckenham substation, where it will either be distributed to meet demand in the shaded area on the map at Figure 3.1.4-A above or fed back into the National Grid Transmission network for consumption outside of the area. Neither JBM Solar (or any other party operating the solar farm) or the Council has any control over where the generated energy is sent for consumption.

3.1.9 The National Grid 66kV network supply area from Feckenham substation where the PV farm is connecting to, is significantly larger (approximately double the area of

Wychavon District) than the geographical area of Wychavon District, which is 663.5 km^2.

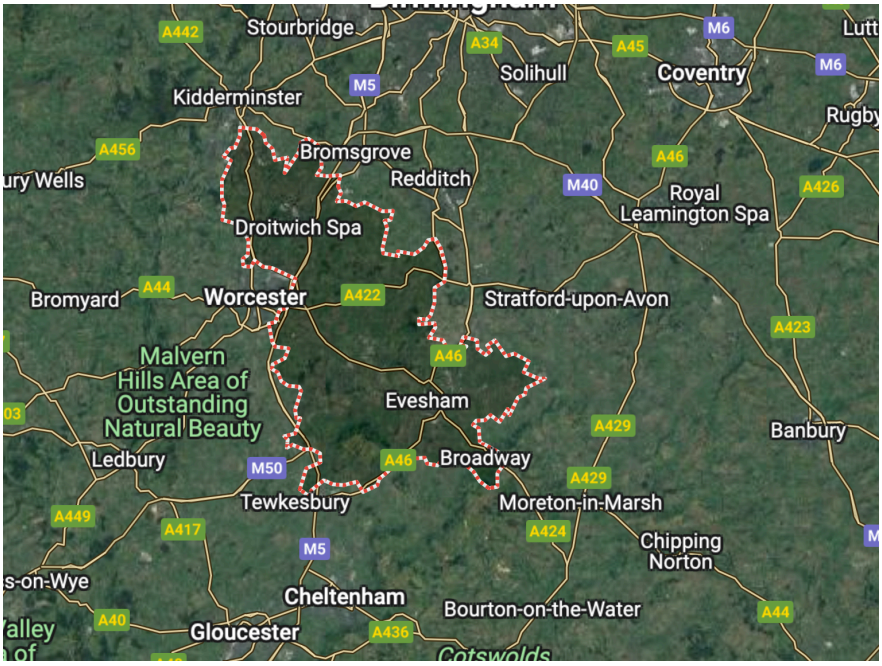

Figure 0-A Wychavon geographic area

3.1.10 It is likely that the current 356.41MW of generation capacity connected to Feckenham 66kV substation comprises Hospital Generators, Water treatment Works Generators, Renewable energy projects including BESS, Solar PV, wind, EfW, hydro, AD and Biomass technologies.

3.1.11 It is also likely that the 301.53 MW of accepted connection offers is predominantly Solar PV/BESS projects. The 49.9 MW PV BESS project at the site will be part of the accepted connection offers.

3.1.12 This also confirms that at least 49.9MW of the National Grid consented quantum of 301.53MW does not currently have a planning permission, so cannot be considered a to be project that is certain to progress.

3.1.13 The small 4.55 MW total quantum of yet to be accepted connection offers is likely to be the sum of a number of smaller G99 grid connection applications and is a strong indication that the capacity for new generation connection at Feckenham 66kV substation has been reached. This also indicates that any connection greater than 1MW is unlikely to be possible until post 2030, regardless of whether these smaller renewable energy projects are in the District of Wychavon or further afield in the Borough of Redditch and other areas. In early 2023, National Grid Transmission have been reviewing the impact of renewable generation on their EHV transmission network. The ability to connect additional energy generation that could be exported to the National Grid transmission network, is highly unlikely without significant transmission system upgrades. Such upgrades are unlikely to be delivered in the next 5-15 years. This will have a major and significant impact on the ability to connect new renewable generation schemes not only in Wychavon, but also in neighbouring local authorities including Redditch and other areas. The Government is aware of this significant issue, and further details of any mitigation and strategy are expected to

be announced in June 2023.

3.1.14 As part of the grid connection offer, the connection point will be defined by National Grid and this is likely to be on the proposed solar farm site. If the location of the proposed solar farm was to change, it is likely that the grid connection would be forfeited, and a reapplication would be required. This would delay the project to the 2030's.

4 Energy Yield Appraisal - Land east of Stock Green

4.1 Yield review

4.1.1 A PVSyst yield appraisal model was created (PVSyst is the Banks preferred PV modelling software) and assuming a construction start period of 2024, Jinko Solar 610Wp modules in strings of 24 modules (1500V) have been selected, coupling to 13 SMA Sunny Central 4000kW inverters, with a 33kV site distribution, and a 33/66kV transformer and a 66kV cable run to Feckenham substation.

4.1.2 It is likely that for a 49.9 MVA grid connection, the installed solar PV capacity will be about 70MWp. This is because the proposed solar farm is based on a tracker system (where the panels track sunlight), where a ratio of around 1.35 is typical. The maximum output of 49.9 MW is multiplied by 1.35 to calculate a maximum solar capacity of about 70MWp.

4.1.3 The estimated number of 610Wp bifacial PV modules is 115,000.

Table 4.1.3-A Annual Generation

	Generation
	kWh
January	1,980,089
February	3,352,646
March	7,209,873
April	10,376,626
May	12,396,040
June	12,432,274
July	12,128,094
August	10,488,851
September	8,197,781
October	4,622,550
November	2,642,492
December	1,533,386
Year total	**87,360,701**

4.1.4 The maximum energy a 49.9MVA connection at 100% duty cycle can output (24 hour/365 day) is 424,860 MWh. An estimated generation of 87,361 MWh compared to a maximum possible of 424,860 MWh demonstrates an indicative maximum operational capacity of 20.5% for the proposed solar farm when taken as an average over 12 months.

4.1.5 As the PV/BESS System is DC coupled, there is the potential to avoid inverter clipping, and an additional 1.8% of capacity could be generated per annum.

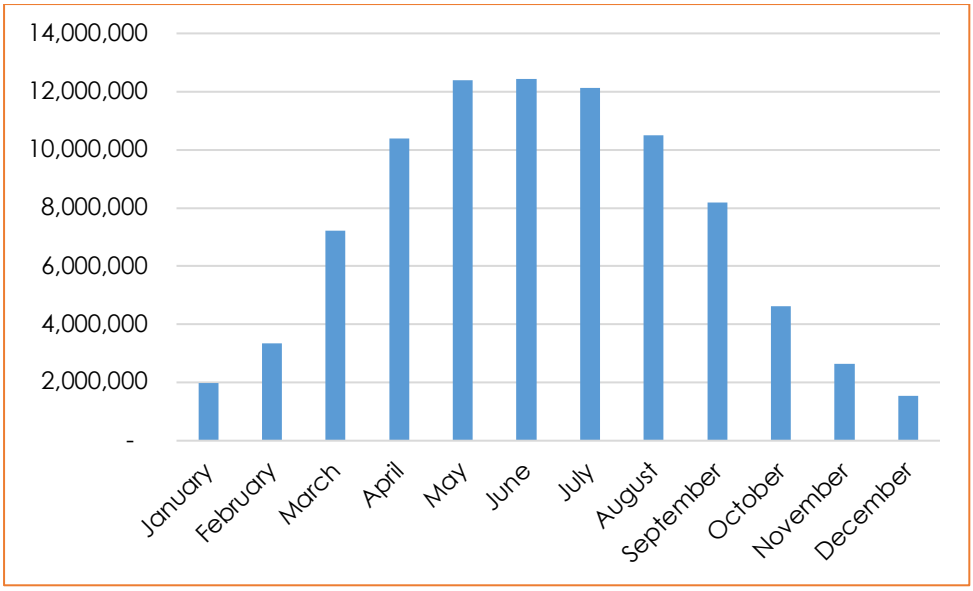

Figure 4.1.5-A Monthly solar PV Generation profile (kWh)

4.2 Capacity Factor impact review

4.2.1 The estimated annual capacity factor value aligns with the calculation from the applicant's planning statement. Appraising the effectiveness of the annualised capacity factor can be misleading, as the UK energy demand profile is maximised in the winter period, with lower demands in summer with longer and warmer days. Nationally the winter energy demand will grow with the need to electrify heating. A closer review of the annual 20.5% capacity factor shows a large variance over the year.

Table 4.2.1-A Capacity Factor review

	PV Farm kWh Generation	Days in Month	Max output from 49.9MVA connection	Max Operating Capacity
January	1,980,089	31	36,084,000	5%
February	3,352,646	28	32,592,000	10%
March	7,209,873	31	36,084,000	20%
April	10,376,626	30	34,920,000	30%
May	12,396,040	31	36,084,000	34%
June	12,432,274	30	34,920,000	36%
July	12,128,094	31	36,084,000	34%
August	10,488,851	31	36,084,000	29%
September	8,197,781	30	34,920,000	23%
October	4,622,550	31	36,084,000	13%
November	2,642,492	30	34,920,000	8%
December	1,533,386	31	36,084,000	**4%**
Year	87,360,701	365	424,860,000	21%

4.2.2 Table 4.2.1-A shows that in December only 4% of the consented grid capacity for the PV farm is being used which means that 96% of the capacity of the solar farm is not being used. This is turn means that 96% of such important capacity cannot be used by other generation technologies elsewhere that could make a more noteworthy contribution to the winter peak energy demand challenge.

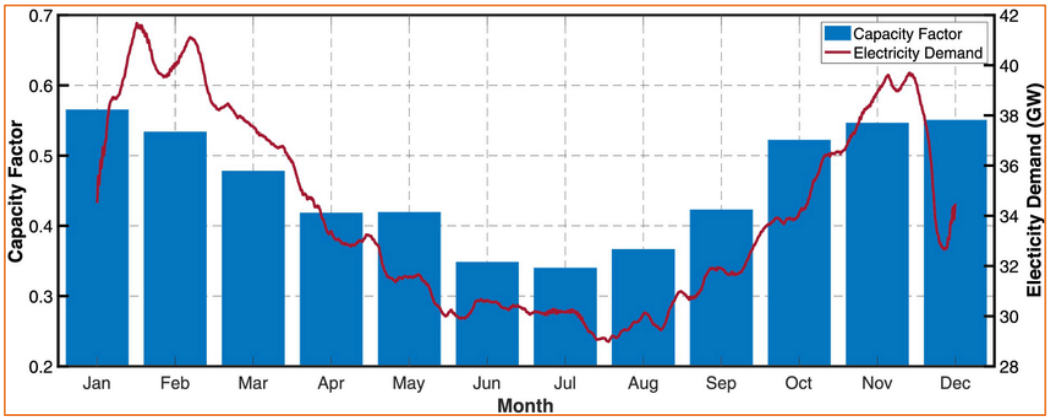

Figure 4.2.2-A Monthly average electricity demand profile. The blue bars demonstrate national grid capacity already the subject of a grid connection.

4.2.3 It is clearly demonstrated from average energy demand that the average national electricity demand in June/July when the PV farm is most effective is approximately 30GW and is significantly higher and up to 42GW in the winter periods when the PV farm would be the least effective. The PV farm capacity factor in June is a factor 9 times larger (36%) than in December (4%), when peak demands can be expected, and national energy security is most exposed. This is not unexpected, as solar PV will naturally work better in the summer period, and other generating technologies can provide the winter demand. In the context of the proposed PV farm at Wychavon, this would be acceptable if there was an unlimited availability of grid capacity in order to connect renewable generation, but in 2023 this is most certainly not the case.

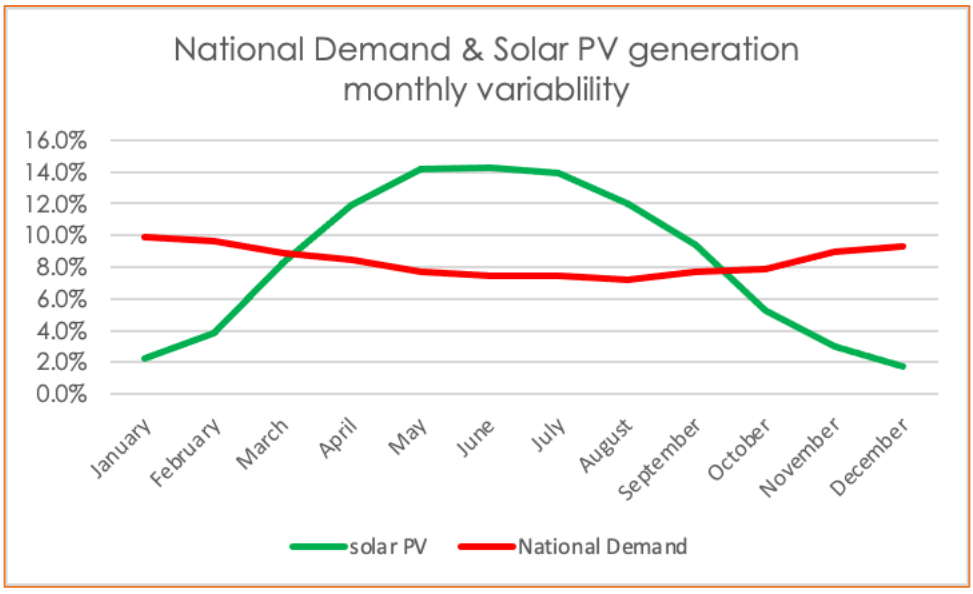

Figure 4.2.4-A Monthly comparison of PV generation and national demand

4.2.4 The graph in figure 4.2.4-A, shows that the contribution to the UK energy generation mix of solar PV monthly profile is contrary to the UK annual demand profile, and at times of peak demand, the contribution of solar is minimal.

4.2.5 As is well documented, the UK is transitioning from a centralised power system with large power generation plants supplying the UK via the EHV National Grid, to the provision of local distribution networks feeding customers typically at Low voltage or larger users at 11kV or sometimes 33kV. The generic network design for centralised power generation had not anticipated the rapid uptake of large volumes of localised

generation, and in 2023 there are major limitations appearing that is significantly limiting the ability to connect new generation schemes in the UK of this size.

4.2.6 Since renewable energy started being connected in the UK in the early 1990s, predominantly with Landfill Gas and Wind under the Non Fossil Fuel Obligations, there was sufficient flex in the existing network to accommodate smaller scale embedded energy. However, the significant uptake of renewables and in particular solar PV since 2010 has seen a dramatic increase in the total installed capacity of approximately 16GW, and as a consequence connecting new generation has become more challenging, and as of early 2023, has got to a point where the level of installation and new applications is so large that more and more locally produced renewable generation can be exported back to the National Grid transmission network for national use rather than regional/local consumption. As of 2023 National Grid are essentially preventing most new connections with an export greater than 1MW until the early 2030s and in some cases even 2038, as there is significant network reinforcement required. Wychavon District has been a UK leader in PV installation adoption since 2005.

4.2.7 There are strong arguments and debates concerning the lack of network development by National Grid, but the issue has been significantly compounded in recent years by a significant increase in the level of large scale 49.5MW grid connection applications for solar PV and large batteries in advance of securing planning permission. These applications are often on land in close proximity to National Grid substations, so the cable route is shortest. It is of note that in Ireland a grid approval cannot be granted without first securing planning permission.

4.2.8 It is noteworthy that the list of consented projects from JBM solar (outlined in the document BESS Technical Statement Roundhill Wood Solar Farm W-23-00270-FUL.pdf) were, with the exception of one 25MW project, all for 49.9 MW of AC capacity, and unlike the current planning application, all in close proximity to large National Grid or large Distribution Network operator substations.

4.2.9 49.9MW is the upper limit before the level of complexity on generation connection grid applications increases significantly. It is very likely that all the projects (with planning permission outlined in the JBM Solar BESS Technical document referred to above) secured a grid connection in advance of securing planning permission. Such a grid connection application (known as a G99 grid connection) is typically less than half a day's work and all that is needed is a letter of authority from the landowner, there is no requirement to obtain planning permission first.

4.2.10 It is therefore relatively easy to submit multiple identical grid connection applications, and it is not surprising there has been an unprecedented level of grid connection applications in the UK. After securing a grid connection it is easy to preclude the less favourable locations, for example where the connection cost may be greater, before strategic decisions are made on whether to incur the cost of a planning application.

4.2.11 Currently (based on National Grid data) according to National Grid, in the UK there are in total an estimated 300GW of consented projects across the UK with new connection agreements , predominantly PV & BESS, subject to National Grid review in order to meet a peak UK annual demand of 40-50GW. In this respect there is an excess for UK peak demand of approximately 250GW but with no interrogation of which projects are feasible and likely to become operational. Many of the projects with a consented grid connection are not progressed by applicants/landowners for commercial reasons but the grid connection process in the UK does little to address this issue caused by redundant or slow-moving projects.

4.2.12 This methodology is logical for a PV/BESS developer strategy, but as grid capacity has now become a very precious commodity, the impact and perspective of other stakeholders within the network also needs major consideration, and in particular geographically tied energy using residents, authorities and businesses who will unsurprisingly have a concern and interest about protecting themselves against rising energy costs. Residents and local businesses who want to undertake their own renewable schemes to mitigate against climate change, lower energy costs and improved energy security are often precluded from doing so because of the severe constraints on grid capacity.

4.2.13 The connection and capacity issues are complex. It is likely that very few people within the electricity supply region of the Feckenham 66/11 kV substation have an appreciation of the potential limitations of the grid capacity in their region, and the potential impact that a 49.5MW PV/BESS system (such as the current planning application) may have on their ability to secure a grid connection.

4.2.14 It has to be assumed that JBM Solar are now very aware of the major impact of the National Grid capacity and connection limitations, and the consequent impact for any future project within the area fed by the Feckenham 66/11kV substation. It is common knowledge that throughout England and Wales the National Grid statement of works reviews have essentially stopped any further new project connections with an export greater than 1MW until at least the early 2030s.

4.2.15 There are 2 principal ways this can impact on local stakeholders.

- Wychavon District Council, Worcestershire County Council, the NHS, and Emergency Services are currently essentially precluded from developing any renewable scheme of their own to offset local energy production for schools, social housing and council and community buildings on a scale greater than 1MW until the early 2030s at the earliest. In comparison to the proposed solar farm of 49.9MW Stock Green project, 1MW is a diminutive size.

- Businesses and in particular those with high electricity usage will be precluded from undertaking their own renewable energy schemes to lower/control their energy bills, which in turn could impact their commercial viability and/or ability to continue operating.

4.2.16 Currently, residential property owners in the region wishing to undertake small scale renewable projects should not be affected, but this is not 100% assured.

4.2.17 It is my opinion that the solar farm development market has grown fast, and the rapid deployment of PV farms has been advantageous for a number of reasons, but in 2023, the country is at a crossroad, and a more considered review is required. This is principally due to the grid network constraints, and consequences for stakeholders who cannot change their grid connection provider or move out of the geographic area where they are resident and may suffer as a consequence.

5 Review of Planning Statement

Section 5.2
Solar Energy UK's briefing note (Appendix 1) notes that "solar farms reduce the UK's carbon footprint, displace extortionate fossil fuels, cut bills, create jobs, benefit nature, and bolster the nation's energy security."

5.1.1 I partially agree with statement 5.2 and that "solar farms reduce the UK's carbon footprint, displace extortionate fossil fuels, cut bills, create jobs, benefit nature". As clarification almost any PV installation and not PV farms alone will reduce the UK's carbon footprint, displace extortionate fossil fuels, cut bills, and create jobs. Rooftop PV systems because of their location on roofs are unlikely to provide benefits to nature but provide generated energy in close proximity to point of energy use.

5.1.2 In my opinion, the statement that the PV farm on Land east of Stock Green will bolster the nation's energy security is misleading for the following reasons.

Energy security

5.1.3 The International Energy Agency (IEA) defines energy security as the uninterrupted availability of energy sources at an affordable price. UK national demand peaks are typically in January and December each year, when the output from a PV farm is at its lowest, and typically only 15% of June/July peaks, when national energy demand is significantly lower. The higher risk of interruptions is in the winter period, and there are other technologies that are more appropriate to mitigate the risk of interruptions in the winter peak demand periods. Examples of these technologies include wind generating technology, which has a more matching operating profile, anaerobic digestion, and the early stage but emerging adoption of tidal energy which has predictable intermittency profile.

Capacity Factor.

5.1.4 The annual average capacity factor of the PV farm is 21% (see paragraph 4.1.4), and the capacity factor average between December and February is 4.5%. This means that at the period of highest risk to energy security the capacity deficit from a perfect maximum of 100% is 95%. Technology such as wind coupled with BESS could provide a significantly higher capacity factor in this period.

Section 5.3
The development will have an export capacity of up to 49.9MW. A solar farm of this size will therefore generate a significant amount of electricity from renewable sources, and this will mean a reduction of approximately 43,839 tonnes5 of CO2 emissions annually (approximately 1,753,560 tonnes over the operational lifespan of 40 years). This represents a significant contribution to the legally binding national and international requirement and associated targets to increase renewable energy generation and reduce CO2 emissions, as outlined in this Statement. For context, the proposed solar farm can meet the equivalent energy needs of approximately 18,186 homes in the District.

5.1.5 I do not agree with statement 5.3, and there are significant inaccuracies with the claims.

5.1.6 It is correct to state that a solar farm of this size will generate a significant amount of electricity from renewable sources. However, the $C0_2$ reduction is not correct, as 43,839 tonnes of CO_2 emissions annually should be sourced from the Greenhouse gas reporting. Conversion factors in 2022 and beyond mean that the CO_2 content per kWh of electricity is reducing, and in 40 years should be close to zero. 1,753,560 tonnes (referred to in section 5.3 quoted above in the applicants planning statement) is 43,839 multiplied by 40. This is misleading and not correct, as it is now rare for any higher emitter (such as coal power stations) to be operating at peak PV generating months of the year, and the CO_2 value used in the calculation (0.527 kg/kWh) in the Applicant's Planning Statement was calculated as offset against the highest CO_2 emissions from coal power plant, and not from Government conversion factors for UK electricity, that are revised each year.[1]

[1] https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting

5.1.7 The reality is that more polluting energy sources (such as coal power stations) are unlikely to be utilized for most of the year (unless there is an urgent need during the winter months), yet the Applicant has not made the necessary deductions in their CO_2 saving calculations to reflect this.

5.1.8 In 2022, only 1.5% of power generated energy came from coal power stations, down from 43% in 2012, compared to 4% of power generated from solar .[2] It is misleading to calculate CO2 savings in comparison to coal power stations that are likely not to be operational in the peak PV generating months.

5.1.9 It is not correct and is misleading to state that the proposed solar farm can meet the equivalent energy needs of approximately 18,186 homes in the District. The solar farm will connect to the Feckenham substation at 66kV, and the map in Figure 3.1.4-A, outlines the area the substation provides energy to. This is an area with a geographic coverage significantly larger than Wychavon district. The substation and associated 66 & 11kV network cannot discriminate between Wychavon district homes and other homes outside the Wychavon geographic area. Wychavon district is more rural than local towns like Redditch, also supplied from the substation has and with a higher energy consuming population. Any preference for the generated energy to be fed to rural areas in Wychavon from the substation is not possible. The energy produced will be sent to areas with the greatest demand, which in Feckenham is likely to be the urban areas of Redditch and other densely populated areas. For these reasons, claiming the proposed solar farm can meet the equivalent energy needs of approximately 18,186 homes in the Wychavon District is not correct and is misleading.

5.1.10 In March 2023, RWE acquired JBM Solar. RWE is a large utility company providing coal, gas and nuclear generated energy as well as solar and wind, so it is likely the energy produced by the proposed solar farm will be transacted with RWE customers, the vast majority of which are likely to be outside of the Wychavon geographic area.

Co-located Battery Energy Storage System (BESS)

Section 5.4
*The development will include battery energy storage system (BESS) which consists of 20no. battery storage containers evenly distributed throughout the proposed site. The British Energy Security Strategy explains that the Government will encourage "all forms of flexibility" in the energy system and will develop policy to enable investment in "**sufficient large-scale, long-duration electricity storage**". It also sets out support for solar that is collocated with other functions, including storage, to maximise the efficiency of land use.*

5.1.11 The Planning Statement outlines that there will be 20no. battery storage containers evenly distributed throughout the proposed site, which is a good engineering solution, as we can assume the PV & BESS are DC coupled. The claim makes reference to "sufficient large-scale, long-duration electricity storage". In simple terms, long duration electricity storage in the context of solar PV means storing surplus energy generated in June for use in December. It is highly unlikely long duration storage will be commercially viable in the timescales of this project, and before the planning application is determined.

5.1.12 This is because the technology for long duration storage has not been developed so that it is ready for use and in reality, this type of technology is decades away from being in a useable form. Unless there is a major technology and commercial breakthrough in long duration storage systems, the proposed solar farm will likely be

[2] https://www.nationalgrid.com/stories/energy-explained/how-much-uks-energy-renewable

adopting lithium or potentially flow battery technology. These types of batteries operate regular battery cycling (i.e., the charge and discharge of a battery which typically would be 24 hours for one charge/discharge cycle) and which cannot be considered as long duration storage. In other words, the typical amount of time a battery at a solar farm can store energy is 24 hours. Long duration storage would need to store a quantum of 100s of MWh or GWh's of energy. In context on a sunny day a 70MWp PV array can fully charge a 50-100MWh battery system as proposed for the project by lunchtime, and after that the generated energy would then have to be exported to avoid being lost/discharged. The batteries at the site would not have sufficient capacity to be effective for long duration storage.

5.1.13 The document "BESS Technical Statement Roundhill Wood Solar Farm W-23-00270-FUL" submitted with the planning application states *"There is a wide variety of BESS technologies available today, with Lithium-Ion systems being the most popular. However, there is no guarantee that this is the chemistry solution that this development will deploy. The alternatives could include Flow, Lead-Acid, Sodium-Sulphur, Lithium-Iron Phosphate to name a few"*. None of these technologies can be considered to be long duration storage and making reference to "long duration storage" in the planning statement is misleading when read by an audience not generally expected to be familiar with battery technology innovation.

Section 5.6
The Net Zero Strategy also makes clear that as we rapidly decarbonise energy systems, we must also de-risk the delivery challenge and provide flexibility in order to integrate renewables and balance their intermittency. Doing so will involve pursuing innovative solutions, including new storage technologies.

5.1.14 Contrary to the applicant's Planning Statement, there is no reference to adoption of long duration storage in document "BESS Technical Statement Roundhill Wood Solar Farm W-23-00270-FUL". It is very unlikely the design solution for the solar/BESS system can adopt a long duration storage solution, as currently there is not a relevant technology that is commercially available. The applicant's statement is considered to be misleading.

Community Benefit Fund
Section 5.23.
The Proposed Development would also incorporate a community benefit fund of £180,000 to support the installation of rooftop solar PV systems on local community buildings as well as help fund other important local sustainable initiatives. Whilst this is a benefit of the scheme, it is not one that should be included in the overall planning balance as it is not directly related to mitigating the impacts of the proposed development.

5.1.15 The PV/BESS system will generate 81,233MWh of electricity, and as it is DC coupled, an additional 1.8% is possible, giving a total of £9.923 million in revenue in the first year of operation, and a 40 year life expectancy.

5.1.16 Additionally, the potential revenues if the battery system operates in the National Grid Ancillary services market could provide very significant additional revenues.

5.1.17 In my opinion I do not consider that a £180,000 community benefit fund is particularly generous, taking into consideration the negative impact the proposed solar farm will directly have on the potential connection of other renewable/BESS projects in the district.

6 Review of JBM Solar Technical Statement on Battery Energy Storage Systems (BESS)

Section 3.2
In the planning statement, it is explained (or will be explained) that the 49.9MW power proposal would provide electricity equivalent to the average electrical needs of approximately 18,186 typical Wychavon homes annually and assist towards reducing carbon dioxide emissions, saving approximately 43,839 tonnes of CO2 per annum.

6.1.1 This statement (taken from the Applicant's technical statement on BESS) is not correct, as the connection from the Wychavon PV/BESS project connects to the Feckenham substation at 66kV, and the geographic area fed from the Feckenham 66kV substation covers a significantly larger area than the Wychavon District. See paragraph 5.1.9 of this report for a detailed analysis.

6.1.2 The Government Greenhouse gas reporting conversion factors for 2022[3] outline a homogenised carbon content of UK electricity of 0.19338 kg CO2e per kWh. It is not correct to use the 0.527 kg CO_2e per kWh value for CO_2 emissions for conventional fossil fuel generation as a comparative benchmark. Instead the value of 0.19338 kg CO_2e per kWh should be used, as the PV farm cannot determine which generating technology emissions it is offsetting against. This lowers the CO_2 emissions from 43,839 tonnes as stated. See paragraphs 5.1.6 to 5.1.8 of this report for a detailed analysis.

6.1.3 Each year the Government Greenhouse gas reporting conversion factor reduces. In 2010 it was 0.48531, in 2015 it had lowered to 0.46219, and in 2020 it was 0.23314. It is not correct to state "Over the lifetime, this equates to 1,753,560 tonnes of CO2 avoidance" as each year the comparative CO2 content of the electricity supply is reducing.

Section 4.12

Solar energy generation avoids the need for the use of carbon-heavy fossil fuel generation. As such it directly offsets CO2 emissions as per the below formula:

Energy Production Households Equivalent Formula

- *[Capacity in MW] x [24 hours] x [365 days] x [Capacity Factor] / [Annual Average domestic consumption for Wychavon]*
- *Similar to 5.2, the capacity factor is derived from the design of the solar farm. The annual average domestic consumption per household is taken from the government's statistics..*
- *49.9 x 24 x 365 x 19.03% / 4.574 = 18,186 is the number of households that our solar farm will annually provide equivalent power for.*

6.1.4 The Feckenham Substation provides electricity to a larger area than just Wychavon District (as outlined at 5.1.9 above), by a notable amount, so it is highly unlikely that 18,186 Wychavon properties will benefit from the proposed solar farm. It is yet to be determined or stated who would purchase the energy from the site, but it is unlikely to be anything but a small minority of Wychavon stakeholders.

Section 4.13.
You can find JBM's track record below in Table 1. To date, JBM Solar have been successful in securing planning consent for over 675MW of co-located Solar and BESS schemes.

6.1.5 This is not disputed and acknowledged that a grid connection was likely granted in advance of the planning application. However, planning permission has not been granted by Wychavon District Council, and in 2023 National Grid have essentially

[3] https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting

prevented the connection of any network operator generation scheme that can export greater than 1MW until after 2030 at the earliest. This impacts on the District's ability to undertake far more modest scaled projects because of the lack of available grid capacity.

6.1.6 It is noted that, with the exception of Eastfields, all the consented projects (listed in Table 1 of the Applicant's technical statement on BESS) are 49.9MW, and likely to be very similar, which suggests multiple grid connection applications have been submitted, and once connection has been assured a detailed planning review is undertaken.

Section 4.23
Arizona & Liverpool fire
In the case of the Arizona and Liverpool BESS fires there were several key contributing factors which led to a thermal runaway and fire event in each case. There were also several recommendations outlined in the two reports. Table 2 below summarises the issues and recommendations and demonstrates how the proposed BESS will avoid the same mistakes and will be designed in an appropriate and safe manner.

6.1.7 There is in addition a much-publicised BESS fire in Victoria, Australia that destroyed 2 of the 600 3MWh containers, which is global knowledge but not mentioned in the Applicant's document.[4]

6.1.8 It is generally accepted that flow batteries have a far lower risk of fire than lithium based technology. Lithium based batteries are currently the cheapest option and the most available. The best mitigation for fire risk alleviation would be adoption of flow batteries. Fires caused by lithium batteries cannot be extinguished with water and require specialist management. In the context of this rural site, with up to half an hour for first responder fire services to reach, and close to ancient woodland, any fire is likely to spread more quickly. There are a lack of recognised UK technical standards and regulations, which in turn results in planning application proposals that respond in their own way to the health and safety risks posed by solar farms. This is currently being addressed by Government, HSE and other stakeholders, but it is unlikely that recognised UK technical standards will come forward before this planning application is determined.

6.1.9 In December 2022, the Fire Protection Agency published a document "Need to Know Guide RE1 Battery energy storage systems: commercial lithium-ion battery installations", it is not clear whether this document was reviewed, and it is considered important that the battery chemistry is pre-determined in advance of this planning application being determined and the local fire authority given an opportunity to comment further.[5]

6.1.10 The Hereford & Worcester Fire Service was consulted and responded on 30 March as follows -

"Early consideration should be given to access to the site and the provision of sufficient water supplies for fire fighting. Appropriate isolation of the Photovoltaic system in case of fire should be provided."

[4] https://www.energy-storage.news/investigation-confirms-cause-of-fire-at-teslas-victorian-big-battery-in-australia/
[5] https://www.thefpa.co.uk/resource-download/626

6.1.11 In addition to water, appropriate suppression systems should be in place to and assist in slowing and limiting fire propagation across battery modules and racks. The suppression systems will be relevant to the chemistry, and this is why technology predetermination is very important.

Section 4.26
Solar power is at the forefront of the worlds and the UK's decarbonisation efforts. The benefits of replacing CO2-heavy generators with solar and the local benefits of providing power for over 18,186 Wychavon homes every year will be crucial if we are to limit global warming to under 1.5 degrees Celsius. BESS are key enablers necessary for our Net Zero future and our security of supply, with their use case enhanced when collocated with renewable energy sources. The key points are below (also refer to 4.8-4.12):

Summary

1. *• Demand/Generation shifting*
2. *• Environmental and health benefits*
3. *• Double value for the grid*
4. *• Increased security of supply*
5. *• Infrastructure, construction and operation efficiencies and savings*
6. *• Increased safety through advancements*

6.1.12 There is no dispute as to the importance of both PV & BESS as key aspects of the future energy mix at all scales from residential to utility.

6.1.13 As mentioned at paragraph 5.1.9 of this report, the PV farm is connecting to Feckenham 66kV substation. This means that the distribution area of Feckenham 66/11kV substation is significantly larger than the area of Wychavon District, and it is not possible to determine who is the recipient/beneficiary of the solar energy within or outside Wychavon District.

Demand/Generation shifting.

6.1.14 There is little mention of the capability of the BESS system to provide ancillary services, and this is likely to be the most profitable activity for the BESS system.

Environmental and health benefits

6.1.15 It is generally accepted by all but a small minority that clean energy is important and preferable to CO_2 emitting generation.

Double value for the grid

6.1.16 BESS systems at all scales are accepted as one of the mitigations to overcoming intermittency, which is the primary criticism of renewable technology. In the context of Wychavon the BESS system is 20 containers and estimated to be 50-100MWh in capacity size. With a 49.9MW grid connection this can help with NGC ancillary services but will not have a dramatic impact on the capacity factor of the proposed solar farm in the winter months in terms of generating outputs.

Increased security of supply

6.1.17 As has been demonstrated, the capacity factor of the proposed solar farm is 4% in the period of the year when the risk of security of energy supply is highest. It is accepted that DC coupled PV/Battery system is a good technical solution for relative grid efficiency, but consideration needs to be given to the fact that the project will

currently restrict the ability of the installation of other multiple smaller BESS projects in the Wychavon District for at least 7 years, that are likely to be more advantageous to the district than this project. BESS systems have a very high MWh/area density in comparison to PV farms, and a brownfield location is likely to be a better alternative location in line with Government policy (see page 20 of the March 2023 publication Powering Up Britain which states that solar farm development should be located mainly on brownfield, industrial and low/medium grade agricultural land).

Infrastructure, construction and operation efficiencies and savings

6.1.18 DC coupled BESS systems should increase yield by a further 1.81% by lowering inverter clipping, and maximising grid capacity, but the benefits need consideration of the potential impact on feasibility on other smaller projects in the Wychavon District, which will suffer as a consequence if this project proceeds.

Increased safety through advancements

6.1.19 It is premature to determine increased safety through advancements. It is generally accepted that flow batteries are significantly less prone to fire than Lithium batteries, but the planning application currently does not specify its battery technology, and as there are significant differences in battery chemistry and fire resilience, in my opinion this should be predetermined at the planning application stage, and not left undecided.

7 Wychavon District Council Intelligently Green Plan 2020 - 2030

7.1.1 In the opening statement in the Intelligently Green Plan 2020-2030, Wychavon District Council clearly states that tackling climate change is the most important issue facing humanity. It requires action on a global, national, local and personal level. This is a fundamentally important statement, as though the PV/BESS system lies within the boundary of Wychavon District, aside the required planning permission, there would not be a significant level of involvement at local and personal level.

7.1.2 There are 5 primary targets, and these are reviewed in the context of the proposed solar farm.

Target 1: Reduce our own greenhouse gas emissions by at least 75% by 2030.

7.1.3 It is stated that more than half of the emissions were generated from the three leisure centres and the lido. Another 29% came from the waste and street cleaning contractor's vehicles and 11% were generated from heating and powering the Civic Centre. The remainder were from public toilets and other buildings, staff and councillor travel and the waste the Council produced at the Civic Centre.

7.1.4 In March 2023, JBM Solar was acquired by RWE who generate both gas fired and renewable electricity. It is very likely RWE will sell the electricity from the proposed solar farm to their customer base.

7.1.5 Unless Wychavon District purchases "green" electricity directly from RWE or a broker, they will not actually be able to benefit or even claim the electricity generated from the PV/BESS system is providing any metered benefit to helping to reduce the Council's Greenhous gas emissions by 75% by 2030.

7.1.6 Electrical initiatives that could lower the greenhouse gas emissions could include

adding PV & Heat pumps to replace/supplement what is likely to be substantial Gas heating at the leisure centres and facilitating electrifying of the waste and street cleaning contractor's vehicles.

Target 2: Halve district wide carbon emissions from 992 kt CO_2 in 2005 to 496 ktCO_2 in 2030

7.1.7 It is stated that in 2017, the district generated 723 kt CO_2, this amounts to 5.8 tonnes of CO_2 per person. Industry and commerce accounted for 37% of these emissions, 36% were from transport and 27% were from homes. Industrial and domestic emissions have fallen steadily over the past decade, and since 2013 transport-related emissions have increased.

7.1.8 Aside from the small reduction on kg. of CO2 attributable to the UK electricity grid content, the current solar farm proposal will not alter these emissions, unless the electrical energy is purchased from RWE for residents, businesses and other stakeholders within the district.

Target 3: Double the size of Wychavon's low carbon economy by 2030.

7.1.9 There are no manufacturers of principal low carbon products (Inverters, Cable, PV modules, structures, transformers, Switchgear) required for the PV/BESS system within Wychavon District, and no recognised specialist solar contractor who could construct the project. To benefit the local economy, there are likely to be opportunities for Hotels and B&B in the area in the construction phase, however after the project is commissioned it is likely a national O&M contractor would be appointed with the day to day asset management run by RWE, so the benefits to the local economy will be very small.

7.1.10 Having a large scale PV/BESS system is unlikely to assist the low carbon economy to any great degree, and more likely to hinder it, as 49.9MW of grid capacity has been apportioned that will limit the potential for renewable projects within the District.

Target 4: Treble renewable energy generation in the district from 108,119 MWh in 2016 to 324,357MWh in 2030

7.1.11 The 49.5MW PV/BESS system, is anticipated to be 80MWp in DC PV panel size, and would generate 81,233 MWh of renewable energy generation each year in the Borough, even though the 66kV cable would ship 100% of the energy directly into the Borough of Redditch at Feckenham Substation.

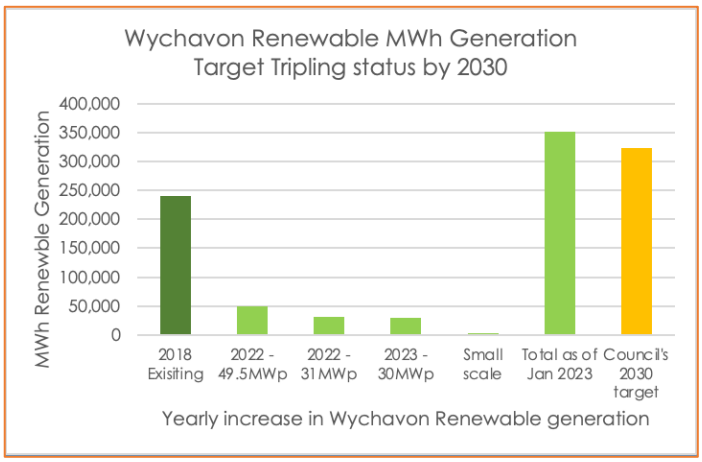

Figure 7.1.11-A Graph showing Wychavon 2030 renewable energy target met by 2023.

7.1.12 In 2018, the level of renewable generation in the Wychavon District was 240,542 MWh, and in 2022/3, planning approval was granted for a total of 110,500 MWp of PV Farms[6], each expected to generate 1000MWh/MWp. An estimated 2.5MWp of smaller scale renewable projects are likely to have been installed in the District in the period up to the start of 2023, and the Wychavon Intelligently Green Plan target of tripling the MWh of renewable energy in the district has been exceeded by 8% without the additional generation anticipated from the proposed solar farm that is the subject of the planning application.

Table 7.1.12-A Wychavon renewable generation 2030 target breakdown

Year	*MWh Generation existing or added*
2018 Existing	*240,542*
2022 - 49.5MWp	49,500
2022 - 31MWp	31,000
2023 - 30MWp	30,000
Small scale 2.5 MWp	2,500
Total as of end 2022	351,042
2030 Target	324,357
Surplus	26,685
Percentage exceeded as of 2022	8%

Target 5: Capture at least 500 tonnes of carbon dioxide equivalent per year by 2025

7.1.13 The PV/BESS project is unlikely to have any noteworthy impact on achieving the target.

8 Conclusions

8.1.1 The key issue in respect of the proposed solar farm, is whether it is the most appropriate or necessary location for a project of this size, or whether there another brownfield location that may be more suitable? The strategy of the Applicant appears to be to target at a national level, grid organisations with connection applications, and once a grid connection has been secured, secure planning permission. This is not necessarily in the best interests of local stakeholders and is why in Ireland grid connections are not issued without planning permission. There are significant shortcomings in the renewable energy benefits set out in the planning application and misleading information presented to the Council and others considering it.

8.1.2 There is an abundance of well-developed PV & BESS projects that have recently been delayed by National Grid to the early to late 2030's, and so the climate change mitigation and low carbon benefits essentially become a zero sum game, as another project or a number of smaller projects with analogous CO_2 reduction credentials could proceed quicker with the release of the consented grid capacity at this site.

8.1.3 Unlike low voltage, 11kV or 33kV generation connections where generally large amounts of the generated energy can be used relatively locally, the proposed solar farm is connecting at 66kV. This means that the distribution network covers a larger

[6] (1) on 13 January 2022 a 49.5 MW solar farm north west of Doverdale (21/01363/FUL)
(2) on 11 May 2022 a 31 MW solar farm in Honeybourne (W/22/00786/FUL) and
(3) on 13 January 2023 a 30 MW solar farm in Bishampton (W/22/01892/FUL).

area, and a large area of the coverage is outside of the Wychavon District area. There are a number of claims of the benefits to Wychavon District that are not correct as a notable amount of the generation would be distributed into areas outside of the district from the Feckenham Substation connection, which is in the Borough of Redditch.

8.1.4 It is assumed that RWE the owners of JBM Solar will resell the energy and with a Power Purchase price of circa 12p/kWh, there are likely to be annual revenues in excess of £9 million per annum for 40 years from the project. The proposed community benefit fund payment of £180,000 to support local sustainable initiatives seems to be low at 0.05% of total estimated and substantial revenues. Notably the project does not actually seem to benefit the District in any advantageous way and could prevent local businesses and residents from progressing their own more modest PV projects. It is unlikely that the proposed solar farm will deliver lower energy bills for residents, businesses and other stakeholders in the Wychavon District.

8.1.5 The CO_2 offset calculations have been undertaken against the Fossil Fuel value of 0.527 Kg CO_2. / kWhe, and not against Government published UK Electricity CO_2/kWh content, which are corrected and lowered annually, so the Applicant's stated and claimed CO_2 savings are far higher over the 40 years than they actually are, which is misleading.

8.1.6 The Wychavon District Council Intelligently Green Plan 2020 – 2030 outlines 5 principal targets to tackle climate change in the district. The proposed solar farm will have no positive benefit on 4 of these 5 targets, and potentially some detraction. The 4th target of trebling renewable energy generation in the district from 108,119 MWh in 2016 to 324,357MWh in 2030 has already been met and exceeded by the Council (see paragraph 7.1.12 of this report and Figure 8.1.6-A). The proposed solar farm will not contribute to halving district wide carbon emissions from 992 kt CO_2 in 2005 to 496 ktCO_2 in 2030 (Target 2 of the Councils Intelligently Green Plan), unless the generated energy is available for use to the stakeholders in Wychavon District.