# Lake District National Park Authority

## Feasibility Assessment and Outline Design for Solar Canopies at Wayfaring House: Revised for ITT

**22nd | July | 2025**

ELECTRIFYING CHANGE

| Version | Revision | Date | Author | Reviewer | Manager |
|---|---|---|---|---|---|
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| 1 | 1 | 22/07/2025 | Rhiannon Williams | Fiona Keysell | Fiona Keysell |
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## Acknowledgement

This report has been prepared for the sole and exclusive use of the Lake District National Park Authority. This report is based on information and data collected by RenEnergy Ltd. Should any of the information be incorrect, incomplete or subject to change, RenEnergy Ltd may wish to revise the report accordingly.

## Disclaimer

## About RenEnergy

We are a boutique, knowledge-based, international renewable energy business, principally focused on the application of solar photovoltaics (PV), energy storage and electronic vehicle (EV) charging.

Our primary trading territories are the United Kingdom (UK) and South Africa (SA), from where we consult on, design and deliver innovative renewable energy solutions to clients around the world.

Since 2006, we have been passionate pioneers in renewable energy, and unwavering advocates for the environmental and value benefits that solar solutions can deliver. We believe that renewable energy can change the world on many levels, from protecting the natural environment to aiding food security. It is this passion that drives the single-minded focus of our brand: "Electrifying Change".

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## Executive Summary

This report has been prepared by RenEnergy Ltd on behalf of the Lake District National Park Authority (LDNPA) and comprises a feasibility assessment and outline design for solar canopies at the authority's main offices at Wayfaring House, Kendal.

In the absence of carrying out technical surveys the proposals should be considered as indicative and have been prepared as a solely desk-based study.

The feasibility assessment includes an analysis of the site's annual electrical demand to inform several design options for solar canopies located at the main car park. These options include two different sized solar canopy systems (89.76kWp and 122.4kWp), as well as options for pairing these systems with a Battery Energy Storage System (BESS) and for an alternative timber frame solution. The purpose of presenting multiple options is to provide the authority with sufficient information to make an informed decision on how best to proceed with the development of solar canopies at their site.

The analysis and modelling have been carried out using PV*Sol Premium; a German software for dynamic solutions which includes 3D visualisation and detailed shading analysis of photovoltaic systems. Additionally, an outline design has been prepared following RenEnergy's standard solar canopy design parameters to show an indicative layout for the proposed solar canopies, including indicative locations for the BESS, inverters and cable routes. The design takes into consideration site constraints identified from the desk-top appraisal and includes sufficient information to prepare and submit a Full Planning Application for solar canopies and any associated equipment that the authority chooses to proceed with.

There are several different design options that the authority could proceed with at Wayfaring House. The optimum solution for the LDNPA will be dependent on their aspirations and motivations for developing the solar canopies at their site. The key factors to consider when determining the most suitable option will be whether the authority is seeking to maximise financial returns, maximise carbon reductions or develop and innovative technology that is in keeping with the sensitive surrounding of the site.

It is important to note that the design of the solar canopy is modular in nature and therefore it can be scaled up or down to align with the future energy demands and carbon reduction ambitions of the site. In summary, the authority will not be constrained in proceeding with one option over the other and can easily adapt the chosen solution in the future.

This document revision (version 1, revision 1) has been prepared for the purpose of the LDNPA's Invitation to Tender for the Design and Build Contract. As such, the financial appraisal has been redacted from the original feasibility study. At the point of preparing this revision, the LDNPA has confirmed they wish to proceed with the 89.76kWp solar canopies, as such the options appraisal for the 122.4kWp canopy and assessment of BESS have also been redacted from the report. Any associated appendices, figures, tables and references have also been intentionally redacted.

It should also be noted that since preparing the original feasibility study, planning approval has been granted via Permitted Development Rights (PDRs), under application reference 20251051PASOLAR for solar canopies at Wayfaring House. For completeness and general information, the planning appraisal section has been kept within this revision.

# 1. Introduction

1.1. The Lake District National Park Authority (LDNPA) are seeking to develop solar canopies at their main offices at Wayfaring House, located at the Murley Moss business park in Kendal.

1.2. The rationale for developing solar canopies at Wayfaring House is for the on-site generation of a clean electricity source that will feed directly into the main building and provide a portion of the site's electrical demand. As such, the solar canopies will also contribute to the authorities' carbon reduction targets and provide an opportunity for cost savings and long-term revenue generation.

1.3. The LDNPA have elected RenEnergy to carry out a desk-top feasibility assessment and outline design for the solar canopies at Wayfaring House. The outline design will be used to inform a planning application for the solar canopies and will eventually enable the authority to tender for the Design and Build Contract.

1.4. The purpose of the study is to assess the site's capacity for accommodating solar canopies, taking into account the site's electrical demands, on-site technical constraints and the financials of developing the technology, to provide the authority with high-level design options to consider for progressing to a detailed Design and Build project. The report concludes with an overall summary of our findings, recommendations and next steps for progressing each project.

# 2. Site Context

2.1. Wayfaring House is located at the Murley Moss Business Park in Kendal, approximately 1.25 km northwest of the village Oxenholme in Cumbria. Whilst the Lake District National Park Authority's main offices are located at Murley Moss Business Park, the site itself is not located within the boundary of the Lake District National Park, but is approximately 2.3 km to the east of it.

2.2. The site is located immediately south of the intersection between Oxenholme Road, which forms the site's eastern boundary, and the A65, which forms the site's western boundary. The southern boundary of the site is demarcated by a small but dense woodland area which runs parallel to the Natland Beck.

2.3. The business park comprises the Wayfaring House building to the west, with the eastern half of the site comprising the main car park area. Well developed vegetation is present across the entire site, consisting of hedgerows, large trees and tree lines and a central grassland island in the car park. The presence of significant vegetation is in keeping with the aesthetics of the wider area that forms the Lake District, and it is largely considered to be a visually sensitive site.

### Lake District National Park Authority's Climate Change Commitment

2.4. The LDNPA are part of the Zero Carbon Cumbria Partnership which seeks to tackle climate change across Cumbria, led by a partnership of more than eighty organisations. The vision for the partnership is to work towards a net zero county by 2037 with improved quality of life, people living in balance with their environment and a sustainable low carbon economy.

2.5. The authority has been running a carbon reduction programme since 2007, and by March 2019 had reduced their own carbon emissions by 52 per cent from 772 tonnes $CO_2e$ per year to 367 tonnes. The authority has already completed numerous carbon-reduction projects across their portfolio of buildings and vehicles and are committed to a continued programme of carbon reduction.

2.6. Their strategy is to prioritise lowering their own carbon emissions to the minimum possible before considering measures for offsetting them, and as such are continuing to explore renewable energy solutions to reduce their dependency on grid-supplied fossil fuels.

## 3. Energy Consumption Analysis

3.1. Half-hourly (HH) electrical consumption data has been supplied by the LDNPA for the period 01/01/2024 – 31/12/2024 for the site's main electrical meter. This meter serves the main building and the offices which operate within it. The total annual consumption for the main meter was 74,309 kWh.

3.2. Electrical consumption data was also supplied for EV charging units located within the site's car park. The site has 4 x 100kW rapid chargers and 10 x 7kW chargers. Hourly consumption data was only available for the rapid chargers. An annual total was provided for the 7kW chargers. The total annual consumption for the rapid EV chargers was 53,722 kWh whilst the total for the 7kW chargers was 19,571 kWh.

3.3. The hourly consumption data for the rapid chargers was provided for a month per quarter (March, June, September and December). A daily average has been calculated for each quarter and represents the average kWh of energy consumed each hour of the day. A summary of the daily averages for each quarter is shown below.

3.4. The daily average consumption data for each quarter was used to estimate an annual consumption profile for the rapid chargers. The data from each quarter was used to represent the following two months of the year, i.e. the data from March was modelled for March, April and May. Once this profile was established, the total annual consumption data for the 7kW chargers was distributed across the profile to represent the additional load that these chargers contribute.

3.5. The consumption data for the EV chargers was imported into PV Sol alongside the half hourly data supplied for the main meter to represent the total site consumption within a year. Figure 1 shows the monthly values for the main meter and EVC chargers. The total consumption for the main meter and EV chargers is estimated to be 147,602 kWh/year.

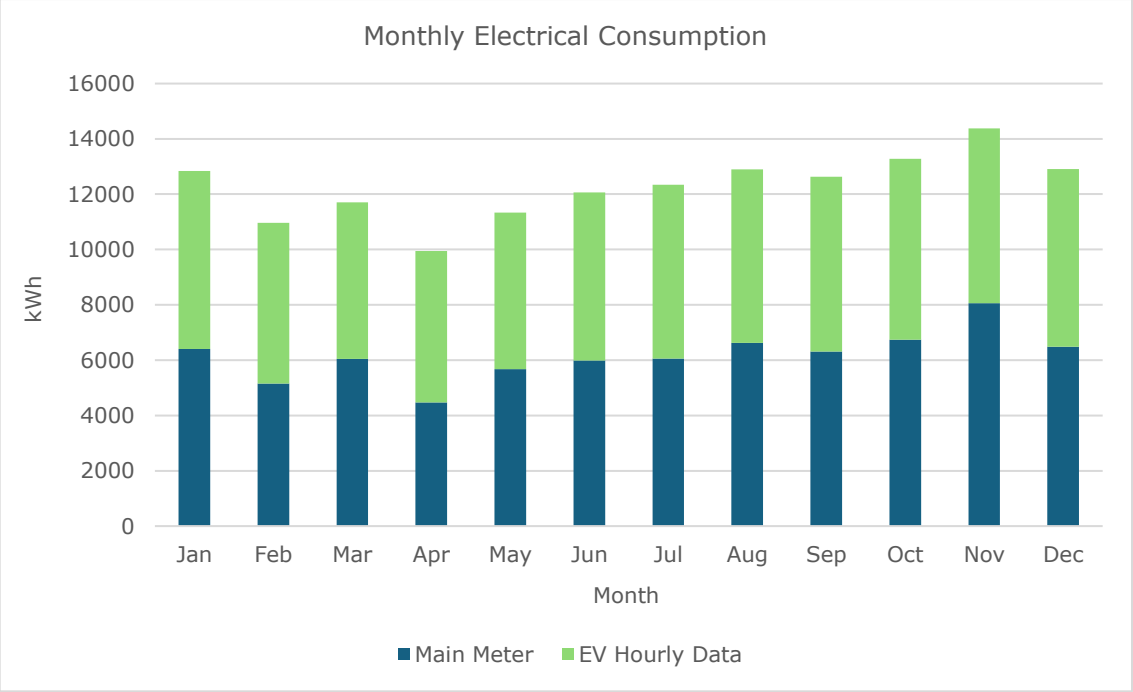


*Figure 1 Monthly electrical consumption for the main meter and EV chargers*

3.6. Figure 2 below shows the total consumption per hour in 2024 for the main meter and EV chargers combined. As expected, the majority of usage occurs throughout the day at the business center. The graph shows that demand starts to increase from 07:00 and continues to increase throughout the morning before peaking at midday. A sharp decrease in demand is shown between 12:00 and 13:00, followed by a more gradual decline into the evening. This profile is typical of a business center and generally aligns with the operating hours of the site (08:00-18:00). The graph also shows an additional spike in demand between 19:00-20:00 which decreases towards 22:00. From 22:00 it is shown that there is a low but consistent demand up to ~00:30 before dropping to almost no demand between 01:00 and 05:00.

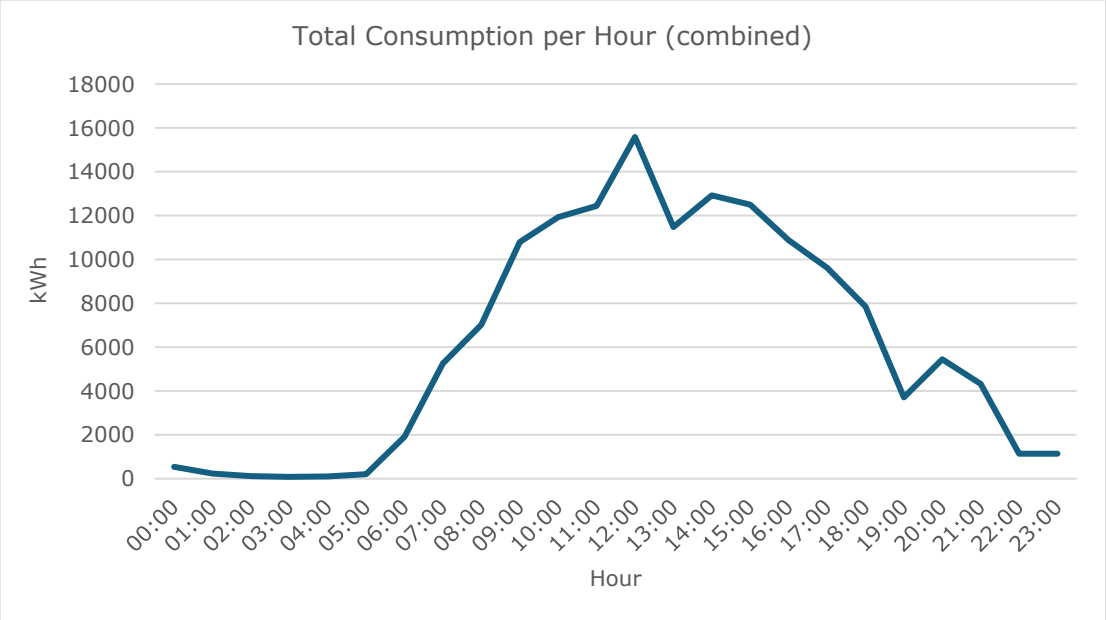


*Figure 2 Total Consumption per hour*

3.7. Figure 3 shows a breakdown of the hourly consumption profiles between the main meter and EV chargers. As shown, the main meter has a steadier demand profile, which gradually increases in the morning, and remains relatively consistent throughout the day before gradually decreasing into the night. Interestingly, the graph shows that despite the business center closing at 18:00, there is an evening/nighttime energy demand from the main meter. This could potentially be from staff working past 18:00 as well as appliances that run throughout the night.

3.8. The EV charger profile shown in Figure 3 shows that, as with the main meter, most of the energy demand occurs during the day between the operating hours of the site. The graph also shows that the spike in energy demand at midday is a result of increased EV charger use at this time. As expected, the demand from the chargers sharply declines between 18:00-19:00 (as the center closes and staff unplug their cars), but does increase again between 19:30-22:00. This is not considered to be unusual given the EV chargers are available for the public to use 24 hours a day.

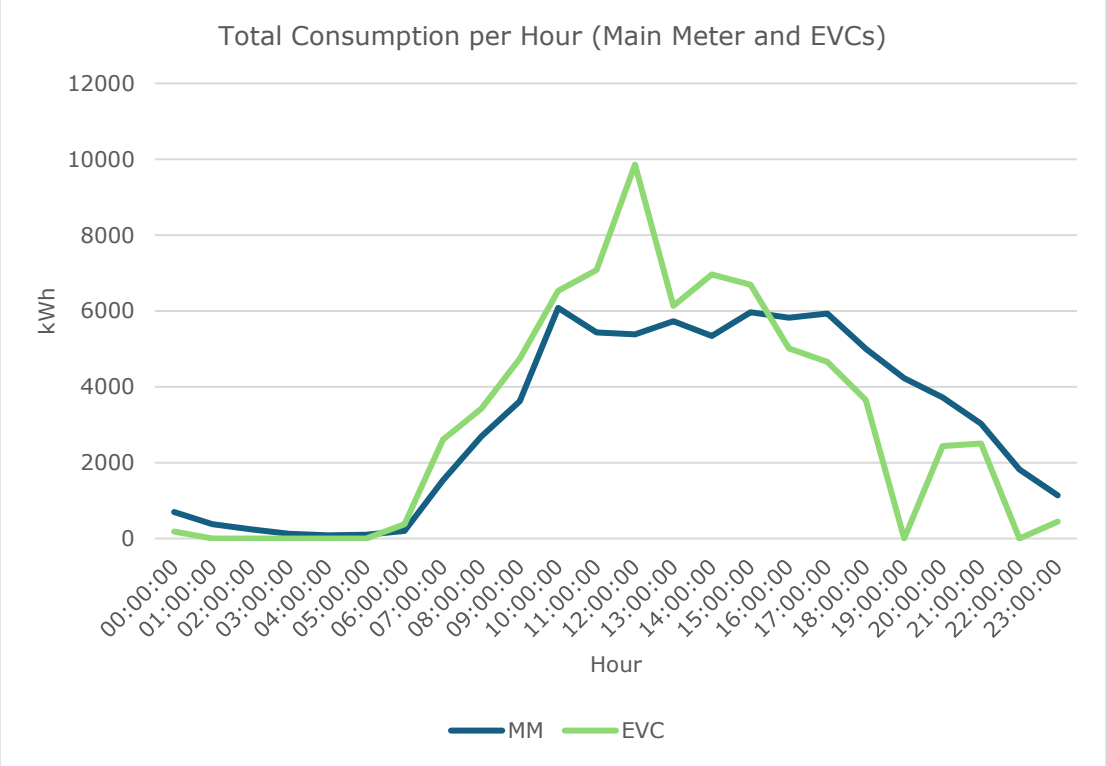


*Figure 3 Total consumption per hour (main meter and EVCs)*

3.9. In summary, an assessment of the site's energy consumption from the main meter and on-site EV chargers shows a typical energy consumption profile for a business park, with the majority of energy consumption occurring throughout the day in line with the operating hours of the site between 08:00 and 18:00. This consumption profile is well-suited to a solar PV system given the alignment with the generation profile of solar PV. However, both datasets also demonstrate that there is an evening and nighttime load at the site which would suggest that a Battery Energy Storage System (BESS) would also be a viable option for the site. This is discussed in more detail in section 4.

## 4. Planning and Design Considerations

4.1. It should be noted that since preparing the original feasibility study, planning approval has been granted via Permitted Development Rights (PDRs), under application reference 20251051PASOLAR for solar canopies at Wayfaring House. For completeness and general information, the following planning appraisal section which formed part of the original feasibility study has been kept within this revision.

4.2. Any significant design changes following contract award may require a new planning application to be submitted.

4.3. Since December 2023, solar canopies can be approved under Permitted Development Rights, subject to the proposals meeting the eligibility criteria set out within Class OA, Part 14 of the Town and Country Planning (General Permitted Development) (England) Order 2023. Development is not permitted by Class OA if any part of the development:

- Exceeds 4m;
- Is within, or within 10m of, the curtilage of a dwellinghouse or a block of flats;
- On a site designated as a scheduled monument or on land within the curtilage of a scheduled monument;
- Within the curtilage of a listed building;
- For the display of an advertisement;
- If the off-street parking are in use by virtue of Class B (temporary use of land)

4.4. The full list of conditions can be found within the above listed section of the General Permitted Development Order.

4.5. Should the proposal meet all the eligibility criteria, it can be approved by a Prior Approval notification submitted to the LPA. The timescales for this application include a validation period of 2-3 weeks and a subsequent 56 day determination period. There is a fixed fee for Prior Approval applications and the only mandatory documentation is a Site Plan.

4.6. Should the proposal be in breach of any of the eligibility criteria, a Full Planning Application is required.

4.7. For the proposed solar canopies at Wayfaring House, it is not considered that there would be a breach of the Permitted Development criteria for Class OA, and as such the scheme could be approved via a Prior Approval application. However, there are several factors which deem the site slightly more contentious than most solar canopy proposals (outlined in the following section), most notably the sensitive nature of the site as located within the Lake District (although the site is not within the National Park) as well as the requirement of the authority to demonstrate a particular due care in their proposals given their role as an authoritative body.

4.8. As such, it is our recommendation to prepare a Full Planning Application for the proposed solar canopies. This will ensure that all of the identified constraints have been considered in determining the application and demonstrate that the LDNPA

have taken the appropriate steps to minimise any impact to the site and it's sensitive surroundings.

4.9. In addition, BESS cannot currently be approved via Permitted Development Rights and therefore if a BESS is to be included a Full Planning Application would be required. It may therefore be advised to prepare one Full Planning Application for both the solar canopy and BESS to enable the LPA to assess the cumulative impact of both.

4.10. To determine whether any constraints exist at, or within the vicinity of, the site, an assessment has been carried out using LandTech's LandInsight software. LandInsight is an industry recognised online site searching tool providing comprehensive and high-quality property intelligence data. The purpose of the assessment in this context is to summarise the constraints which will determine the requirements of a planning application. The findings of the assessment should be a key consideration when preparing the necessary documentation for the planning application. The full report from LandInsight can be found in Appendix 1.

## Planning Policies

*Flood Risk*

4.11. Figure 4 shows the flood zones present on the site. As indicated, the site is within flood zone 2 which is defined as having a medium probability of flooding from rivers and sea as per the Environment Agency's flood risk classifications. This is a result of the site's proximity to Natland Beck which demarcates the site's southern boundary and is shown in pink on Figure 4.

4.12. National Planning Policy states that a flood risk assessment (FRA) needs to be carried out as part of the planning application for developments within flood zone 2.

*Figure 4 Flood Risk map from LandInsight*

*Employment Land Use and Settlement Boundaries*

4.13. The site is located within the South Lakeland Primary Employment Area as per South Lakeland council's Land Allocations Map (2019) which forms part of their Local Plan. This would be taken into consideration when determining the planning application. Given that the adoption of renewable energy would improve the viability of the business park by reducing outgoing costs, the proposed development is considered

to support ongoing employment within the area, and this will be viewed favourably by the council.

4.14. The site is also located within the South Lakeland Settlement Boundary. Settlement boundaries are a key consideration in determining planning applications and, subject to other planning constraints, there will be a presumption in favour of development within a settlement boundary. The location of Murley Moss Business Park within the South Lakeland Settlement Boundary therefore presents an additional case for the approval of the solar canopy.

*Public Rights of Way*

4.15. As shown in Figure 5, there is a Public Right of Way (PRoW) (Footpath 070) along the southern boundary of the site. The effect of a development on PRoW is a material consideration in determining planning applications. The LPA will therefore take the proximity of the proposed development to the PRoW into consideration. However, given the proposal would not alter or obstruct the footpath it is not considered to be grounds for objection.

*Figure 5 Pubic Rights of Way from LandInsight*

*Protected Areas*

4.16. The southern boundary of the site is demarcated by the Natland Beck which forms part of the 'River Kent and Tributaries' Site of Special Scientific Interest (SSSI), as shown in Figure 6. Whilst the site is not located within the SSSI, it is located within the SSSI's Impact Risk Zone.

4.17. For sites that are within proximity to an SSSI, the LPA will likely consult with Natural England to determine whether the proposed development will impact the protected area and will also refer to the Designated Sites database to find out about the activities that are likely to damage a specific site.

4.18. Despite the business park housing the LDNPA main offices, the site is not located within the Lake District National Park - it is located approximately 2.3 km to the

west. The site is not located within or near any other protected areas, Areas of Outstanding Natural Beauty (AONB) or Conservation Areas.

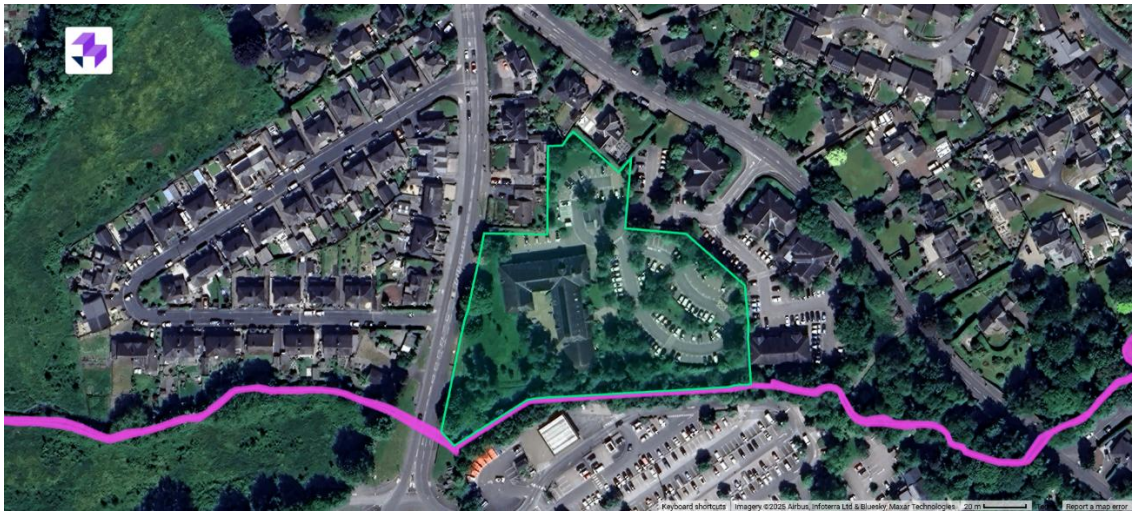

*Figure 6 Protected Areas from LandInsight*

*Biodiversity Net Gain*

4.19. Biodiversity Net Gain (BNG) became mandatory for all applications for new development from 2nd April 2024. Generally, applications for solar canopies can apply for an exemption on the basis that the baseline habitat value for most carparks is zero (given most carparks are tarmac or concrete which offer little to no provision for wildlife habitats).

4.20. However, given the presence of vegetation on-site at the Murley Moss Business Park, such as a considerable number of trees and patches of grassland, the proposals would unlikely qualify for the exemption. In addition, it is expected that trees will need to be removed to accommodate the installation of the solar canopies and to prevent shading of the solar panels. Given the removal of trees will result in a loss of habitats, the planning application will need to demonstrate how enhancement measures will be implemented to compensate for the loss via a BNG assessment.

Biodiversity Improvement Areas

4.21. As shown in Figures 7 and 8, the site is located partly within a Restorable Habitat area (yellow) and partly within the Network Enhancement Zone 2 (orange), as defined by Natural England.

4.22. The Restorable Habitat designation represents areas with restoration activity potential that would support relict habitats and lead to an expansion of wildlife-rich habitats. In this case it is likely to pertain to the habitats associated with the River Kent and Tributaries SSSI. Network Enhancement Zone 2 represents land which connects existing areas of primary and associated habitats, but which is less likely to be suitable for the creation of the primary habitat.

4.23. These designations will likely be considered by the LPA in assessing proposed BNG enhancement measures. In this case it would likely be expected that any proposed

enhancement measures should support the restoration of the identified Restorable Habitat.

*Figure 7 Restorable Habitat Area from LandInsight*

*Figure 8 Network Enhancement Zone from LandInsight*

### Archive Bore Hole, Buried Services and Topographical Data

*Archive Bore Hole*

4.24. Archive bore hole data is publicly available on the British Geological Survey website and offers free, direct, online access to the National Geoscience Data Centre's (NGDC) collection of onshore scanned boreholes, shafts and well records.

4.25. Borehole data will determine the underlying geology of a site. This is a key factor in determining the best method of fixing the solar canopy to the ground and will inform the type of screw pile that is required based on information such as soil classification, soil corrosivity, oxygen and moisture levels and the depth of any groundwater encountered.

4.26. Unfortunately, bore hole record data is not available for Wayfaring House or the immediate area surrounding the site. As such, we recommend that the council

instructs a geotechnical survey of the carpark at the Design and Build stage of the solar canopy.

4.27.

*Buried Services*

4.28. Appendix 2 shows the buried services mapping provided by the LDNPA. Figure 9 below shows a snip taken from the map and includes marked up lines to highlight the key services present on site which need to be considered within the proposals. The key for the map has also been marked up and is shown in Figure 10.

4.29. As shown, there are numerous buried services present at the site. There appears to be a gas pipe (yellow) which runs adjacent to the southern area of parking bays proposed for the solar canopies. This pipe connects into the building at the plant room. Several other underground services are also shown to connect into the building at this point, including the water mains (blue), an electrical 3-phase cable (pink) and foul drains (brown).

4.30. As this point marks the connection into the building's plant room, the AC cable from the solar canopy will also need to enter the building at this point in order to connect the canopy to the site's main incomer. Careful consideration will therefore be required when designing the cable route given there are multiple underground utilities located at the same point.

4.31. As the services map provided by the council is dated 1993, it is strongly recommended that an up-to-date buried services survey is carried out for the Design and Build Stage of the project to confirm the location and depths of the underground services. This will enable a safe and considered cable route to be designed which does not impact the existing infrastructure or pose a health and safety risk to the installation team.


*Figure 9 Snip of services map provided by the LDNPA*

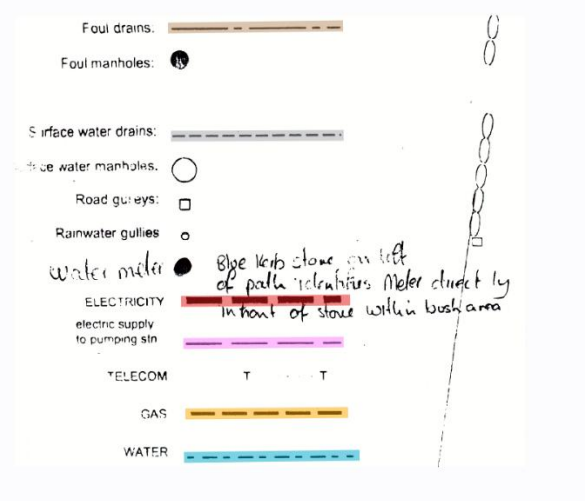


*Figure 10 Key for Figure 9*

*Topography*

4.32. In the absence of a survey, topographical information for the site has been obtained from LandInsight. Figure 11 below shows a heat map which illustrates the topography of the site taken from LandInsight. Figure 12 shows the key. The topography of the site is shown to be largely flat (<2°). The steepest parts of the site appear to be around the perimeter, particularly at the southern boundary of the site where the ground is prohibitively steep (>20°) as it descends towards Natland Beck. However, this presents no issue to the proposed solar canopies which are proposed at parking bays to the north and south of the central vegetation island within the main car park.

4.33. Some gentle (2°-5°) and moderate (5°-10°) are present on site, including at the southern row of parking bays where the solar canopies are proposed. The slope of the ground here will therefore need to be accounted for within the design of the solar canopy frame to ensure the panels are positioned at the optimum orientation.

4.34. A topographical survey (which typically is carried out alongside buried services) should be carried out at the Design and Build Stage of the project as the results will provide specific elevations at multiple points across the car park. The results will therefore more accurately inform the design of the solar canopy.

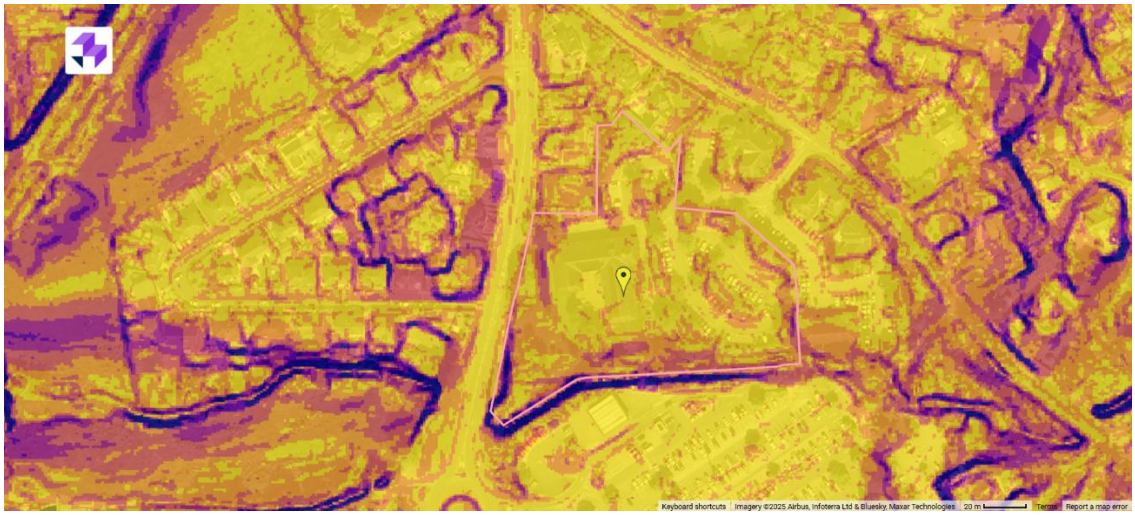


*Figure 11 Topographical map from LandInsight*

| | |
|---|---|
| Flat | < 2° |
| Gentle | 2°-5° |
| Moderate | 5°-10° |
| Steep | 10°-15° |
| Very steep | 15°-20° |
| Prohibitively Steep | > 20° |

*Figure 12 Key for Figure 11*

# 5. Options Appraisal

5.1. The following section of the report presents the results of the modelling which was carried out using PV*Sol Premium; a German software for dynamic solutions which includes 3D visualisation and detailed shading analysis of photovoltaic systems. The full PV Sol reports can be found in Appendices 3-6.

5.2. The site's electrical consumption data for the main meter and EV chargers were imported into the software to assess the performance of the proposed solar canopies against the energy demand of the site. In addition to the site's electrical consumption data, the existing roof-mounted solar array was also modelled. This will provide the LDNPA with a complete understanding of how the proposed solar canopies will contribute to their energy demand alongside the existing generation from the roof array.

5.3. Several models have been prepared to demonstrate the options available for pursuing solar canopies at Wayfaring House and the following section of the report presents these models and assesses the results.

### Modelling/Design Parameters

*Existing Solar Array*

5.4. As the HH data provided by the LDNPA is for the period 01/01/2024-31/12/2024, the data already accounts for site's consumption of the energy generated from the existing roof-mounted solar array (29.7kWp) which was installed in 2015. The data therefore reflects the site's electrical demand from the grid after it has consumed electricity from the existing solar array.

5.5. For the modelling to calculate the total energy covered by the existing solar array and the additional solar canopies, we would need consumption data dated before the installation of the roof-mounted solar array. However, data from pre-2015 would not accurately represent the site's current electrical demand which most likely has changed in the last 10 years.

5.6. Therefore, the results of the modelling only represent the contribution of the solar canopies, and do not reflect how much of the site's total demand is covered by the combined systems. For example, if the solar canopies are shown to cover 40% of the site's electrical demand, this is the electrical demand after the site has already consumed from the roof array.

5.7. What the modelling does represent is the exact amount of kWh/year still consumed from the grid after the site has consumed from the roof array and solar canopies.

*Tree Assessment*

5.8. One of the key considerations in modelling the solar canopies at Wayfaring House is the presence of multiple established trees within and around the car park. Figure 13 shows a marked-up map of the site and the trees located around the parking bays where the canopies are proposed. Appendix 7 includes photographs taken during the initial site visit and shows the large trees located at and around the central island between the two areas proposed for the solar canopies. A row of young trees is also located on the central island however these were not included within the initial tree

modelling as they are currently not established enough to cause any shading to the solar canopies. However, the future impact of shading from these trees once they are fully grown will need to be considered.

5.9. Using the photographs we have estimated the height of the five large trees to be approximately 12m. These trees were modelled in the software to assess the resultant impact of shading on the solar canopies. Additional trees were also modelled further south of the proposed location for the canopies to represent the dense vegetation that is present at the site. Figure 14 shows how these trees were modelled in the software.

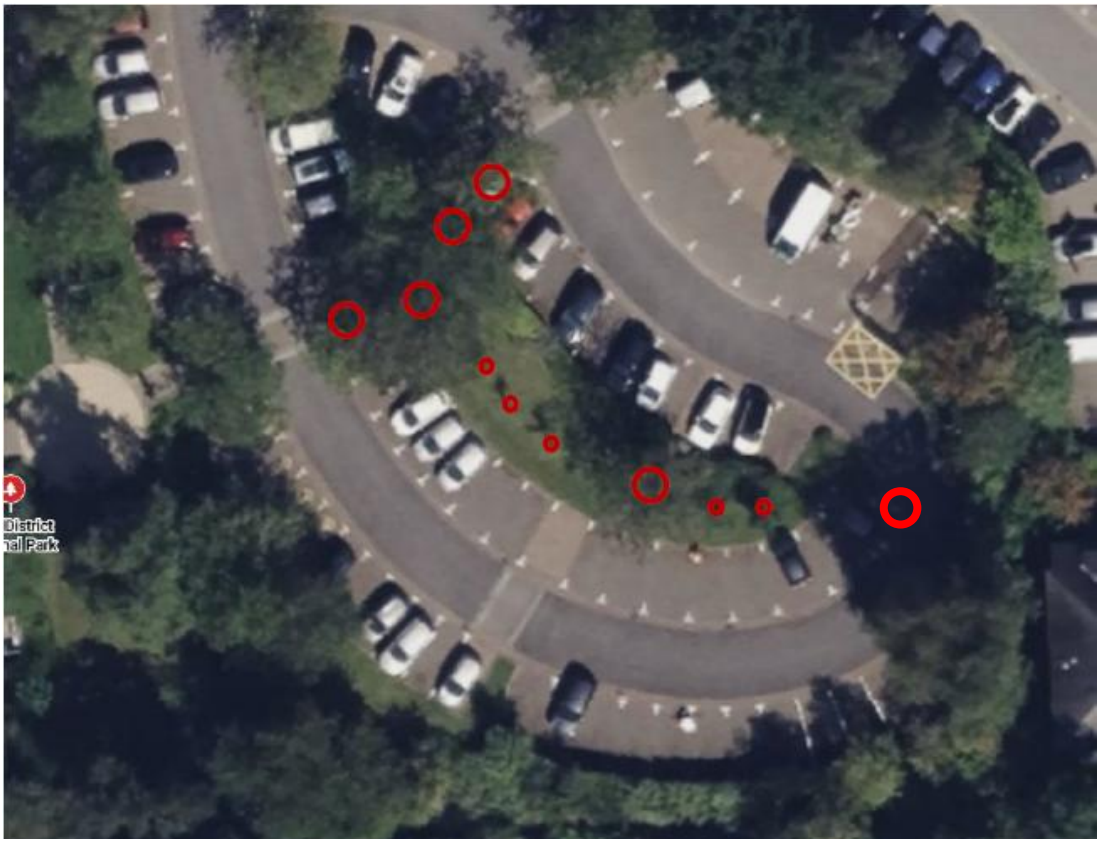

*Figure 13 Marked up map showing trees on-site*

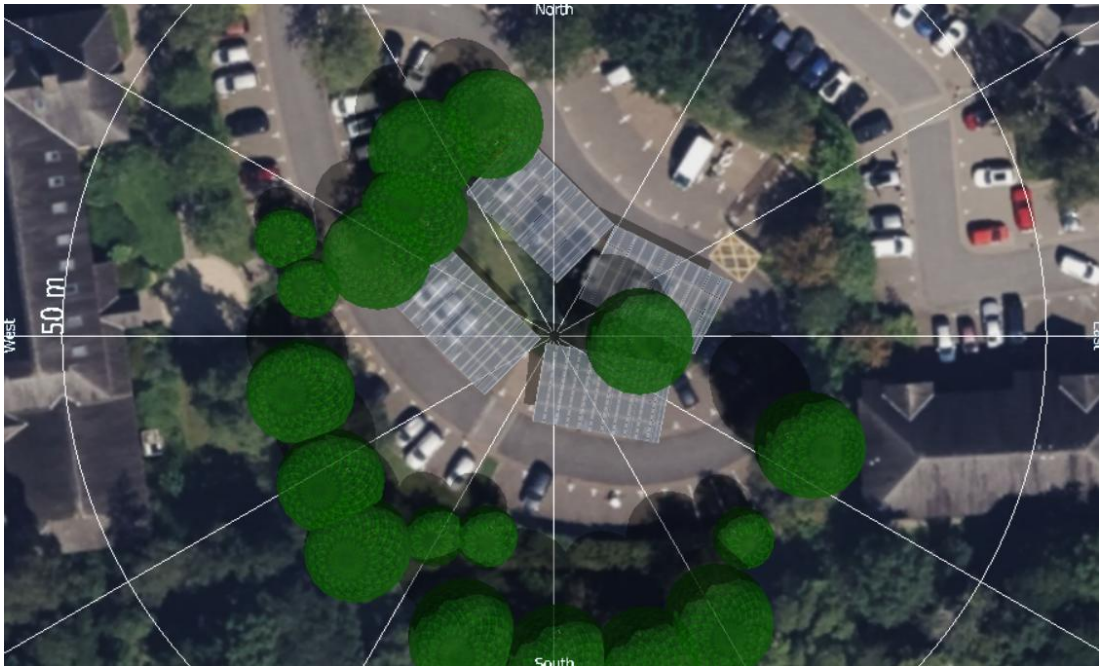


*Figure 14 Trees modelled in PVSol software*

5.10. The initial modelling of the trees found there would be a 45% yield reduction due to shading. The trees therefore pose a significant constraint to the performance of the proposed solar canopies. In addition to the impact from shading, the trees are likely to physically obstruct the solar canopy and could result in damage or constrain the size of the solar canopy if they are to remain. Whilst the trees could be trimmed back, this would require regular maintenance and therefore incur an ongoing cost for the lifetime of the solar canopies.

5.11. It is not considered to be technically or financially viable to proceed with the solar canopies without the removal of the trees that are located around the central island. As such, the remainder of the modelling does not account for the trees located here and assumes these would be removed as part of the development. The removal of trees will need to be considered within the Full Planning Application and will impact the outcome of the Biodiversity Net Gain Assessment. It is likely that a mitigation strategy and replacement planting will need to be incorporated within the proposals.

### Option 1 – 89.76kWp Solar Canopy covering 20 parking bays

5.12. As outlined within the SoW provided by the LDNPA, they expect the solar canopy to cover no more than 10 parking spaces on each side of the central island. This is therefore the parameter that was used to model the solar canopies. Figure 15 below shows the proposed solar canopies covering 10 parking spaces on either side (20 in total) and Table 1 shows a summary of the key performance metrics.

*Figure 15 Option1 - 89.76kWp solar canopy*

Table 1 Key Performance Metrics for Option 1

| Metric | Solar Canopy | Solar Canopy with existing solar |
|---|---|---|
| PV Generator Output | 89.76kWp | 119.46kWp |
| Annual Generation (per year) | 72,971 kWh | 100,074 kWh |
| $CO_2$ reductions ($kgCO_2$/year) | **6,472** | |
| Self-Consumption | 71.70% | |
| Solar Fraction | **35.50%** | |

5.13. The total capacity of the solar canopies alone is 89.76kWp which would generate 72,971 kWh/year. Based on the site's annual demand, the site would consume 71.7% of the energy generated from the solar canopies thereby enabling a 35.5% Solar Fraction (the percentage of the site's demand covered by the solar generation).

5.14. When considered with the existing roof-mounted solar array, the total combined capacity of both systems would be 119.46kWp and the annual generation would be approximately 100,074 kWh/year, however the exact percent consumed from both the roof array and canopies is unclear, as the HH data already accounts for the consumption from the roof array.

# 6. Outline Design

6.1. Each 'pair' of solar canopies will share an inverter cage in which the inverters for each section will be located (i.e. 2 inverters per cage). It is proposed to run the DC cable (magenta) from each module along the back of the canopy frame and into the inverters, from which the AC cable (blue) will connect back to the main incomer located within the internal plant room.

6.2. The proposed cable routes have been designed to account for the underground services identified on the services plan provided by the LDNPA. The route aims to minimise crossing existing services where possible. This will be subject to an updated buried services survey to confirm the locations and depths of those shown on the previous plan and to identify any new services that have since been installed at the site. Where possible the cable should be routed through areas of soft standing as these provide easier ground for digging trenches and require less intensive techniques than areas of hard standing.

### Proposed Solar Canopy Designs

6.3. The proposed solar canopy designs have been developed to accommodate the layout and orientation of the parking bays. Given that the parking bays are in singular rows, largely oriented to the south, a single 'Mono' pitch design has been chosen whereby the solar PV modules are all mounted at a single inclination and orientation. Figures 18 and 19 show the elevations for the two types of Mono pitch designs proposed at Wayfaring House. The full frame elevation drawings can be found in Appendices 10 and 11.

6.4. The proposed design is a '3 + 1' design whereby the frame mounts 4 PV modules vertically. The 'plus 1' relates to the additional module which is an extension to our standard 3-panel high design and enables a higher capacity system to be installed at sites which can accommodate the additional row. As the LDNPA car park benefits from a central island of vegetation between the two rows of parking bays, it is considered that there would be sufficient space for the additional row of modules to overhang here, and thereby affording the site with a greater yield from the solar canopies.

6.5. There are two designs to accommodate the different directions in which cars enter the parking bays at the site, whilst maintaining the same orientation of the solar panels. As shown on the layout plan the 'high front' design is proposed at the row of bays to the north of the island, where cars enter the parking bays from north to south. The 'low front' elevation is proposed at the row of bays to the south of the island and at the additional section of proposed parking bays, where cars enter the parking bays from south to north.

6.6. Rather than use concrete foundations, or pile driven support beams which are costly, disruptive and less environmentally sustainable, the proposed frame designs would be supported by a small base (situated every 2-3 parking bays and subject to a detailed design) fixed to the ground using a screw pile anchor system. Designed with car park users in mind, the bases would not obstruct the opening of front or rear doors whether forward or reverse parked.

6.7. Above the base is an 'N' shaped framework which provides a cantilever onto which the purlins are mounted, which support the PV modules, leaving the underside of the solar panels visible. The absence of roof sheeting within the proposed design facilitates rainwater run-off through and behind the panels; therefore, the water is

not displaced or accumulated in any way, avoiding the need for additional surface water drainage solutions.

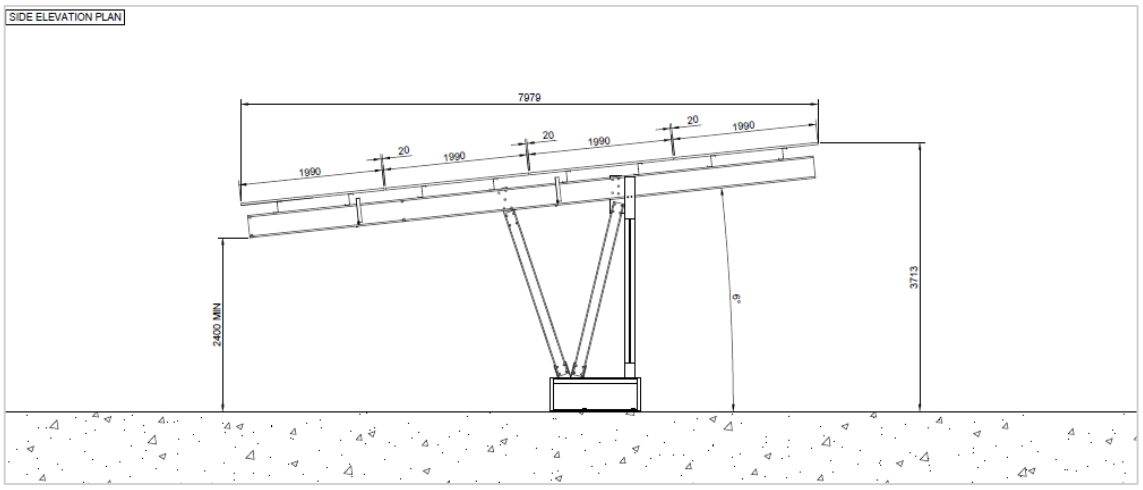


*Figure 16 Frame Elevation Drawing – Low Front*

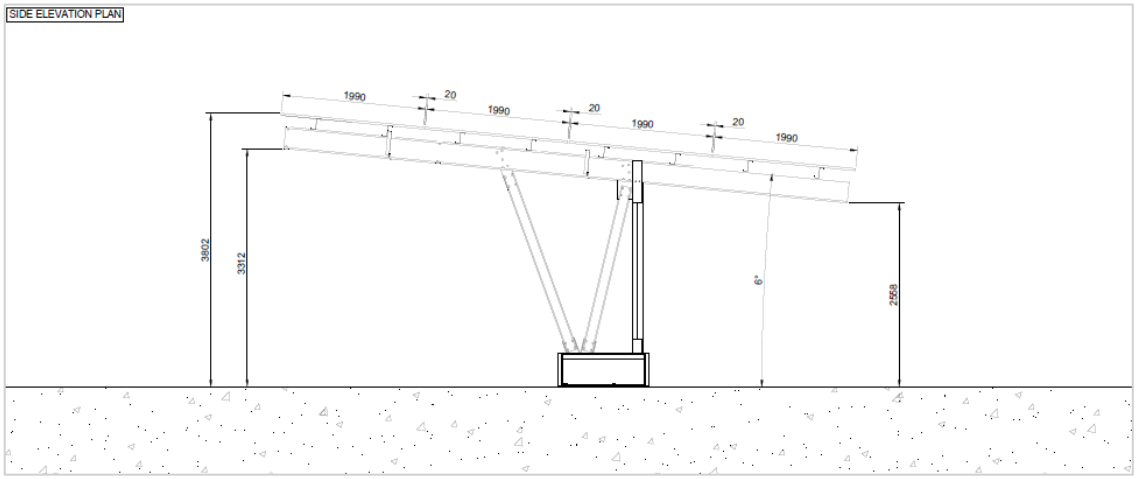


*Figure 17 Frame Elevation Drawing – High Front*

6.8. For the 89.76kWp solar canopy, each of the four canopy sections have been configured using a Fronius Symo Advanced 20kW inverter. As standard, we recommend locating the inverters in a fenced enclosure adjacent to the solar canopies. A fenced unit ensures the inverters are protected and prevents tampering whilst simultaneously facilitating enough air flow around the inverters to keep them cool. By locating the inverters adjacent to the solar canopies, as opposed to the plant room, a minimal amount of DC cable is required between the PV modules and inverters. Appendix 23 shows a detailed elevation drawing for the proposed inverter enclosures.

6.9. All solar canopy sections have been modelled using the Longi LR7-60HTH-510M solar PV modules which have a wattage of 510W. The 510W module has recently become part of our standard solar canopy designs as it offers a larger generating capacity whilst remaining relatively modest in size. The solar panel is made from tempered glass with anti-reflective coating (ARC) to maximise absorption from the sun and minimise the impact of glare from light reflection.

6.10. LED lighting will be fitted to the underside of the solar carport to provide lighting and to prevent black spots within the car park. The LED lighting can be controlled to align with the business park's current lighting arrangements. This is particularly useful for site's such as Wayfaring House where the surrounding area may be especially sensitive to artificial lighting.

### Impact on Carbon Reduction from Tree Removal

6.11. As outlined within section 4, the proposed design assumes that the necessary amount of trees will be removed to accommodate the solar canopies and reduce the impact of shading.

6.12. Given the carbon sequestration potential that trees afford, the LDNPA should consider the impact of tree removal when measuring the carbon offsetting values from the proposed solar canopies. This will ensure the authority is considering the full scope of their carbon footprint and will demonstrate the legitimacy of their carbon reporting. To assist the authority in understanding the likely impact of removing the trees at Wayfaring House, estimations have been made using a Tree Carbon Calculator.

6.13. For the purpose of this study, calculations have been made for the five mature trees and five young trees located around the central island between the two parking bays where the solar canopies are proposed, as indicated on Figure 13.

6.14. The Tree Carbon Calculator estimates how much carbon dioxide a tree absorbs based on its species and age. In the absence of an arboricultural survey, a standard tree species has been used in the calculations and as such all trees have been inputted as Oak, given it is the most common tree type in the UK. The age of the larger trees has been estimated as 50 years, whilst the younger trees have been estimated as 5 years.

6.15. The results of the calculation are summarised below.

Table 2 Summary Tree Carbon Sequestration Calculations

| | Larger Trees | Smaller Trees |
|---|---|---|
| Quantity | 5 | 5 |
| Tree Type | Oak | Oak |
| Age (years) | 50 | 5 |
| Total Carbon Sequestration ($kgCO_2$/year) | **165.00** | **115.50** |

6.16. As shown, the carbon sequestration for both sets of trees is relatively low in comparison to the carbon reductions that the solar canopies would afford per year. Therefore, the removal of the trees is greatly outweighed by the benefits of generating an on-site renewable energy source, and this point should be highlighted in the planning application when justifying the scheme.

6.17. The above calculations do not account for the removal of additional trees to accommodate the additional solar canopy section proposed at the north of the site. However, should the LDNPA wish to proceed with this area for solar canopies it can be assumed that there would be an equally low impact with regards to loss of carbon sequestration potential in comparison to the offsetting afforded by the solar canopies.

### Design Caveats

6.18. As this study has been solely desk-based, without carrying out technical surveys to inform the design, the following design caveats apply:

6.19. All designs are indicative and subject to the following surveys being carried out:

- **Geotechnical survey** of the site to assess the load bearing capacity of the carpark to accommodate the proposed solar canopies and to inform appropriate anchors required to fix the canopy to the ground. This should extend to the area proposed for the BESS to assess the capacity of the ground to accommodate the unit.
- **Screw pile anchor pull-out tests** which will determine the size of the anchors required to hold the weight of the solar canopy and ensure it is adequately fixed to the ground.
- **Topographical and buried services survey** to inform the exact inclination of the frame and to enable the safe routing of the cables back to the point of connection.
- **3D drone survey** to accurately model the on-site features e.g. buildings and trees.
- **Arboricultural survey** to accurately identify tree species and ages and therefore assess the impact of tree removal. The survey will also assess the potential impact of tree roots and inform the cable route and trenching.
- **Electrical survey** of the existing infrastructure to inform the detailed electrical design and Single Line Diagram.
- **Mechanical survey** of the car park to identify any features of the carpark to be accounted for within the layout of the canopies and mounting solution.
- **Vehicle swept path analysis** to ensure an adequate amount of space is retained between the solar canopies for larger vehicles using the site.
- **A G99 application** should be submitted to the DNO at the earliest opportunity to determine the export capacity of the site.

6.20. The following surveys should also be instructed to inform the design and accompany a Full Planning application.

- **Flood Risk Assessment**
- **Landscape and Visual Impact Assessment**
- **Arboricultural Assessment**
- **Preliminary Ecological Appraisal (if trees are to be removed)**
- **Biodiversity Net Gain Assessment**
- **Planting Plan** to assess the impact of tree removal and provide a potential mitigation strategy for replacement planting.

# 7. Summary and Discussion

7.1. It is understood that the initial brief from the LDNPA was to cover a maximum of 20 parking spaces at the site. However, a larger system has been modelled and presented to demonstrate how the site could benefit in the future should the authority wish to increase the generating capacity of the site further. The purpose of presenting multiple options is to provide the authority with sufficient information to make an informed decision on how to proceed.

7.2. Given this, should the authority wish to discount the larger solar canopy system in the short term, then the best next option for generating long term value is the 89.76kWp solar canopy system (without a BESS). Due to the system having a lower generating capacity, the solar canopies would only cover 35.5% of the site's remaining electrical demand and therefore there would be a lower reduction in carbon emissions (6,472 $kgCO_2^e$/year). However, this is still considered to be a valuable contribution to the site's electrical demands and commitment to reducing carbon emissions.

7.3. Should the authority choose to proceed with a larger canopy size, it should be noted that there would be a greater embodied carbon footprint associated with the purchase of a steel frame. However, whilst the immediate embodied carbon footprint would be greater than the smaller system, this would be offset by the increased energy generation capacity and therefore the greater reduction in carbon emissions in the long term.

7.4. In summary, the best option for proceeding with solar canopies at Wayfaring House will be dependent on what the LDNPA is hoping to achieve from the technology. It is likely that the authority will be looking for a balanced combination of financial returns and carbon reductions.

7.5. It is important to note that the design of the solar canopy is modular in nature and therefore it can be scaled up or down to align with the future energy demands and carbon reduction ambitions of the site. As such, the authority will not be constrained in proceeding with one option over the other and can easily adapt the chosen solution in the future.

### Next Steps

1.1. In any case, the next steps for progressing a project would be to:

1. Review the proposed options to inform a decision on likely design to take forward as a project. RenEnergy can revise the planning drawings accordingly to enable the LDNPA to prepare and submit a Full Planning Application.

2. At this stage the authority may wish to seek pre-application advice to confirm the extent of technical supporting documents required to accompany the full planning application.

3. Instruct a contractor for the Detailed Design and Build Contract, to progress the scheme on behalf of the LDNPA.

4. The chosen contractor should submit the G99 application for the appropriate system size and instruct the upfront technical surveys that are required to complete the detailed design, as listed in section 5.

5. Once designs have been finalised the project can be mobilised in line with the chosen contractors procurement and construction programme.