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Humshaugh Net Zero CIC

RCEF

Low Carbon Feasibility Study

Workstream 1 – Solar PV

Stage 1 - Final Report

February 2021

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Third-Party Disclaimer

Document Revisions

No.	Details	Date
1	First Draft Report	Dec 2020
2	Second Draft Report following client comments	Feb 2021
3	Final Report	Feb 2021

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(REF: 1601)

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D3 Associates Ltd

Report for

Humshaugh Net Zero CIC

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1 Introduction

Humshaugh Net Zero CIC (HNZ) are engaged in the process of reducing the Parish’s carbon footprint and tackling climate change and to achieving the Government and Northumberland County Council Net Zero targets. They have consulted with the local community to ascertain their views and are looking to identify a viable approach to low carbon energy generation, particularly electricity, in the Parish of Humshaugh.

The Rural Community Energy Fund (RCEF) is a £10 million programme to support rural communities in England to develop renewable energy projects. HNZ have been successful with a stage 1 application, the funds being used to deliver this feasibility study. Stage 2 grants are available to further develop identified feasible projects for business development and planning.

1.1 Description of the Brief

Workstream 1 of this study is to assess the potential for the installation of solar PV arrays within the Parish. The key elements in the Scope of Work are:

- Site and resource assessment
- Array considerations
- Cost data
- Performance assessment
- Funding Options
- Practical aspects
- Risks

2 Site and Resource Assessment

A desk top survey has been undertaken to ascertain the potential resource for solar PV within Humshaugh Parish. The survey was limited to roof top or small scale ground mounted installations within property boundaries, these include the farms in the Parish. The two quarries have been considered, however, HNZ have stated initially solar farms on agricultural land is not to be included in this assessment, however, a potential site was subsequently identified near Lincoln Hill. During a desk top survey it is difficult to identify poor agricultural land, e.g. old quarries, which could be suitable of ground mounted solar PV arrays.

2.1 Quarries

There are two active quarries within the Parish; Keepershield operated by Hanson Aggregates and Haughton Strother by Thompsons of Prudhoe.

2.1.1 Keepershield

Keepershield is an active crushed rock quarry with planning permission to extract up to February 2042. There is a small area to the west of the quarry within their control and outside the extraction limits which could be considered for ground mounted solar. However, the site is the wrong side of the quarry for the electricity supply, the ground is uneven which isn’t ideal and recently planted trees to the south will in time will provide significant shading. Therefore, the site is not recommended for further consideration.

Photo 1: Keepershield Quarry – potential site for ground mounted solar PV

2.1.2 Haughton Strother

Haughton Strother quarry is situated on land owned by the Nunwick Estate by the river North Tyne. The planning permission for extraction ends on the 31st October 2022 and the site is to be restored in accordance with the agreed Nature Conservation Management Plan. A main feature of the restoration is the creation of two lakes. As seen from the Bing Maps image in Photo 2 below works are currently in progress.

The installation of floating PV arrays has been considered which could add to the environmental benefits of the site. Investigation on the government's flood risk website[1] shows the area is at high risk to river flooding (refer to Photo 3), therefore, the site is not recommended for further consideration.

[1] https://www.gov.uk/check-flood-risk

Photo 2: Haughton Strother quarry

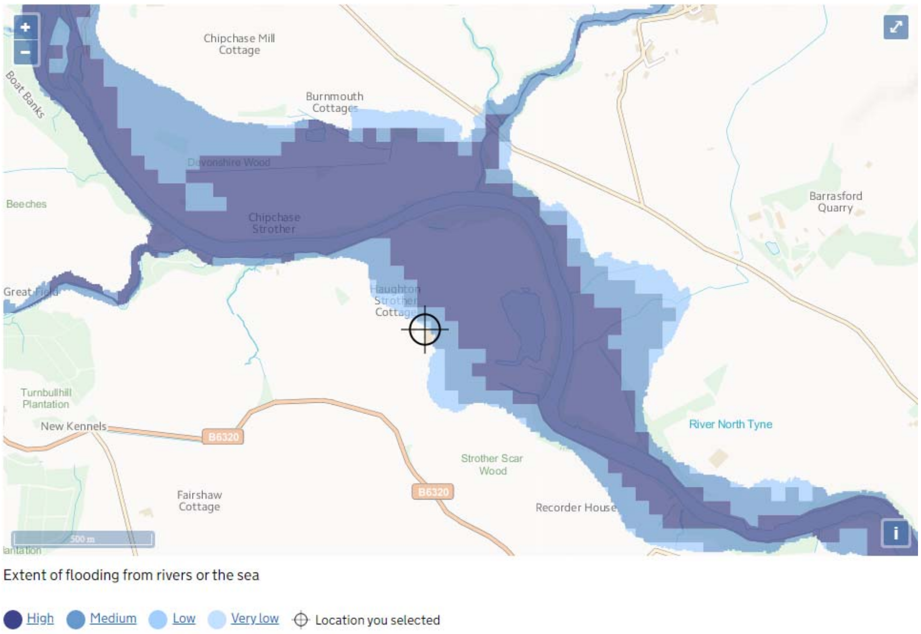

Photo 3: Flood Risk Map

2.2 Residential Properties

According to the Humshaugh Carbon Footprint Household Survey 2020 there are approximately 350 households in the Parish.

A high level desk top survey of the Parish using Google Earth and Bing Maps has been carried out and approximately 80 houses have been identified as being potentially suitable for the installation of a roof top PV array. The following criteria were used in the assessment:

- Orientation of roof between south east and south west
- An available roof of 20m^2, the approximate size of a 4kW array
- Roof not visible from the road within the Conservation Area
- No significant shading from trees

Note, there will be other properties that will be suitable for smaller arrays and to confirm the suitability of roofs is subject to a site survey. Also, a 4kW array is considered an appropriate size for the majority of properties as it will generate approximately 3,200 – 3,500kWh/year, the average electricity demand for a household. The installation of a 4kW array is also generally allowed under permitted development for planning purposes outside of the Conservation Area.

Based on a 4kW array on each of the 80 households, the potential total installation size is **320kW**.

For those households with an increased electricity demand, due to the installation of a heat pump or an electric vehicle, a larger PV array would be beneficial, alongside battery storage, to make full use of the electricity generated.

2.3 Barns

A desktop survey of barns within the Parish has been undertaken. Naturally, it is very difficult to assess the material and condition of the roof and to confirm whether the building is structurally sound. However, there are barns that appear to have a newer roof with no or minimal shading in the following locations worth a closer examination from a site visit:

- Waterside
- Haughton Mains
- Keepershield
- Heathridge
- Green Carts
- Black Carts

- Leazes Head

The size of the most cost effective array will depend on how much electricity can be used by the farm (replacing electricity bought) and the cost of upgrading the grid connection (if required).

For new build barns an integrated array which replaces the roofing material will have a lower capital cost particularly if scaffolding is already in place.

Photo 4: PV panels being installed on a barn roof (photo courtesy of Geowarmth)

2.4 Other Properties

Along with the residential properties, there are other potentially suitable buildings such as the school, hotels and historic buildings within the Parish. As these are larger buildings with a higher electricity demand so there is potential to install a larger, say 10kW or more PV array. The size of the array could be matched to their demand though would necessitate a planning application and an application to Northern Powergrid. Further detailed analysis of specific properties can be undertaken during Stage 2.

For the purposes of this study an estimated 10no. buildings could accommodate a 10kW array, therefore, the potential total installation size is **100kW.**

2.5 Solar Farm site

A two acre area of land close to Lincoln Hill has been identified as a potential site for a ground mounted array. This could support a ground mounted installation of up to **500kW** and Figure 1 in the WS6 report shows there is a single transformer nearby at the end of a 20kV overhead line so it is highly likely the grid will to be upgraded from the 3 phase supply.

2.6 Grid Connection

A system with a 3.68kW maximum export, generally a 4kW array, may be installed without prior permission from the District Network Operator (DNO) under Guidance G98. The DNO for Humshaugh is Northern Powergrid (NPG). The installer will inform NPG once the installation is complete.

For installations above 4kW, or a system which includes battery storge, prior to the installation a G99 application must be submitted to NPG for permission to connect to the distribution network, the current cost is £350+VAT. NPG will review the network and determine whether it can accept the new generation. The turnaround time is 45 working days.

3 Array Considerations

3.1 PV Panel Options

Solar PV panels are made up of a number of silicone PV cells which are made from layers of semi-conducting material, usually silicon. There are numerous manufacturers on the market selling panels of different outputs, efficiencies, appearances and sizes.

Monocrystalline panels which are made from a single block of silicon are more expensive than polycrystalline panels, however, they have higher efficiencies therefore produce more electricity. The particular panel an installer will offer will be the one that he considers to be the most cost effective at that time and will change as panel prices change.

A typically roof or ground mounted 60 cell PV panel is approximately 1600 x 1000mm in size, 70mm thick and weighs 20kg. Power outputs a couple of years ago where around 250W, however, this has now increased to 350 to 400W. Larger, 72 and 78 cell, panels are available with sizes up to 2200mm. Efficiencies have increased in recent years from around 17% to over 23%. Therefore, for a similar cost and the same size array the amount of electricity generated has increased significantly.

The appearance of panels vary; Photo 5 is a polycrystalline panel, Photo 4 below an integrated black panel chosen to match the roof tiles:

Photo 5: Integrated black PV panels

An emerging technology is perovskite-silicon tandem cells which have demonstrated in the lab an efficiency of 28%. Perovskite is a synthetic material which when combined with silicon absorb more of the sun’s spectrum, hence the increase in efficiency. Oxford PV, one of the leaders in the field forecast the cells to enter the market in 2021.

3.2 Array Configurations

3.2.1 Roof mounted

The most common residential PV array is a roof mounted installation. These can be fixed to a variety of pitched roofs, i.e. slates, clay tiles or metal sheets, the mechanical fixing dependent on the roof covering. Also, if roof repairs or a replacement is being undertaken an integrated array where the solar panel surface lines up with the roof covering could be considered. Prior to an installation, the existing roof covering, and roof structure should be assessed by a suitably competent person.

The array does not have to be on one single roof but can be split between two roofs, for example one south east and one south west facing.

Flat roof arrays are also common and would be ideal for the school roof, these can be orientated due south and pitched at 20° to maximise the output. The arrays are not fixed through the roof covering but utilise a ballast system.

Photo 6: Typical flat roof mounted ballast system

3.2.2 Ground Mounted

Ground mounted options are becoming more common place, and are especially favoured in conservation areas and where the roof isn't accessible or not structurally strong enough. There are different mounting systems available:

- Using a metal frame screwed into the ground, an example is included in Appendix A
- Low profile metal frame similar to roof mounted, an example is the Van der Valk system included in Appendix A
- Using a ballast system (see photo below)

Photo 7: Ground mounted ballast system

The cost for a ground mounted system is slightly higher than a roof system due to the additional installation works and is also dependent on the distance of the trenching and cabling required to the property. Savings can be made if the householder prepares the area for the array and excavates/backfills the trench.

3.2.3 Floating

Lakes, reservoirs and other inland bodies of water are becoming more common as sites for floating PV arrays. The main benefit to the systems is they don't take up any valuable land area. Naturally, capital costs are higher than conventional land based solar farms due to more challenging installation, environment and anchoring costs, estimated to between 5 and 15%. However, this may be offset by lower reservoir lease costs. In addition, maintenance is more difficult as was demonstrated when the array in photo 7 caught fire in May this year due to an electrical fault.

Reservoirs, if the site includes a pumping station, have the advantage of having a local electricity demand which can be offset and a suitable electricity connection. Also, shading is likely to be irrelevant and the cooler conditions can reduce energy losses thereby increasing the output. The array can reduce evaporation in warmer weather.

Photo 8: The Lightsource bp 6.4MW floating PV array on London's Queen Elisabeth II reservoir

3.2.4 Building Integrated PV (BIPV)

There are many alternative uses for conventional panels such as canopies, facades, brise soleil, car ports and to replace glazing in balcony handrail system. Where the orientation and inclination are in the optimum position (refer to Section 3.4) the systems can be cost effective particularly when replacing other elements.

Photo 9: Solar PV car port

Other roofing materials include solar slates and tiles. These are currently expensive and not as efficient as conventional PV panels; however, they may be appropriate where the appearance of the roof is a critical factor.

Photo 10: Tesla solar roof tile

There are many other innovative BIPV products currently being developed, though many are still not commercially viable. The so-called “solar-skin” unveils a future where every single component of a building – roof, façade, window – can contribute to generating renewable electricity.

Flexible solar panels are thin, lightweight modules that can be bent or rolled up. Their portability makes them suited for off-grid applications such as camping, caravans, motorhomes or boats.

Due to their lower efficiency, these types of panels are not generally suitable for roof tops as they’d need a disproportionate amount of space to generate power for the building – about twice as much space as conventional crystalline PV panels for the same output. For domestic and commercial roofs, traditional polycrystalline or monocrystalline panels is recommended. Flexible PV does have some interesting niche uses, however, and the potential for future applications in places where regular panels aren’t suitable.

3.2.5 Tracking PV

A niche market are PV panels which track the movement of the sun during the day. Trackers can be single axis where they tilt to the optimum angle or dual axis where they rotate and tilt. The output from a dual axis system such as shown in Photo10 have a higher output of approximately 30% over static panels. However, these systems have a higher capital cost and require an ongoing maintenance contract for the tracking system with the risk of increasing call outs as the systems age. For this reason, the majority of PV installers currently steer clear though new more robust devices are coming to the market. There is a local installer in Hexham, Hadrian Electrical Engineering, who installs dual axis PV trackers and offers a maintenance contract, therefore, in this area they could be considered.

Photo 11: Pole mounted tracking PV

3.3 Array Sizes

Solar panels can be installed in an array of any size providing the space and suitable grid connection is available. As stated in section 2.2, a 4kW array has been considered an appropriate size for a residential property as the annual electrical output is approximately the same as the family household demand. 2 or 3kW arrays could be more appropriate for smaller households and couples. However, electricity demand will increase as more households employ heat pumps and purchase electric vehicles. Householders are now installing larger roof top or ground mounted arrays though this is dependent on a successful application to NPG. When sizing an array, careful consideration should be given to try to match the demand profile with the times of generation to maximise usage within the property. The addition of diverters to the hot water storage tank and battery storage will assist though a whole project assessment will need to be carried out to determine the financial viability.

3.4 Factors which affect output

The main considerations in determining whether a PV array is suitable are:

- Orientation – for pitched roofs due south is ideal and will maximise the potential output, however, between south east and south west is considered acceptable (refer to Figure 1: the UK solar orientation chart).

- Inclination - a 10º to 20º pitch for flat roofs and ground mounted arrays is preferable and a pitched roof between 30º and 50º. Note, a steeper pitch will increase the output during the winter months, a lower pitch during summer months.
- Shading on a PV array reduces the output dramatically. Shading on one panel in a row of panels (a string), or even one cell, will reduce the output of the whole row to virtually zero. To overcome this, modern panels use a bypass diode to minimise the effects of shading.
- Microinverters – A more recent development to maximise output and overcome shading effects is the installation of a microinverter on each panel. Whilst probably not appropriate for a small roof top array it can be financially beneficial for larger arrays that experience some shading. An example is the SolarEdge inverter which comes with a 12 year warranty as standard, and the optimisers come with a 25 year warranty as standard. The following video link may be of interest on how the SolarEdge inverters and power-optimisers work:

  https://www.youtube.com/watch?app=desktop&v=-Bsq7umcffg&feature=youtu.be

Orientation Chart showing output for different orientation and tilt angles (% of maximum)

Tilt (°)	West									South									East
	90	80	70	60	50	40	30	20	10	0	10	20	30	40	50	60	70	80	90
0	87	88	90	91	92	92	93	93	93	93	93	93	92	92	91	90	89	87	86
10	84	87	90	92	94	95	95	96	96	97	97	96	95	94	93	91	89	87	84
20	82	85	90	93	94	96	97	98	99	99	98	97	96	95	93	91	88	84	81
30	78	83	87	91	93	96	97	98	99	100	98	97	96	95	93	89	85	81	78
40	75	79	84	87	92	94	95	96	96	96	96	95	94	92	90	86	82	77	72
50	70	74	79	83	87	90	91	93	94	94	94	93	91	88	83	80	76	73	70
60	65	69	73	77	80	83	86	87	87	87	88	87	85	82	78	74	71	67	63
70	59	63	66	70	72	75	78	79	79	79	79	79	78	75	72	68	64	61	56
80	50	56	60	64	66	68	69	70	71	72	72	71	70	67	66	60	57	54	50
90	41	49	54	58	59	60	61	61	63	65	65	63	62	59	60	52	50	47	44

Figure 1: UK solar orientation chart

3.5 Maintenance

There are several observations the PV array owner should make on a regular basis:

- Visual check from ground level to check for damaged or slipped panels, particularly after snow
- Visual check of the inverter for damage or fault
- Check the output on a regular basis and compare to previous data, a reduced figure could highlight potential damage

Most PV installations do not require cleaning, PV panels have a surface coating on them to help water and dust run away, and they are considered self-cleaning if pitched at greater than 10 degrees. However, in some locations where there is too much dust, plant debris (leaves etc) or bird excrement the panels can get dirty. Avoid locating panels under TV ariels which birds use.

Before cleaning check with the panel manufacturer to see if the panels can be cleaned without breaking or having an impact on the warranty. In addition, ensure an appropriate access system is used.

The best method to clean panels is using a water fed pole with a soft brush, combined with a squeegee. Abrasive materials should not be used as they may damage the panels, nor should detergents that could cause streaks. Also, avoid cleaning panels when the weather is hot, as spraying cold water on hot panels could potentially cause damage and smudging, instead clean in the morning, evening or on cooler days.

3.6 Mounting Systems

As described in the sections above there are several mounting system options for each type of installation. Each installer will have their preferred method which will mainly be directed by the chosen panel manufacturer. For a flat roof, a ballast system will avoid the need for mechanical fixings through the roof covering, for pitched roofs the roof covering material will influence the choice. Naturally, a mechanical fixing needs to be into a suitable structural roof timber. Examples of systems are shown in the photos below:

Photo 12: A tile roof hook mount bracket system

Photo 13: A simple solar installation on slate roofs by solarslateplate.co.uk

Photo 14: Solar limpet by solarlimpet.co.uk

4 Cost Data

4.1 Typical installation cost - Householders

The budget costs below are for installations on a 2 storey house with a slate roof using a 310W panel (all figures include VAT):

4.34 kWp System (14 x 310W) = **£5,500** which equates to £1,267/kWp

10.23 kWp System (33 x 310W) = **£11,100** which equates to £1,075/kWp

For a ground mounted array on a frame system with the contractor undertaking all the installation work, typical costs are:

4.34 kWp System (14 x 310W) ground mount (assumed 10m cable run and simple trench) = **£6,500**.

10.23 kWp System (33 x 310W) ground mount (assumed 10m cable run and simple trench) = **£13,000**.

Cost savings of around £1,500 can be made if the householder prepares the site for the installer and excavates/backfills the trench for the electrical connection to the property

The addition of a single Tesla Powerwall Battery (5kW output and 13.5kWh storage with full back up functionality) = £8,800.

The addition of an Eddie immersion controller = £550 – assuming the existing immersion and electrical circuit are in place.

When considering the addition of a diverter to a hot water cylinder, it may be appropriate to replace the cylinder with a new highly insulated unit.

4.2 Typical installation cost – Larger properties

For larger properties, barns or solar farms the installation cost is more site specific and obtaining quotations is recommended. The cost of the electrical connection becomes more significant the larger the installation and a quotation from Northern Power Grid is essential. However, there are economies of scale and you should expect an installation around 100kWp to cost around £850/kWp.

5 Performance Assessment

5.1 Estimated Annual Output

There are several online PV calculators available which will determine the approximate output for a household PV array including potential energy savings and income. The majority will not be particularly accurate as they will generalise on location, parts of the UK are much sunnier than others, and overestimate how much electricity generated is used by the household. Under the Feed-in Tariff scheme, which closed in March 2019, 50% of the electricity was deemed to be used and 50% exported. In reality, it is difficult to use 50% as during the summer months when the output will be at its peak electricity demand is generally lower. It is more likely the property is empty during the day resulting in more electricity exported.

The Energy Saving Trust Solar Energy Calculator[2] is easy to use, from a reliable source and requests more information to get a more accurate figure. Importantly, it asks when the property is occupied. The figures below are the outputs from a calculation based on a property in the NE46 4BP postcode with a 30^0 pitched roof facing due south, minimal shading, occupied all day:

Estimated annual electricity generated = **3,419kWh/year**

Potential annual benefit: fuel saving = £226, payments from the Smart Energy Guarantee (@4p/kWh = £79, therefore, total = **£305**

Potential annual CO_2 savings = **1,050 Kg**

If the householders are out all day until 6pm, the potential annual benefit drops to **£206**

When obtaining quotations from an installer it is essential to use a contractor which is accredited under the Microgeneration Certification Scheme (MCS), available at https://mcscertified.com. The scheme was originally set up to provide a guarantee of competency of the installer and the products for the Feed-in Tariff scheme. Even with the closure of the scheme it still provides confidence that the supply, design, installation and commissioning of a PV system (up to 50kW) is carried out to a high standard.

An MCS contractor must estimate the total annual generation of the system using the methodology stated in the latest version guidance document[3].

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[2] Available at https://energysavingtrust.org.uk/tool/solar-energy-calculator/

[3] MIS 3002, The Solar PV Standard (Installation) Version 4, available at https://mcscertified.com/standards-tools-library/

5.2 Summary Table

The table below summarises the costs and output various scenarios.

	Type	Rooftop	Rooftop integrated tiles (in new roof)	Freestanding (small)	Freestanding (large)	Tracking system pole mounted, dual axis
CAPITAL	installation					
Installation		£5,500	£5,200	£20,100	£325,000	£35,500
Other				£3,000	£35,000	£3,000
Electrical connection		0	0	Site specific	Site specific	Site specific
Project Management		Incl	Incl	Incl	5%	incl
OPERATING COSTS	annual					
Insurance		0	0	100	2000	100
O&M		0	0	0	1000	360
Other - inverter replacement		£750	£750	£2,300	£50,000	£2,300
Install size	kWp	4.34	4.34	11.7	500	11.7
Asset lifetime	Years	25+	25+	25+	25+	25+
Production	kWh	3,419	3,419	10,612	453,500	15,385
Revenue	p/kWh	5.5	5.5	5.5	6	5.5
Annual CO2 savings	tonnes	1	1	3.1	130.6	4.4

Table 1: Summary of option costs and outputs

Notes:

- Equipment costs and inverter replacement costs based on installer quotes or budget costs
- Large array is based on £650/kWp
- Statutory fees and NPG application have been included
- For the large freestanding array, a cost for security fencing (@£60/m) and CCTV has been included
- For a grid connection cost an application will need to be submitted to NPG
- The majority of revenue for smaller arrays is from replacing electricity bought form the supplier, the figure of 5.5p/kWh quoted is the Octopus Energy SEG for exporting surplus electricity
- Carbon emissions based on UK Government GHG Conversion Factors for Company Reporting Scope 3, which includes emissions from Transmission and Distribution

6 Funding Options

As stated in Section 5.1, the Feed-in Tariff (FIT) which was set up to support the generation of electricity from small scale renewable energy installations closed in March 2019. Currently, there is no government funding scheme to support the capital cost of installing PV. However, the Smart Export Guarantee (SEG) was set up to provide a guaranteed income stream for surplus generated electricity which is exported to the grid. To be eligible a PV system needs an export meter.

The amount of money received is down to your electricity supplier, the government only obligated the suppliers to buy at a price above zero. At present, the best value suppliers are Social Energy, Octopus, E.ON and Bulb who offer a price of around 5.5p/kWh. The Solar Trade Association provide an up to date league table[4] which is worth monitoring to ensure you receive a fair market price.

The SEG will allow electricity supply companies to include battery storage as part of their tariffs. However, it is up to the individual supplier as to whether they will reward power exporting from a storage unit and how they do it; there is no legal obligation.

Suppliers who decide to include storage in their tariff offers will then also decide what type of power is eligible for the SEG. They can decide whether they want to differentiate payments for only ‘green’ electricity (meaning the power coming from PV panels only) or whether payments can also be made on so called ‘brown’ electricity (drawn from the grid) passing through the storage system.

[4] https://www.solar-trade.org.uk/resource-centre/advice-tips-for-households/smart-export-guarantee/

7 Practical Aspects

7.1 Planning

The installation of solar PV panels and equipment on residential buildings and land may be 'permitted development' with no need to apply to Northumberland County Council for planning permission. There are, however, important limits and conditions which must be met to benefit from these permitted development rights:

- Equipment on a building should be sited, so far as is practicable, to minimise the effect on the external appearance of the building and the amenity of the area.
- When no longer needed equipment should be removed as soon as reasonably practicable.
- Panels should not be installed above the highest part of the roof (excluding the chimney) and should project no more than 200mm from the roof slope or wall surface
- The panels must not be installed on a building that is within the grounds of a listed building or on a site designated as a scheduled monument.
- If the property is in a conservation area, or in a World Heritage Site, panels must not be fitted to a wall which fronts a highway.

For ground mounted PV installations, the following specific limits must be met:

- Only the first stand-alone solar installation will be permitted development. Further installations will require planning permission.
- No part of the installation should be higher than four metres
- The installation should be at least 5m from the boundary of the property
- The size of the array should be no more than 9 square metres or 3m wide by 3m deep

Within the Humshaugh Conservation Area listed building consent is required for panels within the curtilage of a heritage asset included in the national heritage assets register. Also, it is possible to install PV panels on listed buildings, for example, the Grade 1 listed Gloucester Cathedral, subject to listed buildings consent.

In all cases it is recommend contact is made with NCC Planning Department to confirm whether your individual situation meets the requirements. If the installation is outside of these limits a full planning application needs to be submitted.

7.2 Building Regulations

Normal Building Regulations do apply for roof mounted PV installations. The ability of the existing roof to carry the load (weight) of the panels will need to be checked and proven. Building Regulations also apply to other aspects of the work such as the electrical installation. It is advisable to use an installer who can provide the necessary advice and submit the required application.

8 Risks

The main risks and mitigation measures have been mentioned throughout the report., they are summarised in the table below:

Risk	Mitigation Measure
Planning Officer objects to the installation	Follow the guidance from the Planning Authority and apply for planning permission if necessary
Building Control refuse application	Ensure a MCS accredited contractor is used and ensure the structural loading is checked and a certificate produced for the electrical installation
Roof failure from additional loading of PV array	Ensure a MCS accredited contractor is used who follows the requirements of MIS 3002
PV output below expectations	Undertake a visual check and contact your installer
PV output below expectations due to shading	Ensure shading is considered at the design stage, in addition avoid siting PV arrays where neighbours' trees may grow and inhibit the output

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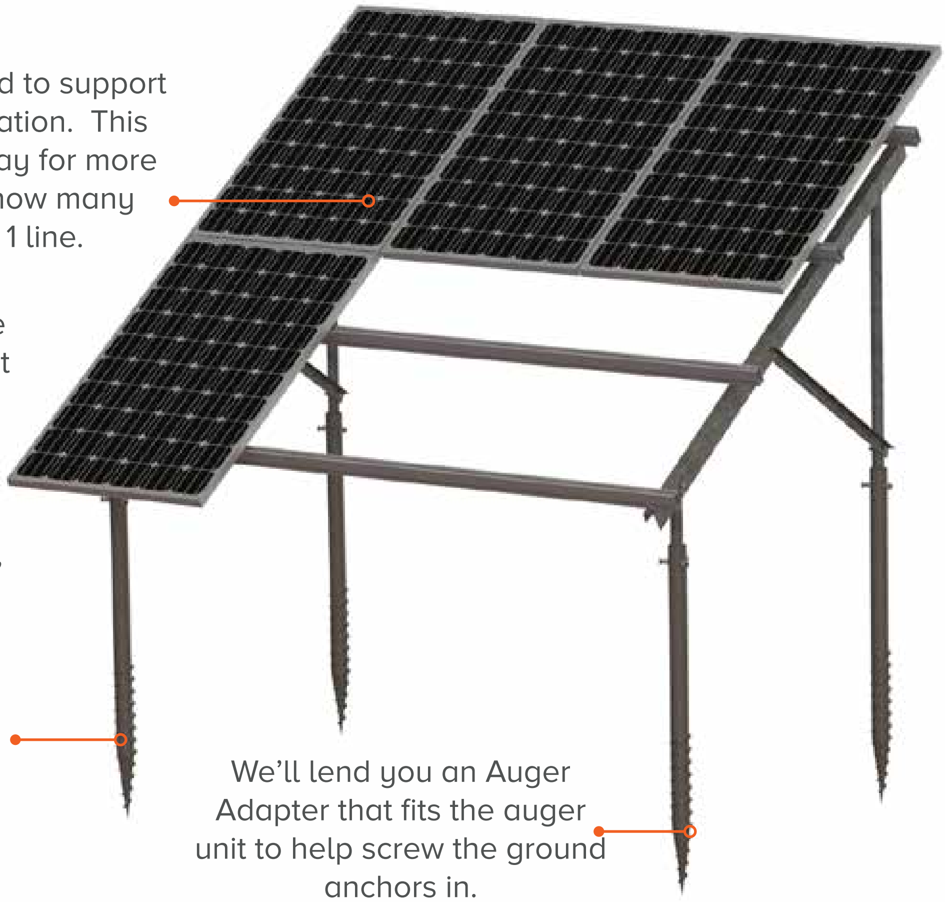
Appendix A: Ground Mounted Frames

PARK TEGRA **GROUND ANCHOR**



Our standard structure is designed to support 2 modules high in portrait orientation. This allows more space within the array for more modules. There isn't a limit to how many modules can be installed in 1 line.

We recommend hiring a 2.5 tonne cylinder head hydraulic auger unit with reverse option for installing the ground anchors.

Sometimes the ground may need more pressure applying. For this, a 4-5 tonne auger unit is more suited.

Screws into ground with a high clay content, making it a fast and popular solution, particuarly for small to medium projects.

We'll lend you an Auger Adapter that fits the auger unit to help screw the ground anchors in.

9.77kg/m²
Weight

Portrait
Module orientation

30°
Standing module angle

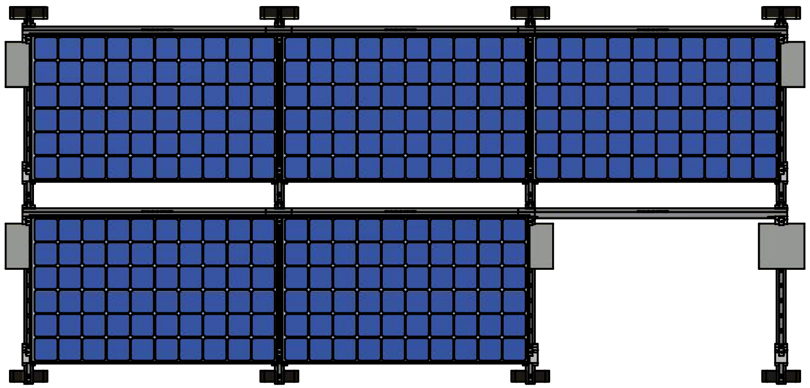
Aluminium, stainless & galvanised steel (EN ISO 1461)
Material

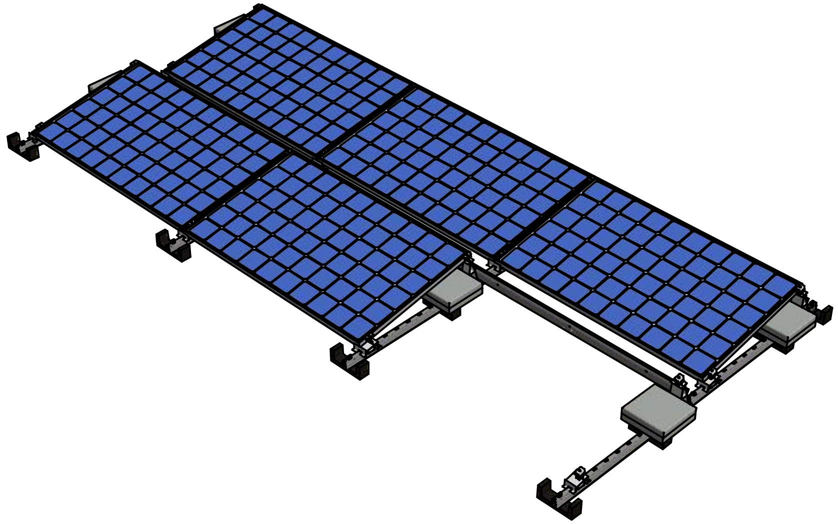
+44 (0) 1451 824 312
info@sunfixings.co.uk
R3 Bourton Industrial Park, Bourton on the Water, Cheltenham, Glos, GL54 2HQ, UK

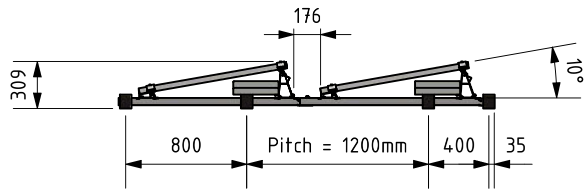
WWW.SUNFIXINGS.CO.UK

V122016

SUNFIXINGS
CONNECTING TO THE FUTURE







American projection:

VAN DER VALK
SOLAR SYSTEMS
www.valksolarsystems.nl

Scale: 1 : 50
Unit: mm
Material:
Author: Robin
Group:
Date: 19-12-2017
Comments:

Project:
Side view drawing

Rev: A
State: Work in Progress

Description:
ValkPro+ L10 South [1200mm]

Part number.:

Size: A4