

Planning Discharge Application.

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Project: *Grange Solar Farm – 13.024 MW (DC) 10MW (AC) Solar PV Park*

Condition 1 – Discharge.

Construction of the proposed solar farm will take place between September 2014 and February 2015 totalling 29 weeks of installation works. Following completion of the entire installation follow on testing will take place however this will pose of non-construction elements (On-site testing and monitoring).

A copy of the project programme has been attached to this document at Appendix C. The programme indicates detailed elements of the solar farm installation along with follow on testing period following energization of the plant.

Maintenance – the plant will remain under monitoring conditions for a period of 1 year following energization. A full monitoring programme will continue for the life of the plant (expected 20 Years). This monitoring will consist of weekly, monthly and annual checks and cleaning works, it will however be non-intrusive to the public and local residents. A copy of our maintenance and monitoring schedule is attached at Appendix J.

Condition 2– Discharge.

The Contractor's project design is set out in the drawings set out in Appendix A. (Drawing Schedules)

The detailed construction design provides a detailed to scale design for the civil, mechanical and electrical installation of the solar generating plant in accordance with the Employer's requirements.

Any design parameters specified in the Employer's Requirements, set out in the Contract and/or any additional restrictions detailed in the Planning Permission H20-0937-13, will be complied with and the Contractor will ensure that the system is fit for purpose.

The design and all equipment comprising the Works will be in accordance with BS7671 and BSEN12831 standards and Laws.

The full performance report has been undertaken using Sustain Solar Ltd. PVsyst software by the in house design team and attached at Appendix I.

Condition 3 – Discharge.

A copy of the WPD offer and Novation agreements has been attached at Appendix K.

Condition 4 – Discharge.

Following completion of the Plant Duration (Expected 20 Years) the plant will be full removed returning the two proposed fields to Arable Farm land. The Plant has been designed to be fully removable utilising the latest technologies and installation methods to ensure that the land remains non-contaminated.

Condition 5 – Discharge.

Construction Management Plan – Grange Solar Farm.

Introduction

This document explains the Contractor's proposals for the design and installation for the Grange Solar Farm 13.024 MW Solar Park installation.

The Solar Park installation includes the PV solar installation, the evacuation infrastructure (medium and high voltage systems and undergrounded electrical line to the point of grid connection), and all other related systems including but not limited to the monitoring and control system, auxiliary services, perimeter fence, surveillance system and communication system.

Project Design

The Contractor's proposed project design is set out in the drawings set out in Appendix a (Drawing Schedules) and attached to this proposal (the "Drawings").

More detailed construction drawings will be prepared prior to commencement of the relevant works and submitted for approval by the Employer.

The detailed construction design will provide a detailed to scale design for the civil, mechanical and electrical installation of the solar generating plant in accordance with the Employer's requirements.

Any design parameters specified in the Employer's Requirements, set out in the Contract and/or any additional restrictions detailed in the Planning Permission H20-0937-13, will be complied with and the Contractor will ensure that the system is fit for purpose.

The design and all equipment comprising the Works will be in accordance with BS7671 and BSEN12831 standards and Laws.

Once the design is completed, a full performance report will be undertaken using Sustain Solar Ltd. PVsyst software by the in house design team and provided to the Employer.

Planning and Planning Discharge

Sustain Project Manager to ensure design complies with planning conditions set out in document H20-0937-13, Dated 1st November 2013. Discharge Application to be issued to South Holland District Council prior to commencement of construction works on site by Sustain Commercial Ltd.

Discharge of all conditions attached Appendix G

All documentation, technical literature and drawings will be uploaded on to the Sustain Solar Share-point portal and will be accessible for review by all authorized and relevant parties.

Technical Submittals

The Contractor will issue technical submittals for the equipment detailed in Appendix B (the "Technical Submittals") for approval by the Employer.

The following information and documents will be included in each Technical Submittal;

- Manufacturer and model
- Technical specifications,
- Certificates (including but not limited to regulatory compliance, CE, protections, class, grid requirements compliance)
- Warranties (product, power, corrosion and others),
- Installation and operation manuals,
- Maintenance manuals

Approval by the Employer

Where matters in this Contractor's Proposal are stated to require the Employer's approval or consent (including but not limited to the Technical Submittals), such consent shall not be unreasonably withheld.

Where the Employer has reasonably withheld its consent because an element does not meet the client's requirements and amendments are required to be made to any design, drawing or other technical submission in order to obtain the Employer's

consent, such amendments shall not constitute a Variation under the Contract and the Contractor shall not be entitled to request an adjustment to the Contract Price or a change to the Time for Completion in relation to such amendments.

Irrespective of the approval by the Employer of the Technical Submittals or the grant of its consent to a proposal made by the Contractor under this Contract, the responsibility for the selection of the equipment and for the design of the Works meeting the Employer's Requirements and being fit for purpose remains with the Contractor.

Obtain DNO Connection

The Contractor will coordinate with EMS for the contestable design & construction with direction and assistance from the Sustain Solar design team whom will manage the initial and final design approval, construction and commissioning with Western Power Distribution for the site.

The ICP will be a subcontractor to Sustain Commercial Ltd. and the Contractor will coordinate for the compliance of the works performed by ICP with the Employer's Requirements and is fit for purpose.

All the documents, information, tests, measurements and studies to be performed and delivered to the UK Power Networks will comply with Western Power Distribution's internal protocols and procedures applicable to solar PV projects.

The detailed construction drawings for the contestable and non-contestable works will form part of the Technical Submittals and will be submitted for approval by the Employer prior to commencement of the relevant works.

Health & Safety

It is the Contractors responsibility to adopt the CDM's H&S file, and complete the onsite H&S plan keeping the H&S records up to date at all times. Once work has commenced on site the Contractor will be responsible for the management of the H&S of all personal entering and working within the site boundaries.

The F10 HSE Application will be submitted by Sustain Solar Ltd. And shared with all Parties, any HSE site visits will be recorded and all parties notified of any findings and notices that may be issued.

The H&S plan will be issued and approved by the CDM coordinator(Supplied by Sustain Solar Ltd.) prior to any work commencing on site and managed by Project Manager during the construction process.

RISKS TO HEALTH & SAFETY

Sustain Solar Ltd has identified the following significant hazardous items. All contractors will be made aware of these risks at tender stage to allow adequate resources to be made available throughout the contract. Sustain Solar Ltd will ensure all of the following risks are assigned adequate resources. Site Specific Method Statements along with supporting Risk Assessments will be produced by the relevant Contractors prior to their works commencing, to ensure all adequate resource and competency levels are achieved and maintained throughout the projects duration. The Risks identified are as follows:

- a) Conditional Planning Permission – The South Holland District Council Planning Application Ref: H20-0937-13 has set out specific conditions under the Town and Country Planning Act 1990 (As Amended) & Town And Country Planning (Development Management Procedure) (England) Order 2010. These specific conditions identified in full detail in Appendix 'E' (or held on site) must be incorporated within all contractors planning, method statements and risk assessments.
- b) Access - The site access point for construction personnel and materials has been identified by Sustain Design and Access equipment to be provided by Sustain Commercial Ltd.
- c) Site Set Up - During the first few days whilst working on site Sustain Commercial Ltd will prepare the site for work, this will continue and incorporate the F10, preparing the security of the site, arranging for suitable storage containers to be delivered, identify welfare

arrangements, implementing the site log, arranging delivery of tools and associated equipment (including any power including temporary lighting arrangements).

d) Design - The complexity of the works taking place on site involve Medium – High risk works involving small excavations, lifting and moving loads and extensive lower and high power electrical works. Sustain Solar Ltd have sanctioned the design works as meeting Construction (Design & Management) Regulations 2007, Regulation 11(1) – (6), 18(1)(2).

e) Noise - In accordance with Sustain Solar Ltd procedure HSA17 & HSA17A all measures will be taken to ensure all plant/machinery and other noisy operations e.g. drilling, operations etc., are carried out to an acceptable level and in accordance with site rules. Sustain Solar Ltd will implement control measures immediately thus protecting all contractors working within the area. Any works that involves noise levels exceeding the current legal limits in accordance with the Noise at Work Regulations 2005

Lower exposure action values:

- daily or weekly exposure of 80 dB;
- peak sound pressure of 135 dB;

Upper exposure action values:

- daily or weekly exposure of 85 dB;
- Peak sound pressure of 137 db.

The noise emissions during construction of the development shall not exceed an LAeq,T noise level of 65 dB 1-metre from the facade of any occupied residential dwelling, during the construction and decommissioning periods.

Sustain Commercial Ltd will where required arrange for Noise assessments to be carried out where required and a control measure may involve working outside normal working hours.

f) Hand-Arm Vibration - The Control of Vibration at Work Regulations (COVWR, 2005) has established the necessity for health surveillance at exposure action value (EAV) over an average weight hour working day, (A8) of 2.5 m/s² using tri-axial measurements or where deemed necessary by risk assessment. The introduction of the lower EAV together with a reduction in the exposure limit value (ELV) of 5.0 m/s² means that many more workers will require health surveillance.

Sustain Commercial Ltd insist that all equipment is used on site is obtained and maintained to ensure that exposure falls below the minimum standard, should it be the case that ELV is 2.5 m/s² or more for an 8 hour day, the risk assessment will dictate that suitable breaks and job rotation will ensure that operators safety is of a paramount.

g) Work near Live Conductors

Sustain Commercial Ltd management enforce strict controls when work near live conductors – *Regulation 4(3)* of the Electricity at Work Regulations 1989 requires that: “Every work activity, including ... work near a system, shall be carried out in such a manner as not to give rise, so far as is reasonably practicable, to danger”.

Regulation 14 deals with work near live conductors and says: “No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless (a) it is unreasonable in all the circumstances for it to be dead and (b) it is reasonable in all the circumstances for him to be at work on or near it while it is live and (c) suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury”.

All works carried out on the Grange Solar Farm Site near or in the vicinity of the fixed live overhead cable will comply with the requirements of the above regulations and Guidance Notice GS6 - Avoidance of danger from overhead electric power lines (See Appendix 'F'). All operators and sub-contractors must comply without deviation.

- h) Underground Services – Sustain Solar Ltd will undertake pre planning inspections and surveys of the Honnington Solar Farm site in accordance with Sustain Commercial Ltd HSA18 & HSF21 procedures to ascertain all underground services, these will be held on site within the Site construction Health and Safety Plan. Requests can be made directly to the Sustain Solar Ltd Project Managers (Contact details can be found within the Project Directory). All contractors must include within the scope of their works to verify all surveys are correct BEFORE any excavations/piling or mechanical digging takes place. Ground markers must be clearly displaced to ensure they are not affected by flooding, snow or back fill soil. CHECK TWICE THEN DIG
- i) COSHH – The Management at Sustain Commercial Ltd will in accordance with HSA08 procedure ensure all substances used during the works will be reviewed and assessed by the Project Manager(s) and details will be disseminated to the site operators and any risks will be highlighted and control measures communicated to those who may be affected by the work involved with the chemical or substance.
- j) Asbestos – In accordance with Sustain Commercial Ltd procedures HSA20 no Asbestos materials will be used at the Grange Solar Farm project, however Sustain Commercial Ltd always ensure that a general contingency procedure for working on site is available should during excavations asbestos be discovered:
- If any area or material is discovered or suspected to contain any Asbestos material, work will stop in that area.
 - The area will be contained
 - The Site Manager will contact the Project Manager
 - The Project Manager(s) will contact the CDM Coordinator and the Client Contact
 - A Local Registered Asbestos Contractor will be contacted to ascertain the material discovered and the material will either be removed or suitably contained – depending on the condition.
 - No work will continue within the affected area until formal written authority is given by the Client, supported by the CDM Coordinator.
- k) Pollution - All measures will be taken to provide a pollution free project where at all possible. Chemicals and substances will be controlled at all times. The Project Manager(s) and Site Manager are responsible for the management of the Site Waste Management Plan (SWMP). All reasonable steps will be taken to minimise the migration of dust. Reasonable efforts shall be made to provide recycling of Paper, Cardboard and Plastics on site by separation of waste at disposal.
- l) Fire - Sustain Commercial Ltd management in accordance with HSA12 procedure will ensure all operatives are made aware of the site and building fire precautions, permits to work and procedures at the mandatory site induction given by the Project/Site Manager.

Fire extinguishers will be made available on site in accordance with the requirements laid down within Company Policy the following fire points will be made available at strategic points on site

- X 1 9litre Water Extinguishers
- X 1 5kg Dry Powder
- X 1 Alarm Device

The Project Manager/Site Manager will identify the method of raising the alarm; this will be incorporated into the local induction

- m) Means of Escape - The emergency escape routes from site will be maintained clear at all times. Should it become necessary to restrict an emergency escape route, due to construction activities, an alternative arrangement will be agreed between Sustain Commercial Ltd Site Management, communicated to all personnel and suitable signage provided.
- n) Cranes/Hi-abs – There are period during the construction works where cranes/hi-abs will be used as the project progresses. All cranes/hi-abs will be hired by reputable companies, all Method Statements and Risk Assessments will be verified to include checks on lifting certificates and training records. The Site Manager/Project Manager(s) will ensure all lifts are programmed in accordingly with the weekly schedules and in accordance with Sustain Solar Ltd HSF07 Lifting Plan Procedure (including HSF07A and HSF07B).
- o) Housekeeping - All Contractors will keep the site at an acceptable level of cleanliness, and Sustain Commercial Ltd will inform all Contractors that trades will be held responsible for their own cleaning operations on a daily basis.
- p) Hot Works - All Hot Works will be strictly controlled via Sustain Commercial Ltd Hot Work Permit HFS18C by the Site Manager/Project Manager(s) via the Site Office.
- q) Manual Handling - Where reasonably practicable the Site Manager/Project Manager(s) will ensure all Manual Handling activities are carried out in accordance with Sustain Commercial Ltd HSA10 procedure and that loads over 20kg, are only handled by a suitable mechanical lifting device. Where this is not possible, the Site Manager/Project Manager(s) will ensure a clear route and adequate number of personnel is available to complete the task.
- r) Construction Materials - All efforts will be made by all contractors to use the safest material possible, which will provide the required performance specification. A COSHH Assessment prepared by a competent person will accompany all Construction Materials deemed hazardous. The COSHH Assessment will be made available to all Contractors who may foreseeably be exposed to the substance. The Site Manager will ensure the COSHH Assessment register is updated and maintained on site at all times.
- s) Working at Height - Any work at height will be carried out in accordance with the requirements the Working at Height Regulations 2005 and Sustain Commercial Ltd HSA24 procedure, all work will be individually assessed as to the type of work equipment available for working at height – ladders are deemed for access use only, however should ladders be the only option the method statement and associated risk assessments will identify this activity. The work equipment may include
- Podium steps and similar purpose-designed workplaces
 - Mobile Aluminium Tower Scaffolds/conventional independent scaffold systems (*erected and inspected by PASMA trained personnel*)
 - Scissor Lifts and platforms (*Only trained personnel will utilise all MWEPS*)
 - Ladders - Only class one and two ladders will be utilised.

Details of all work equipment will be maintained within the work equipment register for each responsible contractor and made available for inspection on request.

- t) Electricity - Any electrical equipment or installation will be in accordance with the I.E.E. Regulations, the Electricity at Work Regulations, HSG141 and Sustain Commercial Ltd HSA18 procedure - all will be installed, tested and maintained by qualified electricians only. All portable electrical equipment will be 110-volt centre tapped to earth, or lower voltage, and PA tested, on a 3 monthly basis. Any extension cables will be fixed at high level whenever practicable to minimise the risks of tripping. Electrical Supplies – 240v/110 v supplies are supplied via a dedicated transformer unit. Sustain Solar Ltd will ensure that a systematic process of Lock out Tag out (LOTO) within all the risers and supply panels. Depending on the supply will depend how the LOTO system will be utilised, details MUST BE CONFIRMED PRIOR TO COMMENCING WITH SITE MANAGEMENT

- u) Welfare - Welfare and Facilities will be located within the Compound Area of the works as agreed by Sustain Commercial Ltd Management. All eating, drinking and toilet use will take place at this location and are **NOT** to occur elsewhere.

Only plastic bottled drinking water may be taken onto the construction site, empty plastic bottles must be disposed of correctly.

Details of these facilities will be given to all personnel at the induction; copies of this information will be placed in the Site Log. The welfare facilities provided will be available for all contractors on site in accordance with Part 4 of the Construction Design and Management Regulations 2007, and will be maintained in a clean and serviceable condition at all times.

- v) Fragile materials - Care will be taken around installed glazing, where it may only be toughened glass and therefore there is a risk of items falling through or the persons below being injured if the glass shatters. If any such glazing is identified, the movement of materials will be limited and strictly controlled, a safe clearance distance implemented or protection installed.
- w) Non construction personnel - There may be a requirement for non-construction personnel to access site. All persons will comply with site protective clothing requirements and must attend a site induction prior to being permitted access to the work area.
- x) Vehicle Obstruction – All contractors/operators must ensure that A358 and subsequent lanes and roads leading to the site are not obstructed at any time; guidance for parking (*contractors/visitors vehicles*) must be sought. The Project Manager(s) will confirm the formal route for deliveries to avoid single track and low bridge routes.
- y) Personal Protection – In accordance with Sustain Commercial Ltd HSA11 procedure all employees/sub contractor's/operators and other persons visiting the Bay Farm site will don the correct Personal Protective Equipment (PPE) at all times; the correct PPE will be available on site for use when required. The Site Manager/Project Manager(s) will ensure that the correct PPE is worn and that suitable spare PPE is available for visitors that attend site

Develop, maintain and update a working construction programme.

A copy of the construction programme is attached at Appendix C

During the design and site mobilisation phase of the project a detailed programme of works will be finalised to ensure that all of the installation processes are planned in their correct sequence and coordinated in a manner consistent with applicable health and safety requirements. This will also ensure that the site and client management teams can review on a daily basis a programme and schedule for the works and highlight any areas where there may cause for review or where progress may have been better than originally forecasted.

A weekly report will be sent to the Employer showing actual progress against planned, delays to any aspect of the Works and the proposed remedial actions. The Contractor shall promptly provide such additional information relating to the content of the weekly report as the Employer shall reasonably require. The Contractor will upload .PDF revisions of each update to SharePoint for review.

Weekly Programme Meetings between Subcontractors and Sustain Commercial PM to be held on site with progress and Delays identified and reported to Sustain Operations Manager.

Site Survey.

A number of detailed site surveys will be undertaken before any works are commenced on site. This will consist of the following

- **Ecological Plan** – To be issued to planning office prior to commencement as well as any other document to be sent to and required by the planning office throughout the construction and commissioning of the PV plant.
- **Archeological Survey, Historical Survey and Plan** – By Employer's contractor to be coordinated and managed by the contractor, to be issued to the local planning office prior to commencement, as well as any other document to be sent to and required by the planning office throughout the construction and commissioning of the PV plant. The planning scope requires a full monitoring of excavations package, whereas the archaeological surveyor attends site as exposure of trenches, road and bases occurs and monitors the spoil exposed along with recording the finds. Reporting any significant finds as and when they may appear.
- **Topographical Survey**, this comprises of a full GPS survey of the site, detailing land rise and fall as well as boundary extents, following which full design can be issued.
- **Geotechnical Survey**, the survey and findings will provide ground compression ratios for the piling and mounting of the solar frame and record any significant materials that may affect the durability of the frame.
- **Pile Load Test and Survey**, this survey will, with support from the Geotechnical survey prove the endurance and performance data for the frame installation.

The above tests will enable the final design of the framework spacing and type to be finalized.

Following the completion of the detailed site surveys listed above and the final approval of the Drawings by the Employer the site will then be marked and posted against the approved Drawings.

The following wooden peg markings will be utilised on site for reference, when setting out the site:

- **Yellow Markers** will be used to mark out the first and last leg of the framework. This will allow the ground workers and piling engineer's to set out their leg and trench routes.
- **Red Markers** will be used to mark out the corners of each Inverter House and the DNO Housing. This will allow the ground workers to form the bases for the equipment and build the trench ways from this location.
- **Blue Markers** will be used to mark out the trenches.
- **White Markers** will be used to mark out the bases for the CCTV cameras. This will allow the concrete for these to be poured and give a setting out point for the ground workers for the CCTV trench route.

Installation of Site Perimeter Fencing.

Installation of site perimeter fencing is undertaken at the start of the project. This will be installed in accordance with the proposed drawing SUS006 which will be required to be approved by the Employer before the relevant works can commence.

During the installation of the fencing, wooden posts (9' 4/5", treated for 30 year desirable life) will be driven (0.6m – 0.8m) into the ground and a standard strained deer mesh (HT 13/190/15) will be attached to the posts. At points marked out on the drawing there will be shallow animal points directly under the fencing to allow small wildlife through the fencing.

As shown on the drawing there will be 4 no access gates, a 5m wide double leaf gate, to the site at the northern field entrance, a second gate will be installed at the Western entrance to the southern field. The remaining gates will be utilised for Farm access between the two fields allowing access between the fields for Waterway maintenance. The gates will be used for the duration of the project for pedestrians and goods vehicles/Plant access. The gates will be locked on a nightly basis.

Fencing will be maintained at 7.2m minimum distance from all Waterways. 1.2 m of planting will be undertaking externally alongside the fencing thus leaving a 6m gap to the waterways to comply with planning.

A Method Statement and Risk assessment will be required for the above works before they can be carried out and this will be submitted for review and approval by the Employer.

Installation of HV Enclosure and Inverter Housing Bases.

HV Enclosure

There will be one 33KV DNO enclosure installed on site, separated with a single wall to separate the HV switch room from the commissioning room which holds the LV equipment. The HV switch room / enclosure will be brick built to WPD current design. The building will be mounted on a poured concrete base as per design drawing SUS011.

Concrete paths 1000mm wide by 100mm deep will be constructed around the enclosures and steps (made of concrete blocks) will be fitted accordingly to allow access into the compounds. A perimeter pathway will be also constructed around the HV enclosures. Around the enclosure's concrete perimeter there will be open area 3000mm wide made from hard-core for vehicle parking and future maintenance purposes.

Duct work (diameter subject to design) is required underneath the enclosure to connect:

- a. Duct from the inverters to the site's switch room enclosure.
- b. Links between rooms.
- c. DNO connection Point.
- d. AUX / Communications supply.
- e. Duct from Communications Cabinet in Customer house to Metering Room.

Earthing installation on HV enclosure

Earthing will be installed on the enclosure in accordance with WPD design and following an Earthing Study. A small trench will be dug around the enclosures, preferably positioned under the concrete pathway which runs around them. Earth cable will be installed into the Base excavations and earth-rod's(subject to design) will be positioned around the enclosure.

To finish off the installation, the earth rods will be connected to the earth cable for the HV and from there to a connection point within the HV switch room. The earthing will comply with the prevailing acceptable isolation rates for this kind of installation.

Transformer and Customer House Bases

Transformer bases will be constructed by excavating at locations an area 6.2m long *2.6m wide and 250mm deep, shuttering and re-enforced concrete poured to provide a solid concrete base for mounting the Transformer house .

The Customer house will be constructed by excavating at location an area 6.2m long *2.8m wide and 300mm deep shuttering and re-enforced concrete poured to provide a solid concrete base for mounting the Customer house .

Duct entry points into the concrete base's will be placed prior to concrete being poured as per design drawings.

Earthing installation on Inverters

Earthing needs to be installed beneath the enclosure. Earth Cable will be installed into the bases of the Inverters, prior to the pouring of concrete, earth rods (subject to design) will be positioned within the any excavation and attached to any steel within the excavation and then concrete poured to contain the rod within the Earthing cap.

To finish off the installation the earth rods will be connected to the bare copper HV earth cable and to any steel mesh contained within the concrete and from there to a connection point within the inverter at the HV earth bar.

Earthing

A bare copper cable will be laid in all LV and HV trench routes which will be staked at all point of connection on the site. The DC cable will also be connected to the solar mounting system which in turn will be linked using insulated 6491b cabling and connected at the DC Earth Bar at the HV Enclosure.

The installation of the Earthing will be done in accordance to drawing SUS008. The Earthing will comply with the prevailing acceptable isolation rates for this kind of installation.

Installation of HV infrastructure, Ducts, Trenches and Cabling.

Internal HV works

The internal HV works will consist of trenching 450mm wide by 1400mm deep according to drawing number SUS004.

During the excavation Archaeological attendance will monitor the excavated spoils and survey the exposed trenching for any significant finds. (see Archaeological Survey) following the Archaeological survey a layer of sand 10 cm thick will be placed in the bottom of the trench ready for the installation of 225mm diameter corrugated pipe (subject to design) and the laying of the cables.

Following the laying of cables within the ducts the ductwork will be over-layed with sand, separate ducts will be installed for communications and fibre optics (monitoring) with Marker Tape and back filled with the spoils that were taken out (all ducts to be laid flat and straight with ropes inserted ready for cable pulling). They will be marked below ground with marker tape and every 50m above ground using cable markers.

The HV Cabling will be WPD standard aluminium single core cabling (size as per design drawings and technical submittals) laid in triplex within 225mm ducts within HV trenching, all cabling to be minimum 5000V tested and pressure tested before closure of trenches commences, cables to be rubber capped both ends immediately following cable pulling to ensure integrity of cable.

External HV works

The external HV works are the works required to connect from the site's HV compound to the primary substation. The cable route is shown in drawing SUS005. The detailed construction drawings relating to the external HV works will form part of the Technical Submittals and will be submitted for approval by the Employer prior to commencement of the relevant works.

The trenches will be 500mm wide to 1200mm deep. Inside the trenches 225mm diameter corrugated pipe (subject to design) and cable will be installed on a layer of sand 10 cm thick and then the trenches will be filled with sand. WPD will mark the trenches using their own marker tape. Sand will be filled to cover the ducts and then the trenches will be back filled with spoils. They will be marked every 50m using cable marker at ground level.

Where road works or any other specialist works are required in relation to the external HV works (including but not limited to crossing gas pipes or other media, bridges, tunnelling under streams, paved or unpaved roads) the appropriate permits will be acquired and all the necessary security measures will be put in place (including but not limited to road works signs and traffic control management systems) in accordance with the requirements of the relevant authorities or bodies and market standard practices.

All HV infrastructures works will be taken care of by a Lloyd's approved groundwork contractor. They will produce a separate method statement for all undertaken works in accordance with the approved design.

Installation of HV infrastructure will be done in accordance to the drawings SUS004 and SUS005

Installation of LV Infrastructure, to include Manholes, Trenches and Cabling.

LV and Communications Trenches

The trenches for the LV Infrastructure and Communication will be 400mm wide by 1000mm deep or as otherwise specified in the final approved Drawings.

The trenches

During the excavation Archaeological attendance will monitor the excavated spoils and survey the exposed trenching for any significant finds. (see Archaeological Survey) following the Archaeological survey a layer of sand 10 cm thick will be placed in the bottom of the trench ready for the installation of various corrugated duct pipes (subject to design) and the laying of the cables.

Following the laying of cables (subject to Design) within the ducts the ductwork will be over layed with sand, separate ducts will be installed for communications and fibre optics (monitoring) with Marker Tape and back filled with the spoils that were taken out

(all ducts to be laid flat and straight with ropes inserted ready for cable pulling). They will be marked below ground with marker tape and every 50m above ground using cable markers.

Manholes

Manholes will be installed in order to wire the system and achieve better maintenance of the cabling system.

Manholes will be required at all LVDB locations, HVSB locations, Switchgear Locations and changes in direction of any trenching.

Manholes to be installed in accordance with Design drawings. And in accordance with technical submittal details. All Manholes to be 450mm Square, composite type with sand laid at bottom minimum depth to meet trenching requirements.

Installation of Solar String Cabling.

Solar String cabling will be attached to frame contained via cable-tie dressing travelling from connection point on solar panels to Inverter location attached to the solar framework. The string cabling will be installed in accordance with electrical regulations and cable type specified as per technical submittals.

Installation of Inverter Power Supplies.

Inverter AC power supplies to be attached to Frame contained via cable-tie dressing from Inverter location travelling to duct entry point, whereas they will travel via twin wall duct work (see LV Infrastructure) to their subsequent LVDB (Low Voltage Distribution Board) for connection.

Installation of Communication Cabling.

Specific design of communications cabling as per design drawings and technical submittals.

Cabling to be installed connecting Inverters in Series (Max 50 Inverters per circuit) travelling from inverter to inverter attached to framework using Cable-tie method returning to a central hub located at HVSB locations (as per design drawings). From HVSB location the cabling will change to an OM4 fibre optics system that will be contained by ductwork within the HV trenching travelling back to Customer house location for its final connection at Central Hub.

Design & Installation of Solar Frames.

Solar frame provided by Zhongxinbo (ZXBO) Ltd. Consisting of Steel driven piles and aluminium framework will be provided by Sustain Solar Ltd.

The installation of the solar framing will commence as soon as the temporary roads on site are set up, following the installation of trenches and duct routes and the appropriate site mark-up is completed from the survey engineers.

The pile positions will be clearly marked and the appropriate piling plant machinery will be on site. The layout of the framing system will be:

- Frame/Module Inclination: 20 degrees
- Minimum distance of Framing from the ground: mm front, 2000mm back
- Minimum pile depth of 1600mm
- 4 panels in landscape design

The design, product specification and the layout of the solar framing and solar cabling will form part of the Technical Submittals and be submitted for approval by the Employer prior to commencement of the relevant works.

Installation of Solar Panels.

The solar panels to be installed are the Sun-tech 255 -20/WD (50%) and Sun-tech 250 -20/WD (50%) Solar Module's. (See technical Submittals for details)

The total number of panels installed will be 51720 across 51 acres of flat land. The panels will be installed in landscape forming strings of 24 panels, with the panels being connected in series.

The installation will be staged within the programme to commence in line with the framework positioning.

Care will be taken for the appropriate layout of the site and the materials in order to maximize efficiency and minimize time spent on logistical issues.

The panels will be physically installed row by row, securing them with mid and end clamps using the correct tools and framing equipment. The top panels will be accessible using step ladders. Walking over the modules is prohibited at all times during the Works. The panel fixings will be Torque fixed and tested upon completion to ensure integrity and durability of panel fixing. As a standard we test 30% of panel's fixings and verify results.

Installation of the Solar Panels will be done in accordance to drawing SUS002. The detailed construction drawings relating to the installation as well as a method statement and risk assessment will form part of the Technical Submittals and be submitted for approval by the Employer prior to commencement of the relevant works.

Installation, Connection and Commissioning of Inverters and Transformers/Switchgear.

Inverters Selection

The Inverters selected for the project are the Huawei Sun2000 Series 28KTL inverter's, a total for 359 Inverters will be installed at locations set out within the design drawings. Each Inverter will have 3 Mppt trackers monitoring a maximum of 6 strings per inverter.

Inverter Connection

Inverters will be mounted to the solar frame using Uni-strut channel and 10mm bolt fixings.

Connection of the inverters will consist of AC Supply to Inverter being terminated at Internal Isolator.

Connection of DC Strings will be via DC internal isolation points within the inverter, Max 6 Strings per inverter.

Pre Commission of Inverter's

When commissioning the system the following tests will be carried out by qualified electricians.

- Carry out installation resistance (you make sure that there is no short circuit between cores or between earth)
- Carry out a continuity test (by closing the circuit and creating pair)
- VOC - Voltage Open Circuit test (checking the voltage on the strings)
- ISC – Closed Circuit Current Test (Checking the current produced by the string or the array monitor) and at the same time we will carry out the irradiance test (watts per meter squared produced by the sun).

All tests will be recorded and added to Operations and Maintenance Manuals.

Transformer Selection

The transformers selected will be Baolin 'E' House Solution, the finalised design will consist of a steel building with the transformer and associated HV switchgear as a containerised solution.

Transformer Connection

Transformer will be mounted upon concrete plinth with wire access entry points via ductwork established within the concrete as it is poured. HV Cabling will be connected to the transformer and interconnecting cabling installed to supply HVDB (High Voltage Distribution Boards).

Pre Commission of Transformer's

TBC upon product selection and manufacturer recommendations

Design and installation of CCTV & Security Systems.

The CCTV security system will be a smart stand-alone system able to recognise the potential threats and respond with the appropriate action (object recognition). The CCTV security system shall utilise motion detection and infra-red sensory technology.

The installation will commence with the start of the ground works. Trenches for the CCTV and security system cabling will be excavated with Timber posts (30 Year treated) will be erected in predesigned positions in the perimeter of the fence to mount the cameras.

A Manhole 450mmX450mmX600mm will be installed per camera pole for the cabling connection. Within the manhole a cable duct will be positioned to allow the cables from the camera to the CCTV trench.

The security trench 300mm wide by 800mm deep, will be excavated around the perimeter of the site. Trenches will be filled with sand, marked with Marker Tape and back filled with spoil.

The security hub AUX / Communications cabinet will be situated inside the customer compound able to send and receive data remotely via satellite. A perimeter pathway will be constructed of 1000mm at the front, 600mm at the sides and the back wide by 100mm deep around the AUX / Communications enclosure for maintenance and secure access purposes.

The planning conditions will be taken into consideration to minimize any visual disturbance.

Installation of the CCTV security system will be done in accordance to drawing SUS007. The choice of manufacturer, model, design and installation of the CCTV security system (including detailed construction drawings) will form part of the Technical Submittals and be submitted for approval by the Employer prior to ordering the CCTV security system.

Site Security

A Temporary CCTV system consisting of 18 cameras will cover the site for the duration of the construction works, the system will be monitored and alarms responded to by local key-holders supervised by Sustain Commercial Ltd.

The permanent CCTV security system will be a smart stand-alone system able to recognise the potential threats and respond with the appropriate action (object recognition). The CCTV security system shall utilise motion detection and infra-red sensory technology.

The installation will commence with the start of the ground works. Trenches for the CCTV and security system cabling will be excavated with Timber posts (30 Year treated) will be erected in predesigned positions in the perimeter of the fence to mount the cameras.

A Manhole 400mmX400mmX500mm will be installed per camera pole for the cabling connection. Within the manhole a cable duct will be positioned to allow the cables from the camera to the CCTV trench.

The security trench 300mm wide by 600mm deep, will be excavated around the perimeter of the site. Trenches will be filled with sand, marked with Marker Tape and back filled with spoil.

The security hub AUX / Communications GRP enclosure will house all the monitoring equipment and it will be situated alongside the customer compound able to send and receive data remotely via satellite. A perimeter pathway will be constructed of 1000mm at the front, 600mm at the sides and the back wide by 100mm deep around the AUX / Communications enclosure for maintenance and secure access purposes.

The planning conditions will be taken into consideration to minimize any visual disturbance.

Installation of the CCTV security system will be done in accordance to drawing SUS007. The choice of manufacturer, model, design and installation of the CCTV security system (including detailed construction drawings) will form part of the Technical Submittals and be submitted for approval by the Employer prior to ordering the CCTV security system.

Landscaping and Permanent access roads.

The landscaping will be done at the end according to the requirements and the conditions of the planning permit, by the Employer and in accordance with Ecological/Soft landscaping Report produced by Sustain PM and also in accordance with the O and M contract.

Permanent Roads

For the construction of the permanent road (4000mm wide by 400mm deep) in the centre of the site suitable soil cover (TERAM) will be used on top of the HV main Trench, to secure structurally the road. On top of the TERAM hard core will be laid at 300mm Depth and 100mm of fine road planings placed on top and rolled flat for finishing surface.

Provisional road

For the construction of the Provisional Roads the site, where marked by the engineers, will be excavate to reach suitable ground (usually between 300mm to 400mm) then the soil and the road will be secured with a layer of TERAM and the road will be filled and finished with Hard Core.

Installation of the Permanent and Provisional Roads will be done in accordance to drawing SUS001.

Commercial Solar PV Testing and Commissioning Protocol

1. String Testing

- a. The following tests will be carried out on each string on site. The test will be carried out at the array monitor to ensure that all cable resistances are accounted for at the time of test.
- b. The test will be carried out by the engineer setting up the PV Array test equipment at the Array monitor they will be testing.
- c. Whilst they are setting up the meter at the array monitor a separate engineer will be setting up the Irradiance Sensor and Thermal on the frame directly adjacent to the array monitor they are testing.

- d. The testing engineer will then affix the clamp meter around the positive cable on the string they are testing.
- e. The testing engineer will then connect the positive and negative test probes into the terminals within the array monitor where the string being tested is connected.
- f. Once all connections are made the engineer will then select the Auto test function on the tester.
- g. The Tester will then automatically run through the following series of tests. The engineer is to record each test result on the Bay Farm Commissioning document within the relevant sections on the test document recording the following results
 - i. Insulation Resistance 1000Vdc – Positive to Earth
 - ii. Insulation Resistance 1000Vdc – Negative to Earth
 - iii. Insulation Resistance 1000Vdc – Positive to Negative
 - iv. Polarity Check – Positive to Negative Voltage Direction Verified
 - v. Open Circuit Voltage Test (Voc)
 - vi. Closed Circuit Current Test (Isc)
 - vii. Irradiance at Time of Test (Wm2)
 - viii. Temperature at Time of Test (Degrees Celsius)

Example of Test Document Below

String Number	M. Cable Positive	M. Cable Negative	10% M. Cable Positive	10% M. Cable Negative	Panel Type	Panel Group	Installed	Dressed	Panels Connected	Array Monitor Terminated	MCA Terminated	Continuity Test	Insulation Resistance - 500Vdc - Positive to Earth	Insulation Resistance - 500Vdc - Negative to Earth	Insulation Resistance - 500Vdc - Positive to Negative	Polarity Check	Open Circuit Voltage Test	Closed Circuit Current Test	Irradiance at Time of Test	Temperature at Time of Test	Cable Label Installed
148.U	67.27	107.81	73.997	118.591	235	3															
149.U	26.73	37.26	77.8	40.986	235	3															
150.U	26.73	37.26	77.8	40.986	235	3															
151.U	26.73	37.26	77.8	40.986	235	3															
158.U	143.35	183.89	157.685	202.279	235	3															
159.U	102.81	143.35	113.091	157.685	235	3															
160.U	62.27	102.81	68.497	113.091	235	3															
161.U	21.75	62.29	23.925	68.519	235	3															
162.U	21.73	32.26	23.903	35.486	235	3															
163.U	32.26	72.8	35.486	80.08	235	3															
170.U	148.35	188.89	163.185	207.779	235	3															
171.U	107.81	148.35	118.591	163.185	235	3															
172.U	67.27	107.81	73.997	118.591	235	3															
173.U	36.74	67.77	24.604	24.967	235	3															

- h. Upon Completion of the string test the engineer will save the results onto the IPAD and commence testing of the next string.

2. DC Mains (If Applicable)

- a. The following tests will be carried out at the Inverter at the cable connection chambers. This is to ensure that the test is carried out at the furthest point of the circuit to ensure that all cable resistances are accounted for at the time of the test.
- b. The test will be carried out by the engineer setting up the PV Array Test equipment at the DC Mains Connection Chamber adjacent to the inverter they will be testing.
 - i. Note ensure that all other DC Mains cabling is disconnected from the common bus bar before the time of test and the bare terminals are insulated.
 - ii. Note ensure that 10,000V Insulated Gloves are worn at the time of test as a safety precaution against any live parts.
 - iii. Note ensure that Testing in progress signage is present at both sides of the inverters and safety barriers are erected at the location of the test.
- c. Once the above is complete the test engineer needs to ensure that all DC Fuses within the string connections on the array monitor connected to the cable under test are in place and the Main Isolator is locked in the OPEN position.
- d. The engineer will then carry out a 1000Vdc Insulation resistance test on the cable ensuring the following is verified.
 - i. 1000Vdc – Positive to Earth

- ii. 1000Vdc – Negative to Earth
- iii. 1000Vdc – Positive to Negative
- e. These results all need to show that there is no resistance between each test before the next test can be carried out.
- f. The engineer will then carry out a Continuity test verifying the Polarity of both the Positive and Negative Cores of the cable under test.
- g. The engineer will then set the Irradiance Sensor and Thermal Sensor on the closest array to the inverter.
- h. The engineer will then place the clamp extension onto the positive core of the DC Mains Cable under test.
- i. The engineer will then clamp the positive and negative probes onto the positive and negative cores within the cable under test ensuring that no other metallic parts are being touched by the cores or test probes.
- j. Upon completion of the above tests and procedures the engineer will then unlock the Main Isolator at the Array Monitor and move it to the closed Position.

WARNING – The connections at the DC Mains Connections Chamber are now LIVE.

- k. The engineer will then press the Auto Test function on the meter and record the following results.
 - i. Insulation Resistance 1000Vdc – Positive to Earth
 - ii. Insulation Resistance 1000Vdc – Negative to Earth
 - iii. Insulation Resistance 1000Vdc – Positive to Negative
 - iv. Polarity Check – Positive to Negative Voltage Direction Verified
 - v. Open Circuit Voltage Test (Voc)
 - vi. Closed Circuit Current Test (Isc)
 - vii. Irradiance at Time of Test (Wm2)
 - viii. Temperature at Time of Test (Degrees Celsius)

Example of Test Document Below

ARRAY MONITOR	Installed	Terminated	Continuity Test - Positive to Earth	Continuity Test - Negative to Earth	Continuity Test - Positive to Negative	Insulation Resistance - 1000Vdc - Positive to Earth	Insulation Resistance - 1000Vdc - Negative to Earth	Insulation Resistance - 1000Vdc - Positive to Negative	Polarity	Open Circuit Voltage Test	Closed Circuit Current Test	Irradiance at Time of Test	Temperature at Time of Test	Cable Label Installed	Connection Torqued
1.7															

- l. Upon completion of the DC Mains Test and recording of the results the test engineer is to return to the Array Monitor and OPEN the DC Mains Isolator ensuring that it is locked off.

- m. They will then return to the DC Mains Chamber and attempt to retry the Auto-Test Function. At this point in time it should come up with a warning stating that it has no Voltage to carry out the test.
- n. Once the above has been verified the engineer can then disconnect the test equipment from the DC Mains Chamber and begin the above test procedure on the next cable
 - i. Note it is IMPORTANT that the above test procedure is followed at all times.
 - ii. The DC Mains Cable can be left connected to the DC Mains Chamber with the Mains Fuses removed for all other cable tests preceding this as it has been electrically verified.

3. AC Continuity Test

- a. The engineer will first begin by disconnecting both ends of the AC Cable.
- b. They will then link between the cores where they will be looking to carry out a continuity test.
- c. Following this they will then connect the test equipment to the opposite end of the cable which they have linked out.
- d. They will then commence the test.
 - i. Note it is expected that all readings between Live and Earth, Neutral and Earth, Live to Neutral should be lower than 1 Ohm.
- e. Upon completion of the test the engineer will then reconnect the cabling at both ends.

4. AC Insulation Resistance Test

- a. The engineer will first check that both ends of the cable are in the open position and that there are no common neutral connections on the circuit. If there is the neutral core within the circuit they are testing will need to be disconnected to ensure that they do not interfere with any other equipment connected to the neutral bar.
- b. They will then place warning signs at one end of the cable ensuring that it is clearly marked that a test is in progress and a safe distance should be left from the test area.
- c. Following this the engineer will proceed to carry out an insulation resistance test on the cable by connecting the test equipment to two cores at a time of the AC circuit in the following sequence. The test voltage is to be set at 500Vdc.
- d. The following sequence will be met when testing the cores of the circuit.
 - i. Live to Earth
 - ii. Live to Neutral
 - iii. Neutral to Earth
- e. Once the test has been completed and Open circuit shown on all test readings the engineer will then discharge any voltage left in the cable down to earth using an insulated cable.
- f. The engineer will carry out the above methodology on ALL AC circuits.

5. Earth Resistance Electrode Testing

- a. The earthing grid on the site for both the AC and the DC systems requires a resistance test to ensure that the site earth grid is acceptable for the electrical equipment connected to it and there electrical fault protection requirements.
- b. This test will be carried out with a long lead methodology connecting a Resistance tester at 2 points within the earth grids and verifying the resistance between these points. This test should be carried out at each inverter verifying the furthest connected point on each Inverter.
- c. The engineer will mechanically fix the test lead to the point of test running a trailing lead back to the inverter they are testing. They will need to verify the resistance of the test leads they are using and ensuring the resistance of the lead is recorded before the test is carried out.
- d. They will then connect the second test lead to the incoming earth bar at the inverter and verify the resistance between these two points. The resistance should be no greater than 1 Mega Ohm between these two points.

- e. Once the engineer has carried out this test and recorded the results they are to then move onto the next inverter and repeat the testing process.

6. AC Earth Fault Impedance Test

- a. This test is classed as a 'LIVE' test and is to be carried out once the cabling has been energised. All equipment covers except from the point of test should be in place and full signage should be present at the point of test to ensure that ALL personnel are aware that the test is being undertaken.
- b. The engineer will then set the test equipment at the furthest point of the circuit they are testing. This will usually be at the last Array Monitor on the circuit or the Furthest Inverter on a circuit as these supplies are wired as radials.
- c. The engineer will then set his test equipment to carry out an Earth Fault Loop Impedance Test by connecting his equipment to the incoming electrical terminals at the point of test. The following will need to be connected.
 - i. Live
 - ii. Neutral
 - iii. Earth
- d. Once these are connected and the supply is energised the test equipment will show that it is seeing a voltage to the supply. It will then allow you to carry out the test.
- e. The following readings are to be recorded when carrying out the test.
 - i. Recording in Ohms.
 - ii. Perspective Short Circuit (Amps)
 - iii. Perspective Fault Current (Amps)
- f. Once this has been completed the engineer is to isolate the circuit before disconnecting the test equipment and replacing the equipment covers on the point of test.
- g. They are to carry out the same sequence when testing ALL other AC Circuits.

7. Functional Testing

- a. Once the above tests have been completed the engineers will begin functional testing of the installed inverters.
- b. This will mean the energisation of both the AC and DC Cabling to the inverters. This is to be carried out 1 inverter at a time.
- c. Once the inverter is energised the engineers will carry out the start-up and commission process on the inverters following the manufacture's guidelines.
- d. They will then verify on the display of the inverter that they are recording string level current and voltage.
- e. Once this has been verified and the inverter is operating correctly the engineer will proceed to the next inverter if applicable.

8. Network Testing

- a. Before operating the network a data integrity test must be carried out on all lines of the network ensuring that each connection is wired in the correct port as per the manufacture's guidelines.
- b. Once this has been completed the network controller can be energised to allow it to find and assign the devices on the network.
- c. It will then be necessary for the engineers connect a computer to the network controller and configure each device on the network including any inverters, Temperature Sensors, Pyranometers, Meters and Network Controllers within the network.
- d. Once this has been done the engineer can then configure the network portal with the network manufacturer to ensure that all devices are visible on the network and that they can be configured within the portal to ensure monitoring is achievable. This will require each device to be named in accordance with the sites approved Network Schematic.

- e. Once this has been configured monitoring of performance and weather data will be achievable through the remote portal.

9. PR Testing

- a. The PR test is the final test to be carried out on the solar park. It is assumed that all Items relating to the generation of the park will be completed before the PR Test is carried out and no work will be carried out on any generation equipment during the test.
- b. During the period of the performance test all incidents or site outages should be recorded on a diary log and presented at the completion of the test.
- c. Test Parameter's
 - i. The duration of the test on completion shall be 30 consecutive days. A minimum of 50% of the test time should show an irradiance of at least 200W/m2. In the event that the tests on completion are not passed after the 30 day period, if the performance tests are failed for any reason the performance test will be restarted for a further 30 consecutive days.
 - ii. In plane irradiation is measured using the Pyranometers positioned within the plant. These must be mounted at the same azimuth and tilt angle of the array and at a point which is judged to be representative of the overall plant location. The 15 minutely output from each Pyranometer will be recorded and the average of these will be used for the 15 minutely data to represent an average irradiation for the site.
 - iii. Panel Temperature will be recorded by a sensor mounted on the back of the panel at a central point to the installation.
 - iv. For the PR Test the PV System will 100% Available.

The following equation will be used to calculate the PR Test which will be compiled using the RAW Data from each item of required and stored on Share Point. The information will be compiled within a Master Excel File for the purpose of review.

The Performance Ratio will shall be calculated in accordance with the following formulae:

$$PR_j = \frac{E^j_{AC, MV}}{G^j \cdot P_{Peak} [1 + \gamma(T_c^j - T_{STC})]} \cdot A$$

Symbol Key:

J = MEASURED PERIOD

$E^j_{AC, MV}$ = MEASURED YEILD (IN KWH) AT UTILITY MV METERING POINT IN THE PERIOD J;

G^j = MEASURED IN-PLANE IRRADIATION (IN W/M2) IN THE PERIOD J;

P_{Peak} = PEAK POWER (IN KWP) OF THE FACILITY CALCULATED AS THE SUM OF THE INSTALLATIONS DC PEAK POWER;

γ = TEMPERATURE COEFFICIENT OF POWER OF THE PV MODULES;

T_c^j = AVERAGE CELL TEMPERATURE IN THE PERIOD J;

T_{STC} = AVAILABILITY OF THE SYSTEM (IN %) IN THE PERIOD J.

The below template will be used for compiling each field of data.

[illegible]

Condition 6 – Discharge.

Design and implementation thereof have been detailed within the Contractors proposal under Discharge 5.

Condition 7 – Discharge.

Technical product information for on-site buildings have been provided as follows:

1. Appendix L – Customer 33KV Substation.
2. Appendix M – Transformer Buildings
3. Appendix N – WPD DNO Building Schematics

Condition 8 – Discharge.

The Grange Solar Plant does not operate a floodlighting scheme following completion. During construction Task lighting may be utilised during the hours of 6am- 8am (during low light levels) and between 5pm and 7pm, this lighting will be of a portable nature and have a flood span of no more than 25metres from location, thus alleviating any overspill into public areas.

Infra-Red cameras will be situated at 50m intervals along the perimeter, however these will be non-intrusive. A copy of camera specification is attached at Appendix P.

Condition 9 – Discharge.

Project Planting scheme to be issued under separate application for Discharge.

Condition 10 – Discharge.

Project Planting Maintenance scheme to be issued under separate application for Discharge.

Condition 11 – Discharge.

LMP- Landscape Management Plan to be issued under separate application following receipt of details of planting scheme.

Condition's 12 and 13 – Discharge.

Britannia Archaeology have been appointed by Sustain Solar to manage and report all matters relating to Archaeology and Historical data in relation to conditions 12 and 13 of the planning discharge notice. A full detail pre commencement report has been issued to the Council Archaeological team (Louise Jennings) for her approval prior to excavation works commencing.

A copy of the report is attached at Appendix Q.

Condition 14 – Discharge.

Final Report to be issued as separate application following on site investigation works.

Condition 15 – Discharge.

Flood Risk assessment as undertaken as part of original Planning Submission attached at Appendix R.

Condition 16 – Discharge.

Noise Abatement statement detailed under Construction method statement. (Discharge of Condition 5)

Condition 17 – Discharge.

Glare-Impact. The design has been implemented using a 20 degree angle of panel mounting, by using this angle and taking into account that the nearest occupancy relative to the project being 643m from nearest panel we are confident that the residents will have no impact whatsoever from reflective Glare. In the event that a complaint is received Sustain Solar will contact the complaining parties directly and seek a suitable resolution to the issue along with notifying the district authorities of any measures to be undertaken.

Condition 18 – Discharge.

Full detail Cable schedule as Appendix S attached. The lengths of each cable have been indicated as taken from the design drawings. Any cables that will be installed above ground (Not in duct or trenching) have been indicated in Red.

Condition 19 – Discharge.

Sustain Solar Ltd. Confirm that the design complies with planning conditions set out in document H20-0937-13, Dated 1st November 2013.

Appendix A
Drawing Schedules

ID	Title	Proposed Issue Date	Actual Issue Date	Drawing Number	Revision	Status
13	Site Welfare and Logistics Plan			SUS001		Pending
14	PV Array and String Configuration Plan			SUS002		Pending
15	DC and AC Trench Route Plan and Detail			SUS003		Pending
16	Internal HV Trench Route Plan and Detail			SUS004		Pending
17	External HV Trench Route Plan and Detail			SUS005		Pending
18	Fence Route Plan and Detail			SUS006		Pending
19	Security and CCTV Plan and Detail			SUS007		Pending
21	Earthing Plan and Detail			SUS008		Pending
22	AC and Communications Plan and Detail			SUS009		Pending
23	Inverter Detail			SUS010		Pending
24	33KV Switchgear Detail			SUS011		Pending
25	33KV Schematic Plan and Detail			SUS012		Pending
26	DC Schematic Plan and Detail			SUS013		Pending
27	LV Schematic			SUS014		Pending
28	Network Schematic Plan and Detail			SUS015		Pending
29	Cable Schedule Detail			SUS016		Pending
30	Site Access Route Drawing			SUS022		Pending
32	Pole Drawing Layout			SUS023		Pending
33	Trenches Detail			SUS024		Pending
34	Flood Risk Assessment			SUS017		Pending
35	General Layout			SUS025		Pending
36	Transformer Detail			SUS026		Pending
37	Inverters View			SUS027		Pending
38	HV Compound			SUS028		Pending
39	Esm Contestable Works- Drawing Issued			SUS030		Pending

Appendix B Technical Submittals

ID	Title	issued To	Status	Date Issued	Employer response	Response Date
3	Inverter (including spare parts)		Pending			
4	Transformer		Pending			
5	33KV Switchgear		Pending			
6	DNO Switchgear		Pending			
7	DNO Housing		Pending			
8	Inverter Housing		Pending			
9	Fibre Optics		Pending			
10	Photo Voltaic Modules		Pending			
11	Mounting System		Pending			
12	DC Cable		Pending			
13	AC Cable		Pending			
14	Network Cable		Pending			
15	Ducting		Pending			
16	Security and CCTV (including spare parts)		Pending			
17	Monitoring		Pending			
18	Metering		Pending			
19	MC4 Connectors		Pending			
20	Fencing		Pending			
21	Earth Spikes		Pending			
22	Earth Cable		Pending			

Appendix C
Draft Construction Programme

Issued under Separate Cover

Appendix D

Supplier Classification

	PROJECT ITEMS	CONTRACTOR/SUPPLIER
Planning/Surveys	Planning Costs	Sustain Commercial
	Topographical Survey	Sustain Commercial
	Geo-Technical Survey	Sustain Commercial
	Archaeological Survey	Sustain Commercial
	Historical and Ecological Survey	Sustain Commercial
	Setting Out	Sub-Contractor
	Pile Load Testing	Sustain Commercial
Health and Safety	CDM Costs	Sustain Commercial
	Protection of Waterways	Sub-Contractor
	Training and First Aid (up to 12 people)	Sustain Commercial
	Production of Health and Safety Package	Sustain PM/CDM
Welfare and Operational Costs	Sustain Site Office /Meeting Room 32' * 12'	Sustain Commercial
	Subcontractors Office 32' * 10'	Sustain Commercial
	Storage Containers 28' * 12 '	Sustain Commercial
	Toilets 6 + 1 Cubicle	Sustain Commercial
	Drying Room 20' * 12 '	Sustain Commercial
	Canteen 32 ' * 12 '	Sustain Commercial
	Fridge / Microwave / Kettle	Sustain Commercial
	Tables (Canteen)	Sustain Commercial
	Tables (Office)	Sustain Commercial
	Chairs (Canteen)	Sustain Commercial
	Chairs (Office)	Sustain Commercial
	Effluent tank	Sustain Commercial
	Effluent Removal	Sustain Commercial
	Steps for Toilets	Sustain Commercial
	Generator 90	Sustain Commercial
	Generator Diesel Refills	Sustain Commercial
	10000L Water Tank and Pump	Sustain Commercial
	Water Tank Refills	Sustain Commercial
	Fuel Bowser	Sustain Commercial
	Fuel Bowser Refills	Sustain Commercial
	Electrical Cable and Sundries for Welfare	Sustain Commercial
	Plumbing and Mechanical Sundries for Welfare	Sustain Commercial
	Flood-Lighting	Sustain Commercial

	Cleaning and Waste Products	Sustain Commercial
	Tea/Coffee/Sugar/Milk	Sustain Commercial
	40 Yard Skip	Sustain Commercial
	Metal Waste Skip	Sustain Commercial
	Pallet Removal Lorry	Sustain Commercial
Plant and Machinery Costs	Bob-Cat	Sub-Contractor
	10m Tele handler	Sub-Contractor
	Fork Attachments	Sub-Contractor
	Cable Pulling Winch	Sub-Contractor
	Cobra Cable reels	Sub-Contractor
	Rope and Draw-Wires	Sub-Contractor
	Cable Jacks and Bars	Sub-Contractor
Access and Temporary Works	Lion Track Road	Sustain Commercial
	Temporary Bridging of Waterways	Sustain Commercial
Communications	Site Rural broadband (2mb Upload speed)	Sustain Commercial
	Site Rural broadband (2mb Upload speed)	Sustain Commercial
	BT Connection (Broadband)	Sustain Commercial
	Fibre Optics network Connections	Sustain Commercial
	Communications Engineer	Sustain Commercial
HV Coordinating Works		
	Customer House	Sustain Commercial
	33KV Terminations	Sub-Contractor
Generation Equipment	Inverter	Sustain Commercial
	Weather Station and Connections	Sustain Commercial
	Communication Cabinet	Sustain Commercial
	Freight Costs	Sustain Commercial
	Inverter Surrounds	Sustain Commercial

CCTV (Temporary and Permanent)	Temporary Security System	Sub- Contractor
	Servest installation Costs	Sustain Commercial
	CCTV Electrical Installation	Sub- Contractor
	CCTV System	Sub- Contractor
Cable (as per schedule A)	33KV XLPE AWA WPD Approved 185mm	Sub- Contractor
	3 Core SWA - 95mm	Sub- Contractor
	3 Core SWA - 70mm	Sub- Contractor
	3 Core SWA - 50mm	Sub- Contractor
	4 Core SWA - 25mm	Sub- Contractor
	3 Core SWA - 4mm	Sub- Contractor
	8 Pair OM4 Gel Filled Fibre cable	Sub- Contractor
	RS485 Twisted pair Cat 6	Sub- Contractor
	50mm Bare Copper Earth Cable	Sub- Contractor
	35mm Bare Copper Earth cable	Sub- Contractor
	16mm G/Y Earth cable	Sub- Contractor
	4mm DC String cable	Sub- Contractor
Civil Engineering and Groundwork's (See Schedule B - Civil's)	Permanent Site Road	Sub- Contractor
	CCTV Trenching inc. Ductwork and Draw Wires	Sub- Contractor
	DC Trenching inc. Ductwork and Draw Wires	Sub- Contractor
	HV Trenching inc. Ductwork and Draw Wires	Sub- Contractor
	Duct Burial (Frame legs)	Sub- Contractor
	CCTV Manholes	Sub- Contractor
	DC Manholes	Sub- Contractor
	HV Manholes	Sub- Contractor
	Inverter Concrete Base	Sub- Contractor
	Customer Compound Base	Sub- Contractor
	Inverter Base Surround	Sub- Contractor
	Customer Compound Surround	Sub- Contractor
	Waterway Bridging Works	Sub- Contractor
	Concrete Bases for Cable Bridge	Sub- Contractor
	Temporary Access Roads	Sub- Contractor
	Ancillaries'	Sub- Contractor

Ancillary Items (See Schedule C - Ancillaries)	Contingency	Sub- Contractor
	Liquid's and Foam's	Sub- Contractor
	Building Product's	Sub- Contractor
Fencing	2m Deer Fence inc posts	Sub- Contractor
	2 way corner straining posts	Sub- Contractor
	turning posts	Sub- Contractor
	End Strainer Posts	Sub- Contractor
	5m wide double leaf gate	Sub- Contractor
Framework and Installation	Supply Only Framework All Materials	Sustain Commercial
	Installation of Framework	Sub-Contractor
	String Dressing on Frames	Sub-Contractor
	Termination of MC4's Table Ends	Sub-Contractor
Panel's and Installation	Supply Only Solar Panels	TBC
	Installation of Panels (Including Distribution)	Sub-Contractor
	TOTAL	
Commissioning	DC StringTesting	Sustain Commercial
	AC Testing	Sustain Commercial
	Thermo graphic Survey	Sustain Commercial
	PR Testing	Sustain Commercial
	Communications Network Testing	Sustain Commercial
	Photographic Survey	Sustain Commercial
Site Clearance on Completion	Cabin removal and Disconnections	Sub-Contractor
	Site Compound Removal	Sub-Contractor
	Clearance of Temporary Roads	Sub-Contractor
	Ground Levelling	Sub-Contractor
Labour Not Listed	Relocation of Satellite upon completion	Sustain Commercial
	Panel Distribution Supervision	Sustain Commercial
	Connections within Customer House	Sub-Contractor

	Other labour not Itemised	Sub-Contractor
	Roping of Ducts for String Cabling	Sub-Contractor
Other Items	Hedge Planting	TBC
	Flood Risk Assessment	Sustain Commercial
	Potential Underground Drilling Field A - Field B	Sub-Contractor

Appendix E
Breakdowns

To be added upon completion of design quantities

Appendix F
Proposed Suppliers

Products	Supplier	Warranty Period
Solar Mounting Frame	VG Solar	20 years
Solar Modules	Suntech	10 years
Inverters	Sungrow	20 years
Transformer Stations	Baolin	10 Years TBC
Switchgear	Siemens	10 Years
CCTV Cameras	ISD Tech	5 Years
CCTV equipment	ISD Tech	5 Years
Fencing Posts	Topan Fencing	20 Years
Fencing Mesh	Topan Fencing	10 years
Cable SWA	Cleveland	5 Years

Cable AWA	Batt	5 Years
	Batt	5 Years
MC4 Connectors	Moss Electrical	10 years
Ductwork	Drainage Supplies	10 years
Monitoring System	To Be Confirmed	5 Years (as standard)
Concrete Bases	Various	Installer Warranty of 5 years
Substation Plinth	Various	Installer Warranty of 5 years
Satellite Broadband	Henry James	5 Years
Armoured Cable Glands	Cleveland	10 Years
	Batt	10 Years

Appendix G

Planning Conditions

Town and Country Planning Act 1990 Planning Permission

Reference: H20-0937-13 Received: 1st November 2013

Type: FULL

Name: Green Switch Developments Ltd
502 Merlin Park
Ringtail Road
Burscough
Lancashire
L40 8JY

Agent: Green Switch Developments Ltd
502 Merlin Park
Ringtail Road
Burscough
Lancashire
L40 8JY

Description: Installation of a solar park with a maximum output of 10MW
Location : Grange Farm Fishergate
Sutton St James Spalding

South Holland District Council hereby give notice that PERMISSION HAS BEEN GRANTED for the development in accordance with the application and plans submitted, subject to any condition(s) set out below:

- 1 The development must be begun not later than the expiration of three years beginning with the date of this permission.

Reason: As required by Section 91 of the Town and Country Planning Act 1990 as amended by the Planning and Compulsory Purchase Act 2004.

- 2 The development hereby permitted shall be carried out in accordance with the following approved plans:
1:2500 location plan received 24 October 2013;
Site layout plan (dwg. No. GSS1000-005) received 3 January 2014;
Planning Statement (dated October 2013) received 24 October 2013;
Landscape and Visual Appraisal (dated 23 September 2013) received 24 October 2013;
Transport Statement (dated October 2013) received 24 October 2013;
Cultural Heritage Statement (dated October 2013) received 24 October 2013;
Ecological Appraisal (Report No. 13-GSS-001-01) dated 5 August 2013).

Reason: For the avoidance of doubt and in the interests of proper planning.

- 3 The planning permission is for a period not exceeding 25 years from the date that the

decision

development is first connected to electricity grid. The date of first connection to the grid shall be notified in writing to the Local Planning Authority within 28 days of this event occurring.

Reason: To limit the long term effects of the development and in recognition of the temporary lifespan of the structures.

This Condition is imposed in accordance with Policy SG4 of the South Holland Local Plan, 2006 and advice within Section 11 of the National Planning Policy Framework, 2012.

- 4 On cessation of the use of the land (or any part of the land) as a solar park for electricity production through use of solar panels as approved by this permission all buildings, structures, fences, gates, posts, solar panels and fixings shall be removed from the site (or the relevant part of the solar park that has ceased operation) within 6 months of the cessation of use and the land shall revert back to agriculture.

Reason: The site is located in an area of countryside where development other than agriculture would not normally be permitted and when the site ceases to be used as a solar park then it will be required to revert back to agriculture.

This Condition is imposed in accordance with Policy SG4 of the South Holland Local Plan, 2006 and advice within Section 11 of the National Planning Policy Framework, 2012.

- 5 Prior to work commencing a detailed Construction Management Plan shall be submitted to and approved in writing by the Local Planning Authority. The Construction Management Plan shall include the following details:
- A traffic management plan for construction and delivery vehicles entering and leaving the site, including times of movement so as to protect the amenity of nearby residents;
 - Start and finish time of construction activity (including any pile driving) and methods to minimise disturbance during the construction period;
 - Phasing of the development;
 - Details of surfacing of the track between the farm yard and site and also the proposed lay-down and parking areas;
 - Measures to be taken to prevent mud from vehicles leaving the site during construction works being deposited on the public highway;
 - Floodlighting and security lighting (note: this must be directed in such a way as not to cause nuisance to nearby properties or public highways).
- The Construction Management Plan shall be adhered to throughout the duration of the construction period.

Reason: To safeguard the amenity of nearby residents and to protect highway safety.
This condition is imposed in accordance with Policies SG13, SG15 and SG17 of the South Holland Local Plan, 2006.

- 6 Notwithstanding the provisions of the Town and Country Planning (*General Permitted Development*) Order 1995 (or any Order revoking and re-enacting that Order with or without modification) no buildings, structures, fences, gates, posts, solar panels, hardstandings, footings, platforms, pavements, bunding, berms, earthworks or other engineering operations shall be constructed, installed or carried out on site other than in accordance with the approved details of this planning permission.

Reason: To protect the character of the countryside and the visual amenities of the locality and also to retain the value of the land for agriculture and wildlife, as the site is located in an area of open countryside where development other than agriculture would not normally be permitted. This Condition is imposed in accordance with Policy SG4 of the South Holland Local Plan, 2006 and advice within Section 11 of the National Planning Policy Framework, 2012.

- 7 Before development is commenced full details of the position, layout, scale and external appearance of the substation(s) and inverter/power stations, including a schedule of external materials, shall be submitted to and approved in writing by the Local Planning Authority. The substation and inverter units shall thereafter be carried out in accordance with the approved details.

Reason: To protect the character of the countryside and the visual amenities of the locality. This condition is imposed in accordance with Policies SG4 and SG14 of the South Holland Local Plan, 2006.

- 8 No external lighting shall be provided on the site at any time once the site is operational.

Reason: To accord with the terms of the application and in the interests of the amenities of the rural locality. This Condition is imposed in accordance with Policy SG13 of the South Holland Local Plan, 2006.

- 9 Before development is commenced a detailed scheme for hedge planting and boundary treatment (including the location, design and height of fences, fence opening details for wildlife movement and measures for their protection) shall be submitted to and approved in writing by the Local Planning Authority. The scheme shall specify species, density, planting size and layout. Fence opening details shall be incorporated within the fencing at the stage of fence construction in accordance with the approved details and thereafter retained.

Reason: To ensure effective screening of the development on the site in the interest of countryside character and amenities and to protect/enhance bio-diversity interests. This Condition is imposed in accordance with Policy SG4 of the South Holland Local Plan, 2006 and advice within Section 11 of the National Planning Policy Framework, 2012.

- 10 The new hedge planting shall be allowed to reach a height of at least 3 metres and shall thereafter be retained at that height. The hedging shall be maintained by the owner(s) of the land and in the event that plants die, are removed or, in the opinion of the Local Planning Authority, become seriously damaged or defective, others of the same species and size as that originally planted shall be planted at the same place, in the next planting season.

Reason: To ensure effective screening of the development on the site in the interest of countryside character and amenities and to protect/enhance bio-diversity interests.
This Condition is imposed in accordance with Policy SG4 of the South Holland Local Plan, 2006 and advice within Section 11 of the National Planning Policy Framework, 2012.

- 11 Prior to work commencing on site a detailed landscape, habitat and site management plan, including long term design objectives, management responsibilities, maintenance schedules for all landscape areas and details for habitat enhancement and protection (and including a monitoring programme) shall be submitted to and approved in writing by the Local Planning Authority. The landscape and site management plan shall thereafter be carried out in full accordance with the approved details.

Reason: To ensure that site maintenance is not detrimental to use of the land by protected species/other wildlife and to ensure effective long term landscape and site management to assimilate the proposal into its countryside context.
This condition is imposed in accordance with advice within Section 11 of the National Planning Policy Framework, 2012.

- 12 No development shall take place until a written scheme of archaeological investigation has been submitted to and approved in writing by the Local Planning Authority. This scheme should include the following and should be in accordance with the archaeological brief supplied by the Lincolnshire County Council Historic Environment advisor on behalf of the Local Planning Authority:
1. An assessment of significance and proposed mitigation strategy (ie, preservation by record, preservation in situ or a mix of these elements);
 2. A methodology and timetable of site investigation and recording;
 3. Provision for site analysis;
 4. Provision for publication and dissemination of analysis and records;
 5. Provision for archive deposition;
 6. Nomination of a competent person/organisation to undertake the work;
 7. The scheme to be in accordance with the Lincolnshire Archaeological Handbook.
- The archaeological site work shall only be undertaken in accordance with the approved written scheme.

Reason: To ensure the preparation and implementation of an appropriate scheme of archaeological mitigation in accordance with national guidance contained in Section 12 of the

National Planning Policy Framework, 2012.

- 13 The applicant shall notify the Lincolnshire County Council Historic Environment Department in writing of the intention to commence at least fourteen days before the start of archaeological work required in connection with Condition 12 above in order to facilitate adequate monitoring arrangements.

Reason: To ensure satisfactory archaeological investigation and retrieval of archaeological finds in accordance with national guidance contained in Section 12 of the National Planning Policy Framework, 2012.

- 14 A copy of the final report required in connection with condition 12 above shall be submitted within three months of the work being carried out to the Local Planning Authority and the Lincolnshire Historic Environment Record. The material and paper archive required as part of the written scheme of investigation shall be deposited with an appropriate archive in accordance with guidelines published in The Lincolnshire Archaeological Handbook.

Reason: To ensure satisfactory arrangements are made for the recording of possible archaeological remains in accordance with national guidance contained in Section 12 of the National Planning Policy Framework, 2012.

- 15 The development hereby permitted shall be carried out in general accordance with the measures set out in the Flood Risk Assessment forming part of this planning application.

Reason: To ensure that the development does not increase the risk of flooding or be at risk of flooding.

This Condition is imposed in accordance with national guidance contained in Section 10 of the National Planning Policy Framework, 2012.

- 16 Noise from fixed plant and machinery shall not exceed the background noise level by more than 5dB(A) when measured as a 15 minute LA(eq) at any residential boundary not within the applicant's ownership.

Reason: To safeguard the amenity of nearby residents.
This Condition is imposed in accordance with Policies SG13 and SG17 of the South Holland Local Plan, 2006.

- 17 Within 28 days from the receipt of a written request from the Local Planning Authority following a complaint to it concerning glint/glare, the solar farm operator shall submit details of proposed mitigation measures and timescale for their implementation. Such information shall be provided



Council Offices
Priory Road
Spalding
Lincolnshire
PE11 2XE

contacts:
admin: 01775 764723
dc officers: 01775 764703
s/board: 01775 761161
facsimile: 01775 762937
planningadvice@sholland.gov.uk
www.sholland.gov.uk

within 3 months of the date of the written request of the Local Planning Authority. The proposed mitigation measures shall be carried out in accordance with the approved details.

Reason: To safeguard the amenity of nearby residents.
This Condition is imposed in accordance with Policy SG13 of the South Holland Local Plan, 2006.

- 18 All cabling shall be installed underground.

Reason: To limit the effects of the development in the interests of the amenities of the locality.
This Condition is imposed in accordance with Policies SG14 and SG17 of the South Holland Local Plan, 2006.

The Local Planning Authority has acted positively and proactively in determining this application by assessing the application against all material considerations, including national guidance, planning policies and representations that have been received during the public consultation exercise, and by identifying matters of concern within the application and negotiating, with the Applicant, acceptable amendments to the proposal to address those concerns. As a result, the Local Planning Authority has been able to grant planning permission for an acceptable proposal in as timely a manner as possible, in accordance with the presumption in favour of sustainable development, as set out within the National Planning Policy Framework.

Copies of all documentation submitted in connection with this application can be viewed online at www.sholland.gov.uk/doitonline/plandev/plansearch.aspx.

Paul Jackson
Planning Manager
11th March 2014

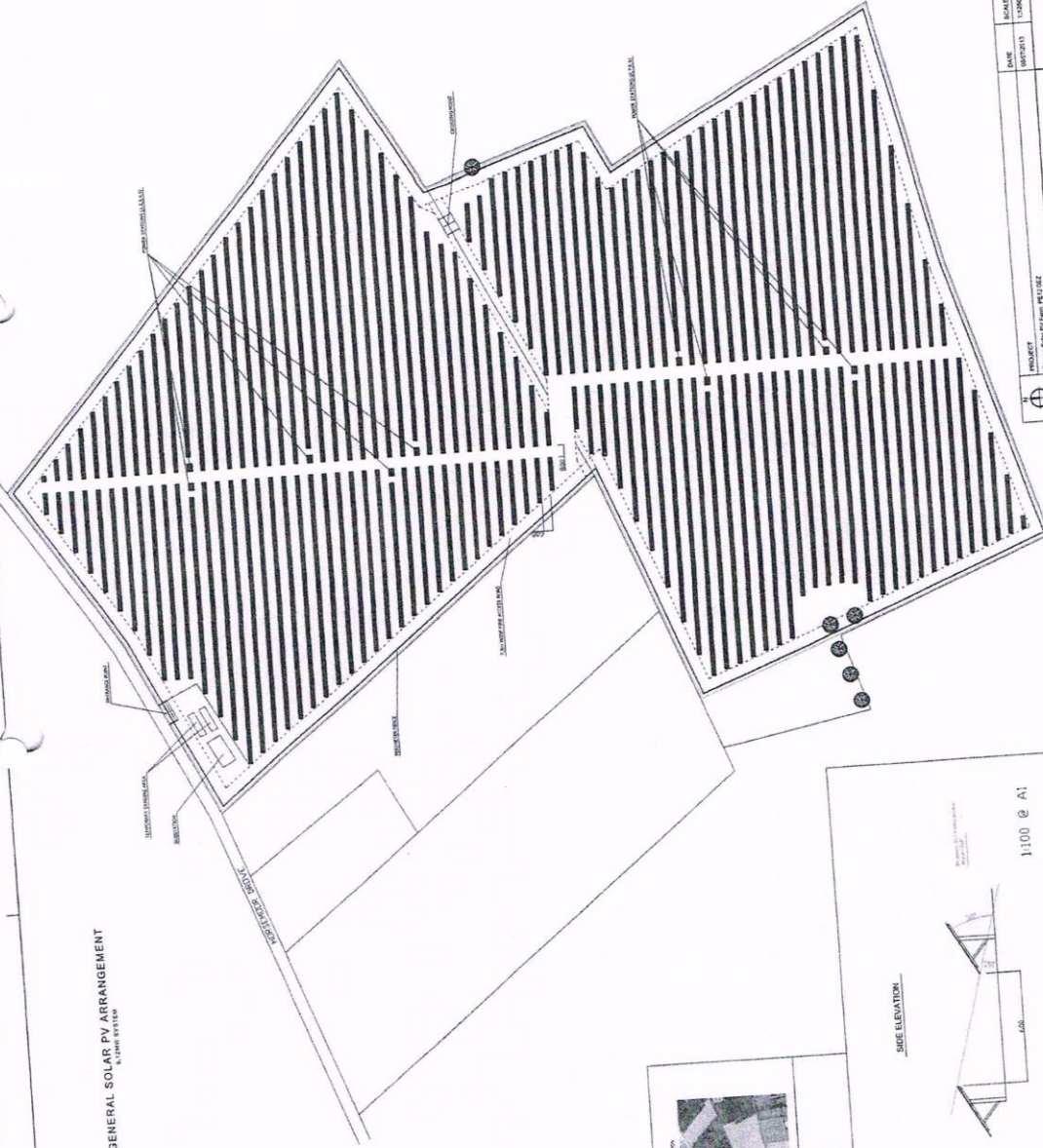
H20-0937-13

This decision refers only to that required for the purposes of the Town and Country Planning Acts and not for Building Regulations or any other legislation.

Maxine O'Mahoney - Director of Commissioning

decision

GENERAL SOLAR PV ARRANGEMENT
S. TIME BY VIEW



10000' 1000' 1000' 1000' 1000'



SIDE ELEVATION



1:100 @ A1

B50

PROJECT	Group 2 Solar PV Farm - Phase 1 & 2
DATE	08/07/2015
SCALE	1:1000 @ A1
ISSUED	07/07/2015
REFERENCE NO.	001/15/001
DESIGNER	Greenfield Solutions Ltd

Appendix H

Testing Schedule

To be added upon completion of design.

Appendix I
PVsyst Simulation

PVSYST V6.25					23/07/14	Page 1/5
Grid-Connected System: Simulation parameters						
Project :	Grange solar farm 250-255W 27.5KW					
Geographical Site	Grange solar farm				Country	United Kingdom
Situation	Latitude	52.8°N		Longitude	0.0°E	
Time defined as	Legal Time	Time zone UT		Altitude	5 m	
	Albedo	0.20				
Meteo data:	grange solar farm	Synthetic - Meteonorm 6.1				

Simulation variant : Grange Farm 250W255W 27.5kW - Purchase Order

Simulation date 23/07/14 08h03

Simulation parameters

Collector Plane Orientation	Tilt	20°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Erbs, Meteonorm
Horizon	Free Horizon			
Near Shadings	According to strings		Electrical effect	80 %
	Shadings of thin objects		Electrical effect	20 %

PV Arrays Characteristics (4 kinds of array defined)

Sub-array "255W 6 Strings"		Si-poly	Model	STP 255-20/Wd	
		Manufacturer	Suntech		
Number of PV modules		In series	24 modules	In parallel	1380 strings
Total number of PV modules		Nb. modules	33120	Unit Nom. Power	255 Wp
Array global power		Nominal (STC)	8446 kWp	At operating cond.	7506 kWp (50°C)
Sub-array "255W 5 Strings"		Si-poly	Model	STP 250-20/Wd	
		Manufacturer	Suntech		
Number of PV modules		In series	24 modules	In parallel	20 strings
Total number of PV modules		Nb. modules	480	Unit Nom. Power	250 Wp
Array global power		Nominal (STC)	120 kWp	At operating cond.	107 kWp (50°C)
Sub-array "250W 6 Strings"		Si-poly	Model	STP 250-20/Wd	
		Manufacturer	Suntech		
Number of PV modules		In series	24 modules	In parallel	738 strings
Total number of PV modules		Nb. modules	17712	Unit Nom. Power	250 Wp
Array global power		Nominal (STC)	4428 kWp	At operating cond.	3938 kWp (50°C)
Sub-array "250W 5 Strings"		Si-poly	Model	STP 250-20/Wd	
		Manufacturer	Suntech		
Number of PV modules		In series	24 modules	In parallel	10 strings
Total number of PV modules		Nb. modules	240	Unit Nom. Power	250 Wp
Array global power		Nominal (STC)	60.0 kWp	At operating cond.	53.4 kWp (50°C)
Total	Arrays global power	Nominal (STC)	13054 kWp	Total	51552 modules
		Module area	83869 m²	Cell area	75274 m²

Inverter

	Model	SUN2000-28k TL		
	Manufacturer	Huawei Technologies		
	Operating Voltage	480-800 V	Unit Nom. Power	27.5 kW AC
Sub-array "255W 6 Strings"	Nb. of inverters	690 * MPPT 1/3	Total Power	6325 kW AC
Sub-array "255W 5 Strings"	Nb. of inverters	12 * MPPT 1/3	Total Power	110 kW AC
Sub-array "250W 6 Strings"	Nb. of inverters	369 * MPPT 1/3	Total Power	3383 kW AC
Sub-array "250W 5 Strings"	Nb. of inverters	6 * MPPT 1/3	Total Power	55 kW AC
Total	Nb. of inverters	359	Total Power	9873 kW AC

Grid-Connected System: Simulation parameters (continued)

PV Array loss factors

Thermal Loss factor	Uc (const)	29.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Array#1	0.97 mOhm	Loss Fraction	1.5 % at STC
	Array#2	68 mOhm	Loss Fraction	1.5 % at STC
	Array#3	1.8 mOhm	Loss Fraction	1.5 % at STC
	Array#4	135 mOhm	Loss Fraction	1.5 % at STC
	Global		Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.4 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

System loss factors

External transformer	Iron loss (24H connexion)	12805 W	Loss Fraction	0.0 % at STC
	Resistive/Inductive losses	0.2 mOhm	Loss Fraction	1.0 % at STC
Unavailability of the system	1.8 days, 3 periods		Time fraction	0.5 %

User's needs :

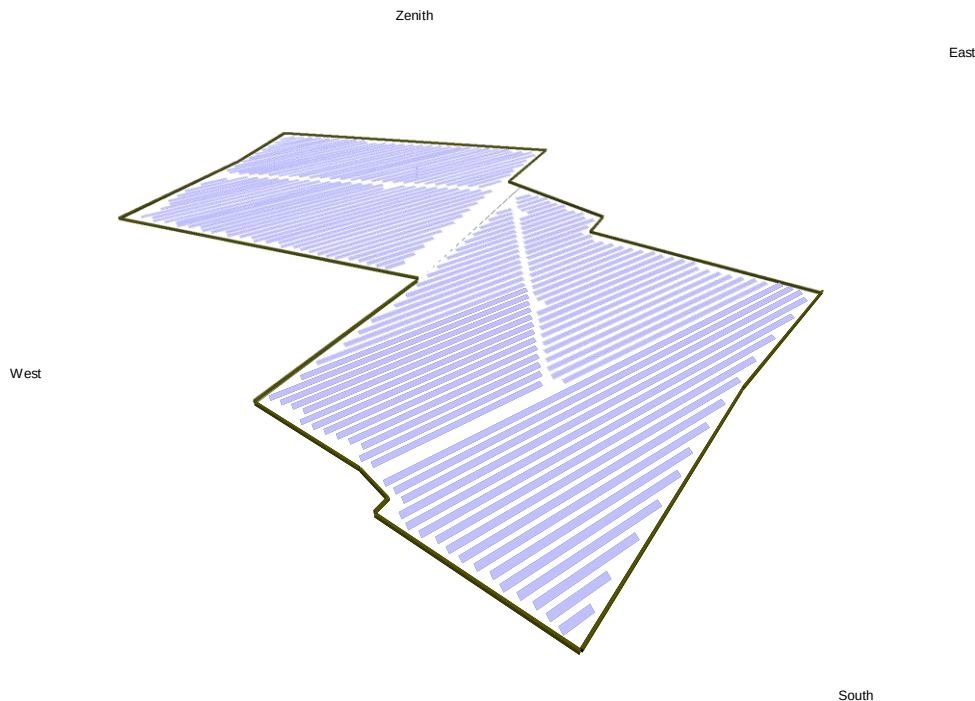
Unlimited load (grid)

Grid-Connected System: Near shading definition

Project : Grange solar farm 250-255W 27.5KW
Simulation variant : Grange Farm 250W255W 27.5kW - Purchase Order

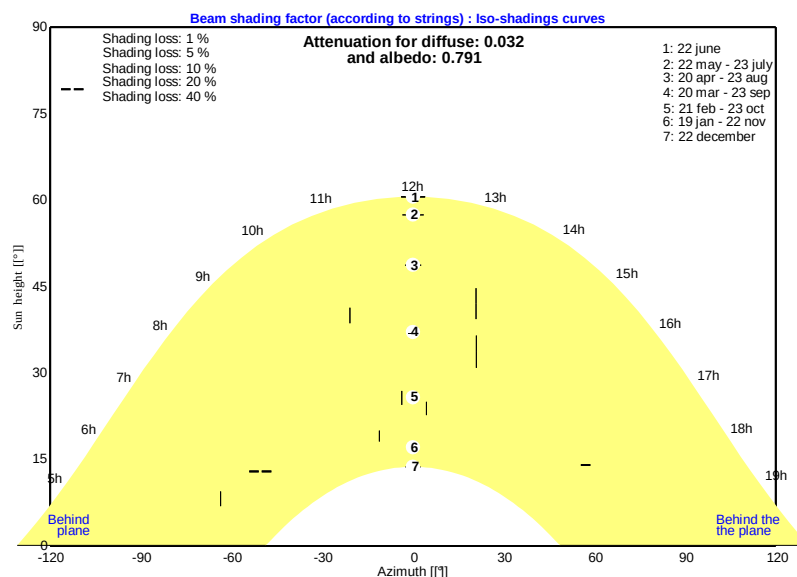
Main system parameters	System type	Grid-Connected		
Near Shadings	According to strings		Electrical effect	80 %
	Shadings of thin objects		Electrical effect	20 %
PV Field Orientation	tilt	20°	azimuth	0°
PV modules	Model	STP 255-20/Wd	Pnom	255 Wp
PV modules	Model	STP 250-20/Wd	Pnom	250 Wp
PV Array	Nb. of modules	51552	Pnom total	13054 kWp
Inverter	Model	SUN2000-28k TL	Pnom	27.50 kW ac
Inverter pack	Nb. of units	359.0	Pnom total	9873 kW ac
User's needs	Unlimited load (grid)			

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Grange solar farm 250-255W 27.5KW



Grid-Connected System: Main results

Project :

Grange solar farm 250-255W 27.5KW

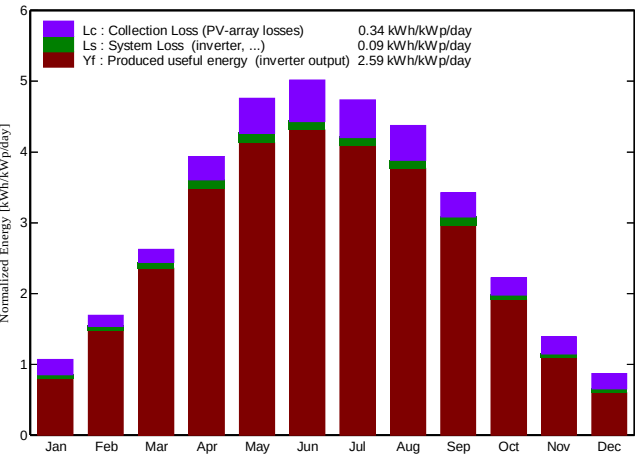
Simulation variant :

Grange Farm 250W255W 27.5kW - Purchase Order

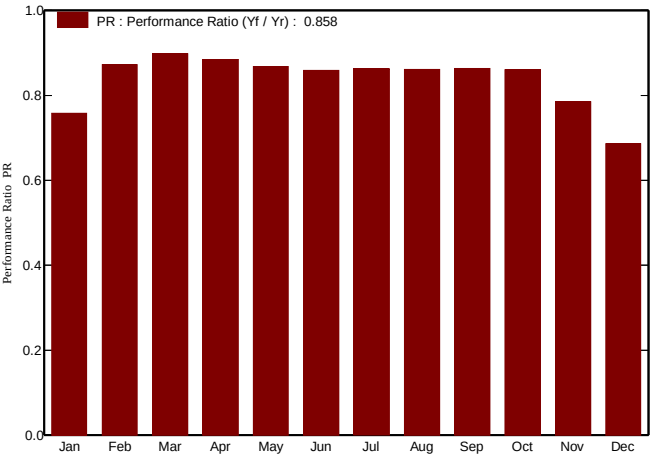
Main system parameters	System type	Grid-Connected	
Near Shadings	According to strings	Electrical effect	80 %
	Shadings of thin objects	Electrical effect	20 %
PV Field Orientation	tilt	azimuth	0°
PV modules	Model	Pnom	255 Wp
PV modules	Model	Pnom	250 Wp
PV Array	Nb. of modules	Pnom total	13054 kWp
Inverter	Model	Pnom	27.50 kW ac
Inverter pack	Nb. of units	Pnom total	9873 kW ac
User's needs	Unlimited load (grid)		

Main simulation results			
System Production	Produced Energy	12338 MWh/year	Specific prod. 945 kWh/kWp/year
	Performance Ratio PR	85.8 %	

Normalized productions (per installed kWp): Nominal power 13054 kWp



Performance Ratio PR



Grange Farm 250W255W 27.5kW - Purchase Order

Balances and main results

	GlobHor	T Amb	GlobInc	GlobEff	EArray	E_Grid	EffArrR	EffSysR
	kWh/m²	℃	kWh/m²	kWh/m²	MWh	MWh	%	%
January	21.2	3.40	33.2	28.0	347	328	12.45	11.80
February	35.5	4.40	47.5	43.8	561	541	14.10	13.58
March	68.8	6.69	81.5	76.5	986	955	14.42	13.98
April	106.5	9.18	118.2	111.7	1412	1365	14.25	13.77
May	142.1	12.29	147.6	139.2	1726	1673	13.94	13.51
June	148.4	15.38	150.6	142.1	1735	1689	13.74	13.37
July	143.1	16.69	147.0	138.5	1702	1656	13.81	13.44
August	122.9	16.99	135.7	128.6	1569	1526	13.79	13.41
September	85.8	14.00	102.8	97.1	1207	1159	14.00	13.44
October	51.2	10.40	69.0	64.4	802	775	13.87	13.40
November	26.8	6.39	41.8	36.4	448	429	12.78	12.22
December	16.4	3.70	27.1	21.6	264	243	11.61	10.69
Year	968.6	9.99	1101.8	1027.7	12759	12338	13.81	13.35

Legends:

GlobHor

Horizontal global irradiation

T Amb

Ambient Temperature

GlobInc

Global incident in coll. plane

GlobEff

Effective Global, corr. for IAM and shadings

EArray

Effective energy at the output of the array

E_Grid

Energy injected into grid

EffArrR

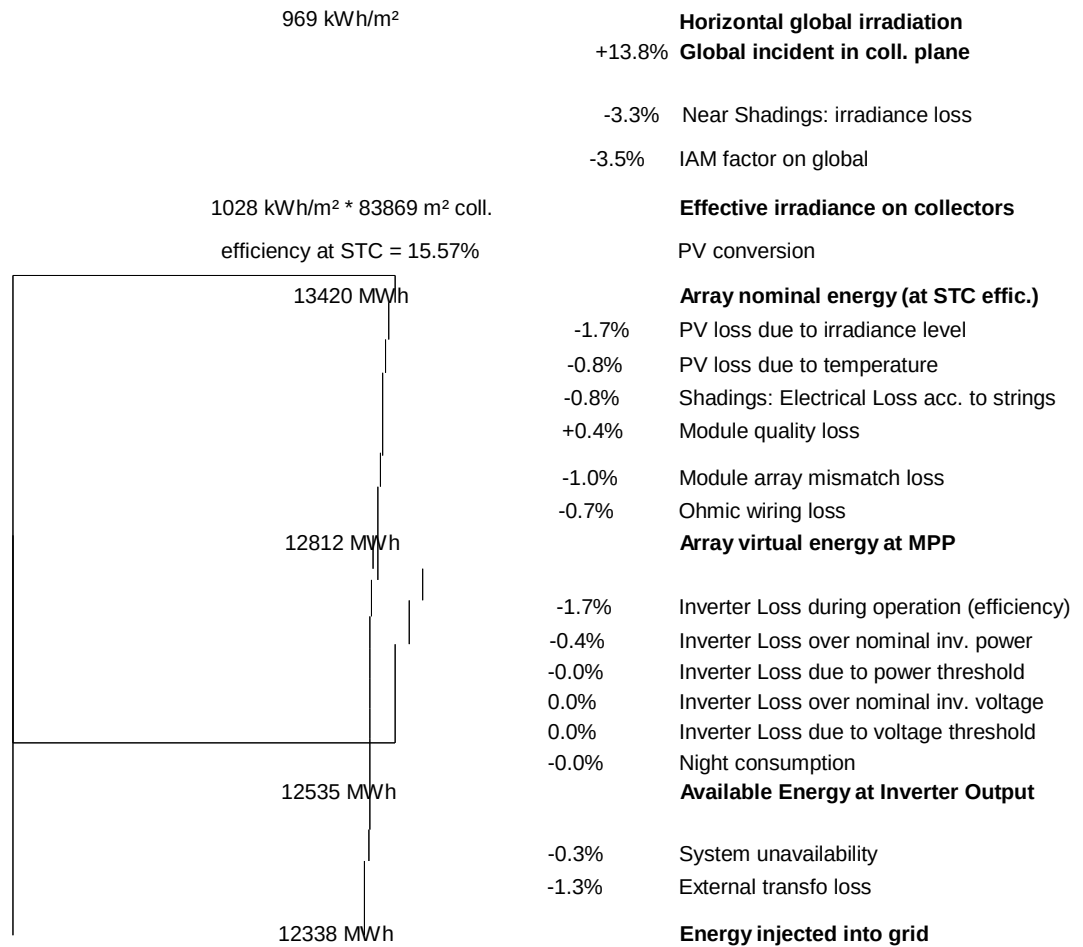
Effic. Eout array / rough area

EffSysR

Effic. Eout system / rough area

PVSYST V6.25		23/07/14	Page
Grid-Connected System: Loss diagram			
Project :	Grange solar farm 250-255W 27.5KW		
Simulation variant :	Grange Farm 250W255W 27.5kW - Purchase Order		
Main system parameters	System type	Grid-Connected	
Near Shadings	According to strings	Electrical effect	80 %
	Shadings of thin objects	Electrical effect	20 %
PV Field Orientation	tilt	azimuth	0°
PV modules	Model	Pnom	255 Wp
PV modules	Model	Pnom	250 Wp
PV Array	Nb. of modules	Pnom total	13054 kWp
Inverter	Model	Pnom	27.50 kW ac
Inverter pack	Nb. of units	Pnom total	9873 kW ac
User's needs	Unlimited load (grid)		

Loss diagram over the whole year



PVsyst Licensed to Sustain Solar Limited (United Kingdom)

Appendix J Maintenance Schedule

Appendix K
WPD Novation Offer