Heckington Fen Solar Park

ENO10123

Outline Design Principles

Applicant: Ecotricity (Heck Fen Solar) Limited

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OUTLINE DESIGN PRINCIPLES

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1 OUTLINE DESIGN PRINCIPLES

1.1 INTRODUCTION

1.1.1 This Outline Design Principles (ODP) document has been prepared on behalf of Ecotricity (Heck Fen Solar) Ltd (hereafter referred to as the "Applicant") to accompany an application for a Development Consent Order (DCO) Application for Heckington Fen Solar Park (hereafter referred to as "the Proposed Development") to the Planning Inspectorate.

1.1.2 Its purpose is to provide the guiding principles for the detailed design of the Proposed Development and is secured by a requirement in the draft DCO. Assuming the DCO is granted, the detailed design for the Proposed Development will be submitted for approval to the relevant local planning authorities (LPAs); the LPAs will assess those details having regard to the principles set out in **Tables 1.1-1.11** of this document and the Environmental Statement (ES) for the Proposed Development as certified by the Secretary of State.

1.1.3 Securing the detailed design post consent, is necessary to achieve technological and design flexibility for the Proposed Development because solar photovoltaic (PV) and energy storage system (ESS) technology is rapidly evolving. The Applicant seeks to allow provision in the DCO for the technological innovation and improvements that may be realised at the time of procurement and construction, in order to ensure that it can construct the Proposed Development taking advantage of innovation, safety improvements and cost-efficiencies.

1.1.4 That necessary flexibility has been facilitated by the adoption of the 'Rochdale Envelope' approach in the ES. The Rochdale Envelope approach ensures the maximum parameters and realistic worst-case scenario have been assessed, and that envelope is defined by the outline design principles set out in this document.

1.1.5 Therefore, by requiring that the detailed design of the Proposed Development must be in accordance with the outline design principles set out in this document, the conclusions of the ES will be upheld, whilst also providing for flexibility.

1.1.6 The draft DCO submitted with the application includes the following Requirement:

Detailed design approval

6.—(1) (1) No phase of the authorised development may commence until details of—

( ) the layout;

(a) scale;

(b) proposed finished ground levels;

(c) external appearance;

(d) hard surfacing materials;

(e) vehicular and pedestrian access, parking and circulation areas, junction improvements and passing places;

(f) refuse or other storage units, sisgns and lighting;

(g) drainage, water, power and communications cables and pipelines; and

(h) programme for landscaping works,

relating to that phase have been submitted and approved in writing by the relevant planning authority for that phase or, where the phase falls within the administrative areas of both the District of North Kesteven and the Borough of Boston, both relevant planning authorities in consultation with the county authority.

(2) The details submitted must accord with the outline design principles and the flood risk assessment.

(3) The authorised development must be carried out in accordance with the approved details.

(4) Sub-paragraph (1) does not apply to the matters listed under sub-paragraph (1)(f) if consent has already been given to the details of those works pursuant to articles 9, 10, or 12.

1.1.7 Therefore, the DCO secures that the final details will be in accordance with this outline plan. The details will be tailored to the relevant phase of works and will be submitted in accordance with the relevant triggers in the above Requirement (i.e. prior to commencement of a "phase"). The number of phases will be determined by the undertaker prior to commencement of the DCO and notified to the relevant planning authority under Requirement 3 of Schedule 2 of the DCO (document reference 3.1); at this stage it is expected that the National Grid extension works (Work No. 6B and 6C) will be a standalone phase meaning that National Grid will submit the final details for their respective works.

1.2 DESIGN PRINCIPLES

1.2.1 The Proposed Development is described in ES **Chapter 4 – Proposed Development** of the ES (document reference 6.1.4). It is classified as an NSIP because it includes a generating station with a generating capacity of over 50 MW. The Proposed Development is also described in Schedule 1 to the draft DCO (document reference 3.1) where the different components of the Proposed Development are divided into works packages which correspond with the work number areas shown on the **Works Plans** (document reference 2.2) which will be subject to differing levels of development and/or management.

1.2.2 Where required, the tables make reference to other documents, such as the **oLEMP** (document reference 7.8). The controls in these other documents are not repeated here as they will be the subject of other Requirements of the DCO.

1.2.3 For each Proposed Development component outlined in **Tables 1.1-1.11**, the parameter has been defined by its:

a) Location – the location of the Proposed Development component within the Proposed Development as assessed within the ES;
b) Scale – either a minimum or maximum parameter which has been assessed in the ES; and
c) Design – relevant design parameter which has been assessed in the ES. All heights are defined in **Tables 1.1-1.11** are Above Ground Level (AGL), unless otherwise specified.

Table 1.1: Work No.1 Design Principles

Proposed Development Component	Parameter Type	Design Principles
Work No. 1— a ground mounted solar photovoltaic generating station with a gross electrical output capacity of over 50 megawatts including— ( ) **Work No. 1A**— (i) solar modules; (ii) solar stations; (iii) inverters; (iv) solar module mounting structures; and (v) a network of electrical cables; and (a) **Work No. 1B**— (i) electrical cables between solar stations and solar modules within Work No. 1A and connecting Work No. 1A to Work No. 2 and Work No. 4.		
Solar PV Array	Location	The solar PV array will be located within the limits of deviation of Work No.1 as shown on the **Works Plan** (document reference 2.2).
	Scale	The maximum area of the solar PV array will be as set out in Appendix 1 to this ODP document (document reference 7.1). The maximum total surface area occupied by the Solar PV array will be 292ha.
Solar PV Modules and Mounting Structures	Location	The solar PV modules and mounting structure will be located within the limits of deviation of Work No.1 as shown on the **Works Plan** (document reference 2.2).
	Scale	The total area of solar PV modules in each field will not exceed the solar PV module areas set out in Appendix 1 and a maximum total surface area of 292ha.
	Scale	The maximum height of the highest part of the solar PV modules will be 3.5m AGL.
	Scale	The minimum height of the lowest part of the solar PV modules will be 1m AGL.
	Scale	The minimum spacing gap between consecutive rows of PV Tables will be 3m and maximum 5m.

Proposed Development Component	Parameter Type	Design Principles
	Design	The solar PV modules will slope towards the south, at a fixed slope of 10, 15 or 20 degrees from horizontal.
	Design	The arrangement of PV Panels within a PV Table will be the same across all PV Arrays within each field.
	Design	The PV Panels will be blue or black in colour (or similar colour).
	Design	The mounting structures will be grey / galvanised steel or aluminium.
	Design	The panel technology will be monofacial and/or bifacial panels.
	Design	Foundations are most likely to be galvanised steel poles driven into the ground. If required, the maximum depth of PV Mounting Structure piles will be 3m below ground level.
	Design	5.3m minimum clearance shall be maintained in still & conductor swing from Electrical Overhead Lines to the highest point of the PV Tables.
Solar Station (a station comprising inverters, transformers, switchgear and associated ancillary and control equipment)	Location	The Solar Stations will be located within the limits of deviation of Work No.1A as shown on the **Works Plan** (document reference 2.2) and within a solar station.
	Scale	The maximum parameter of each solar station will be up to a 13m by 4m footprint, and 4m in height.
	Scale	A maximum of 127 solar stations across Works No. 1.
	Design	Externally finished to be in keeping with the prevailing surrounding environment, most likely with a green, light grey or white painted finish.
	Design	A station comprising inverters, transformers, switchgear and associated ancillary and control equipment with each component for each station either: (a)

Proposed Development Component	Parameter Type	Design Principles
		located outside, sitting on either a ground bearing or piled reinforced concrete foundation slab; or (b) housed together within a container sitting on either a ground bearing or piled reinforced concrete foundation slab.
	Design	Raised above the flood level.
	Design	The Applicant will: I. at the detailed design stage, consider carefully whether the project could be conceived to avoid the use of SF6-reliant assets; II. where the development cannot be so conceived, undertake an assessment of technical alternatives and provide an explanation of why these alternatives are technically infeasible including an explanation of the cost differential between the SF6-reliant asset and the SF6-free alternative.
Inverters	Location	The inverters will be located within the limits of deviation of Work No.1A as shown on the **Works Plan** (document reference 2.2) and within a solar station.
	Scale	The maximum parameters of the inverters (alongside those of the other solar station components) will be limited to the maximum parameters of the solar station.
	Design	The inverters will be centralised at the solar stations, or string inverters will be fixed to the mounting structures.
	Design	All central inverters are located at least 200m away from noise sensitive receptors.
	Design	Externally finished to be in keeping with the prevailing surrounding environment, most likely with a green, light grey or white painted finish.
Transformers	Location	The transformers will be located within the limits of deviation of Work No.1 as shown

Proposed Development Component	Parameter Type	Design Principles
		on the **Works Plan** (document reference 2.2) and within a solar station.
	Scale	The maximum parameters of the transformers (alongside those of the other solar station components) will be limited to the maximum parameters of the solar station.
	Design	Externally finished to be in keeping with the prevailing surrounding environment, most likely with a green, light grey or white painted finish.
Switchgear	Location	The switchgear will be located within the limits of deviation of Work No.1 as shown on the **Works Plan** (document reference 2.2) and within a solar station.
	Scale	The maximum parameters of the switchgear (alongside those of the other solar station components) will be limited to the maximum parameters of the solar station.
	Design	Externally finished to be in keeping with the prevailing surrounding environment, most likely with a green, light grey or white painted finish.
Network of electrical cabling (Work No.1A, 1B, 2 and 4)	Location	The onsite electrical cabling will be located within the limits of deviation of Work No.1A, Work No.1B, Work No. 2 and Work No. 4 as shown on the **Works Plan** (document reference 2.2)
	Scale	Cabling between solar PV modules and solar stations, and solar stations to the onsite substation will be underground with maximum cable trench dimension 0.5m wide and 1.3m deep per circuit, and may be deeper for crossing obstacles. Multiple circuits may run together in some areas.
	Design	Cabling will be above ground level between the PV modules. These will be fixed to the mounting structure along the row of racks. Cabling between the PV modules, solar stations will be buried within underground

Proposed Development Component	Parameter Type	Design Principles
		trenches. Cables between solar station to the onsite substation will be buried within underground trenches. No new overhead lines will be constructed.

Table 1.2: Work No.2 Design Principles

Proposed Development Component	Parameter Type	Design Principles
Work No. 2— an energy storage facility comprising— ( ) energy storage cells; (a) a network of electrical cable circuits; (b) electrical cables connecting to Work No. 1A and Work No. 1B and Work No. 4; (c) a structure protecting the energy storage cells and ancillary equipment, being either one container or multiple containers, mounted on a reinforced concrete foundation slab or concrete piling; (d) heating, ventilation and air conditioning (HVAC) or liquid cooling systems; (e) energy storage stations comprising— (i) inverters and transformers; and (ii) switchgear and ancillary equipment; (f) monitoring and control systems; (g) fire safety infrastructure comprising fire suppression system; and (h) storage structures for the purposes of firefighting comprising containment tanks or a concrete water storage basin or lagoon for the purpose of firefighting.		
Energy Storage Compound	Location	The energy storage compound will be located within the limits of deviation of Work No.2 as shown on the **Works Plan** (document reference 2.2)
	Scale	The energy storage compound area will have a maximum footprint of 78,400m^2 (280m x 280m) and infrastructure within the energy storage compound area will be no higher than 6m.
	Design	The energy storage compound area will include energy storage containers and energy storage stations (containing equipment for the storage of electrical energy, inverters, transformers, and switchgear). Energy storage will be grouped in racks, protected by structures / containers which will be located inside the energy storage compound.
	Design	The design of ESS includes a number of design elements to both prevent, detect and control a fire should one occur. These will include:

Proposed Development Component	Parameter Type	Design Principles
		• Energy storage system will comply with relevant national and international standards • The ESS will be controlled by control systems that will detect if a cell is not operating correctly and fire detection systems and suppression systems, will be installed within the containers; • Each container will have dedicated temperature control system which is designed to regulate ambient temperatures to within safe operating conditions which in turn minimise thermal runaway and the risk of fire; • Off-gas detection systems which can detect the gases given off before a thermal runway event can be utilised to shutdown the malfunctioning cell/rack safely. The sensors used to do this are sensitive down to 1ppm (parts per million); and • Adequate spacing (5m) between the containers to minimise propagation of thermal runaway, ensure adequate air flow and appropriate operational and emergency access.
	Design	Components of the energy storage compound will utilise concrete pad foundations.
Inverters / Power Converters	Location	The energy storage compound inverters/ power converters will be located within the limits of deviation of Work No.2 as shown on the **Works Plan** (document reference 2.2).
	Scale	There will be a maximum of 100 inverters / power converters within the energy storage compound.
	Scale	The maximum dimensions of each inverter / power converter within the

Proposed Development Component	Parameter Type	Design Principles
		energy storage compound are 6m by 3m in plan and up to 6m in height.
	Design	The inverter / power converter is inclusive of the switchgear within the maximum scale dimensions.
	Design	Externally finished to be in keeping with the prevailing surrounding environment, most likely with a green, light grey or white painted finish.
Transformers	Location	The energy storage compound transformers will be located within the limits of deviation of Work No.2 as shown on the **Works Plan** (document reference 2.2)
	Scale	There will be a maximum of 100 transformers within the energy storage compound
	Scale	The maximum footprint will be 5m by 3m in plan and a maximum height of 4m, sited within the energy storage compound.
	Design	Externally finished to be in keeping with the prevailing surrounding environment, most likely with a green, light grey or white painted finish.
Energy storage container housing the energy storage cells	Location	The energy storage containers will be located within the limits of deviation of Work No.2 as shown on the **Works Plan** (document reference 2.2).
	Scale	The maximum dimensions of each energy storage container within the energy storage compound are 13m by 4m (a maximum footprint of 52m^2) in plan and up to 6m in height.
	Scale	There will be a maximum of 200 energy storage containers housing the energy storage cells within the energy storage compound.
	Design	Externally finished to be in keeping with the prevailing surrounding environment,

Proposed Development Component	Parameter Type	Design Principles
		most likely with a green, light grey or white painted finish.
	Design	HVAC or liquid cooling systems will be housed either within each of the containers, attached to the side or top of each of the containers, or located separate from but near to each of the containers.
	Design	The energy storage containers will sit on a suitable concrete foundation and / or steel framework foundation.
	Design	Due to certain combinations and orientations of energy storage containers when assembled together the overall footprint area will be within the proposed scale. Energy storage containers may be made up of multiple smaller units fitted together or close to each other but within the overall footprint area and maximum height dimension.
Energy Storage Stations	Location	The energy storage stations will be located within the limits of deviation of Work No.2 as shown on the **Works Plan** (document reference 2.2)
	Scale	The maximum parameter of each energy storage station will be a maximum footprint of 36m^2 , and 6m in height.
	Design	A station comprising inverters, power conversion system, transformers, switchgear and associated ancillary and control equipment with each component for each station either: (a) located outside, sitting on either a ground bearing or piled reinforced concrete foundation slab; or (b) housed together within a container sitting on either a ground bearing or piled reinforced concrete foundation slab.
	Design	Due to certain combinations and orientations of energy storage components / transformers / switch gear and ring main units when assembled together the overall footprint area will be

Proposed Development Component	Parameter Type	Design Principles
		within the proposed scale. Energy Storage Stations may be made up of multiple smaller units fitted together or close to each other but within the overall footprint area and maximum height dimension.
	Design	The Applicant will: I. at the detailed design stage, consider carefully whether the project could be conceived to avoid the use of SF6-reliant assets; II. where the development cannot be so conceived, undertake an assessment of technical alternatives and provide an explanation of why these alternatives are technically infeasible including an explanation of the cost differential between the SF6-reliant asset and the SF6-free alternative.
Internal Energy Storage Fire Suppression System*	Location	The internal energy storage fire suppression system will be located within the limits of deviation of Work No.2 as shown on the **Works Plan** (document reference 2.2)
	Scale	The water quench, aerosol or foam fire suppression system will be integrated into the design of each energy storage container to a maximum of 6m in height
	Design	Water supply may be integrated into the design of each energy storage container and will be located either within or outside the energy storage container. If located outside, the water supply will either be decentralised and located at each container or centralised and located together with pumping equipment and pipework at a central location(s).
External Tanks*	Location	The external firefighting water tanks will be located within the limits of deviation of Work No.2 as shown on the **Works Plan** (document reference 2.2)
	Scale	Maximum of 2000m^3 of firefighting water will be provided for the energy storage

Proposed Development Component	Parameter Type	Design Principles
		compound, stored in up to 8 tanks 10m diameter and a maximum height of 4m. A further 2 tanks of same dimensions will be available to store potentially contaminated water in the event of a fire. The base of the tanks will sit on a suitable concrete foundation.
	Design	Storage will either be in cylindrical steel tanks, partially or wholly sunk below ground level, within the energy storage compound.
Water Containment*	Location	The firefighting water containment will be located within the limits of deviation of Work No.2 as shown on the **Works Plan** (document reference 2.2)
	Scale	A maximum footprint of 3,600m^2 (120m x 30m) lagoon/ water storage area will be provided in the energy storage compound. The lagoon will be contained by a 1m earth bund or kerb. The lagoon will sit on a suitable concrete foundation.
	Design	An energy storage compound area will contain a bunded lagoon to capture fire water run-off from external fire water during a fire incident.
***Included as worse case to ensure Fire and Rescue Service requirements are covered, however final fire suppression system would be subject to detailed design as noted in the Outline Energy Storage Safety Management Plan (document reference 7.11).		

Table 1.3: Work No.3 Design Principles

Proposed Development Component	Parameter Type	Design Principles
Work No. 3— reception areas, temporary cabins, construction compounds and parking, gatehouses, and service areas in connection with Work No. 1A, Work No. 1B, Work No. 2, Work No. 4, and Work No. 5.		
Construction compounds (inclusive of temporary cabins, parking, reception areas, service areas and gatehouse)	Location	The temporary construction compounds will be located within the limits of deviation of Work No.3 and as shown on the **Works Plan** (document reference 2.2)
	Scale	There will be a maximum of 6 temporary construction compounds on the Energy Park Site (within Work No. 3), with maximum dimension of 50m x 50m x 3m.
	Design	Base to comprise crushed aggregate with the potential to use lime stabilisation
Gatehouses	Location	The gatehouses will be located within the limits of deviation of Work No.3 as shown on the **Works Plan** (document reference 2.2)
	Scale	The maximum footprint of a gatehouse will be 5m x 5m footprint and 4m in height. There will be a maximum of one gate house per construction compound.
	Design	Externally finished to be in keeping with the prevailing surrounding environment, most likely with a green, light grey or white painted finish.

Table 1.4: Work No.4 Design Principles

Proposed Development Component	Parameter Type	Design Principles
Work No. 4— an onsite substation and works in connection with the onsite substation including— ( ) transformers, including associated cooling equipment, bunding and blast walls; (a) switchgear, including circuit breakers, disconnectors and earth switches; (b) substation electrical apparatus, including bus-bars, steel supports, insulation posts, cable sealing ends, surge arrestor, instrument transformers; (c) harmonic filtering reactive power compensation equipment; (d) substation buildings; (e) control buildings or containers; (f) welfare facilities and hardstanding areas; (g) a network of cable circuits; (h) electrical cables connecting to Work No. 1A, Work No. 1B, and Work No. 2; and (i) flood protection measures.		
Onsite Substation	Location	The onsite substation compound will be located within the limits of deviation of Work No.4 as shown on the **Works Plan** (document reference 2.2).
	Scale	The onsite substation components will have a maximum footprint of 20,350m^2 (185m x 110m) and infrastructure within the onsite substation components no higher than 15m AGL.
	Scale	Components of the onsite substation will utilise concrete pad foundations.
	Design	The onsite substation compound will include four HV substations, transformers, switchgear, substation control buildings, welfare facilities, hardstanding areas and electric cabling. For Circuit breaker interrupting technology, although non-SF6 technologies are preferred it is not possible to fully rule-out the need for SF6 should the alternatives that are still in development not meet the operational requirements.
	Design	Where necessary flood protection measures such as increased height of the bunding of the transformer and raised above the maximum flood level.

Proposed Development Component	Parameter Type	Design Principles
	Design	No lighting will be permanently operated. Lighting would be triggered by movement only or manually turned on.
	Design	Externally finished to be in keeping with other infrastructure, most likely grey, galvanised steel.
	Design	The Applicant will: I. at the detailed design stage, consider carefully whether the project could be conceived to avoid the use of SF6-reliant assets; II. where the development cannot be so conceived, undertake an assessment of technical alternatives and provide an explanation of why these alternatives are technically infeasible including an explanation of the cost differential between the SF6-reliant asset and the SF6-free alternative.
Central control building or container (inclusive of welfare facilities)	Location	The substation control buildings or containers will be located within the limits of deviation of Work No.4 as shown on the **Works Plan** (document reference 2.2), within the maximum footprint of the onsite substation area.
	Scale	Maximum parameters for the substation central control building are 20m by 10m in plan and 4m in height.
	Design	The finished floor level of the control room will be at or above 2.25m AOD.
	Design	The control buildings will be a painted block building with external colours and finishes to be confirmed prior to construction, and in keeping with other infrastructure.
Onsite substation- main step-up transformers	Location	The main step-up transformers will be located within the limits of deviation of Work No.4 as shown on the **Works Plan** (document reference 2.2), within the

Proposed Development Component	Parameter Type	Design Principles
		maximum footprint of the onsite substation area.
	Scale	There will be up to 3 main step-up transformers. Maximum parameters for the main step-up transformers are 15m by 10m in plan and 12m in height.
	Design	Externally finished to be in keeping with other infrastructure, most likely grey, galvanised steel.
Onsite substation-auxiliary transformers	Location	The auxiliary transformers will be located within the limits of deviation of Work No.4 as shown on the **Works Plan** (document reference 2.2), within the maximum footprint of the onsite substation area.
	Scale	There will be up to 4 auxiliary transformers. Maximum parameters for the auxiliary transformers are 4m by 4m in plan and 4m in height.
	Design	Externally finished to be in keeping with other infrastructure, most likely grey, galvanised steel.
Onsite substation-distribution substations	Location	The distribution substations will be located within the limits of deviation of Work No.4 as shown on the **Works Plan** (document reference 2.2), within the maximum footprint of the onsite substation area.
	Scale	There will be up to 4 distribution substations. Maximum parameters for the substations are 15m by 5m in plan and 4m in height.
	Design	Externally finished to be in keeping with other infrastructure, most likely grey, galvanised steel or construction blocks.
Onsite substation-substation control room	Location	The substation control room will be located within the limits of deviation of Work No.4 as shown on the **Works Plan** (document reference 2.2). Within the maximum footprint of the onsite substation area.
	Scale	The substation control room will either be located within the onsite substation control

Proposed Development Component	Parameter Type	Design Principles
		building, or in a separate building within the onsite substation area with maximum parameters of 12m by 5m in plan and up to 4m in height.
Hardstanding Areas	Location	The hardstanding area will be located within the limits of deviation of Work No.4 as shown on the **Works Plan** (document reference 2.2), within the maximum footprint of the onsite substation area
	Scale	The maximum footprint of the hardstanding area for Work No. 4 is 12ha.
Flood Protection Measures	Location	The flood protection measures will be located within the limits of deviation of Work No.4 as shown on the **Works Plan** (document reference 2.2), within the maximum footprint of the onsite substation area.
	Design	Where necessary flood protection measures such as increased height of the bunding of the transformer and raised above the maximum flood level.

Table 1.5: Work No.5 Design Principles

Proposed Development Component	Parameter Type	Design Principles
Work No. 5— works to lay electrical cables between Work No. 4 and Work No. 6A. **Work No. 5A**— works to lay electrical cables from Work No. 5 at approximately 52° 56′ 14.1″ N, 0° 13′ 12.0″ W, and 52° 56′ 09.9″ N, 0° 13′ 11.3″ E, running in a southerly and south easterly direction to Work No. 5 at approximately 52° 55′ 51.1″ N, 0° 13′ 19.0″ W, and 52° 55′ 48.7″ N, 0° 13′ 21.2″ W. **Work No. 5B**— works to lay electrical cables from Work No. 5 at approximately 52° 56′ 15.5″ N, 0° 13′ 07.7″ W, and 52° 56′ 09.9″ N, 0° 13′ 11.3″ W running in a south east and south westerly direction to Work No. 5 at approximately 52° 55′ 51.1″ N, 0° 13′ 19.0″ E, and 52° 55′ 50.0″ N, 0° 13′ 17.9″ W.		
Cable Route Corridor connecting the Energy Park to National Grid Bicker Fen Substation	Location	The electrical cabling will be located within the limits of deviation of Work No.4, Work No.5 and Work No.6 as shown on the **Works Plan** (document reference 2.2)
	Scale	The electrical cabling will comprise one 400kV cable circuit underground alongside communication and control cabling.
	Scale	The 400kV cable trench will be 0.6m wide, except from where it meets jointing bays or obstacle crossings. In which case the dimensions described for jointing bays or crossing apply.
	Scale	The 400kV cable trench will be approximately 1.2m deep in agricultural land and deeper for crossing of obstacles.
	Design	Horizontal Directional Drilling (HDD) or similar technology will be used to install the 400kV cables beneath areas of significant engineering difficulties such as the high-pressure gas pipeline, the South Forty Foot Drain and the railway. Furthermore, all Black Sluice Internal Drainage Board (IDB) ditches will be drilled (unless otherwise agreed). The HDD depth will be up to 10m below ground level and subject to agreement with third party asset owners. The cables would be a minimum of 2m plus an additional safety distance (typically 0.5-1m) below the bed of any IDB maintained watercourse in order to prevent risk of any scour exposing the cable.

Proposed Development Component	Parameter Type	Design Principles
	Design	A minimum buffer of 8m around watercourses (measured from the water/channel edge under normal flows) and increased to 9m from Black Sluice IDB maintained drains (unless otherwise agreed) will be maintained within which there will be no above ground built development to avoid disturbance of the watercourse bed and banks, unless otherwise agreed with the relevant drainage authority.
	Design	The 400kV cable will be buried at a minimum depth of 1m when within 50m of receptors sensitive to effects from electromagnetic fields.
Jointing bays within the Cable Route Corridor connecting the Energy Park to National Grid Bicker Fen Substation	Location	The jointing bays will be located within the limits of deviation of Work No.5 as shown on the **Works Plan** (document reference 2.2).
	Scale	Jointing bays will contain 3 joints, one for each cable of the 3 phase 400kV circuit. There will also be an earthing cable and comms and control cables. The connection will have 1 circuit made up of 3 cables (1 cable per electrical phase). The 3 cable joints will sit within one bay 20m in length, by 3m width and 1.2m in depth below ground.
	Design	At each joint bay, earthing link boxes are installed above ground as ground level access points for the cable earthing system. Link boxes will be installed in field margins where possible, or below ground in areas where they would adversely affect land use.
	Design	Jointing bays will be up to 500m apart.

Table 1.6: Work No.6A, Works No. 6B and Work No. 6C Design Principles

Proposed Development Component	Parameter Type	Design Principles
Work No. 6A— creation of a new generation bay and associated works at the existing substation, including— (a) an electrical bay to connect into the existing network at Work No. 6B, including associated outdoor air insulated switchgear (AIS) or indoor gas insulated switchgear (GIS) and electrical apparatus, circuit breakers, disconnectors and earth switches; (b) substation electrical apparatus, including bus-bars, steel supports, insulation posts, cable sealing ends, surge arrestors, instrument transformers; (c) control building; and (d) underground and above ground electrical cables and electrical connectors, including cables for power, control and communication with electrical bays and to connect into Work No. 6B, including associated outdoor AIS or indoor GIS and electrical apparatus. **Work No. 6B**— an extension to the existing substation, including— (a) outdoor AIS or indoor GIS, including circuit breakers, disconnectors and earth switches; (b) substation electrical apparatus, including bus-bars, bus-section and a bus-coupler, steel supports, insulation posts, cable sealing ends, surge arrestors, instrument transformers; and (c) underground and above ground electrical cables and electrical conductors, including cables for power, control and communication with electrical bays and to connect into Work No. 6A and the existing network within the existing substation, including associated outdoor AIS or indoor GIS and electrical apparatus. **Work No. 6C**— works in connection with the extension to the existing substation, including— (a) a cable sealing end compound and construction of a new circuit bay connecting into the existing substation; and (b) underground and above ground electrical cables and electrical conductors, connecting the existing 400kV transmission tower and the new feeder bay.		
National Grid Bicker Fen Substation Extension and Works in Connection	Location	The National Grid Bicker Fen Substation Extension will be located within the limits of deviation of Work No. 6A, Work No. 6B and Work No. 6C as shown on the **Works Plan** (document reference 2.2).
	Scale	The approximate footprint for National Grid Bicker Fen Substation Extension is 27160m^2, and 15m in height from AGL. All of the infrastructure including the electrical bay, substation electrical apparatus, cable sealing end, control room building, perimeter access road will be in the footprint of Work No. 6A, 6B and 6C as shown on the **Works Plan** (document reference 2.2) and the parameters as described.

Proposed Development Component	Parameter Type	Design Principles
	Scale	The footprint of the main electrical bay sitting within the National Grid Bicker Fen Substation Extension will be approximately 1,650m^2 (e.g., 55m by 30m), and 15m in height from AGL.
	Design	National Grid are yet to carry out any detailed design work for the substation extension. Subsequently there may be a need for flexibility on the final built height of the new electrical equipment. Any variation from the Rochdale Envelope will have to comply with Requirement 5 of the DCO process.
	Design	Components of National Grid Bicker Fen Substation Extension will utilise concrete pad foundations. A piling solution may be required depending on the results of geotechnical surveys.
	Design	Access points will be a minimum of 4.5m in width.
Air Insulated Switchgear (AIS) Option	Scale	The footprint for the Air Insulated Switchgear will be approximately 14112m^2, and 15m in height. All of the infrastructure for the Air Insulated Switchgear option will be in the footprint of Work No.6A and Work No.6B as shown on the **Works Plan** (document reference 2.2).
	Design	Noting that National Grid are yet to carry out any detailed design work for the substation extension. Subsequently there may be a need for flexibility on the final built height of the new electrical equipment. Any variation from the Rochdale Envelope will have to comply with Requirement 5 of the DCO process.
	Design	Electrical apparatus including (but not limited to) circuit breakers, disconnectors and earth switches. Externally finished to be in keeping with other infrastructure, most likely grey, galvanised steel. For Circuit breaker interrupting technology, although non-SF6

Proposed Development Component	Parameter Type	Design Principles
		technologies are preferred it is not possible to fully rule-out the need for SF6 should the alternatives that are still in development not meet the operational requirements. Air Insulated Switchgear in the footprint of Work No. 6A, the Applicant will: I. at the detailed design stage, consider carefully whether the project could be conceived to avoid the use of SF6-reliant assets; II. where the development cannot be so conceived, undertake an assessment of technical alternatives and provide an explanation of why these alternatives are technically infeasible including an explanation of the cost differential between the SF6-reliant asset and the SF6-free alternative. Air Insulated Switchgear in the footprint of Work No. 6B, National Grid will: I. at the detailed design stage, consider carefully whether the project could be conceived to avoid the use of SF6-reliant assets; II. where the development cannot be so conceived, undertake an assessment of technical alternatives and provide an explanation of why these alternatives are technically infeasible including an explanation of the cost differential between the SF6-reliant asset and the SF6-free alternative.
Gas Insulated Switchgear (GIS) Option	Scale	The footprint for the Gas Insulated Switchgear will be approximately 5,625m^2 (e.g., 75m by 75m). Some Switchgear apparatus will be housed indoors in a building 30m by 20m, and 15m in height. All of the infrastructure for the Gas Insulated Switchgear option will be in the footprint of Work No.6A and Work No.6B as shown on the **Works Plan** (document reference 2.2).
	Design	Noting that National Grid are yet to carry out any detailed design work for the

Proposed Development Component	Parameter Type	Design Principles
		substation extension. Subsequently there may be a need for flexibility on the final built height of the new electrical equipment. Any variation from the Rochdale Envelope will have to comply with Requirement 5 of the DCO process.
	Design	Electrical apparatus including (but not limited to) circuit breakers, disconnectors and earth switches. Gas Insulated Switchgear partly houses in a building externally finished to be in keeping with other infrastructure, most likely green or grey. Electrical apparatus externally finished to be in keeping with other infrastructure, most likely grey, galvanised steel.
	Design	If a GIS option is pursued, National Grid will avoid the use of SF6 within the GIS system.
Cable Sealing End (CSE) Compound	Scale	The footprint for the Cable Sealing End Compound will be approximately 9041m^2 and 15m in height. All of the infrastructure for the Cable Sealing End Compound will be in the footprint of Work No.6C as shown on the **Works Plan** (document reference 2.2).
	Design	National Grid are yet to carry out any detailed design work for the substation extension. Subsequently there may be a need for flexibility on the final built height of the new electrical equipment. Any variation from the Rochdale Envelope will have to comply with Requirement 5 of the DCO process.

Table 1.7: Work No.7 Design Principles

Proposed Development Component	Parameter Type	Design Principles
Work No. 7— two temporary laydown areas in connection with Work No. 5 and Work Nos. 6A, 6B, and 6C including— ( ) areas of hardstanding, compacted ground or tracking matting; (a) car parking and access; (b) area to store materials and equipment, including electrical cables; (c) site and welfare offices and cabins; (d) security infrastructure, including cameras, perimeter fencing and lighting; (e) site drainage and waste management infrastructure (including sewerage); and (f) electricity, water, waste water and telecommunications connections.		
Construction laydown areas	No design principles applicable as temporary infrastructure. The maximum extent of the construction laydown areas is defined by **Works Plan** (document reference 2.2).	

Table 1.8: Work No.8 Design Principles

Proposed Development Component	Parameter Type	Design Principles
Work No. 8— works to create and maintain a permanent means of access from the A17 to Work No. 1A, Work No. 1B, Work No. 2, Work No. 3 and Work No. 4.		
Site Access	Location	The site access from the A17 will be located within the limits of deviation of Work No.8 as shown on the **Works Plan** (document reference 2.2).
	Scale	The new access from the A17 will be 7m wide to accommodate two HGVs simultaneously, with a bellmouth of up to 43m where it meets the A17.
	Scale	The new access will require the creation of a new T-junction with a visibility splay of 2.4 x 154.48 metres to the west and a visibility splay of 2.4 x 164.23 metres to the east, in accordance with recorded speeds.
Internal Access Tracks	Location	The internal access tracks will be located within the limits of deviation of Work No. 1, 2, 3, 4 and 8 as shown on the **Works Plan** (document reference 2.2).
	Scale	Internal access tracks will be up to 4.5m wide and up to 19km in length.
	Design	New access tracks will have a permeable surface.

Table 1.9: Work No.9 Design Principles

Proposed Development Component	Parameter Type	Design Principles
Work No. 9A— works to create, enhance and maintain green infrastructure and create biodiversity net gain areas, including— ( ) soft landscaping and planting, including tree planting; (a) landscape and biodiversity enhancement measures; (b) earth works; (c) hard standing and hard landscaping; (d) drainage and irrigation infrastructure and improvements or extensions to existing irrigation systems; (e) fencing, gates, boundary treatment and other means of enclosure; and (f) improvement, maintenance and use of existing private tracks. **Work No. 9B**— works to create a permissive path, including installing up to two footbridges, fencing, gates, boundary treatment and other means of enclosure. **Work No. 9C** – works to create a community orchard		
Green Infrastructure	Location	The green infrastructure will be located within the limits of deviation of Work No.9A as shown on the **Works Plan** (document reference 2.2).
	Design	The green infrastructure will be designed as per the OLEMP (document reference 7.8) in accordance with the requirements of the DCO.
	Design	A minimum buffer for new fencing and hedging of 8m around watercourses (measured from the water's/channel edge under normal flows and increased to 9m from Black Sluice IDB maintained drains) will be maintained within which there will be no built development to avoid disturbance of the watercourse bed and banks, unless otherwise agreed with the relevant drainage authority.
Biodiversity Net Gain Areas	Location	The biodiversity net gain areas will be located within the limits of deviation of Work No.9A as shown on the **Works Plan** (document reference 2.2).
	Scale	A minimum of 16.5ha of biodiversity net gain areas will be located within the limits of deviation of Work No.9A as shown on

Proposed Development Component	Parameter Type	Design Principles
		the **Works Plan** (document reference 2.2).
	Design	There will be no built development associated with the Proposed Development within Work No. 9A (with the exception of any stock proof fencing used to control conservation grazing and any conservation related surface water control structures).
Permissive Path	Location	A permissive path will be located within the limits of deviation of Work No.9B as shown on the **Works Plan** (document reference 2.2).
	Design	A permissive path will be created linking into public right of way Heck/15/1 as part of a loop.
Community Orchard	Location	The community orchard will be located within the limits of deviation of Work No.9C as shown on the **Works Plan** (document reference 2.2).
	Design	The community orchard will be designed as per the OLEMP (document reference 7.8) in accordance with the requirements of the DCO.
Hedgerows	Design	A minimum buffer of 8m around watercourses (measured from the water/channel edge under normal flows) and increased to 9m from Black Sluice IDB maintained drains (unless otherwise agreed) will be maintained within which there will be no hedgerows or tree planting to avoid disturbance of the watercourse bed and banks, unless otherwise agreed with the relevant drainage authority.

Table 1.10: Work No.10 Design Principles

Proposed Development Component		Parameter Type				
Work No. 10— works to existing streets to facilitate access to Work Nos. 1 to 9B.						
Works to Streets	Location	The works to streets will be located within the limits of deviation of Work No. 10 as shown on the **Works Plans** (document reference 2.2) as more particularly described in the relevant Schedule 4 and 5 of the draft DCO and shown on the **Streets and Access Plan** (document reference 2.7)				
		Street and Access Plan Reference	**Proposed Development Phase**			
			Construction	**Operation**	**Decommissioning**	**Comment**
		Energy Park				
		EP/A	√			Access EP/A will only be used for a temporary period of time during the construction phase until such time that the Access EP/B is complete.
		EP/B	√	√	√	Access EP/B is the primary access to the Energy Park and will be used during all phases.

		Cable Run				
		CR/B	√	√		Access CR/B and CR/C are on to the A17 and will be used during the construction and operational phases of the Cable Run. Access to the Cable Run is not required during decommissioning as the cable and infrastructure will remain in-situ.
		CR/C	√	√		
		CR/D	√			Access CR/D is an existing access junction on to the A17. It will only be used for a temporary period of time during the construction phase. Access to the Cable Route is not required during decommissioning as the cable and infrastructure will remain in-situ.

		CR/E	√	√		Access CR/E will be used during the construction and operational phases. Access to the Cable Route is not required during decommissioning as the cable and infrastructure will remain in-situ.
		CR/F	√	√		Access CR/F to CR/Q will be used during the construction and operational phases. Access to the Cable Route is not required during decommissioning as the cable and
		CR/G	√	√		
		CR/H	√	√		

		CR/I	√	√		infrastructure will remain in-situ.
		CR/J	√	√		
		CR/K	√	√		
		CR/L	√	√		
		CR/M	√	√		
		CR/N	√	√		
		CR/O	√	√		
		CR/P	√	√		Access CR/P and CR/Q are existing access junctions on to Vicarage Drove.
		CR/Q	√	√		
	Scale	EP/A, CR/D, and CR/E access points will utilise existing access points and as existing. No improvements are considered necessary at this stage.				
	Scale	EP/B access point will be a minimum of 7m in width.				

	Scale	Temporary access points for the Cable Run will be a minimum of 3.5m in width.

Table 1.11: Further Associated Development Design Principles

Proposed Development Component	Parameter Type	Design Principles
Further Associated Development In connection with and in addition to Work Nos.1 to 10 further associated development including— ( ) works within highways, including— (i) alteration of the layout of any street permanently or temporarily, including increasing or reducing the width of the carriageway of any street by increasing or reducing the width of any kerb, footway, cycleway, or verge within the street including removal of any vegetation; and altering the level or increasing the width of any such kerb, footway, cycleway or verge within the street including removal of any vegetation; and works for the strengthening, improvement, repair, maintenance or reconstruction of any street; (ii) street works, including breaking up or opening a street, or any sewer, drain or tunnel under it, and tunnelling or boring under a street; (iii) relocation, removal or provision of new road traffic signs, signals, street lighting, road restraints and carriageway lane markings; (iv) works to place, alter, remove or maintain street furniture or apparatus (including statutory undertakers' apparatus) in, under or above a street, including mains, sewers, drains, pipes, cables, cofferdams, lights, fencing and other boundary treatments; and (v) works to facilitate traffic management and to deliver information relating to the authorised development; and (a) other works and development, including— (i) works for the provision of fencing and security measures such as CCTV, lighting, communication boxes and access control booths; (ii) laying down of internal access tracks, ramps, means of access, footpaths, and roads; (iii) bunds, embankments, trenching and swales; (iv) boundary treatments, including means of enclosure; (v) laying out and surfacing of permissive paths, including the laying and construction of drainage infrastructure, signage and information boards; (vi) foundations for structures of buildings being reinforced concrete pad foundations with piled foundations employed in locations where the ground is not sufficiently stiff to allow for pad foundations; (vii) works to the existing irrigation system and works to alter the position and extent of such irrigation system; (viii) electrical, gas, water, foul water drainage and telecommunications infrastructure connections and works to, and works to alter the position of, such services and utilities connections; (ix) works to alter the course of, or otherwise interfere with, non-navigable rivers, streams or watercourses; (x) surface water drainage systems, storm water attenuation systems including storage basins, oil water separators, including channelling and culverting and works to existing drainage systems; (xi) site establishments and preparation works including site clearance (including vegetation removal, demolition of existing buildings and structures); earthworks (including soil stripping and storage and site levelling) and excavations; the alteration of the position of services and utilities; and works for the protection of buildings and land;		

Proposed Development Component	Parameter Type	Design Principles
(xii) landscaping and other works to mitigate any adverse effects of the construction, maintenance or operation of the authorised development; and (xiii) tunnelling, boring and drilling works, and further associated development comprising such other works or operations as may be necessary or expedient for the purposes of or in connection with the construction, operation and maintenance of the authorised development but only within the Order limits and insofar as they are unlikely to give rise to any materially new or materially different environmental effects from those assessed in the environmental statement.		
Fencing	Location	Fencing will be located within the limits of deviation of Work No.1-10 as shown on the **Works Plan** (document reference 2.2).
	Scale	Fencing around the Energy Park will not exceed 3m in height AGL.
	Design	Fencing to be a welded metal mesh fence design, or deer fencing assessed with wooden post supports and metal stock fencing. Clearances above ground, or the inclusion of mammal gates, will be included to permit the passage of wildlife.
	Location	All fencing will be a minimum of 15m from all National Grid overhead line (OHL) tower bases.
Security measures including CCTV and lighting	Location	Security measures will be located within the limits of deviation of Work No.1-10 as shown on the **Works Plan** (document reference 2.2).
	Scale	CCTV towers will not exceed 3.5m in height and will up to 620 in number.
	Design	CCTV lighting will be infrared (not visible) during hours of darkness.
	Design	No lighting will be permanently operated.

1.3 APPENDIX 1: FIELD DATA

1.3.1 **Table 1.12** sets out the total area of each of the 32 fields and the maximum surface area of solar PV panels in each field (to the nearest 1 metre) in order to limit the maximum coverage of solar PV panels included in the Proposed Development. The field reference numbers in **Table 1.12** are linked to **Figure 1.4- Field Plan** (document reference 6.2.1).

1.3.2 In order to derive a maximum surface area of PV Panels within each field, a hypothetical row spacing of up to 3 metres has been used in order to demonstrate a realistic minimum row spacing for the chosen PV Table arrangement. This arrangement represents a realistic worst case maximum coverage of Solar PV Panels (derived by multiplying the number of PV Panels by the surface area of a single PV Panel) which is secured by this document and cannot be exceeded.

Table 1.12: Maximum Coverage of PV Panels within each Field

Field	Area of Field (ha)	Maximum Surface Area of Solar PV Modules within Field (ha)	Fenced Area (ha)	Actual Surface Area of Solar PV Modules within Field (ha)
G4	12.22	6.84	9.77	5.61
G5	3.84	2.25	3.21	1.74
G6	5.87	3.26	4.66	2.62
G7	27.5	17.62	25.16	14.59
G9	7.42	4.57	6.53	3.79
G10	11.4	7.08	10.11	5.83
G11	7.62	2.98	4.26	2.27
G12	15.7	9.45	13.50	7.81
G13	5.67	2.54	3.63	2.03
G14	9.9	5.37	7.68	4.45
G15	7.84	4.29	6.13	3.55
G16	7.39	4.31	6.16	3.38

Field	Area of Field (ha)	Maximum Surface Area of Solar PV Modules within Field (ha)	Fenced Area (ha)	Actual Surface Area of Solar PV Modules within Field (ha)
G17	8.1	4.81	6.88	3.92
G18	13.58	7.52	10.75	6.37
G19	20.85	8.76	12.52	7.40
G20	7.48	4.70	6.72	3.41
G21	7.45	4.38	6.26	3.54
G23	7.34	4.24	6.05	3.38
SH1	36	25.15	35.93	21.14
SH2	47.21	31.70	45.28	26.81
SH4	17.66	8.76	12.51	7.20
SH5	8.67	5.71	8.15	4.61
SH6+SH7	10.91	6.65	9.50	5.35
SH8	36.74	16.67	23.81	14.02
SH9	35.78	24.52	35.03	19.93
SH10	17.58	11.22	16.03	9.18
SH11	17.48	11.51	16.45	9.43
SH12	16.48	11.06	15.80	8.86
SH13	13.74	9.16	13.08	7.09
SH14	28.92	17.32	24.74	14.06
SH15	12.18	7.55	10.78	6.16