



# SOLAR & ANEROBIC DIGESTION

## Capabilities

### Solar Generation Schemes

#### Feasibility

Kedvale Consultants has participated in the connection of a significant number of schemes ranging from some 2MW connected at 11kV to 30MW connected at 66kV. We have acted on behalf of the solar developer and on behalf of independent connection providers to provide complete system design and connections in accordance with host DNO standards.

- Earthing design
- Connection determination
- Determination of Fault levels
- Determination of flicker and voltage suppression
- Harmonic analysis
- Primary switchgear selection
- Secondary switchgear selection
- Key line diagram
- Protection and control apparatus
- LVAC and DC systems.
- Cable selection.
- Cost model and contracting strategies

KCL are able to engage DNOs and TSOs in dialogue so as to ensure client's schemes are engineered fit for the purpose for which the client intends them and that there is no betterment of extraneous systems at the clients expense.

#### Plant Performance Criterion

The parameterisation of the electrical apparatus is paramount and Kedvale Consultants are able undertake sophisticated electrical network analysis using industry recognized software tools to predict various system criterion such as:-

- Fault Level & Load Flow
- Transient stability to ensure compliance with Engineering Recommendation P28
- Harmonic Penetration Levels to ensure compliance with Engineering Recommendation G5/4.
- Distribution System Losses and plant optimisation.
- Protection Coordination to select protection settings.

Kedvale are able to scrutinise developer schemes to ensure that the overall system is able to interface with the host DNO without significant issues ensuring seamless commissioning.

#### Witches Farm Hoarwithy, Herefordshire

Kedvale consultants were appointed by the Independent Connections Provider (ICP) GEW<sup>2</sup> to provide the connection design which constituted a "tee off" from a 66kV overhead line. Kedvale established the circuit topology and then went on to establish plant ratings and to deploy a protection scheme provide rapid fault disconnection.

Kedvale's scope of work was as follows:-

- Production of Scheme single line diagram
- Substation Layout
- Plant specification
- Earthing Design
- Protection Design
- Plant Interlocking Design
- Fault Level Calculations

- Preparation of Multicore Schedules
- Core Sheets for connections

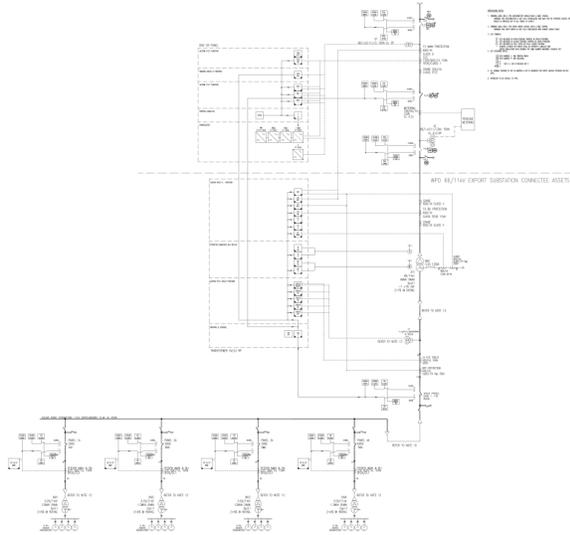


Figure 1 Single Line Diagram

### Williams Farm Solar Project

Kedvale Consultants was appointed as designer for the connections work to be undertaken by GEW2 who are an independent connections provider based in the East Midlands. Kedvale's remit was to facilitate a full design commensurate with Scottish Power (Manweb) standards, and to integrate the solar park into the DNO network through a secondary 33kV switchboard, to be procured via the solar developer.

Williams Solar Park is a 25MW solar farm connected to the Manweb 33kV overhead line systems near Wrexham. The connection was effected by turning in a 33kV overhead line circuit. Each OHL line feeder was connected to a 33kV ring feeder panel on a three panel 33kV switchboard. The third circuit breaker on the switchboard was connected to customers secondary 33kV switchgear.

Kedvale expedited the civil engineering design and full electrical design in a fast paced programme driven by the need to commission the site in advance of the withdrawal of the ROCs by the government at the end of the financial year.

The DNO substation was accommodated in a purpose designed and built concrete raft and brick

masonry structure with precast concrete roof. The substation is cut into the adjoining relief to form a flat and level construction site, there was a significant amount of spoil removed.

The substation included 110 and 48V DC battery and charging systems together with associated distribution, SCADA outstation, fiscal metering, LVAC systems and protection systems.

Kedvale Consultants provided technical specifications to enable the procurement of all electrical apparatus. We also received all vendor drawings and commercial offers and scrutinised the same to ensure technical compliance. Once in receipt of the vendors design Kedvale Consultants provided a full integrated design package to facilitate site installation, including multicore cable schedules and core sheets for cable terminations.

For this particular project due to its fast pace we also produced a full commissioning plan with project customised test sheets which were issued to the incumbent DNO for approval and then to the Commissioning Engineer for completion contemporaneous with the site commissioning progress.



Figure 2 Civil Engineering Works, Foundation and Slab Complete



Figure 3 Completion of Superstructure



Figure 4 View of Three Panel 33kV Switchgear



Figure 5 Interior of 33kV Substation Showing Various Apparatus

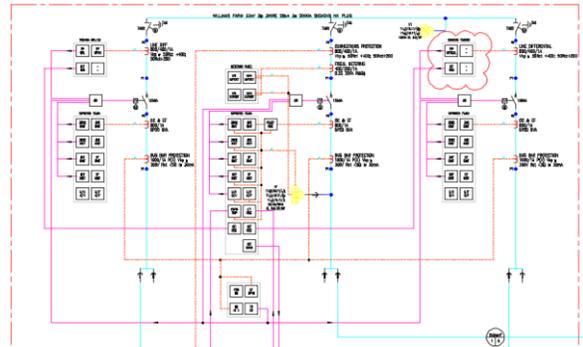


Figure 6 Main Protection & Connections Diagram for Manweb 33kV Board

Kedvale consultants prepared the Commissioning plan including all test sheets to be completed by the commissioning Engineers and obtained prior approval before testing commenced.

#### Eaglescliffe

Eaglescliffe was a small 5MW solar PV installation embedded into a private industrial 11kV ring system operated by Tetley Beveridges in the North East of England. The connection to the private ring was effected by means of an 11kV ring main unit with integral metering transformers and accommodated within a GRP enclosure. A radial cable was connected to the solar park developer’s modular substation.

The private network emanated from a three panel 11kV Reyrolle LMT metalclad switchboard dating from the late 1960s or early 1970s feeders were protected by Reyrolle induction disc relays. The protection on the RMU tee of had to be graded with the electromechanical relays located on the private ring feeders which proved a challenge.

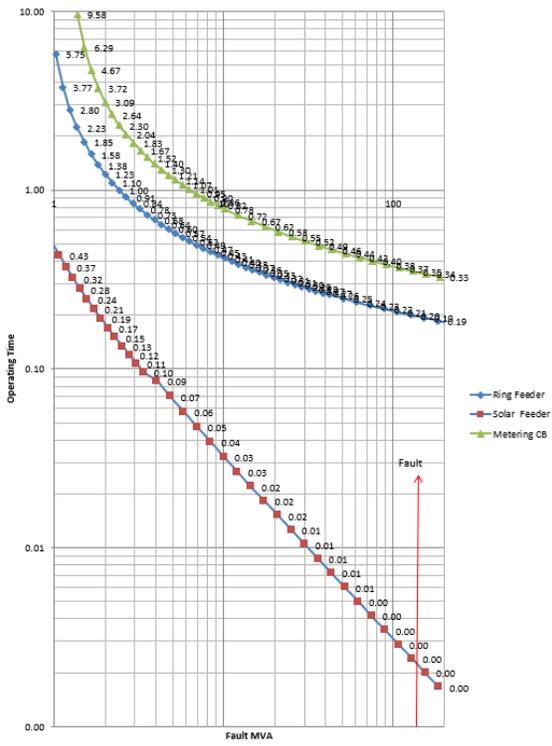


Figure 7 Relay Grading Study



Figure 8 Metering RMU at Eaglescliffe



Figure 9 Operating Facia of RMU at Eaglescliffe

### Other Solar Projects

Other solar energy projects undertaken by Kedvale Consultants include:-

- Monty's Court Farm Somerset
- Manmoel South Wales
- Potters Bar Hertfordshire
- Upper Meadowley
- Bratton Flemming
- Workington
- Bryncrynan

### Anaerobic Digestion

Kedvale Consultants has been retained by the Apsley Estate near Andover Hampshire to review and prepare electrical designs to facilitate the installation of a substantial anaerobic digestion plant and expansion of same. The plant concerned produces gas for injection into the gas grid and produces process electrical power as part of the process with a limited capacity to export extra power into the DNO 11kV overhead line network.

The electrical infrastructure comprises two biogas engines producing 1.1MW at 400V, the majority of this power is consumed by the process of gas production and hence substantially diminishes the import power from the DNO. The plant is connected via 11/0.4kV 800kVA transformer to a private 11kV ring main unit to facilitate switching and protection. The interface with the DNO is a metering RMU connected between the private network and the DNO 11kV system. A 400V 1000kVA diesel generator is used to provide emergency shutdown power in the event of a loss of grid situation. All generators and the 400V incomer are equipped with ENA Engineering Recommendation G59 protection.

### Anaerobic Digestion Power Quality

Kedvale Consultants Ltd were approached by Trevasse Farms who had a AD plant installed with a unit capable of exporting 500kW at 400V. The DNO supplied the consumer by means of an extensive 11kV overhead line feeder with significant two phase loads connected for rural consumers. In the winter period the connected load increased by virtue of on and off-peak heating. The result was that in the winter there was significant negative phase sequence currents brought about by the load imbalance.

The above issues caused nuisance tripping of the generator and periods of constraint affecting revenue earning capability.

The incumbent DNO sought to resolve the issue by means of the installation of two 11kV regulating transformers between phases and to be pole mounted on the 11kV OHL. Despite a DNO estimate in excess of £120,000 the offer explicitly excluded a guarantee that the solution would resolve the power supply quality issues.

Kedvale consultants were approached to review the solution and ascertain if there was an economically viable alternative. KCL held a consultation meeting with the DNO to ascertain the level of system modelling that had been expedited in order to underpin the engineering solution. KCL became concerned that the suggested regulator was too slow to be able to respond to system imbalances and the nuisance tripping may well continue.

KCL decided to enter into detailed engineering dialogue with vendor partners to supply a 600kVA 400V Automatic Voltage Regulator with semiconductor switching elements to vastly increase switching response times.

The proposed unit would be ground mounted and would be located in the clients LVAC intake switchroom with minor adaptation in civil engineering. Owing to the unit being LV connected, substantial

savings were realised by being able to provide safety isolations to accord with the Electricity At Work Regulations by means of Competent Electricians, with no necessity for the DNO to provide any safety from the system services.

The new Automatic Voltage Regulator (AVR) was connected between the clients intake LVAC switchboard and the generator. A bypass facility was provided to facilitate maintenance of the AVR system allowing export generation if the DNO system has negative sequence current below the generator protection threshold.

After establishing a full technical specification, obtaining compliant offers a contract for manufacture was placed. KCL was retained to scrutinise all design submissions and to oversee factory acceptance testing in the manufacturers works.

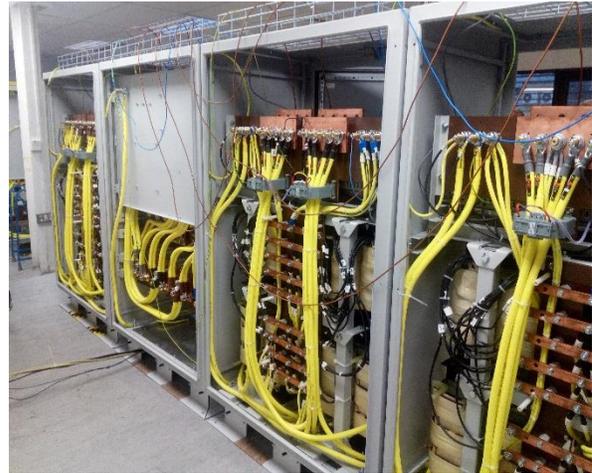


Figure 11 600kVA 400V Buck/Bost Power Electronic Switched AVR.



Figure 10 Popular Pole Top Regulating Transformer

---