Isle Of Wight Renewable Energy Resource Investigation

Review Of Potential For Connection Of Embedded Generation Sources Into Existing Public Electricity Supply Distribution System

March 2011

Prepared for:
Jim Fawcett (Isle Of Wight Council)
Enterprise House
St. Cross Business Park
Newport
Isle of Wight
PO30 5WB

Prepared by:
Grontmij
41 Corn Street
Bristol
BS1 1HS

T +44 (0)117 927 8850
F +44 (0)117 927 8888
E john.evans@grontmij.co.uk

Report Status:	Final dated 12/11/10 amended in accordance with client request	
Job No:	103326	

	Name	Signature	Date
Prepared By:	John Evans	*John Evans*	23 March 2011
Checked By:	Colin Clarke	*Colin Clarke*	23 March 2011
Approved By:	Ed Oborn	*Ed Oborn*	23 March 2011

1 REVISION HISTORY

No.	Description	Author		Checked		Approved	
0	Draught Issue For Review	J Evans					
		Date	07/06/2010	Date		Date	
A	First Issue With Review Comments Incorporated	J Evans		C Clarke		E Oborn	
		Date	15/10/2010	Date	18/10/2010	Date	18/10/2010
B	Second Issue With Client Comments Incorporated	J Evans		C Clarke		E Oborn	
		Date	12/11/2010	Date	15/11/2010	Date	15/11/2010
C	Third Issue With Client Comments Incorporated	J Evans		C Clarke		E Oborn	
		Date	23/3/2011	Date	23/3/2011	Date	23/3/2011

2 SCOPE

As part of an overall study of renewable energy generation development prospects on the Isle of Wight, a review of the existing public electrical distribution system was undertaken to determine the following:

- The extent and capacities of 132kV, 33kV and 11kV overhead line / underground cable networks
- The circuit ratings and fault levels available on existing equipment, and determination of likely extent of equipment replacement / upgrading, or alternative mitigation measures, necessary to accommodate the additional generation capacities proposed
- The locations and arrangements of existing 132kV / 33kV substations and 33kV / 11kV substations, including present provision of spare / future bays
- The quantities and ratings of substation transformers, including identification of tap changer ranges and facilities for system voltage control
- Verification of existing undersea cable connection capacities and investigation of operational constraints
- Understanding of the effects upon the IOW distribution network due to modes of operation of East Cowes power station (standby oil fired open cycle gas turbine power plant, capable of operation as short notice peak lopping / frequency support plant, or as synchronous condenser plant, and possibly as black start-up plant for IOW or mainland power stations)
- Identification of likely locations for future connections from proposed renewable generation schemes, including typical extent of new overhead line / underground cable works and typical footprints of new substations
- Identification of possible locations for future subsea cables, if existing cables unsuited / unavailable for proposed renewable generation scheme output.

3 BACKGROUND

Grontmij were requested by Jim Fawcett (Principal Officer – Environment, Isle of Wight Council) to review the island's electrical distribution system, with a view to identifying whether and where smaller scale renewable generation projects might be connected to the existing distribution network facilities. Scottish & Southern Energy Power Distribution (the distribution network operator serving the Isle of Wight) provided background information and forwarded the detailed Long Term Development Statement document covering the years 2009 to 2014, from which much of the following data is derived.

4 REFERENCE DOCUMENTATION

- Long Term Development Statement for Southern Electric Power Distribution plc's Electricity Distribution System (November 2009) – available on request from Southern Electric Power Distribution plc:
  http://www.ssepd.co.uk/LTDs
- The Distribution Code (November 2010) – available to download from:
  http://www.energynetworks.info/dcode-homepage/
- The Grid Code (October 2010) – available to download from:
  http://www.nationalgrid.com/uk/Electricity/Codes/gridcode/
- Standard Conditions of the Electricity Distribution License – available to download from:
  http://www.ssepd.co.uk/SSEInternet/uploadedFiles/Power_Distribution/Technical_and_Professional_Information/ConsolidatedDistributionLicenseConditions.pdf
- Statement of Methodology and Charges for Connection to Southern Electric Power Distribution PLC's Electricity Distribution System:
  http://www.ssepd.co.uk/SSEInternet/uploadedFiles/Power_Distribution/Technical_information/Charging_statements_and_look-up_tables_2009-2010/SEPD_charging_statements_and_look-up_tables_2010-11/Doc1.pdf
- Preliminary distribution network expansion and reinforcement proposals considered by Southern Electric Power Distribution plc network planning department in response to Isle of Wight Council enquiries (October 2008)

5 GLOSSARY OF TERMS

- Fault level – measure of the energy (strictly apparent power) that is available at the location of a fault (short circuit between conductors or between conductor and earth) on an electrical distribution system
- MW_e – generator electrical output - real (active) power, expressed in megawatts, representing the revenue earning potential of a generating source
- MVA – network circuit rating - apparent power, expressed in megavoltamperes, representing the transport capacity of the various elements of a public electrical power distribution system
- pf – power factor, expressed as a unitless value – the ratio of real power to apparent power

Generally, the capacity of electrical distribution circuits are described in terms of MVA, since the circuit components (typically overhead lines, underground cables, transformers and switchgear) are rated at a design current at a nominal voltage, without reference to the circuit power factor. However, generators are usually described in terms of both MW_e and MVA with a defined power factor, since generators are normally required to contribute to the demand for imaginary (reactive) power (an overhead necessary to excite and sustain the electromagnetic elements of the distribution network and consumer loads, expressed in megavoltamperes reactive), in addition to the revenue earning real (active) power output. In this respect, the power factor represents the proportion of the generation source rating that can be dedicated to revenue earning – typically, developers will aim to achieve unity power factor, attempting to utilise the entire capacity of the generation source for the derivation of revenue. However, dependent upon the connection agreement in place, and as required by the Distribution Code (and the Grid Code, if applicable), the generation source may be required to operate at a power factor below unity, in order to contribute to the demand for imaginary (reactive) power.

- Circuit breaker – circuit switching device capable of operating under fault conditions, usually called on to interrupt incipient fault currents, but occasionally called upon to energise previously faulted circuits
- Circuit breaker making capacity – the maximum fault level that a circuit breaker can successfully close onto without destruction, expressed in kiloamperes (kA).
- Circuit breaker breaking capacity – the maximum fault level that a circuit breaker can successfully interrupt without destruction, expressed in kiloamperes (kA).

The fault levels of the existing distribution network are calculated at all substations to ensure that the making and breaking capacities of the installed switchgear are not exceeded under the worst case fault conditions that can occur on the distribution network. The feasibility for addition of renewable generation sources to the existing network, and the choice of network voltage level to which generation export connections may be made, will be governed in part by the available margin for increase in fault levels, due to the contributions from the additional generation sources.

- Busbars – distribution conductors common to numerous circuits, usually found in switchgear assemblies and substations
- Cable – assembly of fully insulated conductors within overall protective sleeve, generally for installation underground or underwater
- Line – arrangement of uninsulated conductors relying upon separation in air for insulation purposes, generally for installation on overhead poles or pylons
- Transformer – electromagnetic coupling device used to allow transfer of electrical power between distribution networks operating at different voltage levels
- Substation – installation comprising distribution network switchgear, usually of two voltage levels, interconnected by transformers
- Switchgear – assembly of busbars and circuit switching apparatus (usually circuit breakers) with isolation, earthing and measuring facilities
- Tee joint – simple mechanical joint to connect a branch conductor into a continuous conductor, forming a three way connection (two in, one out or one in, two out)

6 OVERVIEW

The public electricity supply on the Isle of Wight is the responsibility of the Southern Electric business of Scottish and Southern Energy Power Distribution, as statutory distribution network operator. Southern Electric own and operate the 132kV, 33kV and 11kV distribution infrastructure, with the exception of the assets associated with East Cowes power station (RWE npower ownership) and Arreton Nurseries combined heat and power plant (Wight Salads ownership). A map showing the general locations of the various substations and a simplified single diagram of the existing network are included in the accompanying drawings – see diagrams 1, 2 and 3 in Appendix 1.

6.1 132kV System

The Isle of Wight is supplied from the Southern Electric primary substation at Fawley, via an intermediate substation at Langley, by three 132kV circuits. Each of the three 132kV circuits comprises a submarine cable section beneath the Solent, with an underground cable section on the Isle of Wight and an overhead line section on the mainland. Each of the three circuits is rated at 124MVA (winter) / 99MVA (summer), with two of the circuits terminating at Wootton Common 132kV / 33kV substation, and the third circuit terminating at East Cowes 132kV / 33kV substation. A 132kV overhead line serves as an interconnector circuit between Wootton Common substation and East Cowes substation, rated at 125MVA (winter) / 80MVA (summer). All three circuits are normally in service, and the 132kV system normally operates with all elements interconnected.

The 132kV system on the island serves four 132kV / 33kV distribution transformers – two 90MVA units located at Wootton Common substation, and two 45MVA units located at East Cowes substation. All four transformers are of vector group YNd1, and are equipped with on-load tap changers on the 132kV windings, each having a -20% to +10% range. Earthing transformers are provided for the 33kV distribution network at both Wootton Common substation and East Cowes substation, and it is understood that the star points of the earthing transformers are resistance earthed.

The island demand typically varies between a minimum of approximately 40MVA and a maximum of approximately 130MVA, which normally results in the Isle of Wight importing electrical power from the mainland.

The 132kV switchgear at Wootton Common substation is rated at 78.8kA peak making capacity and 31.5kA rms breaking capacity for three phase fault conditions, and is presently subject to three phase fault levels of 32.61kA peak make and 13.21kA rms break. The 132kV switchgear at Wootton Common substation is rated at 100kA peak making capacity and 40kA rms breaking capacity for single phase fault conditions, and is presently subject to single phase fault levels of 18.09kA peak make and 14.77kA rms break.

The 132kV switchgear at East Cowes substation is rated at 54.5kA peak making capacity and 21.8kA rms breaking capacity for three phase fault conditions, and is presently subject to three phase fault levels of 33.96kA peak make and 13.68kA rms break. The 132kV switchgear at East Cowes substation is rated at 78.8kA peak making capacity and 31.5kA rms breaking capacity for single phase fault conditions, and is presently subject to single phase fault levels of 19.58 kA peak make and 15.63kA rms break.

A simplified single diagram of the existing 132kV network showing the existing equipment ratings and 2014 load demands is included in the accompanying drawings – see diagrams 2 and 4 in Appendix 1.

6.2 Existing Generation Facilities

There are presently two significant sources of generation on the Isle of Wight.

East Cowes power station, comprising two $70MW_e$ open cycle gas turbine driven generators burning fuel oil, operates on an infrequent and intermittent basis only, for peak lopping, frequency support, reserve margin maintenance and allied duties. East Cowes power station is connected to the 132kV distribution network at East Cowes substation, via two RWE npower-owned 11.4kV / 132kV generator step-up transformers at East Cowes power station, each rated at approximately 90MVA. East Cowes power station is licensed for operation under the requirements of the Distribution Code and the Grid Code.

Arreton combined heat and power plant, comprising a distributed collection of eight (originally eighteen) $2MW_e$ spark ignition gas engine driven generators burning natural gas, operates on a continuous basis, though the electrical output is likely to be process-led, as the plant primarily serves the heat, overnight lighting and CO_2 demand requirements for the nursery glasshouse complex. Arreton combined heat and power plant is connected to the 33kV distribution network via a tee-joint in the Wootton Common / Ventnor 33kV circuit, via a Wight Salads-owned 11kV / 33kV step-up transformer (rating unknown). Arreton combined heat and power plant is licensed for operation under the requirements of the Distribution Code.

There are two further, smaller sources of embedded generation, either presently connected to the Isle of Wight electrical distribution network, or identified as future connections, according to the Long Term Development Statement:

A 1.8MW wind turbine driven generator at Shalfleet substation – this is a proposed connection at 11kV, for which planning permission has been gained, but construction is yet to commence.
A 1.3MW diesel engine driven generator at Ryde substation – this is connected at 11kV, but no further details have been verified in respect of the current status of this installation.

There are also two further generation schemes not mentioned in the Long Term Development Statement:

A 2.3MW steam turbine generator within the waste-to-energy gasification plant installed at the Resource Recovery Facility, located at Forest Park (OS reference 447127, 089740 (WGS84 co-ordinates 50.705404,-1.333979)). It is understood that this scheme is connected at 11kV into Newport substation.

A landfill gas scheme at Standen Heath – this is a proposed scheme, for which details of the electrical output have not been verified. It is likely that this scheme would include a steam turbine generator and be connected at 11kV.

6.3 33kV System

Primary power distribution on the Isle of Wight is effected at 33kV, via ten primary substations and an associated distribution network comprising predominantly overhead lines in rural areas and on the outskirts of built-up areas, with a small extent of underground cabling to terminal connections located within built-up areas. Additionally, there are three further substations under Network Rail ownership, supplying the island railway electrical traction system from the 33kV network. The island 33kV network is supplied from Wootton Common 132kV / 33kV substation and from East Cowes 132kV / 33kV substation, with an additional contribution from the Arreton combined heat and power plant, as described elsewhere in this document. The 33kV distribution network is normally operated with all circuits in service and with all elements interconnected, with the exception of the bus section switch at Sandown substation busbar, which is normally kept open, and would only be closed during abnormal network operating conditions.

A simplified single diagram of the existing 33kV network showing the existing equipment ratings and 2014 load demands is included in the accompanying drawings – see diagrams 2 and 5 in Appendix 1.

6.3.1 Wootton Common Substation

Wootton Common 33kV substation is an outdoor substation presently configured with eight interconnection circuits, with two of the interconnection circuits derived via a tee joint in the vicinity of the substation. There are no 33kV / 11kV transformers at Wootton Common substation. The 33kV circuits, with summer circuit ratings, are:

- **a. Arreton 33kV Substation Interconnector (Tee Joint)** – 35MVA
- **b. Binstead 33kV Substation Interconnector No.1 (Tee Joint)** – 35MVA
- **c. Binstead 33kV Substation Interconnector No.2 (Tee Joint)** – 35MVA
- **d. East Cowes 33kV Substation Interconnector No.1** – 25MVA
- **e. East Cowes 33kV Substation Interconnector No.2** – 25MVA
- **f. Newport 33kV Substation Interconnector No.1** – 25MVA
- **g. Newport 33kV Substation Interconnector No.2** – 25MVA
- **h. Sandown 33kV Substation Interconnector (Tee Joint)** – 24MVA
- **i. (Shared Interconnector – Tee Joint)** – 35MVA
- **j. (Tee Joint To) Newport 33kV Substation Interconnector** – 23MVA
- **k. (Tee Joint To) Ventnor 33kV Substation Interconnector** – 25MVA

The 33kV switchgear at Wootton Common substation is rated at 44.6kA peak making capacity and 17.5kA rms breaking capacity for three phase fault conditions, and is presently subject to a three phase fault level of 16.835kA rms break. The corresponding fault level margins are:

Making Capacity	**(not available)**
Breaking Capacity	**0.665kA rms**

Practically, a margin as low as 0.665kA on breaking capacity indicates that the existing 33kV switchgear at Wootton Common cannot accept any further increase in fault level. Any proposals to install generation sources on the island either to be connected at 33kV or to be connected in the vicinity of Wootton Common substation are likely to have an impact on the fault level margins at Wootton Common substation, and may require the replacement of the existing switchgear at Wootton Common substation. There may be some mitigation available due to the reduction in quantity of combined heat and power generation units at the Wight Salads complex at Arreton from eighteen to eight, dependent upon the fault contribution attributed to the original complement of Arreton generators and the fault contribution that is attributed to the revised complement for network planning purposes.

Wootton Common substation is the central distribution substation for the Isle of Wight 33kV system, with two incoming cable circuits from the mainland 132kV system and reinforcement connections to East Cowes substation at both 132kV and 33kV. The 33kV substation makes extensive use of overhead busbar connections, but it is not clear whether any spare bays are currently available within the existing substation plot and busbar arrangement.

Wootton Common 33kV substation is located in a rural location, at OS reference 452770, 090349 (WGS84 co-ordinates 50.710391,-1.25398). It is unlikely that any increase in the quantity of 132kV or 33kV circuits could be accommodated within the footprint of the present substation. In particular, the arrangement of the 33kV busbars (two main busbars wrapped around a reserve busbar) makes the addition of further circuits over the original design complement a difficult prospect within the confines of the established site. However, there is potential for expansion of the substation site beyond its present curtilage, should the need arise and the adjoining land be made available.

6.3.2 East Cowes Substation

East Cowes 33kV substation is an outdoor busbar substation presently configured with four interconnection circuits (two of which converge to a single circuit at a subsidiary busbar in the vicinity of the substation) and two transformer feeder circuits. There are two 30MVA 33kV / 11kV distribution transformers at East Cowes substation. Both transformers are of vector group Dyn11, and are equipped with on-load tap changers on the 33kV windings, each having a -17% to +6% range (to be confirmed). The star points of the transformers are resistance earthed. The 33kV circuits, with summer circuit ratings and 2014 transformer demands, are:

a. **East Cowes 11kV Substation Feeder No.1 (Transformer No.1) – 23.1MVA**
b. **East Cowes 11kV Substation Feeder No.2 (Transformer No.2) – 23.1MVA**
c. **Shalfleet 33kV Substation No.1 Interconnector (To Common Busbar) – 25MVA**
d. **Shalfleet 33kV Substation No.2 Interconnector (To Common Busbar) – 25MVA**
e. **(Common Busbar To) Shalfleet 33kV Substation Interconnector – 24MVA**
f. **Wootton Common 33kV Substation No.1 – 25MVA**
g. **Wootton Common 33kV Substation No.2 – 25MVA**

The 33kV switchgear at East Cowes substation is rated at 44.6kA peak making capacity and 17.5kA rms breaking capacity for three phase fault conditions, and is presently subject to a three phase fault level of 16.107kA rms break. The corresponding fault level margins are:

Making Capacity	**2.4kA peak**
Breaking Capacity	**1.393kA rms**

East Cowes substation is a significant distribution substation for the Isle of Wight 33kV system, with one incoming cable circuit from the mainland 132kV system and reinforcement connections to Wootton Common substation at both 132kV and 33kV. East Cowes substation is also the point of connection for East Cowes power station. The 33kV substation makes extensive use of overhead busbar connections, but it is not clear whether any spare bays are currently available within the existing substation plot and busbar arrangement.

East Cowes 33kV substation is located in a semi-rural / industrial location, at OS reference 450508, 094315 (WGS84 co-ordinates 50.746252,-1.285473). It is unlikely that any increase in the quantity of 132kV or 33kV circuits could be accommodated within the footprint of the present substation. In particular, the arrangement of the 33kV busbars (two main busbars wrapped around a reserve busbar) makes the addition of further circuits over the original design complement a difficult prospect within the confines of the established site. However, there is potential for expansion of the substation site beyond its present curtilage, should the need arise and the adjoining land be made available.

6.3.3 Newport Substation

Newport 33kV substation is an outdoor substation presently configured with four interconnection circuits and three transformer feeder circuits. There are three 30MVA 33kV / 11kV distribution transformers at Newport substation. All three transformers are of vector group Dyn11, and are equipped with on-load tap changers on the 33kV windings, each having a -17% to +6% range. The star points of the transformers are resistance earthed. The 33kV circuits, with summer circuit ratings and 2014 transformer demands, are:

a. **Newport 11kV Substation Feeder No.1 (Transformer No.1) – 31.38MVA**
b. **Newport 11kV Substation Feeder No.2 (Transformer No.2) – 31.38MVA**
c. **Newport 11kV Substation Feeder No.3 (Transformer No.3) – 31.38MVA**
d. **Shalfleet 33kV Substation Interconnector – 17MVA**
e. **Wootton Common 33kV Substation No.1 Interconnector – 25MVA**
f. **Wootton Common 33kV Substation No.2 Interconnector – 25MVA**
g. **Wootton Common 33kV Substation Interconnector (Tee Joint) – 23MVA**

No 33kV circuit breakers are installed at Newport substation.

Newport 33kV substation is located in a built-up location, at OS reference 450081, 089561 (WGS84 co-ordinates 50.703542,-1.292173). The substation has been recently expanded by the addition of the third 30MVA transformer, and there is little prospect for further expansion of the substation site due to the built-up nature of the substation location.

6.3.4 Ryde Substation

Ryde 33kV substation is an outdoor substation presently configured with two interconnection circuits and two transformer feeder circuits. There are two 30MVA 33kV / 11kV distribution transformers at Ryde substation. Both transformers are of vector group Dyn11, and are equipped with on-load tap changers on the 33kV windings, each having a -17% to +6% range. The star points of the transformers are resistance earthed. The 33kV circuits, with summer circuit ratings and 2014 transformer demands, are:

a. **Ryde 11kV Substation Feeder No.1 (Transformer No.1) – 19.71MVA**
b. **Ryde 11kV Substation Feeder No.2 (Transformer No.2) – 19.71MVA**
c. **Network Rail Rowborough 33kV Substation Interconnector (Tee Joint) – 35MVA**
d. **Network Rail Ryde St. John 33kV Substation Interconnector (Tee Joint) – 35MVA**

No 33kV circuit breakers are installed at Ryde substation.

Ryde 33kV substation is located in a built-up location, at OS reference 459538, 0919691 (WGS84 co-ordinates 50.724309,-1.157879). There is little prospect for further expansion of the substation site due to the built-up nature of the substation location.

6.3.5 Shanklin Substation

Shanklin 33kV substation is an outdoor substation presently configured with two interconnection circuits and two transformer feeder circuits. There are two 30MVA 33kV / 11kV distribution transformers at Shanklin substation. Both transformers are of vector group Dyn11, and are equipped with on-load tap changers on the 33kV windings, each having a -10% to +3% range. The star points of the transformers are resistance earthed. The 33kV circuits, with summer circuit ratings and 2014 transformer demands, are:

a. **Shanklin 11kV Substation Feeder No.1 (Transformer No.1) – 13.55MVA**
b. **Shanklin 11kV Substation Feeder No.2 (Transformer No.2) – 13.55MVA**
c. **Sandown 33kV Substation Interconnector (Tee Joint) – 24MVA**
d. **Ventnor 33kV Substation Interconnector (Tee Joint) – 25MVA**

No 33kV circuit breakers are installed at Shanklin substation.

Shanklin 33kV substation is located in a built-up location, at OS reference 457811, 081924 (WGS84 co-ordinates 50.634154,-1.183904). There is little prospect for further expansion of the substation site due to the built-up nature of the substation location.

6.3.6 Ventnor Substation

Ventnor 33kV substation is an outdoor substation presently configured with four interconnection circuits and two transformer feeder circuits, derived via two tee joints in the vicinity of the substation. There are two 30MVA 33kV / 11kV distribution transformers at Ventnor substation. Both transformers are of vector group Dyn11, and are equipped with on-load tap changers on the 33kV windings, each having a -17% to +6% range. The star points of the transformers are resistance earthed. The 33kV circuits, with summer circuit ratings and 2014 transformer demands, are:

a. **Arreton 33kV Substation (Tee Joint) Interconnector (Tee Joint) – 25MVA**
b. **Sandown 33kV Substation Interconnector (Tee Joint) – 25MVA**
c. **Shanklin 33kV Substation Interconnector (Tee Joint) – 25MVA**
d. **Ventnor 11kV Substation Feeder No.1 (Transformer No.1) (Tee Joint) – 10.88MVA (17MVA circuit rating)**
e. **Ventnor 11kV Substation Feeder No.2 (Transformer No.2) (Tee Joint) – 10.88MVA (17MVA circuit rating)**
f. **Wootton Common 33kV Substation Interconnector (Tee Joint) – 25MVA**

No 33kV circuit breakers are installed at Shanklin substation.

Ventnor 33kV substation is located in a built-up location, at OS reference 456123, 077539 (WGS84 co-ordinates 50.597573,-1.208141). There is little prospect for further expansion of the substation site due to the built-up nature of the substation location.

6.3.7 Sandown Substation

Sandown 33kV substation is an outdoor substation presently configured with five interconnection circuits and two transformer feeder circuits, with two of the interconnection circuits derived via a tee joint in the vicinity of the substation. There are two 15MVA 33kV / 11kV distribution transformers at Sandown substation. Both transformers are of vector group Dyn11, and are equipped with on-load tap changers on the 33kV windings, each having a -15% to +5% range. The star points of the transformers are resistance earthed. The 33kV circuits, with summer circuit ratings and 2014 transformer demands, are:

a. **Network Rail Sandown 33kV Substation Interconnector – 22MVA**
b. **Sandown 11kV Substation Feeder No.1 (Transformer No.1) – 13.55MVA**
c. **Sandown 11kV Substation Feeder No.2 (Transformer No.2) – 13.55MVA**
d. **Ventnor 33kV Substation (Tee Joint) Interconnector – 25MVA**
e. **Wootton Common 33kV Substation Interconnector (Tee Joint) – 25MVA**
f. **(Shared Interconnector – Tee Joint) – 25MVA**
g. **(Tee Joint To) Shanklin 33kV Substation Interconnector – 24MVA**
h. **(Tee Joint To) Wootton Common 33kV Substation Interconnector – 24MVA**

No 33kV circuit breakers are installed at Sandown substation.

Sandown 33kV substation is located in a built-up location, at OS reference 459896, 085063 (WGS84 co-ordinates 50.662175,-1.153927). There is little prospect for further expansion of the substation site due to the built-up nature of the substation location.

6.3.8 Freshwater Substation

Freshwater 33kV substation is an outdoor substation presently configured with two interconnection circuits and two transformer feeder circuits. There are two 15MVA 33kV / 11kV distribution transformers at Freshwater substation. Both transformers are of vector group Dyn11, and are equipped with on-load tap changers on the 33kV windings, each having a -17% to +6% range. The star points of the transformers are resistance earthed. The 33kV circuits, with summer circuit ratings and 2014 transformer demands, are:

a. **Freshwater 11kV Substation Feeder No.1 (Transformer No.1) – 7.42MVA**
b. **Freshwater 11kV Substation Feeder No.2 (Transformer No.2) – 7.42MVA**
c. **Shalfleet 33kV Substation Interconnector No.1 – 25MVA**
d. **Shalfleet 33kV Substation Interconnector No.2 – 25MVA**

No 33kV circuit breakers are installed at Freshwater substation.

Freshwater 33kV substation is located in a built-up location, at OS reference 434339, 086944 (WGS84 co-ordinates 50.681152,-1.515315). There is little prospect for further expansion of the substation site due to the built-up nature of the substation location.

6.3.9 Binstead Substation

Binstead 33kV substation is an outdoor substation presently configured with four interconnection circuits and two transformer feeder circuits, derived via two tee joints in the vicinity of the substation. There are two 15MVA 33kV / 11kV distribution transformers at Binstead substation. Both transformers are of vector group Dyn11, and are equipped with on-load tap changers on the 33kV windings, each having a -17% to +6% range. The star points of the transformers are resistance earthed. The 33kV circuits, with summer circuit ratings and 2014 transformer demands, are:

a. **Binstead 11kV Substation Feeder No.1 (Transformer No.1) (Tee Joint) – 6.94MVA (25MVA circuit rating)**
b. **Binstead 11kV Substation Feeder No.2 (Transformer No.2) (Tee Joint) – 6.94MVA (32MVA circuit rating)**
c. **Network Rail Rowborough 33kV Substation (Tee Joint) Interconnector (Tee Joint) – 35MVA**
d. **Network Rail Ryde ST. Johns 33kV Substation (Tee Joint) Interconnector (Tee Joint) – 35MVA**
e. **Wootton Common 33kV Substation Interconnector No.1 (Tee Joint) – 35MVA**
f. **Wootton Common 33kV Substation Interconnector No.2 (Tee Joint) – 35MVA**

No 33kV circuit breakers are installed at Binstead substation.

Binstead 33kV substation is located in a rural location, at OS reference 456426, 091393 (WGS84 co-ordinates 50.719435,-1.202044). It is unlikely that any increase in the quantity of 33kV circuits could be accommodated within the footprint of the present substation. However, there is potential for expansion of the substation site, should the need arise and the adjoining land be made available.

6.3.10 Shalfleet Substation

Shalfleet 33kV substation is an outdoor substation presently configured with four interconnection circuits, two transformer feeder circuits and a bus section circuit. There are two 15MVA 33kV / 11kV distribution transformers at Shalfleet substation. Both transformers are of vector group Dyn11, and are equipped with on-load tap changers on the 33kV windings, each having a -10% to +10% range. The star points of the transformers are resistance earthed. The 33kV circuits, with summer circuit ratings and 2014 transformer demands, are:

a. **East Cowes 33kV Substation (Common Busbar) Interconnector – 24MVA**
b. **Freshwater 33kV Substation Interconnector No.1 – 25MVA**
c. **Freshwater 33kV Substation Interconnector No.2 – 25MVA**
d. **Newport 33kV Substation Interconnector – 17MVA**
e. **Shalfleet 11kV Substation Feeder No.1 (Transformer No.1) – 6.94MVA**
f. **Shalfleet 11kV Substation Feeder No.2 (Transformer No.2) – 6.94MVA**

The 33kV switchgear at Shalfleet substation comprises two line circuit breakers on the Freshwater interconnector circuits, plus a bus section circuit breaker. The 33kV switchgear is rated at 33.4kA peak making capacity and 13.1kA rms breaking capacity for three phase fault conditions, and is presently subject to three phase fault levels of 16.9 peak make and 5.8kA rms break. The corresponding fault level margins are:

Making Capacity	**16.5kA peak**
Breaking Capacity	**7.3kA rms**

Shalfleet 33kV substation is located in a rural location, at OS reference 440844, 088624 (WGS84 co-ordinates 50.695836,-1.423065). It is unlikely that any increase in the quantity of 33kV circuits could be accommodated within the footprint of the present substation. However, there is potential for expansion of the substation site, should the need arise and the adjoining land be made available.

6.3.11 Network Rail Rowborough Substation

Network Rail Rowborough 33kV substation is an outdoor substation presently configured with two interconnection circuits and a transformer feeder circuit, derived via a tee joint in the vicinity of the substation. The 33kV circuits, with summer circuit ratings, are:

a. **Binstead 33kV Substation (Tee Joint) Interconnector (Tee Joint) – 35MVA**
b. **Network Rail Rowborough Substation (Tee Joint) – 15MVA**
c. **Ryde 33kV Substation (Tee Joint) Interconnector (Tee Joint) – 35MVA**

Network Rail Rowborough 33kV substation is located in a rural location, at OS reference 460422, 088398 (WGS84 co-ordinates 50.69211,-1.145936). The substation is owned by Network Rail, and is very unlikely to be available for augmentation or expansion, being specifically designed and located for dedicated rail traction supply duty rather than for public electricity supply distribution purposes.

6.3.12 Network Rail Ryde St. Johns Substation

Network Rail Ryde St Johns 33kV substation is an outdoor substation presently configured with two interconnection circuits and a transformer feeder circuit, derived via a tee joint in the vicinity of the substation. The 33kV circuits, with summer circuit ratings, are:

a. **Binstead 33kV Substation (Tee Joint) Interconnector (Tee Joint) – 35MVA**
b. **Network Rail Rowborough Substation (Tee Joint) – 9MVA**
c. **Ryde 33kV Substation (Tee Joint) Interconnector (Tee Joint) – 35MVA**

Network Rail Ryde St. John 33kV substation is located in a built-up location, at OS reference 459571, 091917 (WGS84 co-ordinates 50.723839,-1.157425). The substation is owned by Network Rail, and is very unlikely to be available for augmentation or expansion, being specifically designed and located for dedicated rail traction supply duty rather than for public electricity supply distribution purposes. Additionally, the substation is in close proximity to Ryde substation – see 5.3.4 above.

6.3.13 Network Rail Sandown Substation

Network Rail Sandown 33kV substation is an outdoor substation presently configured with a transformer feeder circuit. The 33kV circuit, with summer circuit ratings, is:

a. **Network Rail Sandown Substation – 22MVA**

Network Rail Sandown 33kV substation is located in a built-up location, at OS reference 459850, 085058 (WGS84 co-ordinates 50.662137,-1.154577). The substation is owned by Network Rail, and is very unlikely to be available for augmentation or expansion, being specifically designed and located for dedicated rail traction supply duty rather than for public electricity supply distribution purposes. Additionally, the substation is in close proximity to Sandown substation – see 5.3.7 above.

6.3.14 Arreton Substation

Arreton 33kV substation is an indoor substation presently configured with a transformer incoming circuit and two interconnection circuits derived via a tee joint in the vicinity of the substation. There is an 11kV / 33kV step-up transformer at Arreton substation, of unknown rating. The 33kV circuits, with summer circuit ratings, are:

a. **(Shared Transformer Infeed – Tee Joint) – 38MVA**
b. **(Tee Joint To) Ventnor 33kV Substation Interconnector – 35MVA**
c. **(Tee Joint To) Wootton Common 33kV Substation Interconnector – 35MVA**

.

Arreton 33kV substation is located in a rural location, at OS reference 454930, 084899 (WGS84 co-ordinates 50.661187,-1.224203). The substation is owned by Wight Salads, and is unlikely to be available for augmentation or expansion. However, there is spare capacity within the step-up transformer rating, due to the reduction in quantity of the combined heat and power units from eighteen to eight, giving a nominal margin of 20MVA, based on the $2MW_e$ combined heat and power unit rating and assuming the transformer is rated for eighteen such units. On the basis that the infrastructure remains for the ten units removed, there may be the possibility of effecting connection at 11kV within the Wight Salads complex, subject to technical feasibility and the appropriate commercial agreements.

6.4 11kV System

With the exception of Wootton Common substation and the three Network Rail Substations, 33kV / 11kV transformers and 11kV distribution switchboards are located at all of the remaining 33kV substation sites, serving the local 11kV distribution systems via overhead lines and underground cables. Overhead line circuits (predominantly for rural distribution) are generally configured as open rings with pole-mounted 11kV / 0.433kV transformers, whereas underground cable circuits (predominantly for urban distribution) are generally configured as open rings with ground mounted 11kV / 0.433kV transformers connected via ring main units.

No information is freely available in the public domain on the quantity, ratings and characteristics of the individual circuits for 11kV substations, as the extent, complexity and ongoing development of the 11kV network is beyond the scope of the published Long Term Development Statement. Such information may be obtained on a chargeable basis from Southern Electric, upon submission of specific request details.

The primary substations on the 11kV system are:

6.4.1 East Cowes Substation

East Cowes 11kV substation is an indoor substation adjacent to the 33kV East Cowes substation, with a firm capacity of 30MVA and a 2014 predicted maximum demand of 23.1MVA. The 11kV switchgear at East Cowes substation is rated at 33.4kA peak making capacity and 13.1kA rms breaking capacity for three phase fault conditions, and is presently subject to three phase fault levels of 24.2kA peak make and 8.4kA rms break. The corresponding fault level margins are:

Making Capacity	**9.2kA peak**
Breaking Capacity	**4.7kA rms**

6.4.2 Newport Substation

Newport 11kV substation is an indoor substation adjacent to the 33kV Newport substation, with a firm capacity of 38MVA and a 2014 predicted maximum demand of 31.38MVA. The 11kV switchgear at Newport substation is rated at 33.4kA peak making capacity and 13.1kA rms breaking capacity for three phase fault conditions, and is presently subject to three phase fault levels of 25.8kA peak make and 9.3kA rms break. The corresponding fault level margins are:

Making Capacity	**7.6kA peak**
Breaking Capacity	**3.8kA rms**

6.4.3 Ryde Substation

Ryde 11kV substation is an indoor substation adjacent to the 33kV Ryde substation, with a firm capacity of 30MVA and a 2014 predicted maximum demand of 19.71MVA. The 11kV switchgear at Ryde substation is rated at 33.4kA peak making capacity and 13.1kA rms breaking capacity for three phase fault conditions, and is presently subject to three phase fault levels of 19.6kA peak make and 7.1kA rms break. The corresponding fault level margins are:

Making Capacity	**13.8kA peak**
Breaking Capacity	**6.0kA rms**

6.4.4 Shanklin Substation

Shanklin 11kV substation is an indoor substation adjacent to the 33kV Shanklin substation, with a firm capacity of 30MVA and a 2014 predicted maximum demand of 13.25MVA. The 11kV switchgear at Shanklin substation is rated at 33.4kA peak making capacity and 13.1kA rms breaking capacity for three phase fault conditions, and is presently subject to three phase fault levels of 16.9kA peak make and 6.5kA rms break. The corresponding fault level margins are:

Making Capacity	**16.5kA peak**
Breaking Capacity	**6.6kA rms**

6.4.5 Ventnor Substation

Ventnor 11kV substation is an indoor substation adjacent to the 33kV Ventnor substation, with a firm capacity of 30MVA and a 2014 predicted maximum demand of 13.55MVA. The 11kV switchgear at Ventnor substation is rated at 33.4kA peak making capacity and 13.1kA rms breaking capacity for three phase fault conditions, and is presently subject to three phase fault levels of 19.7kA peak make and 9.0kA rms break The corresponding fault level margins are:

Making Capacity	**20.3kA peak**
Breaking Capacity	**7.0kA rms**

6.4.6 Sandown Substation

Sandown 11kV substation is an indoor substation adjacent to the 33kV Sandown substation, with a firm capacity of 15MVA and a 2014 predicted maximum demand of 10.88MVA. The 11kV switchgear at Sandown substation is rated at 33.4kA peak making capacity and 13.1kA rms breaking capacity for three phase fault conditions, and is presently subject to three phase fault levels of 16.0kA peak make and 6.4kA rms break. The corresponding fault level margins are:

Making Capacity	**17.4kA peak**
Breaking Capacity	**6.7kA rms**

6.4.7 Freshwater Substation

Freshwater 11kV substation is an indoor substation adjacent to the 33kV Freshwater substation, with a firm capacity of 15MVA and a 2014 predicted maximum demand of 7.42MVA. The 11kV switchgear at Freshwater substation is rated at 33.4kA peak making capacity and 13.1kA rms breaking capacity for three phase fault conditions, and is presently subject to three phase fault levels of 13.6kA peak make and 6.7kA rms break. The corresponding fault level margins are:

Making Capacity	**19.8kA peak**
Breaking Capacity	**7.4kA rms**

6.4.8 Binstead Substation

Binstead 11kV substation is an indoor substation adjacent to the 33kV Binstead substation, with a firm capacity of 15MVA and a 2014 predicted maximum demand of 6.94MVA. The 11kV switchgear at Binstead substation is rated at 33.4kA peak making capacity and 13.1kA rms breaking capacity for three phase fault conditions, and is presently subject to three phase fault levels of 19.0kA peak make and 7.4kA rms break. The corresponding fault level margins are:

Making Capacity	**14.4kA peak**
Breaking Capacity	**5.7kA rms**

6.4.9 Shalfleet Substation

Shalfleet 11kV substation is an indoor substation adjacent to the 33kV Shalfleet substation, with a firm capacity of 15MVA and a 2014 predicted maximum demand of 6.94MVA. The 11kV switchgear at Shalfleet substation is rated at 33.4kA peak making capacity and 13.1kA rms breaking capacity for three phase fault conditions, and is presently subject to three phase fault levels of 16.6kA peak make and 6.6kA rms break. The corresponding fault level margins are:

Making Capacity	**16.8kA peak**
Breaking Capacity	**6.5kA rms**

7 DISCUSSION OF EMBEDDED GENERATION CONNECTION POSSIBILITIES

7.1 General Considerations

The connection of any embedded generation to the public power distribution network in the Isle of Wight requires a detailed analysis of the effects of the proposed generation upon the public power distribution network. Such analysis would generally be undertaken by the network modelling and system planning department within Southern Electric, with contribution from the generation scheme developer, designers and suppliers. Dependent upon the rating and technology of the generation scheme proposed, the extent of analysis will vary, but in all cases will need to examine:

- The steady state loading of the existing distribution network infrastructure, to determine whether the contribution from the proposed embedded generation scheme would cause thermal overloading of the existing distribution circuit and equipment, or would remove margin allowed for future load growth. A first pass estimate of the maximum possible embedded generation capacity that could be connected into each of the existing 33kV distribution circuits is included within this report, to give an indication of the likely potential for connection of generation sources in the range $5MW_e$ to $40MW_e$. The data used to make the estimation is the distribution system minimum (summer) circuit ratings and the 2014 minimum demand loads at the various 33kV substations, as obtained from the Long Term Development Statement appendices. No such data is readily available for performing a similar exercise for the existing 11kV distribution circuits, due to the limitations described in section 5.6, so no equivalent estimate is made in respect of small scale generation schemes connected at 11kV.
- The capability and capacity of the existing primary distribution transformers for handling reverse direction power flow.
- The effect upon system fault levels due to the contribution from the proposed embedded generation scheme, to determine whether the existing distribution network infrastructure could withstand the effects of fault conditions. A first pass estimate of the available fault level margins (make and break) on the existing 11kV and 33kV distribution circuits is included within this report, to give an indication of the likely potential for connection of generation sources up to approximately $40MW_e$. The data used to make the estimation is the distribution system make and break fault levels at the various substations, and the corresponding switchgear making and breaking capacities, as obtained from the Long Term Development Statement appendices.
- The modifications required to the electrical protection scheme for the existing distribution network to accommodate the proposed embedded generation scheme, to ensure that the safety and reliability of the public power distribution network is maintained.
- The effect of the embedded generation capacity upon the system voltage profile of the existing distribution network, to determine the necessary modifications to the voltage control regime.
- The stability of the public power distribution network, when subject to loss of the embedded generation contribution.
- For renewable generation schemes relying upon solar or wind energy sources, the effects of intermittent and broadly unpredictable generation contributions

In respect of connection to the public power distribution network, any embedded generation scheme must comply with the provisions of either Engineering Recommendation G59/2 (for schemes with an electrical output of less than $5MW_e$ connected at 11kV or below) or Engineering Recommendation G75/1(for schemes with an electrical output of more than $5MW_e$ connected at 11kV or above, or for schemes with an electrical output of less than $5MW_e$ connected at 33kV). Southern Electric additionally require that all embedded generation rated above 200kVA ($200kW_e$ at unity power factor) be provided with neutral voltage displacement protection.

Compliance with the relevant stipulations of the Distribution Code is mandatory, and additionally, for generation schemes above $50MW_e$ output, compliance with the requirements of the Grid Code is also compulsory.

7.2 Methods Of Connection

Depending mainly upon the output rating of the particular renewable generation scheme proposed, and to a lesser degree on the availability of a suitable existing circuit at an appropriate voltage level in the vicinity of the site of the proposed generation scheme, the following options are available for connection into the distribution network:

- Teeing into the existing distribution network, by intercepting an existing circuit either at an existing substation or at a convenient location on a suitable local overhead line or underground cable. Teeing in involves a minimum scope of equipment at the point of connection, but offers correspondingly limited robustness and security of supply, and is only suitable for connections made at 11kV or 33kV, with generation schemes with outputs typically under $40MW_e$. The tee in circuit requires a circuit breaker at the generation source location, fully integrated into the overall protection scheme for the complete distribution circuit. The network operator may require the provision of sectionalising switchgear at the location of the tee in connection, and may additionally require the sectionalising switchgear to perform automatic reconnection of supply, should third parties be dependent upon the teed in circuit.

- Connecting into the existing distribution network at an existing substation busbar via a new dedicated generation spur circuit (overhead line or underground cable). Provision of a dedicated generation spur circuit at an existing substation requires the adoption of an existing spare circuit breaker, or otherwise the expansion of the substation to provide the necessary additional circuit breaker. A dedicated generation spur circuit provides a robust and flexible connection arrangement, but at greater cost than a tee in circuit, and subject to the availability of an existing or new spare circuit breaker at the appropriate substation. Dedicated generation spur circuits are suitable for all voltage levels and generation output levels under consideration on the Isle of Wight, and each would be complete with the corresponding level of protection, monitoring and control facilities.

- Connecting into the existing island supply network via a new substation at the renewable generation location, with new overhead lines and / or underground cables to the existing neighbouring substation(s), with the appropriate upgrading of the equipment at the existing substation(s). Construction of new substations is only likely to be justified for large output generation schemes (typically over $40MW_e$), where on-site transformation to 132kV is appropriate, and new 132kV distribution circuits are installed for connection to Wootton Common and / or East Cowes substations. Due to the sparse nature of the existing distribution network in the southern region of the island (11kV distribution only), any generation schemes with outputs greater than $5MW_e$ proposed for this area are likely to involve the provision of a new 132kV substation unless a 33kV generation spur circuit can be accommodated.

7.3 11kV System Connections

The connection of embedded generation into existing 11kV circuits within public power distribution networks is significantly influenced by the available location at which the connection can be made. In general, if the connection can be made directly into a primary substation via a new, dedicated 11kV circuit, embedded generation schemes of up to around 10MVA ($10MW_e$ at unity power factor) may be connected at 11kV, depending upon achieving compliance with the general considerations detailed above. However, if connection must be made at a point remote from the associated primary substation, adopting an existing public power distribution network circuit as the embedded generation connection, the effects of the generation contribution (typically thermal influence of generation output; voltage gradient modification; voltage dip / flicker effects from wind turbine generators) tend to significantly limit the maximum generation contribution that can be accommodated without requiring mitigation or reinforcement measures. Each case must be considered on its own merits, but typically a rating of 1MVA ($1MW_e$ at unity power factor) may be considered as a reasonable default maximum embedded generation limit for connections remote from primary substations, without the benefit of the appropriate network modelling and system planning.

It should be noted that the 11kV primary substations on the Isle of Wight are typically equipped with circuit breakers with 400A or 630A ratings (specific circuit ratings are subject to individual enquiry), and that circuit breakers are generally not installed at the 11kV / 0.433kV transformer substations distributed around the island, due to the use of ring main units for larger transformer substations in built-up areas and teed connections and fused radial spurs for smaller rural substations. Review of the information available for the 11kV primary indicates that there is presently reasonable margin on the minimum fault making and minimum fault breaking capacities of the existing switchgear – the lowest margins being at Newport substation with 7.6kA headroom on making capacity and 3.8kA headroom on breaking capacity.

7.4 33kV System Connections

The existing 33kV public power distribution network infrastructure comprises two infeed substations at Wootton Common and East Cowes, eight primary substations distributed across the west, north and east of the island, and an interconnecting distribution network consisting predominantly of overhead lines. The lack of circuit breakers at the majority of the primary substations (33kVcircuit breakers are installed only at East Cowes, Shalfleet and Wootton Common substations) dictates that extensions to the existing 33kV public power distribution network are most likely to be effected via tee-joints at convenient locations. It is noticeable that a significant number of tee joints are present in the existing 33kV distribution network, and that only Binstead, East Cowes, Shalfleet and Wootton Common substations offer any potential for expansion of the existing substation plots to accommodate direct connection of further 33kV circuits.

Due to the relatively high rating of the 33kV circuits, the lack of consumers at 33kV and the presence of automatically controlled on-load tap changers on the 33kV / 11kV transformers, the choice of location for connection of embedded generation on the 33kV system is not as restricted by rating as for the 11kV system. As a first attempt to define the typical maximum rating of embedded generation that could potentially be connected to the existing circuits comprising the 33kV system, each circuit is considered at its minimum (summer) rating for upstream export to the corresponding infeed substation, with the minimum downstream demand load allowed additionally as the balance of the allowable generation contribution. In practice, the actual maximum capacity that may be connected will be significantly reduced from the figures quoted below, due to the need to satisfy the general connection considerations described above, with the control of voltage gradient most likely to impose a limitation on the allowable generation contribution. Additionally, the margins between actual fault levels and capabilities of the existing 33kV switchgear at East Cowes substation and Wootton Common substation are low, indicating that either the fault contributions from any embedded generation must be limited (e.g. reduction in generation capacity; remote location of embedded generation; provision of fault current limitation equipment; etc), or the existing 33kV switchgear at East Cowes substation and / or Wootton Common substation must be replaced by equipment with higher making and breaking capacities.

A simplified single diagram of the existing 33kV network showing the maximum permissible embedded generation contributions is included in the accompanying drawings – see diagrams 2 and 6 in Appendix 1.

Binstead No.1 Tee Joint (Binstead No.1 Transformer Circuit)	**26.5MVA (26.5MW_e @ 1pf)**
Binstead No.1 Tee Joint (Ryde / Ryde St. Johns Circuit)	**40.9MVA (40.9MW_e @ 1pf)**
Binstead No.1 Tee Joint (Wootton Common Circuit)	**42.4MVA (42.4MW_e @ 1pf)**
Binstead No.2 Tee Joint (Binstead No.2 Transformer Circuit)	**33.5MVA (33.5MW_e @ 1pf)**
Binstead No.2 Tee Joint (Ryde / Rowborough Circuit)	**40.9MVA (40.9MW_e @ 1pf)**
Binstead No.2 Tee Joint (Wootton Common Circuit)	**42.4MVA (42.4MW_e @ 1pf)**
Freshwater No.1 Circuit	**26.0MVA (26.0MW_e @ 1pf)**
Freshwater No.2 Circuit	**19.0MVA (19.0MW_e @ 1pf)**
Newport No.1 Circuit	**34.5MVA (34.5MW_e @ 1pf)**
Newport No.2 Circuit	**32.5MVA (32.5MW_e @ 1pf)**
Newport No.3 Circuit	**38.5MVA (38.5MW_e @ 1pf)**
Ryde No.1 Circuit	**40.9MVA (40.9MW_e @ 1pf)**
Ryde No.2 Circuit	**40.9MVA (40.9MW_e @ 1pf)**
Sandown No.1 Circuit	**13.4MVA (13.4MW_e @ 1pf)**
Sandown No.2 Circuit	**30.7MVA (30.7MW_e @ 1pf)**

Sandown Tee Joint (Sandown No.2 Circuit)	**30.7MVA (30.7MW$_e$ @ 1pf)**
Sandown Tee Joint (Shanklin No.1 Circuit)	**28.0MVA (28.0MW$_e$ @ 1pf)**
Sandown Tee Joint (Wootton Common Circuit)	**33.7MVA (33.7MW$_e$ @ 1pf)**
Shalfleet No.1 Circuit	**28.0MVA (28.0MW$_e$ @ 1pf)**
Shalfleet No.2 Circuit	**21.0MVA (21.0MW$_e$ @ 1pf)**
Shanklin No.1 Circuit	**28.0MVA (28.0MW$_e$ @ 1pf)**
Shanklin No.2 Circuit	**29.0MVA (29.0MW$_e$ @ 1pf)**
Ventnor No.1 Tee Joint (Ventnor No.1 Transformer Circuit)	**13.4MVA (13.4MW$_e$ @ 1pf)**
Ventnor No.1 Tee Joint (Sandown No.1 Circuit)	**13.4MVA (13.4MW$_e$ @ 1pf)**
Ventnor No.1 Tee Joint (Arreton Tee Joint Circuit)	**13.4MVA (13.4MW$_e$ @ 1pf)**
Ventnor No.2 Tee Joint (Ventnor No.2 Transformer Circuit)	**19.7MVA (19.7MW$_e$ @ 1pf)**
Ventnor No.2 Tee Joint (Shanklin No.2 Circuit)	**29.0MVA (29.0MW$_e$ @ 1pf)**
Ventnor No.2 Tee Joint (Wootton Common Tee Joint Circuit)	**31.8MVA (31.8MW$_e$ @ 1pf)**
Wootton Common Tee Joint (Newport No.2 Circuit)	**32.5MVA (32.5MW$_e$ @ 1pf)**
Wootton Common Tee Joint (Ventnor No.2 Tee Joint Circuit)	**31.8MVA (31.8MW$_e$ @ 1pf)**
Wootton Common Tee Joint (Wootton Common Circuit)	**51.3MVA (51.3MW$_e$ @ 1pf)**

Note that the real power figures at unity power factor (MW$_e$ @ 1pf) listed above are for illustrative purposes only – in practice, the power factor throughout the 33kV network will always be less than unity, and the available real power transport capacity will be reduced correspondingly.

A more detailed analysis of the existing 33kV circuit loadings and operational limitations, and of the effects of connecting embedded generation at various locations within the present distribution network, may be achieved using the circuit data available from the detailed Long Term Development Statement document and performing a PC-based load flow simulation, typically using a proprietary power systems analysis software package, for example the ERACS product. Although the definitive analysis of the load flow and short circuit conditions on the Isle of Wight distribution network can only be performed by the Southern Electric Power Distribution plc network planning department, an independent study can be used to assess the feasibility of design proposals prior to selection of the scheme to be put forward for consideration by Southern Electric.

7.5 132kV System Connections

The existing 132kV infrastructure on the Isle of Wight comprises three submarine cables (two from the mainland to Wootton Common substation and one from the mainland to East Cowes substation), an overhead line between Wootton Common substation and East Cowes substation, and circuit breakers at both Wootton Common and East Cowes substations.

There are no 132kV network reinforcement schemes relevant to the Isle of Wight identified in the 2009 – 2014 issue of the Long Term Development Statement, indicating that Southern Electric were not aware of any firm proposals to increase the generation capacity on the Isle of Wight at the time of publication of the Long Term Development Statement. However, Southern Electric have separately indicated in correspondence regarding the renewable generation proposals identified in this document that there are present concerns over the condition, capacity and duty of the existing submarine cables and associated plant serving the Isle of Wight, and that the replacement of at least one of the circuits with an uprated cable is presently under consideration. Furthermore, Scottish and Southern Energy Power Distribution made an application for marine geotechnical investigation for a new submarine cable link from Lepe on the mainland to a landfall in Thorness Bay west of Gunard on the Isle of Wight in April 2010, under a proposal to replace the existing submarine cable link during 2012 – 2014.

Renewable generation proposals with outputs in tens to hundreds of megawatts represent very significant changes to the characteristics of the existing network, in terms of system operation, rate of growth of circuit load and duty of plant. Due to the potential contributions from the 140MW$_e$ open cycle power plant at East Cowes and the 16MW$_e$ (formerly 36MW$_e$) combined heat and power station at Arreton, and considering the minimum load condition on the island distribution system, Southern Electric have stated that they consider that the existing submarine cables are likely to become insufficiently rated for export to the mainland if significant generation contributions are connected to the existing island distribution network.

Southern Electric have suggested two alternative approaches to resolving the issues related to the potential level of power export from the Isle of Wight and the rating limitations imposed by the existing submarine cables.

The first proposal is to include the uprating of the submarine cable link to the mainland as a part of any system reinforcement works that Southern Electric would need to undertake on the Isle of Wight to accept a significant increase in generation capacity. Southern Electric will require financial contribution from the developers of any significant generation schemes to the network reinforcement necessary to accommodate the additional generation capacity. Any proposal to significantly increase the generation capacity on the island must therefore consider the extent of 132kV system reinforcement that is likely to be required to achieve integration of such additional generation.

The second proposal is to limit the extent and capacity of any new generation sources on the island, to ensure that the existing 132kV infrastructure operates within its design limits. Such limitation of renewable generation scheme output and location will tend to discourage large capacity developments, and favour small scale proposals. It is possible that some mitigation in maximum allowable renewable generation capacity may be negotiated with Southern Electric, National Grid Transco (owner and operator of the UK transmission networks, responsible for the balancing of generation capacity and load demand nationally), and RWE npower (owner and operator of East Cowes power station) to allow large capacity renewable generation sources to share the 132kV submarine cable link capacity presently allocated to the output of East Cowes power station, on the basis that East Cowes power station only operates infrequently, and that the export capacity of the existing submarine cables would therefore usually be available for renewable generation output. However, as East Cowes power station is usually called to operate by National Grid Transco under low frequency conditions, sharing of the 132kV submarine cable link capacity with large capacity renewable generation sources will nullify the grid frequency support role of East Cowes power station if the large capacity renewable generation sources are operational during the low frequency excursion period. Under such circumstances, the output of East Cowes power station will be required to augment the output of the large capacity renewable generation sources, to provide the necessary frequency support, and the 132kV submarine cable link must be able to carry the combined export capacity of all operational generation sources on the island. Without an increase in rating, the existing 132kV submarine cable link would not be able to transport the export power level demand from the island to the mainland. On this argument, it is unlikely that any significant element of shared capacity on the 132kV submarine cable link will be acceptable to Southern Electric, National Grid Transco or RWE npower.

Typically, generation contributions with ratings in excess of 40MVA ($40MW_e$ at unity power factor) are connected directly at 132kV, with the connections invariably requiring either new substations or extension to existing substations. As there are two existing 132kV substations on the Isle of Wight, separated by a relatively short section of overhead line, any connection at 132kV would preferably be realised by running new overhead lines or underground cables from the new generation site(s) to either Wootton Common substation and / or East Cowes substation. There are presently adequate margins on thermal ratings and short circuit / earth fault capacities on the existing 132kV equipment at Wootton Common substation and, to a lesser extent, at East Cowes substation, to allow connection of schemes up to around 100MVA ($100MW_e$ at unity power factor). However, as discussed above, without reinforcement of the submarine link capacity, it is unlikely that Southern Electric would allow the connection of such additional generation capacity to the Isle of Wight 132kV system.

Based on the data in the Long Term Development Statement and on correspondence with Southern Electric, a provisional estimate of the margin presently available within the existing submarine cable link capacity may be made:

- Total number of submarine cables installed — Three
- Maximum number of cables in service (firm supply condition with one cable failure) — Two
- Worst case maximum (summer) rating of each submarine cable — 99MVA
- Derived maximum operational submarine cable rating (2 x 99) — 198MVA

- Maximum active output capacity of East Cowes power station — $140MW_e$
- East Cowes power station operational power factor (typical value under Grid Code) — 0.90

- Maximum apparent output capacity of East Cowes power station (140 / 0.90) ~155MVA
- Maximum output of Arreton CHP complex 16MW_e
- Arreton CHP complex operational power factor (typical value under Distribution Code) 0.95
- Maximum apparent output capacity of Arreton CHP complex (16 / 0.95) ~17MVA
- Minimum Isle of Wight load demand (island consumption from Southern Electric) 35MVA
- Derived maximum submarine cable export demand ((155 + 17) - 35) 137MVA

- Derived margin within existing submarine cable link capacity (198 – 137) **61MVA**

The existing 132kV submarine cable link dates from 1972, is approximately 5.3km long, and comprises a total of three oil filled three core cables running between Lepe on the mainland and Thorness Bay, west of Gunard, continuing as an underground installation to East Cowes substation and to Wootton Common substation. The proposed replacement cables (as per the marine geotechnical investigation application submitted by Scottish and Southern Energy Power Distribution) are to be solid dielectric three core cables, following the same submarine route as the existing cables, and intended to be buried in a 1.5m deep trench excavated into the sea bed.

8 PROPOSED GENERATION SCHEMES

8.1 Overview

At the time this report was commissioned (March 2010), two potential offshore renewable energy generation schemes were known to the Isle of Wight Council. Based on the proposed locations and ratings of the various schemes, an initial assessment of the possibilities for connection to the existing island public power distribution network is made. Geographically, the northern, eastern, western and central regions of the island are served by the 33kV distribution network, with the northern and central regions additionally accommodating the 132kV distribution system. The southern region of the island is served by the 11kV distribution network only, reflecting the sparsity of settlements in the south of the island. The physical characteristics of the existing distribution network favours connection of small generation sources at 11kV in the south of the island (typically less than $5MW_e$, considering a predominance of low capacity overhead lines serving a widely dispersed rural community). Generation sources of higher output capacity located in the south of the island will require the provision of 33kV or 132kV generation spur circuits or new 33kV or 132kV substations. Elsewhere, connection of small generation sources (typically less than $10MW_e$, considering a predominance of high capacity circuits serving built up areas) would generally be effected at 11kV, with medium capacity generation sources (between $10MW_e$ and $40MW_e$) connected at 33kV and large capacity generation sources (greater than $40MW_e$) connected at 132kV.

8.2 Tidal Energy Scheme

A coastal tidal energy scheme is proposed off St. Catherine's Point, with the subsea cable(s) coming ashore on the south coast of the island. The tidal energy scheme is envisaged as a three stage development, with an initial pilot scheme rated at around $10MW_e$, an interim commercial phase raising the output to around $40MW_e$, and a final commercial phase raising the output to around $100MW_e$. The village of Niton is the nearest settlement to the proposed site of the landfall for the submarine cable. Niton has population of approximately 1000 people, and is served by 11kV overhead distribution circuits supplied from Ventnor substation.

The $10MW_e$ output proposal is rated significantly above the capacity of the 11kV overhead lines presently serving Niton, so there is no prospect of connecting the initial pilot scheme to the existing 11kV overhead distribution network in the vicinity of the village. It would therefore be necessary to construct a new circuit to Ventnor primary substation, via an appropriate combination of overhead line, underground cable and submarine cable. For the initial pilot scheme, connection at 11kV at Ventnor primary substation appears feasible, subject to confirmation by the appropriate analysis. Alternatively, connection could be effected via a tee joint into one of the two 33kV overhead lines serving Ventnor substation. It should be noted that one of the two existing 33kV circuits (to Ventnor No.1 tee joint) has previously been intercepted at Arreton to receive the generation output from the Wight Salads combined heat and power plant. Consequently, the circuit rating headroom available for receiving the generation contribution from the proposed pilot tidal energy scheme is reduced in comparison with the circuit that is not connected to the Wight Salads combined heat and power plant. Subject to detailed analysis, it is suggested that a tee joint is introduced into the existing 33kV circuit from Wootton Common substation to Ventnor substation (to Ventnor No.2 tee joint), to connect the proposed pilot tidal energy scheme and the Wight Salads combined heat and power plant to Wootton Common substation via separate circuits.

Should the second and third stages of the tidal energy scheme be realised, with outputs of $40MW_e$ and $100MW_e$ respectively, it is not possible to utilise the existing 33kV distribution infrastructure at and beyond Ventnor to effect the export connection, due to the output rating being in excess of the maximum permissible generation contribution (31.77MVA ($31.77MW_e$ at unity power factor) on Wootton Common circuit). The $40MW_e$ scheme could be connected to Wootton Common substation by a new 33kV circuit, typically requiring a step-up transformer substation at the location of the submarine cable landfall, and an appropriate combination of 33kV overhead line and underground cable installed to Wootton Common substation. However, it is very likely that such a connection would require the existing 33kV switchgear at Wootton Common substation be replaced, due to the additional fault contribution from the generation causing the fault levels at Wootton Common substation to exceed the making and / or breaking capacities of the existing switchgear. In view of this limitation, and to cater for the eventual realisation of the 100MW_e scheme, which cannot utilise a 33kV connection due to rating considerations, it would be prudent to install a 132kV connection during the development of the 40MW scheme. For the 100MW_e scheme (and preferably for the 40MW_e scheme), a new 132kV circuit would need to be established to Wootton Common substation, via the appropriate combination of overhead lines and underground cables.

It should be noted that the capacities of the existing 132kV submarine cables between the island and the mainland would need to be analysed in detail for the 40MW_e and 100MW_e proposals, as a capacity margin of around 61MVA has been estimated as being presently available on the existing submarine cable link. The connection of a 100MW_e tidal energy scheme to the island 132kV network almost certainly cannot proceed without replacement of at least one of the existing 132kV submarine cables.

8.3 Offshore Wind Scheme

A 100MW_e offshore wind farm development is proposed off the east coast of the island, with the subsea cable(s) coming ashore between Shanklin and Ryde.

At an output of 100MW_e, there is no prospect of using any existing or new 33kV distribution network infrastructure as the means of connection between the wind farm submarine cable landfall site and the substations at Wootton Common or East Cowes, due to the total rating of the wind farm generators. Depending upon the arrangement of the offshore wind farm strings, the distance between the wind farm array and the coast, and the selection of an onshore or offshore substation for the wind farm, the submarine cable connection may come ashore at 132kV, or otherwise be transformed up to 132kV at the landfall site. A new 132kV circuit would need to be established to Wootton Common substation or to East Cowes substation, either via the appropriate combination of overhead lines and underground cables from the landfall site, or possibly, in the case of a 132kV submarine cable destined for East Cowes substation, via a submarine cable laid directly from the wind farm to East Cowes substation.

It should be noted that the capacities of the existing 132kV submarine cables between the island and the mainland would need to be analysed in the case of a generation contribution of 100MW_e, as a capacity margin of around 61MVA has been estimated as being presently available on the existing submarine cable link, and connection of a 100MW_e offshore wind scheme to the island 132kV network almost certainly cannot proceed without replacement of at least one of the existing 132kV submarine cables.

9 CONSIDERATION OF POSSIBILITIES FOR RENEWABLE GENERATION SCHEME DEVELOPMENT

9.1 Existing Generation And Distribution Facilities

Southern Electric have not identified any significant expansion or modification to the Isle of Wight distribution system in the 2009 – 2014 Long Term Development Statement. Review of the predicted growth in load demand on the island during the forthcoming five years shows a modest increase (2.8%), for which the existing distribution system infrastructure and assets are adequately rated. However, refer to section 7.5 above for details on the proposed scheme for replacement of the submarine cables between the mainland and the Isle of Wight by Southern Electric in the near future.

The East Cowes power station is likely to remain as a standby facility for the foreseeable future - on one hand, due to the high fuel costs, high emissions and relatively low efficiency associated with oil fired open cycle gas turbine power plant; and on the other, due to the forthcoming retirement of a large portion of the UK's nuclear and thermal power generation assets due to legislative and lifetime considerations. The three existing 132kV submarine cables between the island and the mainland must be able to export the surplus capacity from the island to the mainland, allowing for the full output from East Cowes power station. Limitation of the export capacity from the island due to the constraints imposed by the thermal rating of the existing cables is unlikely to find support from either Southern Electric or from renewable generation developers. Accordingly, the concerns raised by Southern Electric over the ratings of the submarine cables will need to be addressed as part of any strategy to develop a significant renewable generation contribution on and from the Isle of Wight.

The reduction of the embedded generation capacity at the Wight Salads complex from $36MW_e$ to $16MW_e$ may provide an opportunity to connect renewable generation schemes in the Arreton Valley area at 11kV, taking advantage of the 20MVA spare capacity available in the Wight Salads complex 11kV/33kV transformer, and possibly reusing remaining elements of the 11kV switchgear installation associated with the removed combined heat and power generation units

As per section 6.5, there is a present estimated capacity margin of around 61MVA on the 132kV submarine cable link, which may be considered as the maximum total additional generation capacity that could be proposed for installation on the island without necessarily incurring costs related to replacement of elements of the existing submarine cable link. There are also presently adequate margins on thermal ratings and short circuit / earth fault capacities on the existing 132kV equipment at Wootton Common East Cowes substations, potentially allowing connection of schemes up to around 100MVA, effectively limited to 61MVA by the 132kV submarine cable link capacity, as above. However, Southern Electric have the discretion to impose reinforcement costs upon developers through connection agreement conditions, where Southern Electric consider that reinforcement of the network is necessary to accept the proposed generation contribution. If Southern Electric elect to replace any or all of the existing submarine cables in advance of any renewable generation proposals, it is likely that a proportion of the costs of the uprating exercise will be imposed upon the connection of any subsequent generation contributions, typically based on the generation export capacity required for each connection. As per section 7.5 above, it is likely that Southern Electric will proceed with such a submarine cable replacement scheme within the next three to five years.

9.2 Renewable Generation Developments

9.2.1 Small Scale Renewable Generation Schemes

Small scale renewable generation schemes (up to $10MW_e$ output capacity) would typically be connected to the existing distribution network infrastructure at 11kV, partly because the 11kV system is the most geographically distributed network on the island (especially in the southern region); partly because 11kV is an economically attractive output voltage level for small scale generation schemes; and partly because there may be the possibility of reusing existing 11kV assets at the Wight Salads complex (subject to investigation). The acceptable maximum generation contributions from small scale renewable generation schemes are likely to be reduced in rural locations, due to circuit rating, voltage profile, flicker, and similar considerations limiting the capacity of embedded generation that may be connected to the 11kV public electricity supply distribution network. Conversely, where renewable generation is connected into the 11kV public electricity supply distribution network at, or in the vicinity of, any of the 33kV/11kV substations on the island, it is likely that generation contributions in excess of 10MW$_e$ can be accommodated. In all cases, the developer must approach Southern Electric as a preliminary activity, to determine the particular characteristics and limitations of the 11kV network in the vicinity of the proposed embedded renewable generation scheme, to determine whether connection is feasible, and to what extent, if any, the existing distribution network infrastructure and assets will need to be reinforced to accept the generation contribution. Generally, individual small scale renewable generation schemes connected at 11kV are only likely to require reinforcement on the 11kV network, but if there are numerous such small scale developments, it is possible that there would also need to be reinforcement of the 33kV system (the circuit breakers at Wootton Common and East Cowes substations are the elements most likely to require uprating). However, it is unlikely that the development of a significant quantity of small scale renewable generation schemes would increase the generation levels on the island to such an extent to justify the replacement of the submarine cables to the mainland.

9.2.2 Medium Scale Renewable Generation Schemes

Medium scale renewable generation schemes (between 10MW$_e$ and 40MW$_e$ output capacity) would typically be connected to the existing distribution network infrastructure at 33kV, due to availability of 33kV overhead lines over the majority of the island (with the exception of the southern region). It should be noted that the 33kV network on the island has been conceived and subsequently expanded to utilise the minimum number of circuit breakers, and that much of the network interconnection is achieved through the adoption of tee joints in distribution circuits, as opposed to multiple circuit breakers in numerous substation locations. Accordingly, there are very limited opportunities to connect directly into the busbars within any of the existing 33kV substations without the need for expansion of the substation site. Furthermore, there are equally limited opportunities to expand many of the existing 33kV substations. Practically, these limitations dictate that 33kV connections are likely to be effected either by installing tee joints into existing distribution circuits, or, if justified and appropriate, by the expansion of an existing substation (where possible) or by the construction of the appropriate new substation(s). The latter approach is likely to be of significance if medium scale renewable generation schemes are considered in the southern region of the island. It should be noted that the fault level margins on the 33kV switchgear at Wootton Common and East Cowes substations are low (this is especially significant on the 33kV incoming circuit breakers at Wootton Common substation), and that the increased fault levels consequent to the connection of medium scale renewable generation schemes onto the 33kV network are very likely to require the replacement of at least the incoming circuit breakers at Wootton Common substation. It is also possible that the development of medium scale renewable generation schemes will increase the generation levels on the island to such an extent to justify the replacement of the submarine cables to the mainland. As with the small scale schemes, the developer must approach Southern Electric as a preliminary activity, to determine the particular characteristics and limitations of the 33kV network in the vicinity of the proposed embedded renewable generation scheme, to determine whether connection is feasible, and to what extent, if any, the existing distribution network infrastructure and assets will need to be reinforced to accept the generation contribution. It is possible that 132kV may represent a better choice of connection voltage level for certain medium scale renewable generation schemes, dependent upon location and generation output capacity, by avoiding the requirement for 33kV distribution system network reinforcement.

9.2.3 Large Scale Renewable Generation Schemes

Large scale renewable generation schemes (greater than 40MW$_e$ output capacity) would be connected to the existing distribution network infrastructure at 132kV at Wootton Common and / or East Cowes substation(s), or possibly by diverting the overhead line circuit between the two existing substations and establishing a third 132kV substation at the location of the large scale renewable generation scheme. This approach is potentially of mutual benefit to both the developer and to Southern Electric, especially if the large scale renewable generation scheme(s) are located in the southern region of the island, as the new 132kV substation could be jointly owned, providing the point of connection for the renewable generation scheme, and allowing Southern Electric to establish a new distribution substation (typically at 33kV) to reinforce the existing distribution network and to allow the development of new distribution circuits. It is inevitable that the development of large scale renewable generation schemes will increase the generation levels on the island to such an extent to require the replacement of the submarine cables to the mainland. Again, as with the other schemes, the developer must approach Southern Electric as a preliminary activity, to determine the particular characteristics and limitations of the island 132kV system, to determine whether connection is feasible, and to what extent the existing 132kV system infrastructure and assets will need to be reinforced to accept the generation contribution. As previously stated, it is possible that some mitigation in maximum allowable renewable generation capacity may be negotiated with Southern Electric, National Grid Transco and RWE npower to allow large capacity renewable generation sources to share the 132kV submarine cable link capacity presently allocated to the output of East Cowes power station, on the basis that East Cowes power station only operates infrequently, and that the export capacity of the existing submarine cables would therefore usually available for renewable generation output. However, as East Cowes power station is usually called to operate by National Grid Transco under low frequency conditions, sharing of the 132kV submarine cable link capacity with large capacity renewable generation sources will nullify the grid frequency support role of East Cowes power station if the large capacity renewable generation sources are operational during the low frequency excursion period. Under such circumstances, the output of East Cowes power station will be required to augment the output of the large capacity renewable generation sources, to provide the necessary frequency support, and the 132kV submarine cable link must be able to carry the combined export capacity of all operational generation sources on the island. Without an increase in rating, the existing 132kV submarine cable link would not be able to transport the export power level demand from the island to the mainland. On this argument, it is unlikely that any significant element of shared capacity on the 132kV submarine cable link will be acceptable to Southern Electric, National Grid Transco or RWE npower.

9.2.4 Aggregation Of Renewable Generation Schemes

Any possibility of coordination of a number of renewable generation developments in respect of combining the connection requirements of each project into a single scheme should be encouraged, as such an approach would generally have cost benefits over individual connection arrangements for each generation source. In particular, a coordinated approach between proposed renewable generation schemes would potentially offer savings against connection costs where the schemes are located in reasonable proximity to each other when compared to the intended point of connection to the existing distribution network infrastructure. Should the renewable generation schemes also be of comparable output levels, and export at the same voltage level, the potential for savings in connection costs is further enhanced.

9.2.5 Network Reinforcement Costs and Cost Apportionment Factors

Southern Electric document ‘Statement of Methodology and Charges for Connection to Southern Electric Power Distribution PLC’s Electricity Distribution System’ provides a comprehensive description of the costs involved in effecting connection to the distribution network.

Referring specifically to ‘Section 7 – Connection Charging Statement’, indicative ranges of costs for the various elements of distribution network extension and reinforcement works are listed for guidance purposes. Costs for feasibility studies, assessment and design work, construction and installation work, and testing and energising are included.

Referring specifically to ‘Section 5 – Common Connection Charging Methodology’, two elements of network reinforcement costs are defined, with corresponding cost apportionment factors, namely:

- The Security Cost Apportionment Factor (%) = (Required Capacity / New Network Capacity) x 100%
- The Fault Level Cost Apportionment Factor (%) = (Fault Level Contribution from New Connection / New Fault Level Capacity) x 300%

where:

- Required Capacity is the maximum distribution network connection capacity required for generation source, i.e. typically the export capacity of the renewable generation scheme.

- New Network Capacity is the secure capacity of the Relevant Section of the distribution network following reinforcement, i.e. typically the capacity of the lowest rated element in the distribution network required to effect the connection of the renewable generation scheme to the distribution network.

- Relevant Section is that part or parts of the distribution network that is required to be available under both normal and abnormal running arrangements

- Fault Level Contribution from New Connection is the assessment of the fault level contribution from the generation source at the point of connection to the distribution network, i.e. typically the sustained short circuit contribution of the renewable generation scheme

- New Fault Level Capacity is the fault level rating, following reinforcement, of the equipment installed after taking account of any restrictions imposed by the local network fault level capacity, i.e. typically the fault rating of the lowest fault level capacity element in the distribution network required to effect the connection of the renewable generation scheme to the distribution network.

It should be noted that connections at 11kV will attract contributions to security and / or fault level costs on the 11kV and 33kV networks, but not on the 132kV network. However, should Southern Electric need to reinforce the 132kV network (specifically the submarine cable link) to accommodate a significant increase in generation connected at 11kV, it is inevitable that some of the associated costs for the submarine cable replacement will be apportioned to connection agreements negotiated for generation contributions connected at 11kV. Connections at 33kV will attract contributions to security and / or fault level costs on the 33kV and 132kV networks.

No costings are estimated in this report, due to the lack of conceptual detail for the proposed renewable energy generation schemes, but the connection charging data may be useful for developers to determine indicative project budgets as part of feasibility design and for return on investment analysis purposes.

10 SUMMARY AND RECOMMONDATIONS

10.1 Summary

The connection of renewable generation sources to the existing electrical distribution system on the Isle of Wight is broadly feasible at 11kV, 33kV and 132kV. Connections at 11kV will be limited to small scale schemes, and it is considered that connections in rural locations are likely to be particularly limited by the capacities and characteristics of the existing distribution system. Local network reinforcement measures will need to be considered for all schemes, but especially for those proposed in areas distant from any of the major substations on the island. Connections at 33kV will be limited to medium scale schemes, and although first indications suggest that useful capacity is available the existing 33kV circuits, there is concern over the low fault level margins on the 33kV switchgear at Wootton Common and East Cowes substations. Connection at 132kV is the only option available for large scale schemes, requiring the provision of new infrastructure and assets on the island, and requiring the uprating of the submarine cable links to the mainland.

10.2 Recommendations

- Developers of renewable generation schemes must engage with Southern Electric at the earliest opportunity to determine the feasibility of effecting connection to the existing Isle of Wight public electricity supply distribution system, and to determine the extent and cost of any network reinforcement works required to achieve the appropriate connection
- Coordination of developer's proposals would benefit all parties involves, as a single consideration of the total impact of the various renewable generation schemes is likely to provide a more satisfactory and optimised resolution than separate and independent treatment of each individual proposal
- If minimisation of impact upon the existing distribution network infrastructure and assets is a priority, the ambition and scale of the renewable generation schemes needs to be restricted to avoid any significant costs due to distribution network reinforcement work. Such smaller scale schemes will generally be connected at 11kV, and further investigation of the existing 11kV network will be required. Sharing of capacity on the 132kV submarine cable link to the mainland between renewable generation sources and East Cowes power station may offer some latitude for the development of large capacity renewable generation schemes on the Isle of Wight without incurring significant reinforcement costs, but gaining the agreement of the stakeholders is likely to be challenging.

11 APPENDICES

11.1 Appendix 1 – Map & Diagrams

Appendix 1 comprises a map showing the approximate locations of the existing 33kV and 132kV public electricity supply system infrastructure and assets; a simplified schematic diagram of the 33kV and 132kV networks; diagrams showing the 2014 horizon circuit rating and load demand data based on Southern Electric forecasts; and diagrams illustrating connection possibilities for the two renewable generation schemes identified by the Isle of Wight Council.

11.2 Appendix 2 – Data & Analysis

Appendix 2 comprises transformer and circuit rating data: load demand profile data: and circuit breaker making and breaking capacities extracted from the appendices of the Long Term Development Statement, plus tabulation of the switchgear fault level margins available; and derived estimations of the maximum possible circuit capacities available on the existing 33kV network, based on summer ratings and 2014 minimum load demand data (equating to the maximum possible export capacity for an embedded generation source connected into the corresponding circuit).

103326 Isle Of Wight Renewable Energy Resource Investigation

Review Of Potential For Connection Of Embedded Generation Sources
Into Existing Public Electricity Supply Distribution System

Appendix 1

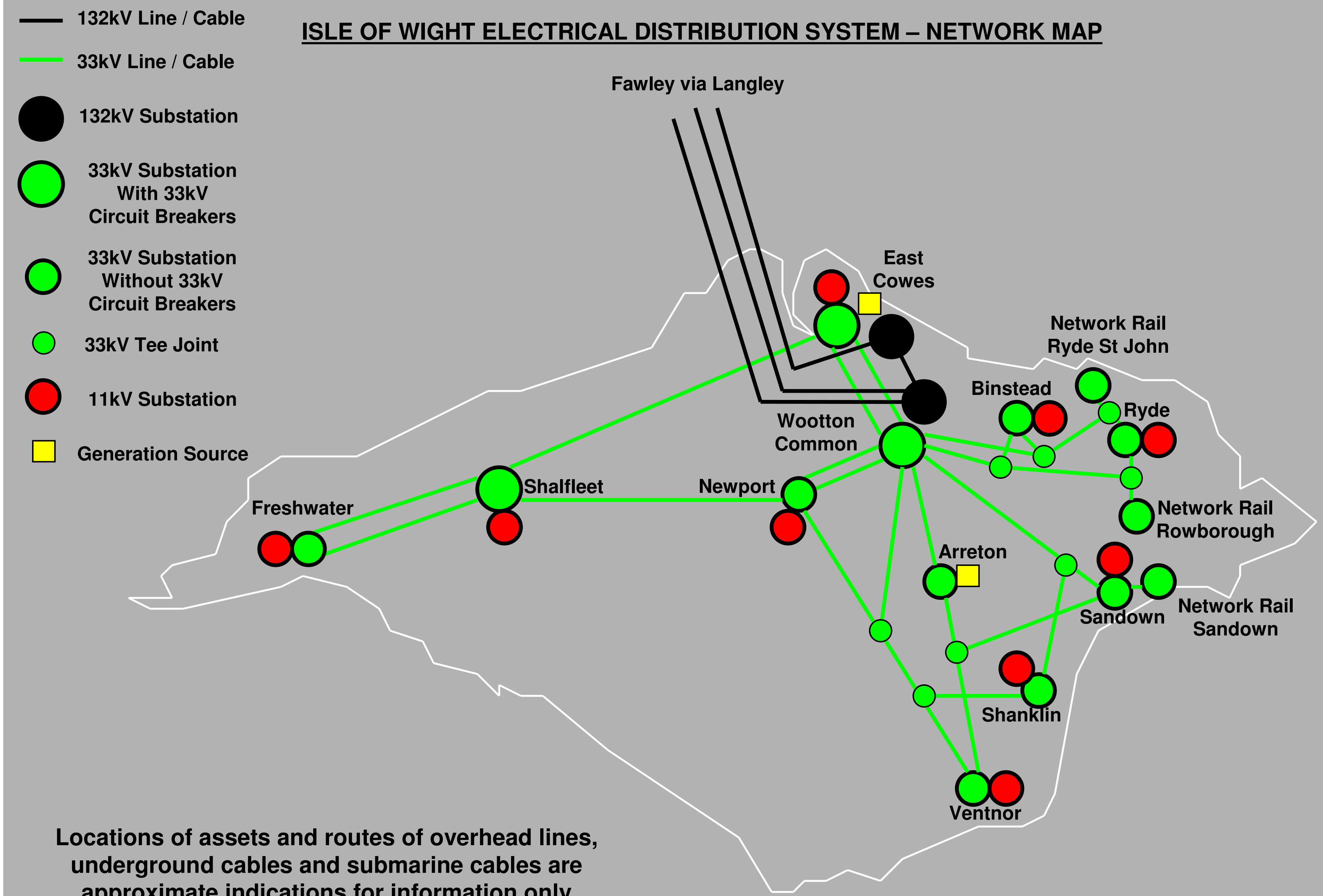
ISLE OF WIGHT ELECTRICAL DISTRIBUTION SYSTEM

Grontmij

www.grontmij.co.uk

ISLE OF WIGHT ELECTRICAL DISTRIBUTION SYSTEM – DRAWING INDEX

ISLE OF WIGHT ELECTRICAL DISTRIBUTION SYSTEM – NETWORK MAP



Locations of assets and routes of overhead lines, underground cables and submarine cables are approximate indications for information only

ISLE OF WIGHT ELECTRICAL DISTRIBUTION SYSTEM – DRAWING KEY

BUSBAR & CIRCUIT VOLTAGE LEVELS

Black line	132kV
Green line	33kV
Red line	11kV

EQUIPMENT & DEMAND RATINGS

TRANSFORMERS (Nameplate)	XXXMVA
CIRCUITS (Summer)	XXXMVA (white box)
MAXIMUM DEMAND (2014)	XXXMVA (magenta box)
MINIMUM DEMAND (2014)	XXXMVA (blue box)
MAXIMUM EMBEDDED GENERATION CONTRIBUTION (2014)	XXX MVA (cyan box)
PROPOSED EMBEDDED GENERATION CONNECTIONS	XXXMW (arrow tag)

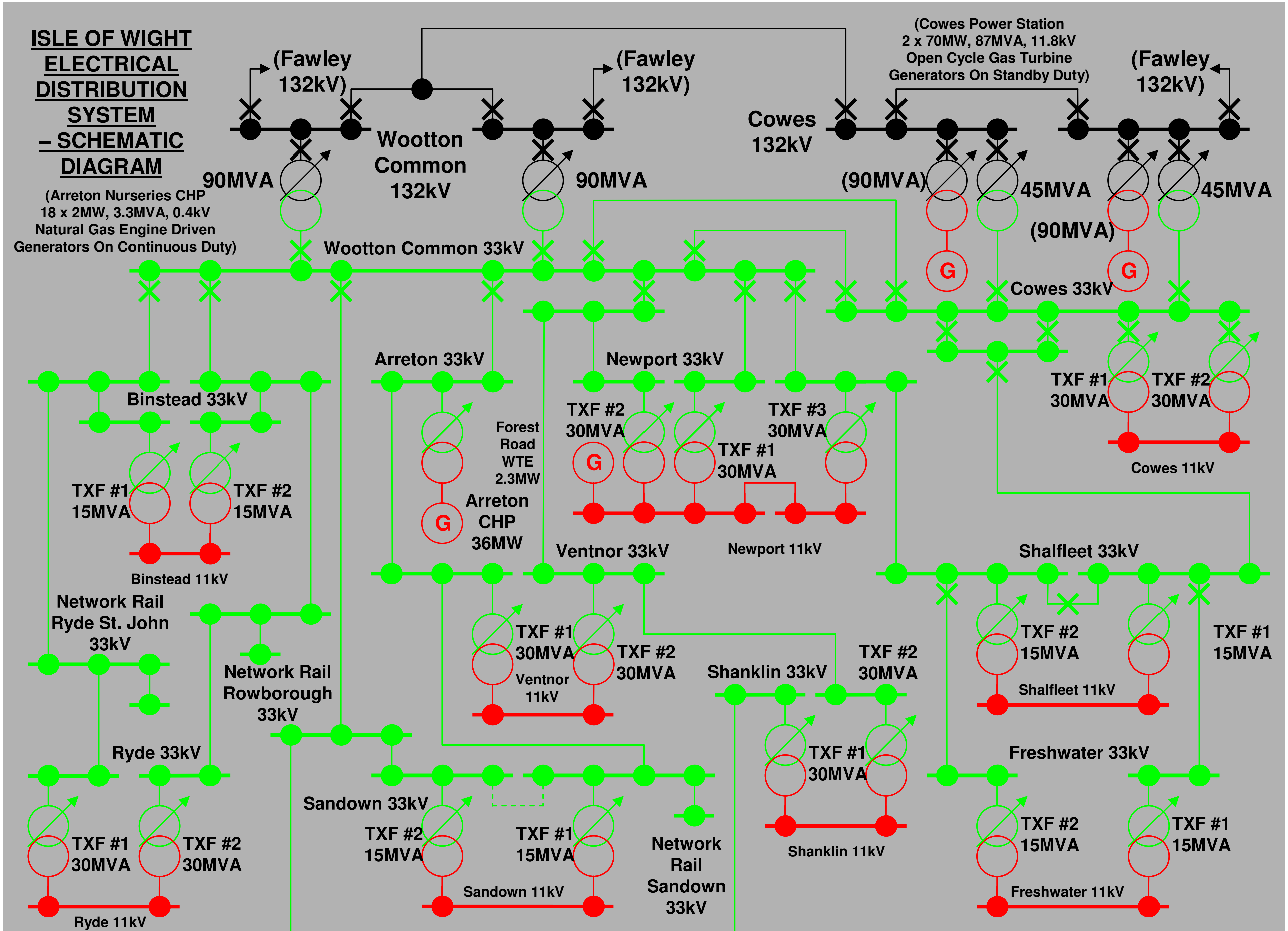
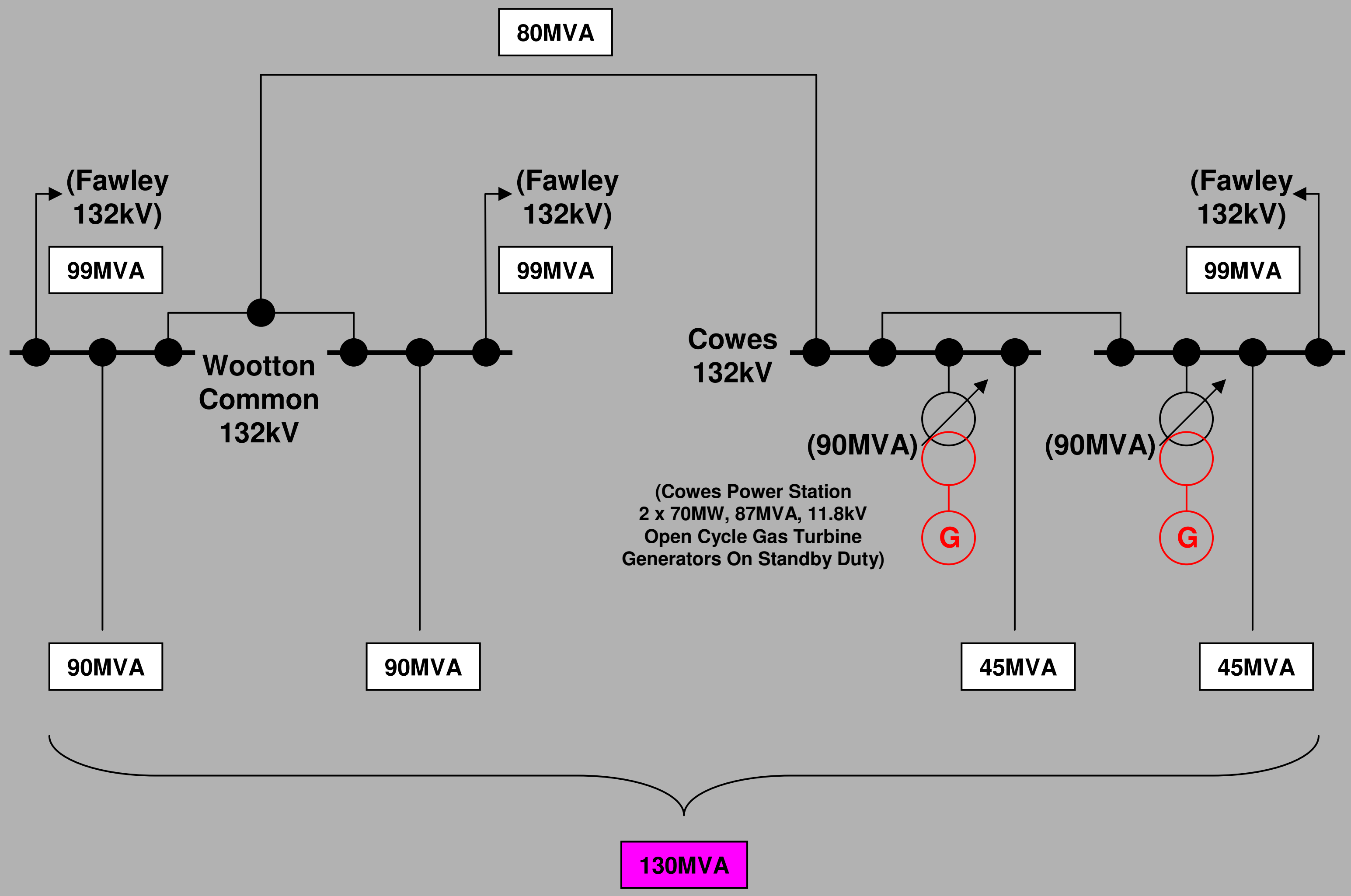
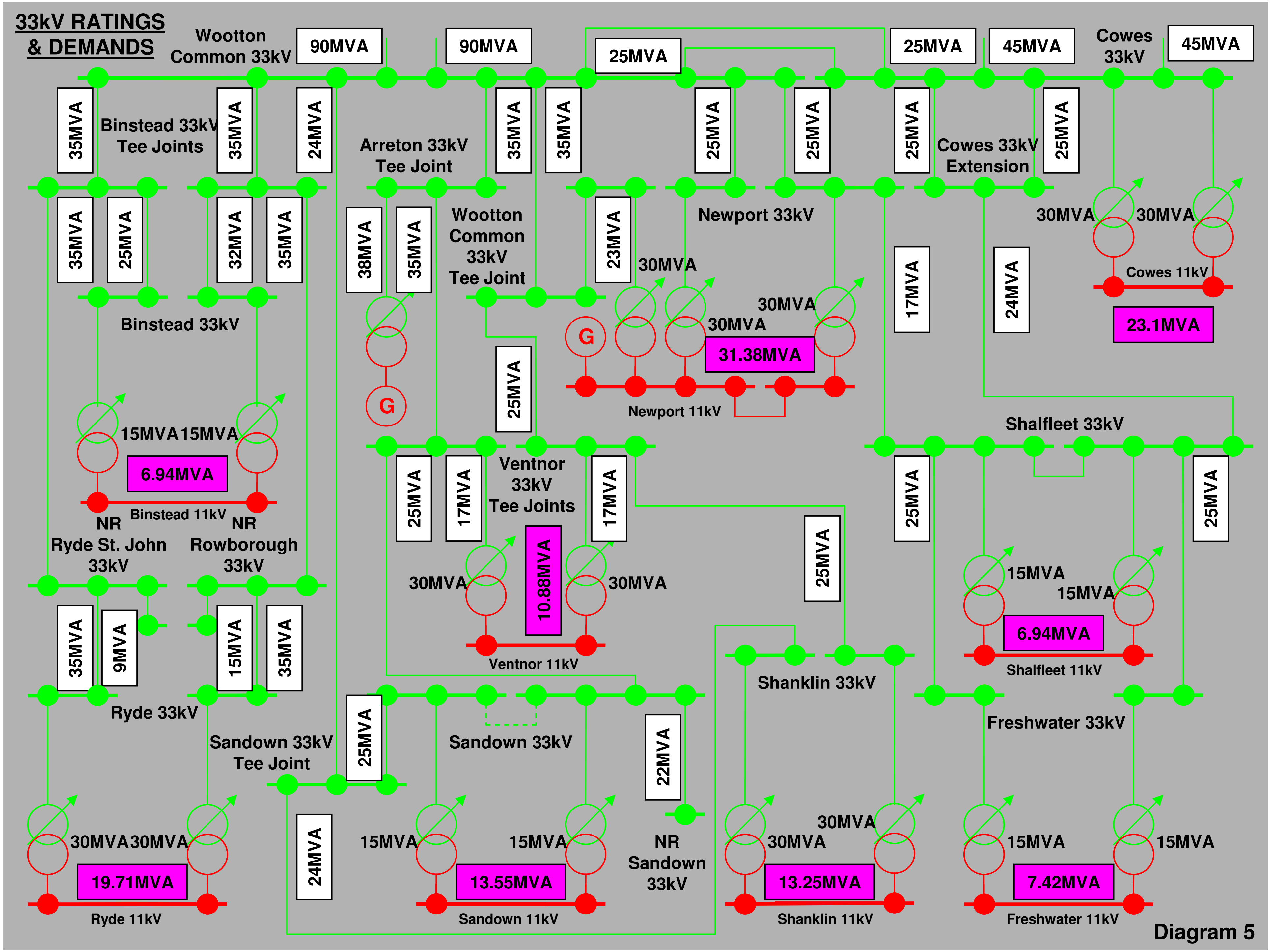
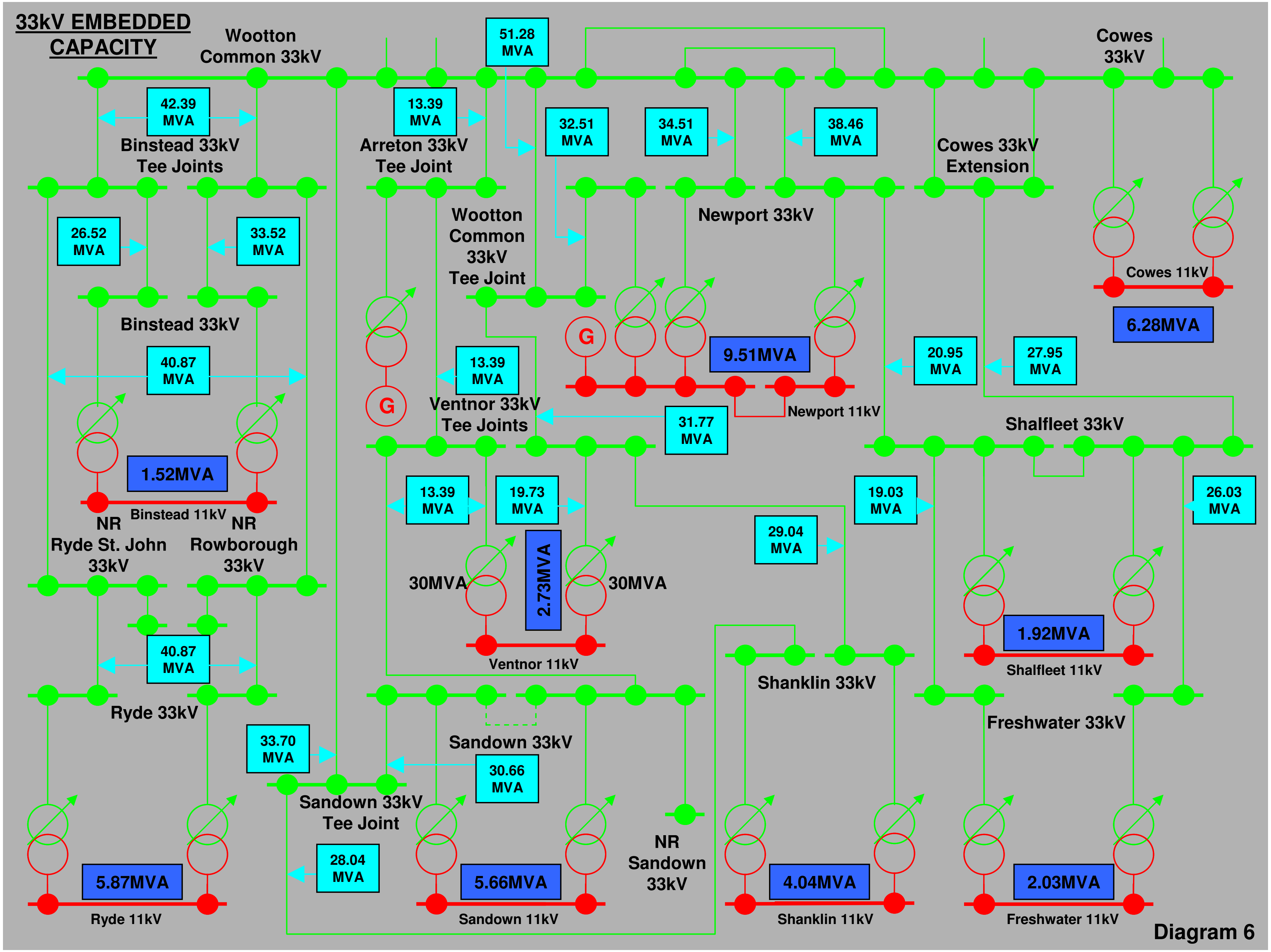

ISLE OF WIGHT ELECTRICAL DISTRIBUTION SYSTEM – SCHEMATIC DIAGRAM
(Arreton Nurseries CHP 18 x 2MW, 3.3MVA, 0.4kV Natural Gas Engine Driven Generators On Continuous Duty)
(Fawley 132kV)
(Fawley 132kV)
(Fawley 132kV)
Wootton Common 132kV
90MVA
90MVA
(Cowes Power Station 2 x 70MW, 87MVA, 11.8kV Open Cycle Gas Turbine Generators On Standby Duty)
Cowes 132kV
(90MVA)
45MVA
(90MVA)
45MVA
G
G
Wootton Common 33kV
Cowes 33kV
Binstead 33kV
TXF #1 15MVA
TXF #2 15MVA
Binstead 11kV
Arreton 33kV
Forest Road WTE 2.3MW
Arreton CHP 36MW
G
Newport 33kV
TXF #2 30MVA
TXF #1 30MVA
TXF #3 30MVA
G
Newport 11kV
TXF #1 30MVA
TXF #2 30MVA
Cowes 11kV
Network Rail Ryde St. John 33kV
Network Rail Rowborough 33kV
Ventnor 33kV
TXF #1 30MVA
TXF #2 30MVA
Ventnor 11kV
Shalfleet 33kV
TXF #2 15MVA
TXF #1 15MVA
Shalfleet 11kV
Shanklin 33kV
TXF #2 30MVA
TXF #1 30MVA
Shanklin 11kV
Ryde 33kV
TXF #1 30MVA
TXF #2 30MVA
Ryde 11kV
Sandown 33kV
TXF #2 15MVA
TXF #1 15MVA
Sandown 11kV
Network Rail Sandown 33kV
Freshwater 33kV
TXF #2 15MVA
TXF #1 15MVA
Freshwater 11kV

Diagram 3

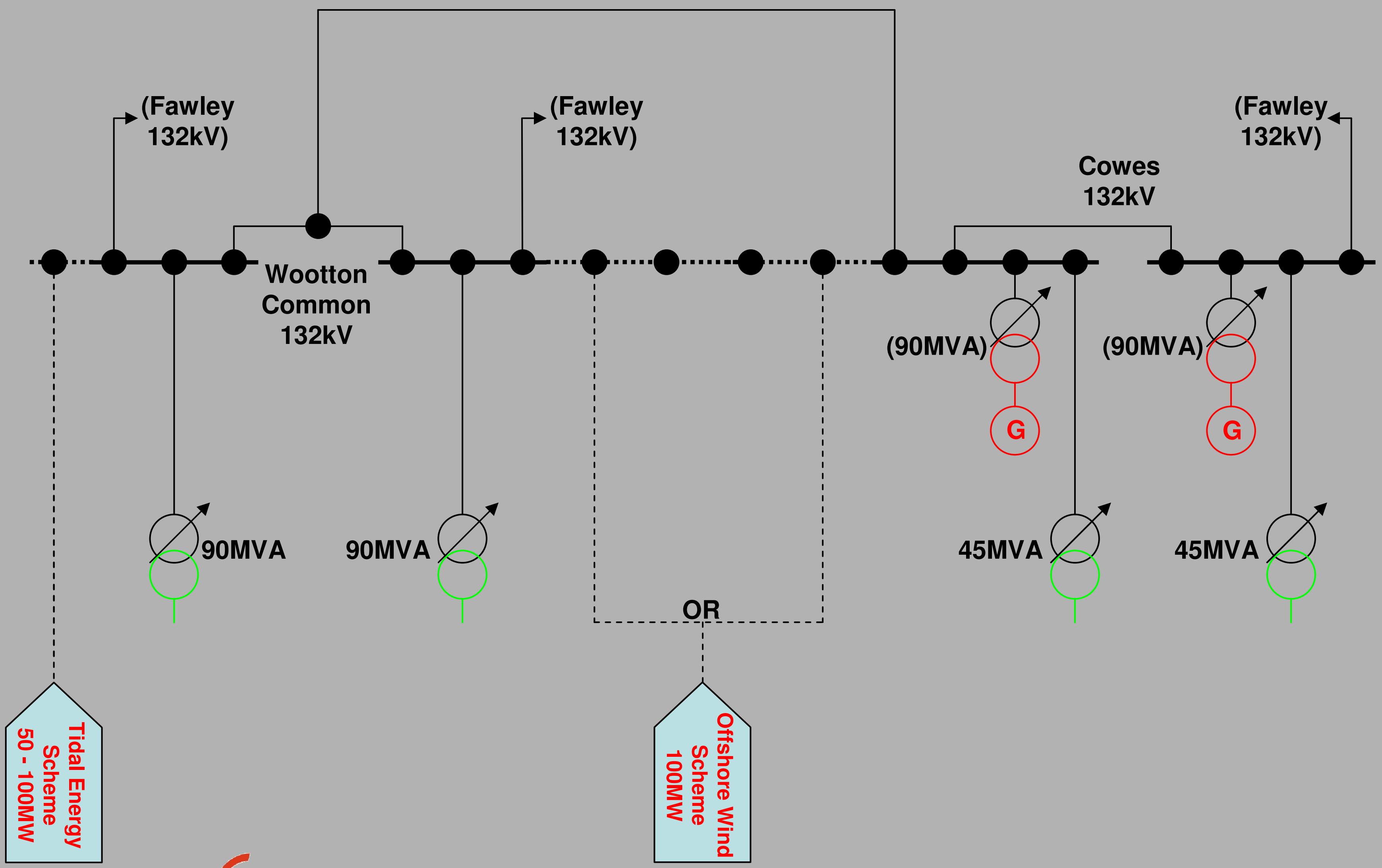
ISLE OF WIGHT ELECTRICAL DISTRIBUTION SYSTEM – 132kV RATINGS & DEMANDS

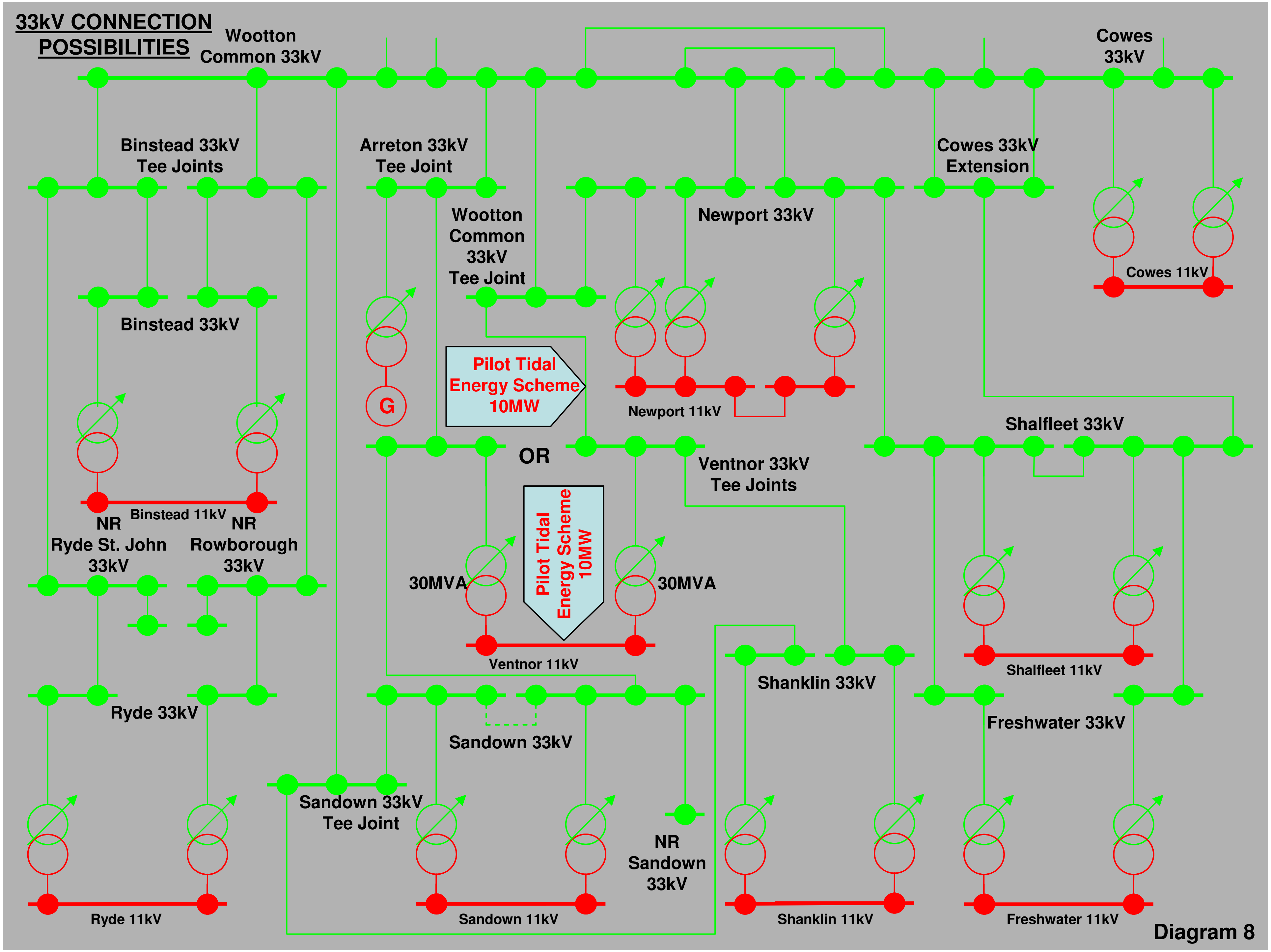



33kV RATINGS & DEMANDS
Wootton Common 33kV
90MVA
90MVA
25MVA
25MVA
45MVA
Cowes 33kV
45MVA
35MVA
Binstead 33kV Tee Joints
35MVA
24MVA
Arreton 33kV Tee Joint
35MVA
35MVA
25MVA
25MVA
25MVA
Cowes 33kV Extension
25MVA
35MVA
25MVA
32MVA
35MVA
38MVA
35MVA
Wootton Common 33kV Tee Joint
23MVA
Newport 33kV
30MVA
30MVA
30MVA
30MVA
30MVA
17MVA
24MVA
Cowes 11kV
23.1MVA
Binstead 33kV
G
31.38MVA
G
25MVA
Newport 11kV
Shalfleet 33kV
15MVA
15MVA
6.94MVA
Binstead 11kV
NR Ryde St. John 33kV
NR Rowborough 33kV
25MVA
17MVA
Ventnor 33kV Tee Joints
17MVA
10.88MVA
25MVA
25MVA
25MVA
30MVA
30MVA
15MVA
15MVA
6.94MVA
Shalfleet 11kV
35MVA
9MVA
15MVA
35MVA
Ventnor 11kV
Shanklin 33kV
Ryde 33kV
Sandown 33kV Tee Joint
25MVA
Sandown 33kV
22MVA
Freshwater 33kV
30MVA
30MVA
19.71MVA
Ryde 11kV
24MVA
15MVA
15MVA
13.55MVA
Sandown 11kV
NR Sandown 33kV
30MVA
30MVA
13.25MVA
Shanklin 11kV
15MVA
15MVA
7.42MVA
Freshwater 11kV
Diagram 5


33kV EMBEDDED CAPACITY
Wootton Common 33kV
51.28 MVA
Cowes 33kV
42.39 MVA
13.39 MVA
32.51 MVA
34.51 MVA
38.46 MVA
Binstead 33kV Tee Joints
Arreton 33kV Tee Joint
Cowes 33kV Extension
26.52 MVA
33.52 MVA
Wootton Common 33kV Tee Joint
Newport 33kV
Cowes 11kV
Binstead 33kV
G
9.51MVA
6.28MVA
40.87 MVA
13.39 MVA
20.95 MVA
27.95 MVA
G
Ventnor 33kV Tee Joints
31.77 MVA
Newport 11kV
Shalfleet 33kV
1.52MVA
Binstead 11kV
13.39 MVA
19.73 MVA
19.03 MVA
26.03 MVA
NR Ryde St. John 33kV
NR Rowborough 33kV
29.04 MVA
30MVA
2.73MVA
30MVA
40.87 MVA
1.92MVA
Ventnor 11kV
Shalfleet 11kV
Shanklin 33kV
Ryde 33kV
Freshwater 33kV
33.70 MVA
Sandown 33kV
30.66 MVA
Sandown 33kV Tee Joint
NR Sandown 33kV
28.04 MVA
5.87MVA
5.66MVA
4.04MVA
2.03MVA
Ryde 11kV
Sandown 11kV
Shanklin 11kV
Freshwater 11kV
Diagram 6

ISLE OF WIGHT ELECTRICAL DISTRIBUTION SYSTEM – 132kV CONNECTION POSSIBILITIES




33kV CONNECTION POSSIBILITIES
Wootton Common 33kV
Cowes 33kV
Binstead 33kV Tee Joints
Arreton 33kV Tee Joint
Cowes 33kV Extension
Wootton Common 33kV Tee Joint
Newport 33kV
Cowes 11kV
Binstead 33kV
Pilot Tidal Energy Scheme 10MW
G
Newport 11kV
Shalfleet 33kV
OR
Ventnor 33kV Tee Joints
Binstead 11kV
NR Ryde St. John 33kV
NR Rowborough 33kV
30MVA
Pilot Tidal Energy Scheme 10MW
30MVA
Ventnor 11kV
Shanklin 33kV
Shalfleet 11kV
Ryde 33kV
Sandown 33kV
Freshwater 33kV
Sandown 33kV Tee Joint
NR Sandown 33kV
Ryde 11kV
Sandown 11kV
Shanklin 11kV
Freshwater 11kV
Diagram 8

103326 Isle Of Wight Renewable Energy Resource Investigation

Review Of Potential For Connection Of Embedded Generation Sources Into Existing Public Electricity Supply Distribution System

Appendix 2

ISLE OF WIGHT ELECTRICAL DISTRIBUTION SYSTEM DATA

132kV to 33kV Transformers

Cowes Substation

	132kV Busbar	33kV Busbar	Vector Group	Rating (MVA)	Tap Changer	Earthing
Transformer No.1	COWE-A1 (13910)	COWE-C (13930)	Ynd1	45	OLTC (+10% to -20%)	Resistance
Transformer No.2	COWE-A2 (13920)	COWE-C (13930)	Ynd1	45	OLTC (+10% to -20%)	Resistance

Wootton Common Substation

	132kV Busbar	33kV Busbar	Vector Group	Rating (MVA)	Tap Changer	Earthing
Transformer No.1	WOOC-A1 (25810)	WOOC-C (25830)	Ynd1	90	OLTC (+10% to -20%)	Resistance
Transformer No.2	WOOC-A2 (25811)	WOOC-C (25830)	Ynd1	90	OLTC (+10% to -20%)	Resistance

33kV to 11kV Transformers

Arreton Substation

	33kV Busbar	11kV Busbar	Vector Group	Rating (MVA)	Tap Changer	Earthing
Transformer No.1	ARNC-C (86013)	ARNC-E (86000)	Yyn0	15	OLTC (+6% to -17%)	Solid
Transformer No.2	ARNC-C (86013)	ARNC-E (86000)	Yyn0	15	OLTC (+6% to -17%)	Solid

Binstead Substation

	33kV Busbar	11kV Busbar	Vector Group	Rating (MVA)	Tap Changer	Earthing
Transformer No.1	BINS-C1 (88708)	BINS-E (88733)	Dyn11	15	OLTC (+6% to -17%)	Resistance
Transformer No.2	BINS-C2 (88709)	BINS-E (88733)	Dyn11	15	OLTC (+6% to -17%)	Resistance

Cowes Substation

	33kV Busbar	11kV Busbar	Vector Group	Rating (MVA)	Tap Changer	Earthing
Transformer No.1	COWE-C (13930)	COWE-E (88729)	Dyn11	30	OLTC (Unknown)	Resistance
Transformer No.2	COWE-C (13930)	COWE-E (88729)	Dyn11	30	OLTC (Unknown)	Resistance

Freshwater Substation

	33kV Busbar	11kV Busbar	Vector Group	Rating (MVA)	Tap Changer	Earthing
Transformer No.1	FRES-C1 (88726)	FRES-E (88731)	Dyn11	15	OLTC (+6% to -17%)	Resistance
Transformer No.2	FRES-C2 (88727)	FRES-E (88731)	Dyn11	15	OLTC (+6% to -17%)	Resistance

Newport Substation

	33kV Busbar	11kV Busbar	Vector Group	Rating (MVA)	Tap Changer	Earthing
Transformer No.1	NEWP-C1 (88723)	NEWP-E (88732)	Dyn11	30	OLTC (+6% to -17%)	Resistance
Transformer No.2	NEWP-C2 (88722)	NEWP-E (88732)	Dyn11	30	OLTC (+6% to -17%)	Resistance
Transformer No.3	NEWP-C3 (88747)	NEWP-E3 (88748)	Dyn11	30	OLTC (+6% to -17%)	Resistance

Ryde Substation

	33kV Busbar	11kV Busbar	Vector Group	Rating (MVA)	Tap Changer	Earthing
Transformer No.1	RYDE-C1 (88710)	RYDE-E (88734)	Dyn11	30	OLTC (+6% to -17%)	Resistance
Transformer No.2	RYDE-C2 (88711)	RYDE-E (88734)	Dyn11	30	OLTC (+6% to -17%)	Resistance

Sandown Substation

	33kV Busbar	11kV Busbar	Vector Group	Rating (MVA)	Tap Changer	Earthing
Transformer No.1	SADO-C1 (88716)	SADO-E (88735)	Dyn11	15	OLTC (+5% to - 15%)	Resistance
Transformer No.2	SADO-C2 (88718)	SADO-E (88735)	Dyn11	15	OLTC (+5% to - 15%)	Resistance

Shalfleet Substation

	33kV Busbar	11kV Busbar	Vector Group	Rating (MVA)	Tap Changer	Earthing
Transformer No.1	SHAL-C1 (88724)	SHAL-E (88730)	Dyn11	15	OLTC (+10% to -10%)	Resistance
Transformer No.2	SHAL-C2 (88725)	SHAL-E (88730)	Dyn11	15	OLTC (+10% to -10%)	Resistance

Shanklin Substation

	33kV Busbar	11kV Busbar	Vector Group	Rating (MVA)	Tap Changer	Earthing
Transformer No.1	SHAN-C1 (88720)	SHAN-E (88736)	Dyn11	30	OLTC (+3% to - 10%)	Resistance
Transformer No.2	SHAN-C2 (88721)	SHAN-E (88736)	Dyn11	30	OLTC (+3% to - 10%)	Resistance

Ventnor Substation

	33kV Busbar	11kV Busbar	Vector Group	Rating (MVA)	Tap Changer	Earthing
Transformer No.1	VENT-C1 (88714)	VENT-E (88737)	Dyn11	30	OLTC (+6% to -17%)	Solid
Transformer No.2	VENT-C2 (88715)	VENT-E (88737)	Dyn11	30	OLTC (+6% to -17%)	Solid

132kV Circuit Ratings

Langley Substation to Wootton Common Substation	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Circuit No.1	LANG-A1	WOOC-A1	124	115	99
Circuit No.2	LANG-A2	WOOC-A2	124	115	99

Fawley Substation to Cowes Substation	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Circuit No.1	FAWL-A2	COWE-A2	124	115	99

Wootton Common Substation to Cowes Substation	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Circuit No.1	WOOC-A3	COWE-A1	125	100	80

33kV Circuit Ratings

Between Arreton Substation and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Arreton Substation (Tee Joint)	1	ARRN-C	ARRN-C1T	42	38	38

Between Arreton Substation (Tee Joint) and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Ventnor Substation (Tee Joint)	1	ARRN-C1T	VENT-C1T	44	41	35

Between Binstead Substation and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Binstead Substation (Tee Joint)	1	BINS-C1	BINS-C1T	31	29	25
Binstead Substation (Tee Joint)	2	BINS-C2	BINS-C2T	35	31	32

Between Binstead Substation (Tee Joint) and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Network Rail Ryde St. John Substation (Tee Joint)	1	BINS-C1T	BRRY-C1T	44	41	35
Network Rail Rowborough Substation (Tee Joint)	2	BINS-C2T	BRRO-C1T	44	41	35

Between Cowes Substation and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Cowes Substation Extension	1	COWE-C	COWE-C1	31	25	25
Cowes Substation Extension	2	COWE-C	COWE-C1	31	25	25

Between Cowes Substation Extension and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Shalfleet Substation	1	COWE-C1	SHAL-C1	30	28	24

Between Freshwater Substation and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Shalfleet Substation	1	FRES-C1	SHAL-C1T	31	29	25
Shalfleet Substation	2	FRES-C2	SHAL-C2T	31	29	25

Between Newport Substation and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Wootton Common Substation (Tee Joint)	1	NEWP-C2	WOOC-C2T	25	23	23

Between Ryde Substation and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Network Rail Ryde St. John Substation (Tee Joint)	1	RYDE-C1	BRRY-C1T	44	41	35
Network Rail Rowborough Substation (Tee Joint)	2	RYDE-C2	BRRO-C1T	44	41	35

Between Sandown Substation and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Network Rail Sandown Substation	1	SADO-C1	BRSA-C1	27	25	22
Sandown Substation (Tee Joint)	2	SADO-C2	SADO-C2T	31	29	25
Ventnor Substation (Tee Joint)	1	SADO-C1	VENT-C1T	31	29	25

Between Shalfleet Substation and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Newport Substation	1	SHAL-C1	NEWP-C3	21	20	17

Between Shanklin Substation and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Sandown Substation (Tee Joint)	1	SHAN-C1	SADO-C2T	30	28	24
Ventnor Substation (Tee Joint)	1	SHAN-C2	VENT-C2T	31	29	25

Between Ventnor Substation and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Ventnor Substation (Tee Joint)	1	VENT-C1	VENT-C1T	20	18	17
Ventnor Substation (Tee Joint)	2	VENT-C2	VENT-C2T	20	18	17

Between Wootton Common Substation and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Arreton Substation (Tee Joint)	1	WOOC-C	ARRN-C1T	44	41	35
Binstead Substation (Tee Joint)	1	WOOC-C	BINS-C1T	44	41	35
Binstead Substation (Tee Joint)	2	WOOC-C	BINS-C2T	44	41	35
Cowes Substation	1	WOOC-C	COWE-C	31	29	25
Cowes Substation	2	WOOC-C	COWE-C	31	29	25
Newport Substation	1	WOOC-C	NEWP-C1	31	29	25
Newport Substation	1	WOOC-C	NEWP-C3	30	26	25
Sandown Substation (Tee Joint)	1	WOOC-C	SADO-C2T	30	28	24
Wootton Common Substation (Tee Joint)	1	WOOC-C	WOOC-C2T	44	41	35

Between Wootton Common Substation (Tee Joint) and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Ventnor Substation (Tee Joint)	1	WOOC-C2T	VENT-C2T	31	29	25

Between Network Rail Rowborough Substation (Tee Joint) and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Network Rail Rowborough Substation	1	BRRO-C1T	BRRO-C1	19	17	15

Between Network Rail Ryde St John Substation (Tee Joint) and ...	Circuit No.	From	To	Winter Rating (MVA)	Spring & Autumn Rating (MVA)	Summer Rating (MVA)
Network Rail Ryde St John Substation	1	BRRY-C1T	BRRY-C1	12	11	9

132kV System Demand Data

Substation	Demand 2008 / 2009 (MVA)	Demand 2009 / 2010 (MVA)	Demand 2010 / 2011 (MVA)	Demand 2011 / 2012 (MVA)	Demand 2012 / 2013 (MVA)	Demand 2013 / 2014 (MVA)	Firm Capacity (MVA)	Minimum Load Scaling Factor (%)	Mimimum Loading 2013/ 2014 (MVA)
Wootton Common & Cowes	129.49	130.04	132.1	132.66	133.23	133.8	182	29	38.8

33kV System Demand Data

Substation	Demand 2008 / 2009 (MVA)	Demand 2009 / 2010 (MVA)	Demand 2010 / 2011 (MVA)	Demand 2011 / 2012 (MVA)	Demand 2012 / 2013 (MVA)	Demand 2013 / 2014 (MVA)	Firm Capacity (MVA)	Minimum Load Scaling Factor (%)	Mimimum Loading 2013/ 2014 (MVA)
Arreton (Infeed)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
Binstead	6.86	6.88	6.89	6.91	6.92	6.94	15	21.9	1.52
Cowes	21.34	21.39	22.94	22.99	23.04	23.1	30	27.2	6.28
Freshwater	7.33	7.35	7.37	7.38	7.4	7.42	15	27.3	2.03
Newport	29.73	30.06	30.38	30.71	31.04	31.38	38	30.3	9.51
Ryde	19.49	19.54	19.58	19.62	19.67	19.71	30	29.8	5.87
Sandown	13.4	13.43	13.46	13.49	13.52	13.55	15	41.8	5.66
Shalfleet	6.86	6.87	6.89	6.91	6.92	6.94	15	27.7	1.92
Shanklin	13.1	13.13	13.16	13.19	13.22	13.25	30	30.5	4.04
Ventnor	10.76	10.78	10.81	10.83	10.86	10.88	30	25.1	2.73
Wootton Common (Infeed)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
Totals	128.87	129.43	131.48	132.03	132.59	133.17			39.56

132kV System Busbar Fault Levels

Cowes 132kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)	Single Phase Peak Make Fault Level (kA)	Single Phase RMS Break Fault Level (kA)	Single Phase Peak Making Capacity (kA)	Single Phase RMS Breaking Capacity (kA)
COWE-A1 Busbar	33.96	13.68	54.5	21.8	19.58	15.63	78.8	31.5
COWE-A2 Busbar	33.96	13.68	54.5	21.8	19.58	15.63	78.8	31.5

Wootton Common 132kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)	Single Phase Peak Make Fault Level (kA)	Single Phase RMS Break Fault Level (kA)	Single Phase Peak Making Capacity (kA)	Single Phase RMS Breaking Capacity (kA)
WOOC-A1 Busbar	32.61	13.21	78.8	31.5	18.09	14.77	100	40
WOOC-A2 Busbar	32.61	13.21	78.8	31.5	18.09	14.77	100	40

33kV System Busbar Fault Levels

Arreton 33kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)	Three Phase Peak Make Fault Level Margin (kA)	Three Phase RMS Break Fault Level Margin (kA)
ARRN-C Busbar	19.4	6.8	62.5	25	43.1	18.2

Binstead 33kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)			
BINS-C1 Busbar	N/A	N/A	N/A	N/A		N/A	(Fault Level Data Not Availalble)
BINS-C2 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)

Cowes 33kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)		
COWE-C Busbar	42.2	16.107	44.6	17.5	2.4	1.393

Freshwater 33kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)			
FRES-C1 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)
FRES-C2 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)

Newport 33kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)			
NEWP-C1 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)
NEWP-C2 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)
NEWP-C3 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)

Ryde 33kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)			
RYDE-C1 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)
RYDE-C2 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)
Sandown 33kV Substation	**Three Phase Peak Make Fault Level (kA)**	**Three Phase RMS Break Fault Level (kA)**	**Three Phase Peak Making Capacity (kA)**	**Three Phase RMS Breaking Capacity (kA)**			
SADO-C1 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)
SADO-C2 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)
Shalfleet 33kV Substation	**Three Phase Peak Make Fault Level (kA)**	**Three Phase RMS Break Fault Level (kA)**	**Three Phase Peak Making Capacity (kA)**	**Three Phase RMS Breaking Capacity (kA)**			
SHAL-C1 Busbar	16.9	5.8	33.4	13.1	16.5	7.3	

SHAL-C2 Busbar	**16.9**	**5.8**	**33.4**	**13.1**	**16.5**	**7.3**	
<u>Shanklin 33kV Substation</u>	**Three Phase Peak Make Fault Level (kA)**	**Three Phase RMS Break Fault Level (kA)**	**Three Phase Peak Making Capacity (kA)**	**Three Phase RMS Breaking Capacity (kA)**			
SHAN-C1 Busbar	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**(Fault Level Data Not Availalble)**
SHAN-C2 Busbar	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**(Fault Level Data Not Availalble)**
<u>Ventnor 33kV Substation</u>	**Three Phase Peak Make Fault Level (kA)**	**Three Phase RMS Break Fault Level (kA)**	**Three Phase Peak Making Capacity (kA)**	**Three Phase RMS Breaking Capacity (kA)**			
VENT-C1 Busbar	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**(Fault Level Data Not Availalble)**
VENT-C2 Busbar	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**(Fault Level Data Not Availalble)**

Wootton Common 33kV Substation	**Three Phase Peak Make Fault Level (kA)**	**Three Phase RMS Break Fault Level (kA)**	**Three Phase Peak Making Capacity (kA)**	**Three Phase RMS Breaking Capacity (kA)**		
WOOC-C Busbar	**N/A**	**16.835**	**44.6**	**17.5**	**N/A**	**0.665**

11kV System Busbar Fault Levels

Arreton 11kV Substation (Not Under Southern Electric Ownership)	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)	Three Phase Peak Make Fault Level Margin (kA)	Three Phase RMS Break Fault Level Margin (kA)	
ARRN-E1 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)
ARRN-E2 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)
ARRN-E3 Busbar	N/A	N/A	N/A	N/A	N/A	N/A	(Fault Level Data Not Availalble)

Binstead 11kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)		
BINS-E Busbar	19	7.4	33.4	13.1	14.4	5.7

11kV System Fault Levels

<u>Cowes 11kV Substation</u>	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)		
COWE-E Busbar	24.2	8.4	33.4	13.1	9.2	4.7

<u>Freshwater 11kV Substation</u>	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)		
FRES-E Busbar	13.6	5.7	33.4	13.1	19.8	7.4

<u>Newport 11kV Substation</u>	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)		
NEWP-E Busbar	25.8	9.3	33.4	13.1	7.6	3.8

<u>Ryde 11kV Substation</u>	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)		
RYDE-E Busbar	19.6	7.1	33.4	13.1	13.8	6

Sandown 11kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)		
SADO-E Busbar	16	6.4	33.4	13.1	17.4	6.7

Shalfleet 11kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)		
SHAL-E Busbar	16.6	6.6	33.4	13.1	16.8	6.5

Shanklin 11kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)		
SHAN-E Busbar	16.9	6.5	33.4	13.1	16.5	6.6

Ventnor 11kV Substation	Three Phase Peak Make Fault Level (kA)	Three Phase RMS Break Fault Level (kA)	Three Phase Peak Making Capacity (kA)	Three Phase RMS Breaking Capacity (kA)		
VENT-E Busbar	19.7	9	40	16	20.3	7

33kV System Embedded Generation Capacity

Point Of Connection

Binstead No.1 Tee Joint	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Binstead No.1 Transformer Circuit	Binstead Demand	1.52	Binstead Tee Joint No.1 - Binstead Transformer No.1 Circuit Rating	25	26.52
Ryde No.1 / Network Rail Ryde St John Circuit	Ryde Demand (Network Rail Demand Disregarded)	5.87	Binstead Tee Joint No.1 - Ryde No.1 Circuit Rating	35	40.87
Wootton Common Circuit	Binstead Demand + Ryde Demand	7.39	Binstead Tee Joint No.1 - Wootton Common Circuit Rating	35	42.39

Binstead No.2 Tee Joint	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Binstead No.2 Transformer Circuit	Binstead Demand	1.52	Binstead Tee Joint No.2 - Binstead Transformer No.2 Circuit Rating	32	33.52
Ryde No.2 / Network Rail Rowborough Circuit	Ryde Demand (Network Rail Demand Disregarded)	5.87	Binstead Tee Joint No.2 - Ryde No.2 Circuit Rating	35	40.87
Wootton Common Circuit	Binstead Demand + Ryde Demand	7.39	Binstead Tee Joint No.2 - Wootton Common Circuit Rating	35	42.39

Freshwater No.1 Circuit	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Freshwater No.1 Circuit	Freshwater Demand	2.03	Limited by Shalfleet No.1 - Cowes circuit rating (24MVA), assuming bus section circuit breaker at Shalfleet to be open	24	26.03

Freshwater No.2 Circuit	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Freshwater No.2 Circuit	Freshwater Demand	2.03	Limited by Shalfleet No.2 - Newport circuit rating (17MVA), assuming bus section circuit breaker at Shalfleet to be open	17	19.03

Newport No.1 Circuit	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Newport No.1 Circuit	Newport Demand	9.51	Newport No.1 - Wootton Common Circuit Rating	25	34.51

Newport No.2 Circuit	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Newport No.2 Circuit	Newport Demand	9.51	Newport No.2 - Wootton Common Tee Joint Circuit Rating	23	32.51

Newport No.3 Circuit	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Newport No.3 Circuit	Newport Demand + Shalfleet Demand + Freshwater Demand	13.46	Newport No.3 - Wootton Common Circuit Rating	25	38.46

Ryde No.1 Circuit	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Ryde No.1 Circuit	Ryde Demand (Network Rail Demand Disregarded)	5.87	Ryde No.1 - Binstead Tee Joint No.1 Circuit Rating	35	40.87

Ryde No.2 Circuit	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Ryde No.2 Circuit	Ryde Demand (Network Rail Demand Disregarded)	5.87	Ryde No.2 - Binstead Tee Joint No.2 Circuit Rating	35	40.87

<u>Sandown No.1 Circuit</u>	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Sandown No.1 Circuit (Zero Transfer Across Bus Section At Sandown Substation)	Sandown Demand + Ventnor Demand (Network Rail Demand Disregarded)	8.39	Limited by Arreton - Wootton Common circuit rating (35MVA), less maximum output of Wight Salads CHP (30MVA)	5	13.39

<u>Sandown No.2 Circuit</u>	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Sandown No.2 Circuit (Zero Transfer Across Bus Section At Sandown Substation)	Sandown Demand	5.66	Sandown No.2 - Sandown Tee Joint (assume at least 1MVA demand from Shanklin)	25	30.66

<u>Sandown Tee Joint</u>	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Sandown No.2 Circuit	Sandown Demand	5.66	Sandown No.2 - Sandown Tee Joint Circuit Rating (assume at least 1MVA demand from Shanklin)	25	30.66
Shanklin No.1 Circuit	Shanklin Demand	4.04	Sandown Tee Joint - Shanklin No.1 Circuit Rating	24	28.04
Wootton Common Circuit	Sandown Demand + Shanklin Demand	9.7	Sandown Tee Joint - Wootton Common Circuit Rating	24	33.7

Shalfleet No.1 Circuit	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Shalfleet No.1 Circuit (Zero Transfer Across Bus Section At Shalfleet Substation)	Freshwater Demand + Shalfleet Demand	3.95	Shalfleet No.1 Circuit Rating - Cowes	24	27.95

Shalfleet No.2 Circuit	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Shalfleet No.2 Circuit (Zero Transfer Across Bus Section At Shalfleet Substation)	Freshwater Demand + Shalfleet Demand	3.95	Shalfleet No.2 Circuit Rating - Newport	17	20.95

Shanklin No.1 Circuit	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Shanklin No.1 Circuit	Shanklin Demand	4.04	Shanklin No.1 - Sandown Tee Joint Circuit Rating	24	28.04

Shanklin No.2 Circuit	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Shanklin No.2 Circuit	Shanklin Demand	4.04	Shanklin No.2 - Ventnor Tee Joint No.2 Circuit Rating	25	29.04

Ventnor No.1 Tee Joint	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Ventnor No.1 Transformer Circuit	Ventnor Demand + Sandown Demand (Network Rail Demand Disregarded)	8.39	Limited by Arreton - Wootton Common circuit rating (35MVA), less maximum output of Wight Salads CHP (30MVA)	5	13.39
Sandown No.1 Circuit	Ventnor Demand + Sandown Demand (Network Rail Demand Disregarded)	8.39	Limited by Arreton - Wootton Common circuit rating (35MVA), less maximum output of Wight Salads CHP (30MVA)	5	13.39
Arreton Tee Joint Circuit	Ventnor Demand + Sandown Demand (Network Rail Demand Disregarded)	8.39	Limited by Arreton - Wootton Common circuit rating (35MVA), less maximum output of Wight Salads CHP (30MVA)	5	13.39

Ventnor No.2 Tee Joint	Mimimum Downstream Demand	Mimimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Ventnor No.2 Transformer Circuit	Ventnor Demand	2.73	Ventnor Tee Joint No.2 - Ventnor Transformer No.2 Circuit Rating	17	19.73
Shanklin No.2 Circuit	Shanklin Demand	4.04	Ventnor Tee Joint No.2 - Shanklin No.2 Circuit Rating	25	29.04
Wootton Common Tee Joint Circuit	Ventnor Demand + Shanklin Demand	6.77	Ventnor Tee Joint No.2 - Wootton Common Tee Joint Circuit Rating	25	31.77

Wootton Common Tee Joint	Minimum Downstream Demand	Minimum Downstream Demand 2013 / 2014 (MVA)	Mimimum Upstream Capacity	Minimum (Summer) Upstream Circuit Rating (MVA)	Maximum Embedded Generation Contribution (MVA)
Newport No.2 Circuit	Newport Demand	9.51	Wootton Common Tee Joint - Newport No.2 Circuit Rating	23	32.51
Ventnor No.2 Tee Joint	Ventnor Demand + Shanklin Demand	6.77	Wootton Common Tee Joint - Ventnor Tee Joint No.2 Circuit Rating	25	31.77
Wootton Common Circuit	Newport Demand + Ventnor Demand + Shanklin Demand	16.28	Wootton Common Tee Joint - Wootton Common Circuit Rating	35	51.28

Busbar References

Node	Node Name	Busbar Name	Voltage (kV)
13900	COWE-E1	COWES	11.8
13901	COWE-E2	COWES	11.8
13910	COWE-A	COWES	132
13920	COWE-A2	COWES	132
13930	COWE-C	COWES	33
25810	WOOC-A1	WOOTTON COMMON	
25811	WOOC-A2	WOOTTON COMMON	132
25812	WOOC-A3	WOOTTON COMMON	132
25830	WOOC-C	WOOTTON COMMON	33
88700	COWE-C1	COWES	33
88701	NRRY-C1	N.R. RYDE ST JOHN	33
88702	NRRO-C1	N.R. ROWBOROUGH	33
88703	NRSA-C1	N.R. SANDOWN	33
88705	WOOC-C2T	WOOTTON COMMON	33
88706	BINS-C1T	BINSTEAD	33
88707	BINS-C2T	BINSTEAD	33
88708	BINS-C1T	BINSTEAD	33
88709	BINS-C2	BINSTEAD	33
88710	RYDE-C1	RYDE	33
88711	RYDE-C2	RYDE	33
88712	VENT-C1T	VENTNOR	33
88713	VENT-C2T	VENTNOR	33
88714	VENT-C1T	VENTNOR	33
88715	VENT-C2	VENTNOR	33
88716	SADO-C1	SANDOWN	33
88717	NRRO-C1T	N.R. ROWBOROUGH	33
88718	SADO-C2	SANDOWN	33
88719	SADO-C2T	SANDOWN	33
88720	SHAN-C1	SHANKLIN	33
88721	SHAN-C2	SHANKLIN	33
88722	NEWP-C2	NEWPORT	33
88723	NEWP-C1	NEWPORT	33
88724	SHAL-C2	SHALFLEET	33
88725	SHAL-C1	SHALFLEET	33
88726	FRES-C1	FRESHWATER	33
88727	FRES-C2	FRESHWATER	33
88728	NRRY-C1T	N.R. RYDE ST JOHN	33
88729	COWE-E	COWES P.S.	11
88730	SHAL-E	SHALFLEET	11
88731	FRES-E	FRESHWATER	11
88732	NEWP-E	NEWPORT	11
88733	BINS-E	BINSTEAD	11
88734	RYDE-E	RYDE	11
88735	SADO-E	SANDOWN	11
88736	SHAN-E	SHANKLIN	11
88737	VENT-E	VENTNOR	11
88738	ARRE-C1T	ARRETON NURSERIES	33
88739	ARRE-C	ARRETON NURSERIES	33
88740	NEWP-C3	NEWPORT	33
88741	NEWP-E3	NEWPORT	11