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Engineering Report 130

Issue 3~~2~~ 201~~9~~4

Guidance on the ~~A~~application of Engineering Recommendation P2, Security of Supply~~guide for assessing the capacity of networks containing distributed generation~~

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Operations Directorate
Energy Networks Association
~~6th Floor, Dean Bradley House~~4 More London Riverside
~~52 Horseferry Rd~~
London
SE1~~W1P~~ 2AU~~F~~

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Revised, 2019.

Amendments since publication

Issue	Date	Amendment
Issue 3	January, 2019	Major revision of Issue 2 to: • Align EREP 130 ~~is aligned~~ with EREC P2/7 [N1] • Provide new guidance on assessing the contribution to security from Demand Side Response (DSR) Schemes and Electricity Storage (ES) • Update the F factors for assessing contribution to security from Distributed Generation (DG), using recent data from ~~Distribution Generation~~DG • Differentiate the contribution to security from DG, DSR Schemes and ES which is contracted with a Distribution Network Operator (DNO) and that which is not~~.~~ This issue has largely been re-structured to improve the flow of the guidance, based on a revised step-by-step flow diagram (see Figure 1). This issue includes the following principal technical changes. Introduction: Updated to reflect expansion of scope and inclusion of DSR Schemes and ES. Clause 1, Scope: Expanded to include DSR and ES. Clause 2, Normative references: Updated to reflect latest relevant references. Clause 3, Terms and definitions: All existing definitions amended to align with EREC P2/7 [N1]. New definitions added for: • Cold Load Pickup • Contracted

		• Demand Facility • Demand Side Response Scheme • Electricity Storage • Non-Contracted • Regulatory Financial Performance Reporting Clause 4, Assessment process overview: Major amendment of guidance on process to reflect a new Figure 1, which replaces the previous process flow diagram (Issue 2 Figure 5.1). Clause 5, Determine the Group Demand and class of supply: Major amendment of guidance on assessing Group ~~d~~Demand. New guidance added to explain what a demand group is (new Figure 2 added). More detailed guidance included on assessing Latent Demand with supporting Annex A. Clarification of de-mini~~n~~mis test when assessing Latent Demand. A new Figure 3 replaces the previous (Issue 2 Figure 5.2), and new guidance on taking account of Cold Load Pickup. Clause 6, Determine capacity of network assets and assess compliance: Major amendment of guidance with the removal of the previous flow diagram (Issue 2 Figure 5.3) considered to be unnecessary. New guidance (Clause 6.2) added on determining the 'intrinsic network capacity'. New guidance (Clause 6.3) added on determining the Transfer Capacity. Clause 7, Contribution to System Security from Contacted DG, DSR Schemes, and ES: New guidance added on assessing the contribution from Contracted DG, ~~/~~DSR Schemes and ES, including the relevant considerations when developing such contracts. This Clause is supported by Annexes C and E. Clause 8, Contribution to System Security from Non-Contacted DG, DSR Schemes, and ES: This clause now replaces the previous guidance on assessing contribution from DG which has been subject to amendment and additions, i.e. guidance now focuses on Non-Contracted aspects and includes new considerations for DSR Schemes and ES. The guidance on de-minimis criteria for individual facilities/schemes has been clarified. The previous flow chart has been removed as it is no longer relevant (Issue 2 Figure 5.4). This clause is supported by Annexes B, D and E. Clause 9, ~~Sufficiency of the system capacity~~Assessing compliance with Table 1: The main amendment to this clause includes new guidance (Clause 9.2) on conducting a high-level review of the options when the system capacity is insufficient to meet System Security requirements. Clause 10, Provision of system security: New clause providing guidance on planning remedial work to address a deficiency in system capacity. Clause 11, Cost Benefit Analysis (CBA): New clause providing guidance on undertaking a supplementary CBA when the options identified for remedial works are not considered viable. Annex A, Identification of Group Demand: The previous guidance on Group Demand (Issue 2, Clause 6.6) has been subject to amendment. New guidance has been added to assist in determination of Latent Demand. Guidance on establishing Latent Demand of DSR Schemes clarified and new guidance on establishing Latent Demand for ES added. Annex B, Capping DG/DSR Schemes/ES: Previous guidance on capping (Issue 2, Clause 6.3) has been removed as the concept of establishing the 'number of DG units equivalent to a first circuit outage' is no longer relevant, i.e. DG/DSR Schemes/ES are now

		considered on a 'per facility' basis. Hence, new guidance now added for capping, covering the capacities that are relevant. The guidance on common mode failures has been subject to a minor amendment to account for active management network. Annex C, Technical check list: Minor amendment to check list for DG to align with changes throughout document. New check list items added for Non-Contracted DSR schemes and Non-Contracted ES. Annex D, Approaches for assessing the contribution from DG to System Security: The F factors for DG have been subject to a major amendment following analysis of DG data collated over the period 2013-2018. The F Factor values for both non-intermittent and intermittent DG apply to the facility~~,~~ i.e. the consideration of the availability of DG units and the number of DG units for non-intermittent types is no longer applicable. Hence, the F factor values in Approach 1 have been replaced with new values. New ~~graphs~~ table for intermittent persistence ha~~ve~~s been added to replace the previous tables & graphs in Approach 2. The types of DG have been updated to reflect the majority of DG connections on DNO networks. The previous methodology in Approach 2, which requi~~r~~ted knowledge of the availability of DG units and the number of units ~~i~~on a facility, has been deleted as it is now longer relevant. A new methodology for Approach 2 has been added for non-intermittent DG, which uses capacity factors. Annex E, Influencing factors for DG/DSR Schemes/ES Security Contribution: The previous guidance (Issue 2, Clause 6.2) on generation availabilities has been subject to major amendment. The explanation on establishing the availability of DG units has been deleted as it is no longer relevant. New guidance has been added for DSR Scheme considerations and ES considerations. Annex F, Examples: New examples have been added for~~,~~ Group Demand, Transfer Capacity, DG, DSR Schemes and ES. Annex G, Interpretation of Imperial College London Report [N8] findings: New Annex added to capture derivation of the F factor tables in Annex D from the Imperial College London report [N8]. Bibliography: The list of relevant informative references has updated.
Issue 2	December, 2014	Minor amendment to incorporate requirements for Demand Side Response (DSR). Document converted to the new ENA Engineering Report (EREP) template. This issue includes the following principal technical changes. Clause 3: New definition for DSR added. Footnote added for definition of Latent Demand. Clause 4.1: Added requirement to consider the contribution from DSR. Added explanation that DSR can be treated as either a reduction in Group Demand or an increase in System Capacity. Clause 6.10: New clause added for DSR. Clause 7.1: Added requirements for assessing the contribution from DSR. Annex A.4: Deleted reference to "ER G75/1". Details of all other technical, general and editorial amendments are included in the associated Document Amendment Summary for this Issue (available on request from the Operations Directorate of ENA).

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Foreword

This Engineering Report (EREP) is published by the Energy Networks Association (ENA) and comes into effect from the date of publication~~December, 2014~~. It has been prepared under the authority of the ENA Engineering Policy and Standards Manager and has been approved for publication by the GB Distribution Code Review Panel (DCRP). The approved abbreviated title of this engineering document is "EREP 130"~~, which replaces the previously used abbreviation "ETR 130"~~.

This document replaces and supersedes EREP~~TR~~ 130, Issue 2~~1~~.

It is expected that readers of this EREP are conversant with the requirements in EREC P2/7 [N1].

Whilst implementing the guidance set out in this EREP, it is expected that compliance with all relevant industry standards is adhered to, including those Standards referenced in Annex 1 of the DCODE [N7]

Where the term "shall" or "must" is used in this document it means the requirement is mandatory. The term "should" is used to express a recommendation. The term "may" is used to express permission.

NOTE: Commentary, explanation and general informative material is presented in smaller type, and does not constitute a normative element.

Introduction

The previous issue of this Engineering Report (EREP) focused on assessing the contribution to System Security provided by Distributed Generation (DG). However, the latest Issue of EREC P2 (Issue 7) [N1] recognises that demand may be secured using a combination of “network assets and non-network assets”. Thus, the guidance in this EREP has been extended to provide guidance on assessing the security contribution from:

- network assets;
- D~~istributed Generation (D~~G~~)~~, Demand Side Response (DSR) Schemes, and Electricity Storage (ES), that are contracted with a Distribution Network Operator (DNO) to provide a security service; and
- DG, DSR Schemes, and ES, that are not contracted with a DNO to provide a security service.

The ~~continuing~~ experience that Distribution Network Operators (DNOs) now have assessing the security contribution from DG has provided~~s~~ an opportunity to refine and consolidate the guidance in this EREP.~~The provisions contained in Engineering Recommendation P2/5 (ER P2/5) for assessing the contribution to System Security as provided by DG were limited to large steam and open cycle gas turbine (OCGT) sets that were prevalent at the time ER P2/5 was published in 1978. With the growth of DG in the UK all stakeholders agreed that it was necessary to carry out a limited revision of ER P2/5 to ensure that the possible security contribution from modern types of DG plant could, where appropriate, be properly recognised.~~

~~The task of revising ER P2/5 was given to a joint working group of DNOs, Generators, the Regulator, academics and consultants. A major part of the work of this group was the production of three reports for Future Energy Solutions (FES) [N2, N3 and N4], (FES being the agency responsible for managing technical projects on behalf of the DTI). These three reports formed the basis of the revised text in Engineering Recommendation P2/6 (ER P2/6) [N1].~~

~~This Engineering Report uses the information contained in the three FES reports to provide background information on the requirements contained in ER P2/6 [N1]. The intention is that this information will guide users of ER P2/6 [N1] to make a consistent interpretation of the requirements therein.~~

~~The purpose of this Engineering Report is to support ER P2/6 [N1] by providing guidance on how to assess the ER P2/6 [N1] compliance of a network containing DG.~~

1 Scope

This Engineering Report (EREP) provides guidance on how to assess whether an electricity distribution system~~ comprising both network assets and DG~~ meets the security requirements specified in EREC P2/~~6~~7 [N1] by means of security contribution from network assets, Distributed Generation (DG), Demand Side Response (DSR) Schemes, or Electricity Storage (ES). In order to achieve this, there is a need to establish the Group Demand, as defined in EREC P2/7 [N1] and to assess the means of securing this demand in accordance with the requirement of EREC P2/7 [N1] Table 1~~security contribution provided from both network assets and DG, taking into account DSR~~. This EREP provides technical guidance on~~ both these issues~~this assessment.~~ The procedures described in this report are based on the same principles that underpinned the previous standard, ER P2/5.~~

~~The contribution to System Security from DG plant specified in ER P2/6 [N1] and this EREP have been derived from the best data available at the time. In the event that more accurate data becomes available it may be appropriate to review the contributions quoted in ER P2/6 [N1] and this EREP.~~

This EREP provides guidance on quantifying the security contribution where the DNO has a contract with a DG facility, DSR Scheme provider or ES facility. It also provides guidance on ~~the assessment of~~assessing the fortuitous security contribution from ~~with a~~ DG, DSR Scheme, ES~~ owner/operatorDG, DSR Schemes and ES~~ where there is no contact in place with the DNO to provide security services.

This EREP~~report~~ also provides general guidance on~~ the likely~~ contractual considerations which are relevant when~~that~~ a DNO is ~~might need to consider when~~ assessing~~looking~~ the~~to include the~~ security contribution with a DG, DSR Scheme, ES ~~owner/operatorfrom a DG, DSR Schemesplant(s) or ES~~ to satisfy the requirements of EREC P2/~~6~~7 [N1]. However, the detail~~sed~~ ~~form that~~of any contractual and commercial considerations might take ~~is~~ this outside the scope of this technical document.

This EREP also provides guidance on the use of cost benefit analysis (CBA) to establish the justification or otherwise, for providing additional security to meet the requirements of EREC P2/7 [N1] Table 1.~~The definitions and numbering of Table 2 (including sub-tables 2-1 to 2-4) used in this report align with those used in ER P2/6 [N1].~~

2 Normative references

The following referenced documents, in whole or part, are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

~~**Other publications**~~

[N1] ENA Engineering Recommendation P2 Issue 7/~~6~~, *Security of Supply* ~~*2006*~~

~~[N2] Security Contribution from Distributed Generation, November 2002. Final report by UMIST for FES. Project K/EL/00287~~

~~[N3] Data Collection for Revision of Engineering Recommendation P2/5, January 2004 Final report by Power Planning Associates (PPAL) for FES. Project K/EL/00303/05.~~

~~[N4] Developing the P2/6 Methodology, April 2004. Final report by UMIST for FES. Project DG/CG/00023/00/00~~

[N2~~5~~] ENA Engineering Report 131, *Analysis Package for Assessing Generation Security Capability – Users' Guide*

[N3] Electricity Act 1989

[N4] Utilities Act 2000

[N5] Energy Act 2005

[N6] Electricity (Northern Ireland) Order 199~~2~~6

[N7] The Distribution Code for Great Britain (DCODE)

[N8] DG data analysis report by Imperial College London, 2019

~~AUTHOR NOTE 1: Reference to ICL report to be updated when it is issued.~~

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE: Defined terms are capitalised where they are used in the main text of this report.

~~3.1~~
~~ASC~~

~~authorised supply capacity~~

3.1~~2~~
Capped
limited (contribution to System Security) during the assessment stage to ensure that the contribution to System Security from the DG, DSR Scheme, or ES~~ plant~~ does not exceed the contribution to System Security ~~by~~from a Circuit~~materiality criteria for the network under consideration~~

NOTE: The term "Capping" should be interpreted as having the same meaning.~~3.3~~

~~CCGT~~

~~combined cycle gas turbine~~

3.2~~4~~
Circuit

part of an electricity supply system between two or more circuit breakers, switches and/or fuses inclusive

NOTE 1: Circuits may include transformers, reactors, cables and overhead lines. Busbars are not considered as Circuits and are to be considered on their merits.~~.~~

[ENA EREC P2/7, Clause 3.1]

~~NOTE 2: An electricity distribution system comprises network assets and non-network assets including DG, DSR Services and ES.~~

3.3~~5~~
Circuit Capacity

appropriate continuous rating or cyclic rating or, where it can be satisfactorily determined, the appropriate emergency rating, taking into account the relevant environmental conditions and the expected demand profile, which should be used for all Circuit equipment and associated protection systems

NOTE: Circuit Capacity should be assessed in MVA.

[ENA EREC P2/7, Clause 3.2]~~ NOTE 1: For First Circuit Outages, the Circuit Capacity will normally be based on the cold weather ratings, but if the Group Demand is likely to occur outside the cold weather period the ratings for the appropriate ambient conditions are to be used. Where the Group Demand does not decrease at the same rate as the Circuit Capacity (e.g. with rising temperature) special consideration is needed.~~

~~NOTE 2: For Second Circuit Outages, in view of the proportions of Group Demand to be met in Table 1 (in ER P2/6 [N1]), the ratings appropriate to the appropriate ambient conditions of the period under consideration should be used, which may be other than winter conditions.~~

~~NOTE 3: "Classes of Supply" are defined in MW, but Circuit requirements should be assessed in MVA with due regard for generating plant MW sent out and MVAr capability where appropriate.~~

Commented [TCL1]: Now captured in Clause 6.

3.4
Cold Load Pickup
difference between the Measured Demand on a Circuit following re-energisation of that Circuit and the demand on that Circuit which the DNO would have reasonably expected had no de-energisation occurred

[ENA EREC P2/7, Clause 3.3]

3.45
Contracted
bilateral agreement between a DNO and party providing System Security from a DG facility, a DSR Scheme or an ES facility

3.6~~56~~
Declared Net Capability (DNC)
declared gross capability of a DG facility~~plant~~, measured in MW, less the normal total parasitic power consumption attributable to that plant

NOTE 1: Declared Net Capability (DNC) as used in this Engineering Report should not be confused with declared net capacity (DNC) as used in the Electricity Act [N3~~2~~] and Statutory Instrument 2001 3270 [N4~~3~~].

NOTE 2: For the purpose of this definition the term “parasitic power consumption” refers to the electrical demand of the auxiliary equipment, which is an integral part of the DG, essential to the DG’s operation. For the avoidance of doubt “parasitic power consumption” does not include demand supplied by the DG to an on-site customer.

NOTE 3: The ~~DNC~~ DNC~~O~~ of ~~Intermittent~~ a DG~~eneration~~ facility is taken as the aggregate nameplate capacity of all the units within the DG ~~facilitiy~~facility~~plant~~, less any parasitic load.

3.7~~6~~
Demand Facility
facility connected to the distribution network~~,~~ which consumes electrical power

3.8~~7~~
Demand Side Response (DSR)
demand ~~normally imported from the distribution network to a consumer’s premises~~ that is controlled in response to an instruction issued as part of an agreed demand side management arrangement with the DNO or other party

[ENA EREC P2/7, Clause 3.4]

NOTE 1: The electrical power consumption ~~for the whole, or part~~ of~~,~~ a Demand Facility can be modified using DSR.

3.9~~8~~
Demand Side Response Scheme (DSR Scheme)
DSR arrangement which is being implemented at a Demand Facility

3.10~~98~~
Distributed Generation (DG)
generating facility~~plant~~ connected to the distribution network, where a generating facility~~plant~~ is an installation comprising one or more generating units

[ENA EREC P2/7, Clause 3.5]

3.11~~09~~
Distribution Network Operator (DNO)
person or legal entity named in Part 1 of the Distribution Licence and any permitted legal assigns or successors in title of the named party~~organisation that owns and/or operates a distribution network and is responsible for agreeing the connection of Distributed Generation to that network~~

[ENA EREC P2/7, Clause 3.6]

NOTE 1: A DNO might also be referred to as a Distributor.

NOTE 2: The definition of a DNO also applies to an Independent Distribution Network Operator (IDNO).

3.12~~1~~
Electricity Storage (ES)
storage facility connected to the distribution network which, behaves as DG when exporting power to the distribution system and, behaves as a Demand Facility when consuming electrical power from the distribution system

NOTE 1: An example of an ES is a battery installation (treated as a Demand Facility when charging and DG when discharging).

NOTE 2: DG is differentiated from ES as it does not store energy.

NOTE ~~2~~3: ES is a form of 'other means' as referred to in ENA EREC P2/7.

3.13~~20~~
First Circuit Outage (FCO)
fault or ~~an~~ pre-arranged Circuit outage

[ENA EREC P2/7, Clause 3.7]~~NOTE: For classes of supply C to F in ER P2/6 [N1] supplies to consumers should not be interrupted by arranged outages.~~

3.14~~31~~
Generator
person who generates electricity under licence or exemption under~~from Section 4.1(a) of~~ the Electricity Act 1989 [N3~~2~~] (as amended by the Utilities Act 2000 [N4] and the Energy Act 2004 [N5~~4~~])

[ENA EREC P2/7, Clause 3.8]

NOTE: ~~or the~~ Electricity (Northern Ireland) Order ~~1992~~ 1996 [~~N4~~N6].

3.154~~12~~
Group Demand
DNO's estimate of the maximum demand of the group being assessed for EREC P2/7~~6~~ [N1] compliance with appropriate allowance for diversity

NOTE 1: When estimating the maximum demand of the group the DNO should, where necessary, take into consideration (but not be limited to) the following: the Latent Demand due to DG, the Latent Demand due to DSR, the Latent Demand due to ES, the effect of Suppliers time of use tariffs, the effect of Network Operator price signals, the effects of Cold Load Pickup and, data granularity implications (instantaneous peak vs. time averaged flow).

NOTE 2: The Group Demand at grid supply points must be consistent with the demand data submitted to a transmission company under the terms of the GB Grid Code [3~~5~~].

~~NOTE 3: Group Demand is the sum of the Latent Demand and the Measured Demand.~~

[ENA EREC P2/7, Clause 3.9]

3.16~~53~~
Intermittent Generation
generation facility~~plant~~ where the energy source of the prime mover can~~-~~not be made available on demand

3.~~14~~17~~6~~
Latent Demand
demand that would appear as an increase in Measured Demand if the DG was not operating, the DSR was not implemented or other means (e.g. time of use tariff, export from electricity

storage devices) of suppressing the Measured Demand within the network (for which the Group Demand is being assessed) was not operating~~were not producing any output~~~~[1]~~

[ENA EREC P2/7, Clause 3.10]

NOTE 1: Latent Demand for an ES~~F~~ exists when there is export or restricted import, ~~during~~at the time of Measured Demand.

3.~~15~~18~~7~~
Measured Demand
summated demand measured at the normal (network) infeed points to the network for which Group Demand is being assessed

[ENA EREC P2/7, Clause 3.11]

3.19~~8~~
Non-Contracted
absence of a bilateral agreement between a DNO and party providing System Security from a DG facility, a DSR Scheme or an ES facility

NOTE: Non-Contracted does not prohibit the existence of a contract outside of DNO involvement.

3.20~~1619~~
Non-intermittent Generation
generation facility where the energy source for the prime mover can be made available on demand

3.~~17~~21~~0~~
Persistence (T_m)
the minimum time for which output from Intermittent Generation must be continuously available for it to be considered to contribute to System Security~~securing the Group Demand~~

3.22~~1~~
Regulatory Financial Performance Reporting (RFPR)
documents and tables collected by Ofgem annually for the purposes of administering compliance and monitoring performance of DNOs in accordance with the regulatory framework

NOTE: Refer to Ofgem guidance on regulatory financial performance reporting.

3.~~18~~2~~2~~3
Second Circuit Outage (SCO)
fault following ~~an~~a pre-~~-~~arranged Circuit outage

NOTE: The recommended levels of security are not intended at all times to cater for a first fault outage followed by a second fault outage or for a simultaneous double fault outage. Nevertheless, in many instances, depending upon switching and/or loading/generating arrangements, they will do so.

[ENA EREC P2/7, Clause 3.13]

~~[1] Where DSR is considered as an increase in network capacity the Latent Demand will need to be increased to reflect the additional demand on the network if the demand side management was not acting to reduce the network demand. Where DSR is considered as a reduction in network demand no adjustment to the Latent Demand is required.~~

3.~~19~~2~~4~~3
System Security
the capability of a system to maintain supply to a defined level of demand under defined outage conditions

[ENA EREC P2/7, Clause 3.16]

3.~~20~~2~~5~~4
Transfer Capacity
capacity of an adjacent network which can be made available within the times stated~~ for the First and Second Circuit Outages~~ in EREC P2/7 Table 1.

~~NOTE: ~~Transfer Capacity will be limited by Circuit Capacity or other practical limitations on power flow~~ associated with the outage(s) in question.~~

[ENA EREC P2/7, Clause 3.18]

4 Assessment process overview

~~4.1 General~~

~~When it is recognised that a system could become non-compliant with ER P2/6 [N1], it may be possible to rely on the contribution from DG and DSR to help maintain compliance. Where compliance cannot be achieved, even with the contribution from existing DG plant or DSR, further security contribution would be required by the DNO either in the form of network reinforcement or by an increased contribution from existing or new DG plant connected to the network or the implementation of a demand side management arrangement.~~When assessing whether a distribution system complies with the security requirements of EREC P2/7 [N1] DNOs should consider the contribution to System Security from:

a) network assets;

b) ~~Distributed Generation (~~DG~~)~~ connected to its network;

c) ~~Demand Side Response (~~DSR~~)~~ Schemes connected to its network~~,~~; and~~;~~

~~a)~~d) ~~Electricity Storage (~~ES~~)~~ connected to its network.

NOTE: The contribution to System Security from DG, DSR ~~Services~~Schemes and ES is variable dependant on whether the DNO has a contractual arrangement with the operator/provider of one of these non-network assets.

~~DSR can be considered either as a reduction in Group Demand, or as an increase in available system capacity. Both approaches have their merits and drawbacks, and it is for the DNO to decide how best to allow for DSR dependent on the circumstances of each case. In either case the DNO will determine what allowance to make for the successful delivery of contracted or expected DSR. The DNO will keep a written record of which approach has been applied and assumptions used in assessing the contribution of DSR.~~

~~In considering the simple diagrammatic representations that follow throughout Clause 4, it should be noted that for simplicity~~The guidance in this EREC simplifies the~~ of~~ presentation of Circuit ratings and ~~,~~security contribution from DG, ~~and allocated~~ DSR Schemes and ES, inferring a simple ~~are simply~~ summation~~ed where appropriate~~ to assess aggregate capacities etc. However, in reality it will always be necessary to perform appropriately complex assessments, probably via modelling software, to ascertain that a Circuit~~equipment~~ is not unacceptably overloaded in the outage~~s~~ scenarios set out in EREC P2/7 [N1]. Note also Section ~~4.c~~5.1~~.~~ of EREC P2/~~6~~7 [N1] where there is a specific requirement that equipment should not be overloaded to a point where it suffers unacceptable loss of life.

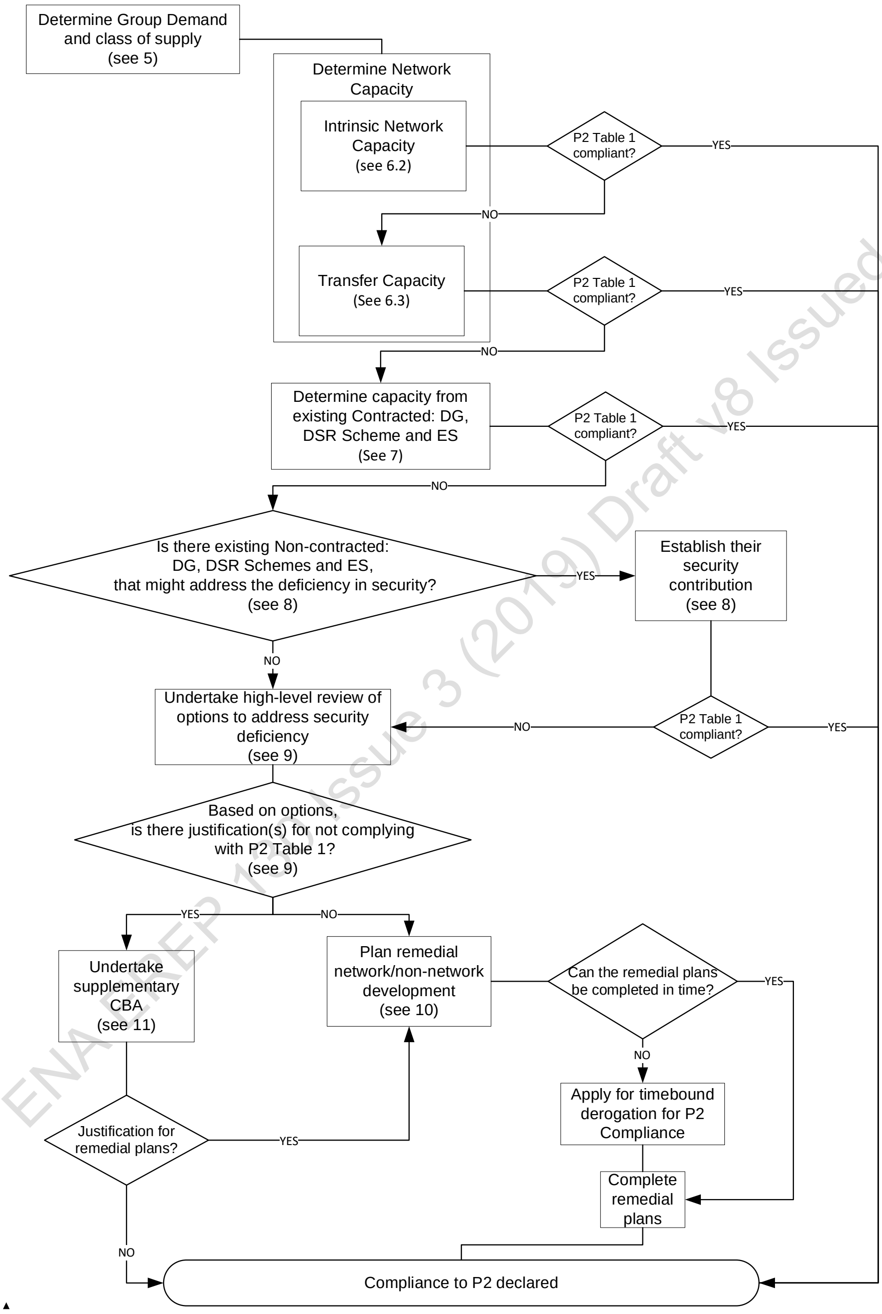
When seeking to assess whether a particular section of network is compliant with the security requirements ~~contained~~ in EREC P2/~~6~~7 [N1] it is necessary to follow a procedure similar to that shown diagrammatically in Figure ~~5.~~1. This figure includes a number of stages and ~~makes~~ refer~~sence~~ to ~~further figures and~~ clauses providing detailed guidance on each of these stages. ~~Note that in Figure 5.1 to 5.3, DSR should be accounted for either as a reduction in Group Demand or increase in network capacity as appropriate.~~ For simplicity the security assessment process described in this EREP~~clause~~ describes~~shows~~ the general methodology which should~~will~~ ~~need to~~ be adapted by the DNO as appropriate.~~to reflect the selected approach to DSR.~~

For DNOs this exercise is a periodic one across the full network, supplemented by specific assessments at points on the network where~~-~~ the ~~s~~System ~~s~~Security needs to be reviewed as a result of changes in network design (including network reinforcement and new connections), DG or ES developments or ~~operation~~implementation of DSR Schemes~~changes to security levels arise from changes in network design, demand (including DSR arrangements) or DG~~. Hence, ~~-plant.~~ongoing compliance with EREC P2/7 [N1] should be achieved.

For substations serving a Group Demand over 12 MW the DNOs shall perform an annual security compliance review, normally aligned to the annual ~~Regulatory Financial Performance Reporting (~~RFPR~~)~~ submission. In addition, for these substations, a security compliance review shall be performed where there are significant changes to network design, demand or generation.

In assessing the security contribution from DG, DSR Schemes and ES~~-plant~~, the DNO will want to balance the effort required to obtain accurate~~-availability~~ data with the risks to loss of supplies from using inaccurate or uncertain data.

NOTE: An overview of the technical issues that may~~will~~ need to be considered are shown in the Technical Check List provided at Annex C~~A~~ to this report.



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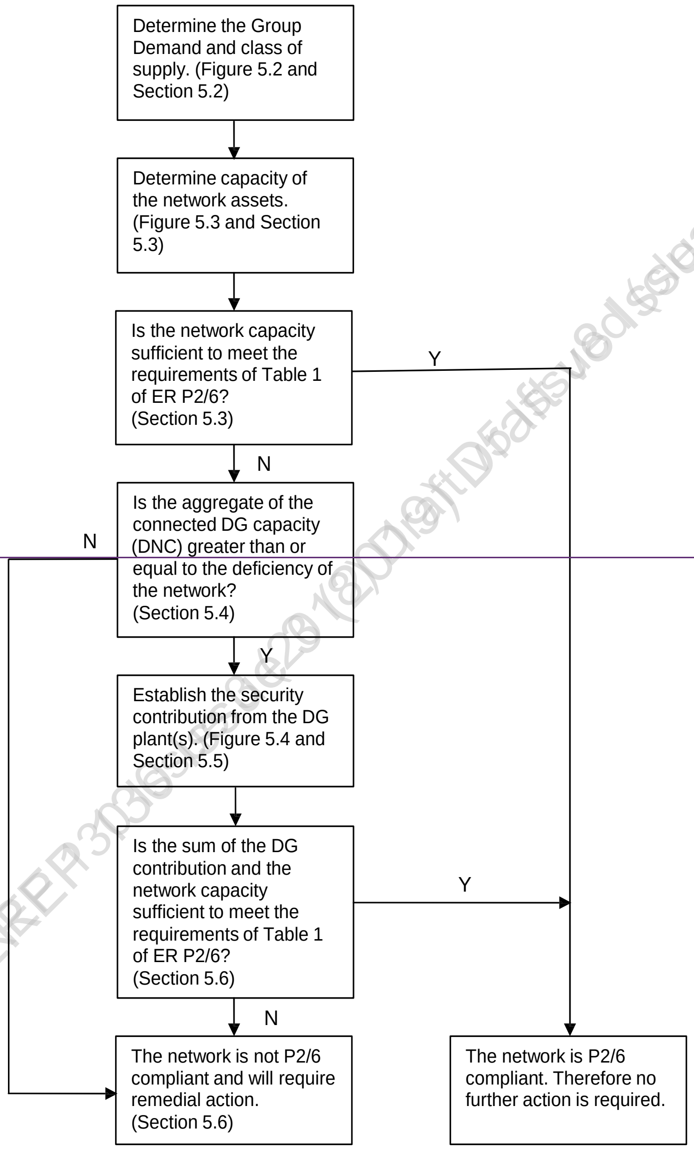


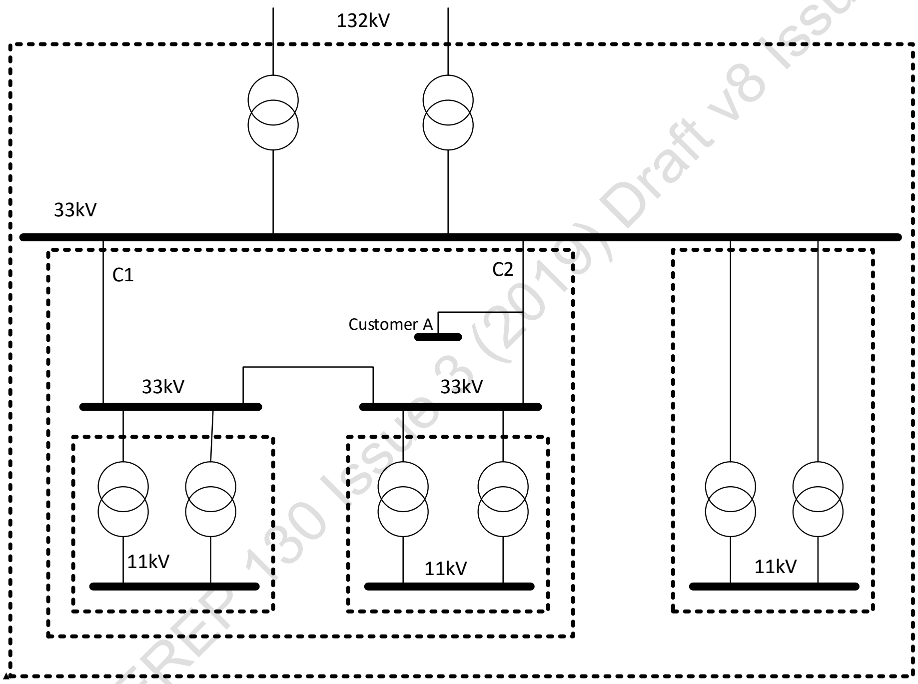
Figure ~~5.~~1 — The assessment process

~~**NOTE: Detailed guidance on each stage of the process is given in the following clauses and figures; the relevant numbers are shown in brackets.**~~

5 Determine the Group Demand and class of supply

Considering a section of network, a DNO should identify the demand groups within its network where a security of supply assessment should be carried out. There will be numerous demand groups in a DNO network and lower voltage demand groups will combine to form larger demand groups, as illustrated in Figure 2.

The DNO should carry out a bespoke assessment of the Latent Demand based on the principles in this clause~~, with experience further clarity may emerge that could be incorporated in a later version of this document~~.



NOTE: 'Dashed' lines indicate a section of network and hence a demand group

Figure 2 – Typical demand groups (section of network) in a network

T~~In order t~~o identify the class of supply (see Table 1 in EREC P2/~~6~~7 [N1]) for each demand group~~the section of network under consideration falls into~~, the Group Demand first needs to be established – Figure 3 outlines the process and the need to determine the Measured Demand, any Latent Demand and the effects of Cold Load Pickup.

~~— See Figure 5.2 below. I~~If there is ~~DG~~ DG, a DSR Scheme or ES connected to~~on~~ the network connected within the demand group,~~-~~ it will be necessary for the DNO to determine whether there is any Latent Demand (see Annex A~~6.6.1~~) and, if so, if it should be added to the Measured Demand to establish the Group Demand. However, to avoid excessive and

Field Code Changed

unproductive computation, there is a de-minimis test to determine the extent of Latent Demand assessment required.

- If the aggregate~~sum of~~ capacity of~~-~~ Non-Contracted; DG~~-DG DNC~~, ~~capacity of~~ DSR Schemes (where this can be readily established), and ~~installed capacity of~~ ES, is less than 5% of Measured Demand, then Group Demand should be taken as the same as Measured Demand.

The de-minimis test shall exclude capacity from C~~c~~ontracted DG, DSR Schemes, and ES, as the DNO should account~~ed~~ for Latent Demand associated with contracts (see Figure 2).

The DNO should establish the Latent Demand based on the principles outlined~~s~~ in this Clause and Annex A. With experience, further clarity may emerge which could be incorporated into later issues of this EREP.

Consider the scenario where the supply to Customer A has been interrupted due to a fault on circuit C2. In this~~is~~ case, where~~of~~ C~~c~~ustomer A ~~, who~~ has agreed to a single circuit risk agreement, EREC P2/7 [N1] ~~indicates~~states that ~~-~~this customer's supply is considered to be restored ~~on activation of such an agreement~~ when there is an outage on circuit C2. C~~For the case of c~~ustomer A's~~, their~~ demand is included in the Group Demand and used to establish the class of supply. However, where such a customer has a connection agreement with the DNO requiring only single circuit security, EREC P2/7 [N1] considers this to be a form of a DSR Scheme Contact between the customer and the DNO and that for the purpose of complying with the requirement to supply the 'minimum demand to be met', activation of this DSR Scheme is equivalent to restoration of demand.

The DNO should also consider whether the Group Demand should be increased to cater for the effects of Cold Load Pickup. Cold Load Pickup is only a concern when supplies to particular electrical loads are being restored following a period of interruption~~-~~. The following are examples of loads which may exhibit Cold Load Pickup characteristics.~~:~~

i. Electrical heating.~~;~~
ii. Refrigeration.~~;~~
iii. Air conditioning.~~;~~
iv. Heat pump (HP),~~;~~ and~~.~~
v. Electric vehicle (EV).

The magnitude of the Cold Load Pickup is dependent on a number of factors including the:

- duration of the outage;~~.~~

  Typically, the longer the duration, the greater the Cold Load Pickup as the natural diversity is lost.~~;~~

- time of day and year when the outage occurs;~~.~~

  Outages in winter particularly, during the evening and overnight, would typically have a greater impact on the Cold Load Pickup resulting from electric heating. Outages in summer, particularly during the day, would typically have a greater impact on the Cold Load Pickup resulting from air conditioning load.~~;~~

- nature of the load.

  Cold Load Pickup is likely to have an impact on the observed Measured Demand that reduces over a period of several hours. However, some demand such as EV chargers may impose a demand lasting only several seconds when supply is restored to a fully charged battery.

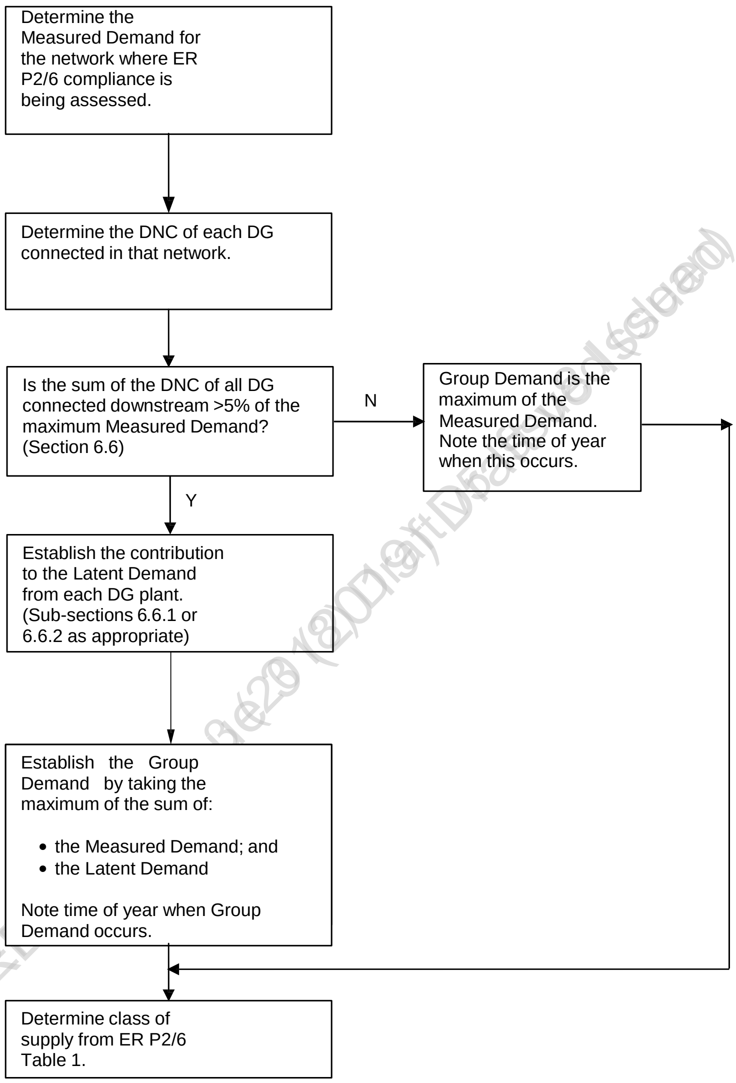
Historically the effects of Cold Load Pickup ~~has~~have not been explicitly taken into account in establishing the Group Demand and the effects have been accommodated within the short time rating of network assets. With increased use of cyclic and emergency ratings for ~~network assets~~Circuits, their capability to accommodate Cold Load Pickup may need to be established. The following criteria should be considered when evaluating the impact of Cold Load Pickup on the Group Demand.

a) Cold Load Pickup should not be ignored if there is awareness that the network assets may not have sufficient short-time rating for a FCO or there is likelihood of the peak Measured Demand occurring during a Cold Load Pickup event; and~~.~~

b) Cold Load Pickup may be ignored if the particular load is less than 10% of the total load for rural networks (where the majority of the ~~overhead~~ network is overhead) and less than 30% for urban networks (where the majority of ~~underground~~ the network is underground)[2].

~~Cold Load Pickup should not be ignored if there is awareness that the network assets may not have sufficient short-time rating under FCO or there is likelihood of the peak Measured Demand occurring during a Cold Load Pickup event~~

[2] A report by Manchester University in 2016 [4] on the assessment of LV network capacity for electric vehicle (EV) and photovoltaic (PV) connection, found that the existing LV networks could host a certain percentage of these onerous loads prior to issues arising with capacity.


Determine the Measured Demand for the network where ER P2/6 compliance is being assessed.
Determine the DNC of each DG connected in that network.
Is the sum of the DNC of all DG connected downstream >5% of the maximum Measured Demand? (Section 6.6)
N
Group Demand is the maximum of the Measured Demand. Note the time of year when this occurs.
Y
Establish the contribution to the Latent Demand from each DG plant. (Sub-sections 6.6.1 or 6.6.2 as appropriate)
Establish the Group Demand by taking the maximum of the sum of:
• the Measured Demand; and
• the Latent Demand
Note time of year when Group Demand occurs.
Determine class of supply from ER P2/6 Table 1.

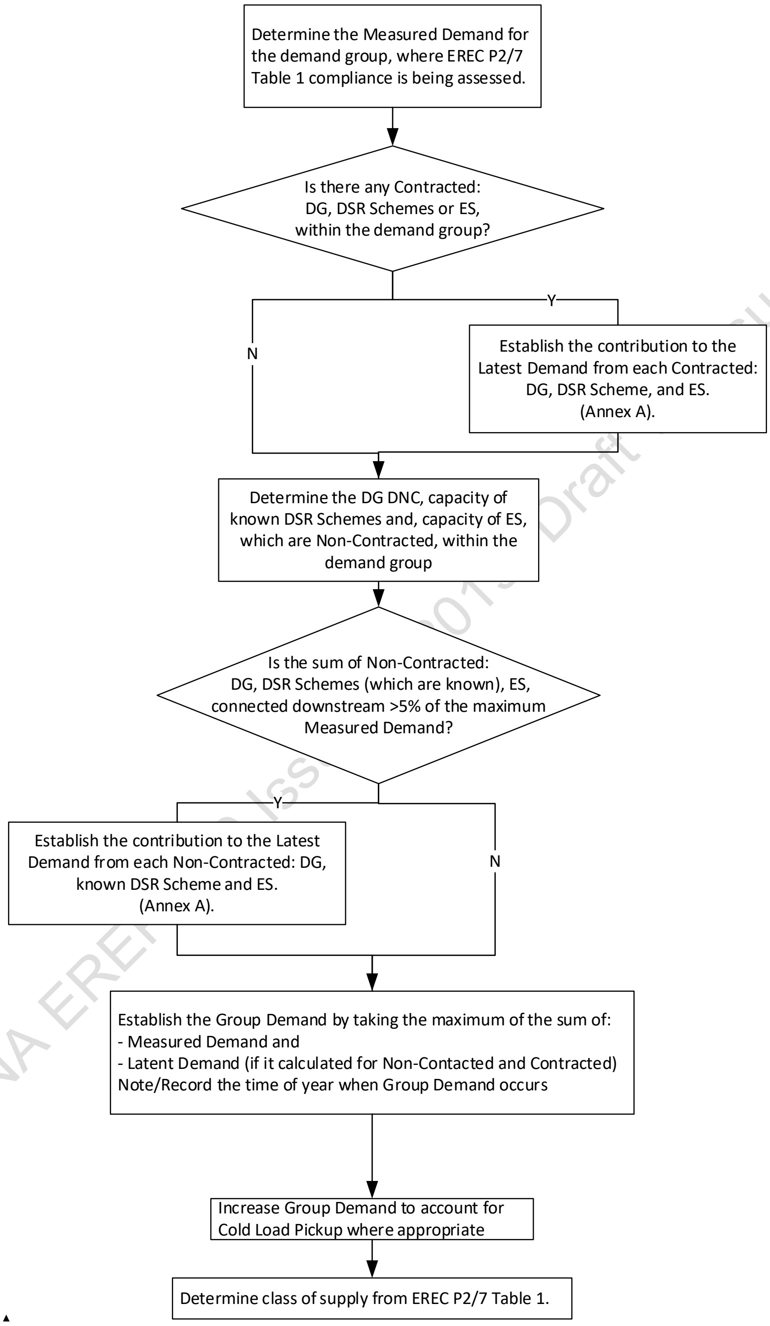


Figure ~~5.~~32 — Determine class of supply and Group Demand

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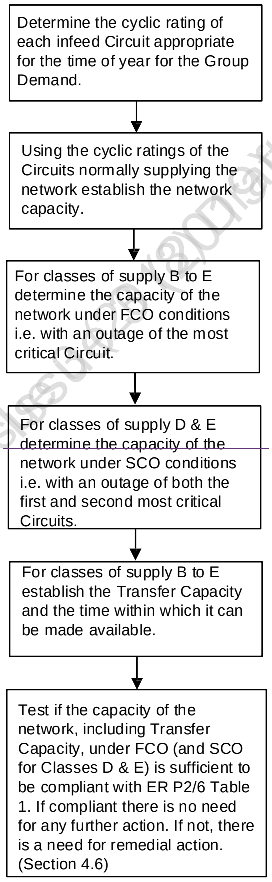
6 Determine capacity of network assets and assess compliance

6.1 General

The next step is to identify the capacity of the existing network assets ~~– see Figure 5.3 below~~and establish if they are ~~. Once the capacity has been deduced it will be necessary to assess whether the existing network capacity is~~ capable of securing the Group Demand identified in Clause 5~~4~~.2, ~~in accordance with the Demand calculated in Clause 5,~~ in accordance with the criteria specified in ER P2/~~6~~7 Table 1 [N1]~~. If this can be achieved, without the need for a contribution from DG, then the network under consideration can be deemed compliant with ER P2/6 [N1] and there is no need for further analysis~~.

NOTE: Voltage criteria and differing Circuit capacities and impedances may be limiting factors in determining the network capacity under FCO and SCO conditions. In such situations the use of network analysis software becomes essential to determine the network capacity.



~~**Figure 5.3 — Determine capacity of network assets and assess ER P2/6 compliance**~~

For F~~irst Circuit Outage~~COs, the Circuit Capacity should normally be based on the cold weather ratings, but if the Group Demand is likely to occur outside the cold weather period the ratings for the appropriate ambient conditions ~~are to~~should be used. Where the Group Demand does not decrease at the same rate as the Circuit Capacity (e.g. with rising temperature) special consideration is needed.

For SCO~~econd Circuit Outages~~, in view of the proportions of Group Demand to be met in EREC P2/7 [N1] Table 1~~ (in ER P2/6 [N1])~~, the ratings appropriate to the appropriate ambient conditions of the period under consideration should be used, which may be other than winter conditions.

The term '~~"~~c~~C~~lass~~es~~ of s~~S~~upply' is associated with a~~" are defined in~~ MW quantity in EREC P2/7 [N1], but Circuit Capacity ~~requirements~~ should be considered~~assessed~~ in MVA with due regard for generating plant MW sent out and MVAr capability where appropriate.

6.2 Intrinsic network capacity

The intrinsic network capacity should be established by considering the Circuit Capacity~~rating~~ of each Circuit supplying the demand group. The intrinsic network capacity is that which is available from the Circuits supplying the demand group under system intact and the depleted network conditions that need to be secured to the level set out in Table 1 of EREC P2/7[N1]: it is the capacity available within 60 s of the commencement of an outage.

NOTE: 60 s relates to an automatic switching facility that does not depend on communications, requires ~~(~~no local manual or remote initiation and ~~required locally or remote)~~ which has been appropriately planned and designed ~~(load on network assets and protection settings considered).~~considering the load on network assets and protection settings. ~~–~~A hot standby arrangement where an on-site transformer normally out-of-service is automatically switched in-to-service within 60 s of an outage occurring would be considered to be part of the intrinsic capacity.

~~AUTHOR NOTE 2: Reviewers to confirm above NOTE is consistent with DNO treatment of transfer capacity in the LI RRP statements.~~

For classes of supply B to E inclusive, the intrinsic network capacity should be determined under FCO conditions, i.e. with an outage of the most critical Circuit.

For classes of supply D and E, the intrinsic network capacity should also be determined under ~~FCO conditions and~~ SCO conditions, i.e. with an outage of both the first and second most critical Circuits.

In the event that the intrinsic network capacity is insufficient to meet the requirements of EREC P2/7 [N1] it will be necessary for the DNO to establish the Transfer Capacity to meet any deficiency in System Security.

6.3 Transfer capacity

The Transfer Capacity should be established when the intrinsic network capacity is insufficient to comply with the requirements of EREC P2/7 [N1] Table 1.

Transfer Capacity relates to the capability of an adjacent network to supply demand of a given demand group during FCO and SCO conditions. Hence in addition to being affected by the Circuit Capacity of interconnection between the demand groups, Transfer Capacity is ~~also largely~~ dependent on the capacity of an adjacent demand group(s) to the one being assessed.

Transfer Capacity is generally utilised by network re-configuration via:

- Automatic switching of available network capacity via a local/remote network management system (typically within 15 mins) i.e. local/remote automation;
- Manual switching of available network capacity via a remote management system (typically within 15 mins) i.e. remote control; or
- Manual switching of available network capacity via local operation of equipment (typically within 3 hrs).

The following considerations are relevant when assessing the available Transfer Capacity.

a) Capacity of the Circuit used to implement the transfer and the time to implement

The Circuit Capacity of the Circuits used to transfer demand relevant to the time when the transfer is required and the demand profile that it would be exposed to.

b) Availability & reliability of the circuit used to implement the transfer

The co-ordination of planned out~~r~~ages is critical when considering the use of Transfer Capacity. Unless there is a ~~very low~~high probability that a Circuit is ~~unavailable for~~available for demand transfer, it may be prudent to ~~apply a fortuitous availability factor to~~reduce the theoretical Transfer Capacity to reflect a Circuit's unavailability.

c) Gross and net demand (if any) on the Circuit used to implement the transfer

Unless a Circuit being considered is clean, i.e. there are no customers connected to it, it is necessary to establish the demand headroom available on the Circuit. Hence, before the Circuit is used to transfer demand, the gross demand (demand without DG/DSR Schemes/ES operating) and net demand (demand with DG/DSR Schemes/ES operating) should be established. This requires additional assessment in accordance with Clauses 5, 7 and 8.

In determining the capacity of a circuit to be used to implement demand transfer, the effects and response of any DG/DSR Schemes/ES must be considered once it is operating as a Transfer Circuit, e.g. fault level implications for connected DG or ES.

d) Impact of the demand transfer on the demand group to which the demand (or generation) is transferred

The DNO should consider whether the demand group 'receiving' the demand transfer will continue to operate within acceptable operating limit.

e) Whether interruptible demand on the adjacent network should be interrupted to create capacity for the transfer

Where relevant, the DNO should establish if it is acceptable to interrupt the supply to customers not affected by the FCO or SCO in order to create the capacity in the receiving demand group to implement the demand transfer.

f) Application of pre-outage transfer and post outage transfer

The DNO may consider it normal practice to re-configure the network in advance of a planned FCO. This may use the same Transfer Capacity as that applied following an unplanned outage.

g) Temporary network re-arrangement due to seasonal ~~a~~effects

The DNO may re-configure the network to an alternative 'normal' arrangement during seasonal events which may affect the Transfer Capacity of a demand group. In this case a security assessment should be considered for each seasonal network configuration.~~.~~ ~~Hence, the Group Demand should be considered for each seasonal event to establish the worst-case situation for System Security.~~

In the event that the intrinsic network Capacity and Transfer Capacity is insufficient to meet the requirements of Table 1 of EREC P2/7 [N1] it will be necessary for the DNO to assess the security contribution of DG, DSR Schemes and ES. With regards to item c) above, the DNO may have already initiated this assessment.

~~might beoptions~~

7 Contribution to System Security from C~~c~~ontracted DG, DSR Schemes, and ES

7.1 General

In considering the security contribution from means other than network assets, the DNO can initiate this by establishing whether the aggregate capacity of DG, DSR Schemes and ES connected to the network might be sufficient to meet any deficiency in System Security. If the aggregate is less than any deficiency, the actual DG/DSR Scheme/ES security contribution will definitely be inadequate to meet the requirements of EREC P2/7 [N1] Table 1 and it will be necessary for the DNO to consider remedial options (reinforcement, additional DSR arrangements etc). However, the contribution of the DG, DSR Schemes and ES might still be of value, in limiting the extent of remedial options.

In the event of the DNO needing to rely on ~~the~~ DG, DSR Schemes and ES~~ output~~, during Circuit outages, the DNO needs to decide whether to rely on the fortuitous contribution associated with their normal commercial operation, or to enter into a commercial arrangement with the DG/DSR Scheme/ES operator/owner~~the Generator is unlikely to be asked to alter the operation of their DG plant to meet the DNO's requirements. Under these conditions, no service is being requested of the DG, and no contract for services is required. The DNO takes the risk of the plant being unavailable at the time of a depleted system. This is analogous to the uncontracted DNO risk of aggregated load being subject to variation above normal maximum demands~~. This clause describes the ~~considerations~~aspects that should be considered when the DNO is entering into a contract arrangement, and Clause 8 describes the assessment of DG/DSR Schemes/ES which are not contracted with the DNO.

There will be DG/DSR Schemes/ES for which the DNO:

- cannot assess the output profiles, either from established or newly connecting DG/DSR Schemes/ES~~F DG plant~~; or
- considers that the DG/DSR Schemes/ES~~DG plant~~ does not exhibit predictable and steady output profiles; or
- requires enhanced System Security contribution~~output from the DG plant~~ beyond~~above~~ the normal observed~~ output~~ profile, either to extend to 24 hrs operation, or to provide temporarily greater MW support~~output~~.

In these cases where the DNO is seeking to rely on the security contribution, the DNO should consider entering into a contract with the DG/DSR Scheme/ES owner/operator. ~~The security contribution should be based on the capacity the DG/DSR Scheme/ES owner/operator is able to offer and provide acceptable reassurance that they will be able to provide the capacity when required by the DNO. In these cases, and where the DNO elects to rely on a security contribution from the DG/DSR Scheme/ES plant, the DNO will need toshould enter into a contract with the Generator DG/DSR Scheme/ES operator/owner to ensure that security services can be reliably provided when requested by the DNO.~~ The contracted security contribution should ~~A security contribution will~~ be based on the capacity the~~service that the Generator~~ DG/DSR Scheme/ES owner/operator is able to~~is able to offer~~offer and provide acceptable reassurance that the~~the security service provider~~y will be able to provide the capacity when required by the DNO~~ and guarantee, and will probably be determined using Approach 3~~. The contract is likely to be such that the ~~Generator~~ DG/DSR Scheme/ES operator/owner takes the risk of the facility~~plant~~ being unable to provide an agreed capacity~~service~~ upon request.

The DNO ~~will wish to~~should assess whether the costs, risks and benefits of procuring ~~additional~~ System Security contribution from DG/DSR Schemes/ES, through such a contract, is a more efficient and cost~~-~~ effective option overall compared to the additional System Security that would be provided by increasing the intrinsic capacity of the network or Transfer Capacity, ~~–~~for example by reinforcement~~ing the network~~.

Where the DNO has a contract with a DG, DSR Scheme or ES owner/operator which governs requests or operational instructions from the~~n~~ DNO, then the security contribution should be based on the terms of the bilateral agreement. The contract shall have considered dominance (Annex B) whereby the DNO is satisfied that any necessary capping has been accounted for within the contract.

7.2 Determine the security contribution from Contracted DG

~~6.1 DG~~

~~System SThis clause provides general guidance on the possible need for contractual and commercial arrangements to be put in place in relation to the security contributions from DG. Similar principles apply to assessing the contribution associated with DSR. However, as expressed in the Scope, the detailed form that these arrangements might take is outside the scope of this technical document.~~

~~The process for determining compliance with ER P2/6 [N1] begins with assessing whether the existing DNO network provides sufficient System Security. Only where the existing network provides insufficient System Security is the contribution from DG considered.~~

~~The Technical Check List in Annex A has been written to provide guidance on t~~The~~ technical~~ issues that may need to be considered by a DNO when looking to enter into a contract with a DG facility owner/operator~~Generator~~ for the provision of a contribution to System Security are described below.~~from a DG plant.~~

~~It is expected that the relevant sections of this check list will be included as a schedule to any security contract drawn up between a Generator and a DNO.~~

a) Number and capacity of generating units in the DG facility, i.e. DNC of the DG facility

b) DG action on receipt of DNO request/instruction for operation

   i. Response time, e.g. cold start/warm start/reconnection times required~~ for DG~~

   ii. Minimum export required~~ from DG~~

   iii. Minimum duration of required operation

c) Communication arrangement with DG facility, including the resilience of these arrangements

d) DG stability requirements and ~~I~~interface protection

   i. Agreed operating parameters and settings

   ii. Fault ride through capability required

~~EAgreed e~~vidence should be presented to demonstrate that the DG will ride through a range of credible network outages. Clause 8.3.1 provides guidance on assessing fault ride through for DG (which is relevant for both Contracted and Non-Contracted DG).

e) Availability/reliability requirements ~~for DG facility~~

f) Coordination of DNO and DG planned outages

g) The provision of information required to monitor the operation of the DG facility

The Contacted DG security contribution associated with the DG shall be based on the terms of the contract.

The security contribution associated with the contract shall incorporate any necessary capping of the DG security contribution to avoid dominance in accordance with EREC P2/7 [N1] Clause 5.2. Annex B of this EREP includes further guidance on capping.

7.3 Determine the security contribution from Contracted DSR Schemes

~~System S~~The issues that may need to be considered by a DNO when looking to enter into a contract with a Demand Facility owner/operator for the provision of a contribution to System Security via a DSR Scheme, are described below.

a) Maximum import capacity of Demand F~~f~~acility;

b) Demand F~~f~~acility action on receipt of DNO request/instruction;

- Response time
- Reduction in demand required expressed as either a maximum import or reduction of present demand (e.g. expressed a percentage of MW reduction)
- Maximum duration of required reduction (e.g. hours per day, maximum number of contiguous days)

c) Communication arrangement with Demand Facility;

~~b)~~d) Coordination of DNO and Demand Facility outages;

e) ~~) t~~The provision of information required to monitor the operation of the Demand Facility and the DSR.

~~AUTHOR NOTE 3: Reviewers to suggest reference to Open Networks Work in this Clause, if considered appropriate.~~

~~A contribution to security from a Contracted DSR Scheme shall be counted when that DSR Scheme is considered to be active at the time of being assessed, e.g. the Demand Facility would have imported maximum demand were it not for the DSR Scheme.~~ For a Contracted DSR scheme, a contribution to security shall be applied when that import constraint is considered to be active and have an observed effect at the time period being assessed. The value of the security contribution from the active constraint shall be based on the observed performance under the terms of the contract, but cannot be greater than the Latent Demand.

The value of the security contribution from the active constraint shall be based on the terms of the contract.

When establishing the contribution value for the contract, it is expected that the DNO takes account of the following factors:~~.~~

Commented [AMC2]: Parag updated to reflect that agreed for ES

i. An increase in demand reduction magnitude increases the security contribution;
ii. An increase in demand reduction duration ~~increases~~ (generally but not necessarily) increases the security contribution;
iii. An increase in demand recovery period increases the security contribution;
iv. A reduction in energy recovery increases the security contribution;
v. A more uniform energy recovery increases the security contribution;
vi. A reduction in the ratio of DSR Scheme capacity : peak network demand, increases the security contribution; and
vii. A peakier~~y~~ load profile increases the security contribution.

The contract shall incorporate any necessary capping of the DSR Scheme security contribution to avoid dominance in accordance with EREC P2/7 [N1] Clause 5.2. Annex B of this EREP includes further guidance on capping.

7.4 Determine the security contribution from Contracted ES

~~System S~~Contracted ES is ES contracted to export at time of peak and/or ES contracted not to import at time of peak.

The issues that may need to be considered by a DNO when looking to enter into a contract with an ES~~F~~ facility owner/operator for the provision of a contribution to System Security are described below.

a) Maximum capacity of ES facility – for both export and import;
b) ~~capacity~~Agreed cycle of operation for ES facility;
   i. Hourly/daily sequence of operations, i.e. times of import and times of export
   ii. Duration of operating sequences (charge/discharge cycle time)
c) ES~~F~~ facility action on receipt of DNO request/instruction for operation;
   i. Response time, e.g. cold start/warm start/reconnection times required ~~for ES facility~~
   ii. Minimum export required ~~from ES facility~~
   iii. Minimum duration of export required
   iv. Reduction in demand required expressed as either a maximum import or reduction of present demand (e.g. expressed a percentage of MW reduction)
d) During ES export – stability requirements and i~~I~~nterface protection;
   i. Agreed operating parameters and settings
   ii. Fault ride through capability required

   Evidence should be presented to ~~Agreed evidence to~~ demonstrate that the ~~ESF~~facility will ride through a range of credible network outages. Clause 8.3.1 provides guidance on assessing fault ride through for generation (relevant for both Contracted and Non-Contracted).
e) Availability/reliability requirements for ES facility;

f) Coordination of DNO and ES planned outages.

The contribution to security from ES which is Contracted to export shall be based on the terms of that contract.

When establishing the contribution value for the contract, it is expected that the DNO takes account of the following factors.

i. An increase in ES capacity increases the security contribution;
ii. An increase in ES power increases the security contribution;
iii. A reduction in ES charge time increases the security contribution;
iv. An increase in ES efficiency increases the security contribution;
v. A reduction in the ratio of ES power~~-~~: peak network demand, increases the security contribution;
vi. A peak~~y~~ier load profile ~~becomes~~ increases the security contribution.

For ES which is Contracted to constrain its import (akin to a Contracted DSR scheme), a contribution to security shall be ~~counted~~applied when that import constraint is considered to be active and have an observed effect~~,~~ at the time period ~~of~~ being assessed~~, e.g. the ES would have imported maximum demand were it not for the constraint~~. The value of the security contribution from the active constraint shall be based on the observed performance under the terms of the contract, but cannot be greater than the latent demand.~~.~~

~~AUTHOR NOTE 4: Above paragraph clarifies requirement for Contracted ES with import constraint i.e. similar to DSR Scheme in Clause above.~~

The contract shall incorporate any necessary capping of the ES security contribution to avoid dominance in accordance with EREC P2/7 [N1] Clause 5.2. Annex B of this EREP includes further guidance on capping.

~~7~~8 ~~Assess the maximum potential security contribution~~Contribution to System Security from N~~n~~on-C~~c~~ontracted DG, DSR Schemes, and ES

8.1 General

~~In the event that network assets alone are insufficient to meet the requirements of ER P2/6 [N1] it will be necessary for the DNO to identify the most efficient mechanism available to enhance System Security, this may mean assessing the contribution from DG. An assessment can be made to establish whether the aggregate DNC of all the DG connected to the network has the potential to meet any deficiency in System Security available from the network assets. If the aggregate DNC would be insufficient to meet any deficiency, the actual DG security contribution will definitely be inadequate to meet the requirements of ER P2/6 [N1] and it will be necessary for the DNO to consider alternative options such as network reinforcement. However the contribution of the DG might still be of value, in limiting the extent of that reinforcement.~~Where the DNO relies on the fortuitous security contribution of N~~n~~on-C~~c~~ontracted DG/DSR Schemes/ES, it should be assessed in accordance with the guidance in this Clause. Where the DNO has a need for a definitive security contribution then the costs, risks and benefits of procuring this from a DG/DSR Scheme/ES owner/operator facility should be assessed (see Clause 7).

If the aggregate capacity of N~~n~~on-C~~c~~ontracted, DG ~~DNC~~, DSR Schemes which are known, and ES, is greater than any system capacity deficiency identified it will be necessary to carry out further analysis to ~~confirm~~ calculate the ~~actual~~ security contribution from these sources. ~~from the DG.~~

NOTE: The aggregate capacity of Non-Contracted items will have been considered earlier in the assessment process, during calculation of Group Demand (see Clause 5).

The aggregate of N~~n~~on-C~~c~~ontracted capacity may contain all or some of the items in a) - d).

a) Non-C~~c~~ontracted DG (the DNO should have notification records of all DG connected to its network);

b) Non-C~~c~~ontracted DSR Schemes which are known to the DNO (the DNO may have visibility of a DSR Scheme through information available from a third party);

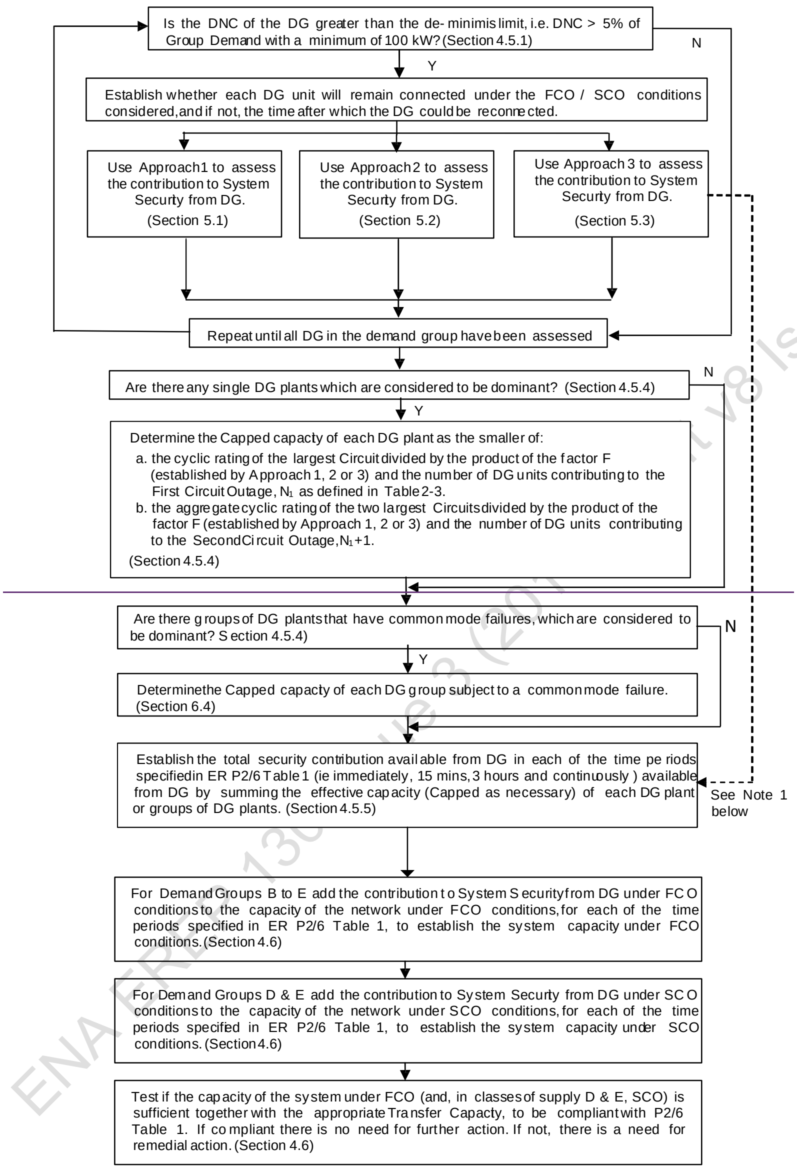
c) Non-C~~c~~ontracted ES export (the DNO should have notification records of all ES ~~generation~~facilities connected to its network);

d) Non-C~~c~~ontracted ES import constraints which are known to the DNO (the DNO may have visibility of an ES import constraint through information available from a third party).

~~The DNO may assess the output profiles fromNC facilities established DG plant, and may conclude that certain plant exhibits predictable and steady output profiles, such as those typically associated with landfill gas schemes. Even though the output may vary over short periods, as can be the case with wind farms, the overall output profile may be considered to be sufficiently predictable and well understood. In these cases, the DNO can determine a security contribution (probably using Approaches 1 or 2) without further recourse to the Generator.~~

~~This step in the assessment process is to check whether the DNC of each DG plant is equal to or above the de-minimis level. A full explanation of de-minimis is provided under Clause 6.5. If the DNC of the DG is above the de-minimis level, it can be taken forward for assessment of its contribution.~~

~~In order to avoid customer supplies from being put at excessive risk from the loss of a DG plant, the maximum allowable contribution to System Security from generation plant under ER P2/5 was limited so that the most material outages, i.e. FCO and SCO were defined as being outages of network Circuits rather than outages of generating plant. The effect of this was to ensure that the security contribution from a generating plant did not dominate the security contribution from network assets.In order to continue this principle so as not to put customer supplies at any more risk under ER P2/6 [N1] than they were under ER P2/5, it is necessary to limit the contribution from DG, i.e. to cap the contribution from DG plants (see Clause 6.3).~~



~~NOTE 1: Where Approach 3 is used to assess the DG security contribution from a collection of Generators, and there is no requirement to cap either an individual DG plant or groups of DG it possible to go direct to establishing the total security contribution.~~

~~Figure 5.4 — Assessing the security contribution from~~

~~The process for assessing the security contribution afforded by a DG plant connected to a network is described in Clause 4.5.~~

8.2 De-minimis criteria

Commented [TCL3]: Content moved from Issue 2 Clause 6.5

~~To avoid excessive and unproductive computation in assessing security compliance where DG exists, it is important to have lower thresholds below which the effects of DG will not be considered. There are two de-minimis tests that should be applied.~~

~~There is a de-minimis test to establish whether there is a need to assess the Latent Demand in order to determine the Group Demand. The test based on the aggregate DNC of all the DG connected to the network under consideration compared to the Measured Demand, is described in 6.6 below.~~

~~NOTE: If the aggregate DNC of all the DG connected to the network under consideration is less than the de-minimis value specified in 6.6, then Group Demand should be taken to be the same as Measured Demand.~~In addition to the de-minimis test in Clause 5, t~~T~~here is another de-minimis test for ~~non-contracted~~Non-Contracted DG/DSR Schemes/ES to establish whether the individual capacity is ~~DG plant is~~ sufficiently small that it is considered inappropriate to assess its s~~s~~Security c~~C~~ontribution. It seems reasonable to base this de-minimis test on the Group Demand of the network to which the DG/DSR Scheme/ES~~ plant~~ is connected. It is recognised that establishing an appropriate de-minimis threshold is subjective, therefore a pragmatic approach needs to be taken. This report recommends that the de-minimis threshold should be set at 5% of Group Demand. ~~with a minimum value of 100 kW, i.e. assessment~~Additionally, sassessments of security contribution are not necessary for a facility~~DG rated~~ below 100 kW in capacity,~~this value.~~ i.e. ~~When testing if a DG plant meets this criterion, the~~ DNC of the DG~~ plant should be used~~, maximum reduction in demand associated the known DSR Scheme, capacity of the ES.~~.~~

~~7.1~~8.3 Determine the security contribution from ~~non-contracted~~Non-Contracted DG

The process for assessing the fortuitous contribution to System Security that can be provided by DG is described in the following sub-clauses~~. and shown diagrammatically in Figure 5.4~~. Where there is more than one DG ~~type~~facility in a network, a similar process is followed to establish the security contribution from each DG facility. The overall security contribution from DG within the demand group is taken to be the arithmetic sum of the contribution from each DG facility within that network.

Commented [AA4]: There is no Figure 4.

~~In order to~~When assessing the contribution to System Security from~~ a~~ DG ~~plant or a group of DG plants~~ it is necessary to use one of the three approaches described in ~~Clause 5~~Annex D. Furthermore,~~These approaches take account of~~ the following influencing factors may be considered in further detail when assessing the DG contribution to security (see Annex E).

- Availability;~~ (see Clause 6.2).~~
- Operating regime;~~ (see Clause 6.7).~~
- Remote generation;~~ (see Clause 6.8).~~
- Intermittency.~~ (see Clause 6.9).~~

By using either generic DG information or bespoke operational data for a particular DG, it is possible to establish ~~security contribution or~~the F factors and hence the security contribution for each~~ individual~~ DG ~~plant(s)~~facility.

This fortuitous contribution is based on the expected normal operational behaviour associated with a typical DG facility operating in the UK.

The assessment of Non-Contracted DG shall incorporate any necessary capping of the security contribution to avoid dominance in accordance with EREC P2/7 [N1] Clause 5.2. Annex B of this EREP includes further guidance on capping.~~NOTE: An overview of the technical issues that will need to be considered is shown in the Technical Check List presented in Annex A to this report.~~

~~7.1.1~~8.3.1 Assessing the ride through capability of the DG~~ plant~~

In the context of utilising the contribution from a DG plant to ensure compliance with the requirements of Table 1 of EREC P2/7~~6~~ [N1], it will be necessary for the DNO to be satisfied with how the DG facility~~plant~~ will respond to ~~both normal and credible abnormal~~ events on the network. For example:

a) during a network fault that results in a FCO event, the DG will need to be either stable enough to remain connected during the fault and then continue to support the requisite level of demand during the period of the FCO, or until the demand can be transferred to an alternative network; or

b) if the DG disconnects as a result of the fault it will be necessary for the DG to ~~be capable of being re-connected~~reconnect and synchronise to the network to support the requisite level of demand either

   i. within the times allowable in Table 1 of EREC P2/7~~6~~ [N1]; or

   ii. sufficiently rapidly to prevent any overloading of any remaining network assets supplying demand.

Unless the DNO has modelled the transient DG performance and has evidence to demonstrate that the DG will ride through a range of credible network outages it should be assumed that the DG will trip during a FCO or SCO unplanned outage. Similarly, the DNO should confirm the reconnection arrangements with the DG operator rather than assuming that a DG will automatically reconnect to the system once the network voltage and frequency has returned within normal pre-fault limits. The behaviour of a DG facility will be less certain during an unplanned outage than during a planned outage, e.g. for a demand group where supply continuity is required for a SCO, transient performance should be modelled under planned outage conditions.

8.4 Determine the security contribution from ~~non-contracted~~Non-Contracted DSR Schemes

~~An appropriate allowance should be made for DSR and it is for each individual DNO to decide if a DSR allowance sits within Group Demand, or in the form of a system capacity addition. The effects of DSR might already be included in the Measured Demand.~~

~~Where DSR is considered as a reduction in Group Demand, the DNO will need to consider the extent to which historic DSR behaviour is a reasonable interpretation of the future effects of that particular DSR arrangement. Where this is considered to be a reasonable interpretation no further action need be taken.~~

~~Where DSR is to be deployed on a contingency basis across future system loading peaks, an assessment needs to be made of the magnitude of the demand reduction that will actually be delivered by the DSR at the time of system peaks. This assessed demand reduction, will need to be deducted from the Measured Demand when assessing whether there is sufficient System Security.~~

Commented [RP5]: This paragraph added to highlight the significance of fault ride through and how it may be assessed. The requirement to consider fault ride through was included in the previous issue of EREP 130.

Commented [TCL6]: Content taken from Issue 2 Clause 6.10

~~In each case the assessment should be formally recorded as part of the overall compliance assessment.~~

DSR Schemes may be present on a network but not contracted with the DNO. In these cases, the assessment of DSR Scheme contribution to security would require either – DNO knowledge of the DSR Scheme or detailed research to determine existence of controlled demand reduction. The DNO is unlikely to have access to appropriate detailed data and this EREP recommends that ~~non-contracted~~Non-Contracted DSR Schemes should be assumed to have no contribution to security, unless the DNO is aware of site-specific details.

~~Hence the security contribution from DSR Schemes should be based on the terms of a contract agreement between the DSR Scheme provider (which may be a Demand Facility or an aggregator) and the DNO (see Clause 7.3).~~

Where the DNO is aware of ~~non-contracted~~Non-Contracted DSR Schemes through liaison with third parties, the details should be acquired where~~is~~ possible. In this case t~~T~~he security contribution ~~in this case~~ should be assessed based on the available information following the principles in Clause 7.4. The DNO should take a view of the confidence they have of this information.

~~be based on that portion of the DSR Scheme capacity (maximum known reduction in demand at the time being assessed) which, the DNO may take account of with appropriate confidence.~~

~~AUTHOR NOTE 5: Reviewers to confirm above paragraph is satisfactory.~~

Any assessment of Non-Contracted DSR Schemes shall incorporate necessary capping of the security contribution to avoid dominance in accordance with EREC P2/7 [N1] Clause 5.2. Annex B of this EREP includes further guidance on capping.

Since the demand reduction associated with a DSR Scheme is ~~initiated~~implemented in response to an instruction, it is distinct from other forms of demand reduction such as supplier time-of-use (TOU) tariffs. An ongoing research project by Scottish and Southern Electricity Networks ~~[5]~~ suggests that there is insufficient evidence that financial incentives, e.g. TOU tariffs, are effective in changing consumer behaviour. Conversely, DNOs may acquire demand profiles of specific customers and details of specific types of tariff arrangements which demonstrate a change in consumer load patterns e.g. 'E7' off-peak heating time switched load, or wind spilling tariffs, where there is a recognizable and predictable link between the tariff and Group Demand. However, unless there is a strong link between tariffs/schemes and a reduction in demand, based on collated data, this EREP recommends that they should not be considered during assessment of network security, i.e. there is no Latent Demand and hence no contribution to security.

8.5 Determine the security contribution from ~~non-contracted~~Non-Contracted ES

The ~~export~~security contribution from ~~non-contracted~~Non-Contracted ES should be based on the recorded details for the facility – the DNO should have the ~~profiles for~~ import and export profile of ~~all~~ ES facilities ~~generation~~ (for facilities >30 kW) connected to its network. The security contribution from Non-Contracted ES export should be subject to a site-specific study, i.e. ENA EREP 131 [N2] (see Annex D.5). The security contribution from Non-Contracted ES import should be subject to a site-specific study based on the principles in Clause 8.4.

~~AUTHOR NOTE 6: Reviewers to confirm agreement with above detail.~~

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The assessment of the security contribution from Non-Contracted ES shall incorporate any necessary capping of the security contribution to avoid dominance in accordance with EREC P2/7 [N1] Clause 5.2. Annex B of this EREP includes further guidance on capping.

The import from ~~non-contracted~~Non-Contracted ES should be assumed as being accounted in the normal demand profile, i.e. within the Measured Demand.

89 ~~Non-Contracted.Determine the s~~Assessing compliance with Table 1~~ufficiency of the network and DG assets~~

9.1 General

Once the ~~potential~~ contribution to System Security from DG/DSR Schemes/ES ~~plant(s)~~ has been determined, it is a simple matter of adding this value to the level of security contribution provided by the network assets. The network under consideration can be deemed compliant with the requirements of Table 1 of EREC P2/7~~6~~ [N1] if the aggregate of the:

- Intrinsic network capacity;
- Transfer Capacity;
- Contracted DG/DSR Schemes/ES; and~~;~~
- ~~Non-contracted~~Non-Contracted DG/DSR Schemes/ES, is sufficient to meet the level of security required in Table 1.

~~DG contribution(s) and network contributi~~It is critically important to note that this capability assessment needs to be done for each of the time periods specified in Table 1 of EREC P2/7~~6~~ [N1]. For instance, in the case of Class C, the two time periods of concern are the demand that must be recovered in 15 mins and the demand that must be recovered in 3 hrs. Both periods must be assessed separately since the required demand, the number of Circuits and the ~~amount of~~security contribution from DG/DSR Schemes/ES could be different in each case. Compliance with EREC P2/7~~6~~ [N1],~~ as in ER P2/5,~~ is required for each time period.

If the demand to be met exceeds the system capacity (i.e. the capacity provided by the network assets plus the contribution from DG/DSR Schemes/ESF) under FCO conditions in any one time period, the system is declared as not complying with the requirements of Table 1 of EREC P2/7~~6~~ [N1]. If the network under consideration is compliant under FCO conditions, then the process moves to checking for compliance under conditions of a SCO, noting that under EREC P2/7~~6~~ [N1] the requirement to remain secure after a SCO only applies to Group Demands in excess of 100 MW.

9.2 High-level review of options

In the event that the system capacity is insufficient to meet System Security requirements, as detailed in Table 1 of EREC P2/7~~6~~ [N1],~~ it will be necessary for the DNO to consider remedial action. Remedial action could mean seeking additional DG contributions or network reinforcement~~ the DNO should undertake a review of the options to address the deficiency, such as:

- network reinforcement; and
- establishing contracts with DG ~~facilities~~, DSR Scheme ~~providers~~, and ES owner/operator~~F facilities~~.

The review of the options should consider:

- b~~B~~udget costs associated with the network and non-network options;

- estimate of the longevity of the solution based on the demand growth scenarios; and
- the asset management strategy and network planning policy for the DNO.

Having understood the budget costs, coupled with the benefits of the options, the DNO should ascertain if compliance with Table 1 of EREC P2/7 [N1] is:

a) economically justifiable; and

b) aligns with the overall asset management strategy.

Should the high-level review of options indicate the compliance with Table 1 of EREC P2/7 [N1] is justifiable, then in-depth planning of the work should commence. Otherwise, the DNO shall prepare a supplementary cost benefit analysis (see Clause 11).

~~9~~10 Provision of system security

In order to remain compliant with EREC P2/7 [N1], the DNO must ensure that there is or is planned to be sufficient ~~s~~System ~~s~~Security to meet the forecast Group Demand. Where a deficiency in ~~s~~System ~~capacity~~Security is identified, a detailed analysis of the options considered in Clause 9 should be undertaken. The detailed analysis should identify whether any network reinforcement or new contractual arrangements can be implemented in a timely manner, i.e. in advance of the demand group becoming non-compliant with the requirements of Table 1 of EREC P2/7 [N1]. Options considered should include:

a) Increasing the intrinsic network capacity (for example, network reinforcement, re-assessing the Circuit Capacity, assessing options for enhancing network voltage management);

b) Increasing the Transfer Capacity or the reducing the time for implementing Transfer Capacity (for example, network automation);

c) Implementing contractual arrangements for security services from DG/DSR Schemes/ES; and~~F~~

d) Implementing a combination of a), b) and c)

In the case where network reinforcement or appropriate contractual arrangements cannot be completed in advance of the DNO network ~~system being~~becoming non-compliant with Table 1 of EREC P2/7 [N1], the DNO shall request a technical derogation from Ofgem [5~~6~~] for a specified period of time, i.e. timebound derogation. ~~The need to submit a timebound derogation may be omitted if the DNO's financial commitment to the network or non-network solution is sufficient evidence for Ofgem.~~

~~AUHTOR NOTE: Reviewers to agree above wording.~~

11 Cost Benefit Analysis (CBA)

A supplementary CBA shall be prepared when the DNO's high-level review of remedial works indicates that the options are not economically justifiable and/or do not align with its asset management strategy.

The CBA shall be based on the costs of achieving the minimum requirements set out in Table 1 of EREC P2/7 [N1] – It should primarily assess whether the cost of the reinforcement or implementing security service contracts to comply with the requirements in Table 1 are reasonable when compared with the improvements in the supply security that would be expected to be delivered~~1.~~~~it should primarily assess weather the reinforcement / contracts are reasonable to comply with Table 1.~~ ~~It should consider the potential additional / reduced investment expenditure established from reinforcement estimates. It should also consider the benefits for establishing DG/DSR Schemes/ES contracts.~~

The DNO's ~~may apply their~~ own CBA template or ~~, otherwise~~ the latest CBA template available from Ofgem ~~should~~ may be used. The CBA should primarily be based on the rate of return principle (discount rate), and should also consider:

~~AUTHOR NOTE 7: Do reviewers haveOfgem to provide a reference to relevant CBAfor the template?~~

a) Network losses and the economic value of those losses; and

b) The cost of supply interruptions to customers;

Expected E~~e~~nergy N~~n~~ot Supplied~~served~~ (EENS) is expressed in MWh over a specific time period (e.g. a year). Using the concept of EENS, it is possible to monetise the shortfall in ~~a~~ system capacity where VoLL has also been calculated since the ~~amount of~~ EENS can then be multiplied by VoLL. Hence, a change in EENS rising from remedial actions may be assessed based on:

- VoLL= £17,000 / MWh; different values of Vo~~O~~LL can be used where deemed appropriate by the DNO
- VoLL impact assessed for an appropriate period of time, relevant for the CBA

In the case where the supplementary CBA ~~provides justification for~~justifies providing additional system security to meet the requirements of EREC P2/7 Table 1, the DNO should progress plans for this, otherwise the CBA shall be used to demonstrate compliance with EREC P2/7 [N1].

~~Influencing factors~~

Commented [TCL7]: Influencing Factors Clause from Issue 2 has largely been moved to Annexes and Clause 8.

~~**9.1 General**~~

~~Whichever of the three approaches is used to determine the security contribution from DG, the generation characteristics need to be assessed to determine whether they are sufficiently normal to allow the application of either the look-up table Approach 1 or Approach 2. If any of the conditions or constraints used to produce the tables in Approach 1 or 2 are considered to be relevant then, as in ER P2/5, special studies will need to be performed. This will entail using the computer program, Approach 3.~~

~~The remainder of this clause provides an explanation of the key factors which will influence System Security contribution provided by DG in a network.~~

Annex A
(normative)

Identification of Group Demand

Commented [TCL8]: Content taken from Issue 2 Clause 6.1

A.1 General

In order to ensure that there is~~are~~ sufficient ~~network assets and DG to secure the customer demand~~S~~s~~ystem S~~s~~ecurity, it is necessary to identify the Group Demand to be secured. This requires that, as far as reasonably practicable Latent Demand within the network is identified and added to the recorded or Measured Demand, taking appropriate account of diversity and coincidence of demand and DG/DSR Scheme/ES~~ output~~ profiles, to establish the Group Demand.

Latent Demand associated with generation, for example DG and ES export, is a straightforward concept which does not warrant detailed explanation.

DSR Schemes are considered as an increase in system capacity, hence the DNO will need to consider the extent to which the Measured Demand should be increased to reflect the demand that has been constrained by the DSR Scheme in order to establish the Group Demand that needs to be secured. Likewise, if an ES facility is Contracted not to import, then the Measured Demand will need to be increased by the constrained import, i.e. the Latent Demand for the ES not importing (akin to a DSR Scheme).

Equation 1 shall be applied when determining Latent Demand.

Latent Demand =

Contracted and ~~Non-contracted~~Non-Contracted (where known) DG export at the time of Measured Demand

+

Amount by which the import at a Demand Facility is reduced by a Contracted or ~~Non-contracted~~Non-Contracted (where known) DSR Scheme, which is active at the time of Measured Demand

+

Contracted or ~~Non-contracted~~Non-Contracted (where known) ES export at the time of Measured Demand

+

Amount by which the import at an ES facility is reduced by a Contracted import constraint, which is an active at time of Measured Demand

Equation. 1

As implied in Equation 1, a DSR Scheme or ES import constraint contract, which is considered not to be active at the time of Measured Demand has no latency, i.e. Latent Demand = 0 MW. In deciding that the demand/import constraint was active for a particular facility, the DNO should consider the following options to determine the Latent Demand.~~:~~

a) The terms of the Contract with the DNO

~~Terms of an agreement~~

The DNO has details of a contract and assumes that the maximum import capacity is required at the time of Measured Demand and is thus being constrained at or below a certain (as per a contract) value.

b) Measured import and observed unconstrained demand

The DNO has knowledge of and understands the demand profile for the particular facility to ascertain the actual demand which is being constrained at the time of Measured ~~of~~ Demand.

Assessing the Latent Demand for an ES which is contracted to constrain import may become complicated if the ES is actually exporting at the time of Measure Demand. However, the ES may change operation in a very short time span, i.e. switch from export to import quickly, and the DNO should consider ~~the~~ such scenarios. Example F.5.2 provides more guidance on such a scenario.

A.2 Contracted DG, DSR Scheme and ES

Where a DNO has a contract with a DG or ES facility to export, then the Latent Demand should be based on the terms of the contract, i.e. the export from the facility will be determined by the contract.

Where the DNO has a contract with a Demand Facility (DSR Scheme) or an import constraint contract with an ES Facility, then the Latent Demand may be determined using one of the options a) or b) in Annex A.1. The implications using the options is described below.

a) The terms of the Contract with the DNO

This method returns the maximum value of the Latent Demand as it is determined by the difference between the maximum import capacity (stipulated in the contract) and the constrained ~~demand~~import capacity. The value may be an overestimate as the customer may not plan to take their maximum import capacity at the time of peak ~~system~~network demand.

b) Measured import and observed unconstrained demand

This method returns a ‘diversified’ value of Latent Demand, i.e. the customer ~~n~~may not necessarily wish to operate at maximum import capacity during the time when they are being constrained. This method is more difficult to apply as it requires an understanding and knowledge of what the import would have been had no import restriction been active ~~it~~, rather than assuming the customer would like their maximum import capacity. The DNO could determine the ‘diversified’ Latent Demand by assessing the customer’s import over a suitable period so that patterns in their import during periods when it is both constrained and unconstrained are established.

The example in F.4.4 indicates how the options a) and b) may be applied to a DSR Scheme and the example in F.5.2 indicates how the options may be applied to an ES with constrained import.

~~A.1~~A.3 ~~Non-contracted~~Non-Contracted DG, DSR Scheme and ES

For ~~Non-contracted~~Non-Contracted DG/DSR Schemes/ES, t~~T~~he most rigorous assessment would require the impact of DG/DSR Schemes/ES known at each network node to be assessed for each half hour period, where the half hour timescale relates to the information typically available from DNO SCADA or the Elexon Settlements system~~s~~. This analysis is potentially extensive, and in the case of ~~d~~Demand Facilities~~sites~~ with on-site generation, DSR Schemes with third parties, or a site with an ES, obtaining the relevant data could be difficult.

The key issue associated with establishing the Group Demand is striking a balance between the need to undertake significant analysis, with data that may not be readily available, and the risks associated with there being insufficient network assets and DG/DSR Schemes/ES to support the Group Demand. The risk arises because if, for example:

- ~~-~~the export from a~~some~~ DG is effectively being considered as~~to be~~ negative demand, i.e. it carries ~~, it is effectively being ascribed~~ a 100% security contribution, or;
- a reduction in demand at a Demand Facility in response to a third party DSR Scheme contract is effectively being considered as negative demand, i.e. it carries a 100% security contribution.

~~.~~The magnitude of the risk relates to the aggregate capacity of Non-Contracted DG/DSR Schemes/ES~~ capacity~~ in the network under consideration rather than the size of any individual DG/DSR Scheme/ES. It is recognised that establishing an appropriate approach is subjective, and that a pragmatic approach~~, as described below~~, needs to be taken. Hence, the 5% de-minimis test described in Clause 5 (

~~Where the aggregate DNC of the DG in any given network exceeds 5% of the maximum value of the Measured Demand of the network, the DNO should make an assessment of the Latent Demand so that it can be added, making appropriate allowances for diversity and coincidence, to the Measured Demand to establish the Group Demand.~~ t~~T~~he 5% figure is a practical limit and relates to the accuracy of typical DNO SCADA information).

The extent of the analysis is dependent upon a number of factors including:

- whether the generation is directly connected to the DNO network, as would typically be the case for landfill generation or a wind farm, or is embedded in a customer's installation with a significant amount of on-site demand, as would typically be the case for an industrial site with CHP generation plant;
- the coincidence of the maximum value of the Measured Demand and the maximum output from DG in the network for which Group Demand is being established.

Where the aggregate capacity of Non-C~~c~~ontracted DG/DSR Schemes/ES~~generation~~ exceeds 5% of the Group Demand, but comprises large numbers of very small facilities~~DG units (e.g. domestic CHP)~~, the capacity~~export~~ from these units need not be added to the Measured Demand, as there will probably be sufficient diversity for the overall network risk to be small. However, if the DNO considers the effect of such facilities~~generation~~ to be material, the use of generic profiles for ~~small-scale generation (such as domestic CHP)~~DG/DSR Schemes/ES would facilitate further assessment of the Latent Demand.

Having established appropriate details of any Non-Contracted DG/DSR Schemes/ES, the Latent Demand should be determined as described in Annex A.1, including options a) and b) for DSR Schemes and ES import constraints.

~~A.2~~A.4 Establishing the Latent Demand from generation only sites, i.e. merchant DG

For a DG facility where there is no on-site demand, the contribution to Latent Demand is the export from the DG facility to the network. As indicated above, the most rigorous method is to summate the recorded half hourly output from all the DG (greater than 100 kW) for the network. These half hourly contributions are then added to the half hourly network demands measured at network entry points to establish the profile of demand from which the maximum demand, i.e. the Group Demand, can be found. However, where it is believed that there is good coincidence between the time of the maximum value of the Measured Demand and the maximum value of the contribution to Latent Demand from each DG facility~~plant~~, it will often be sufficiently accurate to estimate the Latent Demand by summating the export from the DG facility, at the time of the maximum Measured Demand.

~~A.3~~A.5 Establishing the Latent Demand from customer~~'~~s' demand sites with on-site generation

Where a demand site comprises DG with a capacity greater than 100 kW, wherever possible the actual site demand (i.e. the demand measured for the site plus the contribution to the Latent Demand associated with the on-site DG) should be established and the contribution to System Security from the DG should be assessed in accordance with EREC P2/7~~6~~ [N1].

There are a number of options outlined below for treating demand sites with generation, which have differing requirements for the availability and quality of network and generation data. The purpose of describing these options is primarily to expand on some of the issues that need to be considered when assessing the contribution to Group Demand from such sites. Implementation of some of these methods may require an enhancement of existing data systems.

- Option 1. Obtain separate demand and generation data from the site operator in order to separately assess both the overall site demand and the security contribution from the on-site generation.
- Option 2. As Option 1, but where data from the site operator is not available and the DNO uses data from other sources, e.g. its own SCADA data and export information from the BSC Settlements system. The DNO would need to be comfortable that it had sufficiently accurate data to undertake the analysis before applying this option. The security contribution from the generation would be considered separately.
- Option 3. Estimate the contribution to Group Demand by ignoring any contribution to Latent Demand by the on-site generation and assume that only the ASC demand has to be met. It is important to recognise that the maximum site demand may be different from the ASC and any difference should be treated in the same way as for any other demand site that has a possible maximum demand different from its ASC. The security contribution from the generation would be considered separately.

  It is worth noting that where the customer has an ASC lower than the site maximum demand, they are effectively managing internally the risk of their generation not operating and in this case it may not be appropriate for the security contribution of the generation to be separately assessed.
- Net Option 1. The DNO could develop a model of the on-site generation in net terms based on the import/export data at the ownership boundary. Information may be

obtained from the DNO SCADA system and/or the BSC Settlements system. In this case there would be no requirement to separately assess the security contribution from the generation.

- Net Option 2. The most general option is to explicitly allow the DNO to use its engineering judgement to determine the appropriate contribution to Latent Demand of the site to be used in an assessment of Group Demand. In this case there would be no requirement to separately assess the security contribution from the generation.

An approach based on Option 1 is the most robust and is the preferred approach where sufficient data is available and a high degree of accuracy is required. However as described above the application of a pragmatic option for disaggregating the demand and generation will often be sufficient.

A pragmatic approach for assessing the contribution to Latent Demand by on-site generation plant has been identified. This method is not completely rigorous but is generally thought to be appropriate where it is obvious by inspection that there is good coincidence between the maximum values of the Latent Demand and Measured Demand. This technique does cater for the following risks:

- basing the on-site demand on the import/export data at the ownership boundary – which could lead to an under engineered network; and
- ignoring the on-site generation and assuming that the ASC demand has to be met – which could lead to an over engineered network.

The technique for establishing Group Demand is therefore to take the lesser of the following two conditions.

- The expected generation output (G) at the time of the maximum Measured Demand, or
- The site ASC (A) minus the site import[3] (D) at the time of maximum Measured Demand. (i.e. A-D).

and add it to the maximum value of the Measured Demand.

i.e. Group Demand = maximum Measured Demand + min. [G, (A – D)]

The contribution to System Security of the DG should then be treated independently in accordance with ~~Table 2 of ER P2/6 [N1]~~ Annex D.

~~DSR is considered as an increase in system capacity, hence the DNO will need to consider the extent to which the Measured Demand should be increased to reflect the demand that has been suppressed by the DSR in order to establish the Group Demand that needs to be secured. In order to determine the effective security contribution from DSR, an assessment is needed of the magnitude and longevity of the demand reduction which is likely to be delivered by the DSR arrangements in place at the time when the intervention would be needed to meet the security requirements of EREC P2/7 [N1]~~

[3] Note that for a site that is exporting to the DNO's network, the import is simply a negative quantity.

Annex B
(informative)

Capping DG/DSR Schemes/ES

B.1 Dominance and capping

A principle of EREC P2/7~~5~~ [N1] is that outage events~~both FCO and SCO conditions~~ relate to Circuits~~–~~ rather than loss of DG/DSR Scheme/ES contribution~~generation outages~~, i.e. no individual DG/DSR Scheme/ES~~generating unit~~ should be dominant.~~, and ER P2/5 contained explicit criteria to achieve this. Under ER P2/6 [N1] these materiality criteria have been revised from the equivalent provisions in ER P2/5. These revised criteria are:~~ The conditions that should be applied to test for dominance are as follows:

a) the~~ cyclic rating of the largest Circuit is greater than ~~ security contribution~~F%~~ of each of the following items shall be limited to the capacity of the largest Circuit~~:~~

   i. ~~Capacity~~DNC of the largest contracted DG facility;
   ii. ~~the~~ DNC of the ~~N~~~~1~~ largest ~~non-contracted~~Non-Contracted DG;
   iii. Aggregate DNC of multiple ~~non-contracted~~Non-Contracted DG facilities which are susceptible to common mode failure (see B.2);
   iv. Capacity of the largest contracted DSR Scheme provided by a Demand Facility;
   v. Aggregate c~~C~~apacity of contracted DSR Schemes which are susceptible to common mode failure (See B.2);
   vi. Capacity of the largest ~~non-contracted~~Non-Contracted DSR Scheme which the DNO is aware of, i.e. a known DSR Scheme;
   vii. Capacity of the largest contracted ES export~~ units;~~
   viii. Aggregate c~~C~~apacity of multiple contracted ES facilities which export and are susceptible to common mode failure (see B.2);
   ix. Capacity of the largest ES which is contracted to restrict import;
   ~~i.~~x. Capacity of the largest ~~non-contracted~~Non-Contracted ES import restriction which the DNO is aware of, i.e. a known ES import restriction.

b) ~~the cyclic rating of the two largest Circuits is greater than~~the security contribution of the two largest DG/DSR Scheme~~s~~/ES~~ capacities~~, as ~~outlined~~set out in items i) -x) shall be limited to the aggregate rating of the two largest Circuits.~~ F% of the DNC of the (N_1+1) largest DG units.~~

~~If these conditions are not satisfied, then the capacity of the DG units (C_g) used to assess the security contribution should be Capped at the maximum value that satisfies the above assumptions, i.e. for identical units:~~

~~From the first condition~~

$$\cancel{C_g \leq \frac{C_{c1}}{F \cdot N_1}}$$

~~From the second condition~~

$$\cancel{C_g \leq \frac{C_{c1} + C_{c2}}{F \cdot (N_1 + 1)}}$$

~~Where: C_{c1} is the capacity of the largest Circuit (C_{c2} the next largest) and N_1 is the number of DG units equivalent to a FCO, as specified in Table 2-3 or Table 4.~~

~~As part of the assessment procedure outlined under sub-clause 4.5.4 it will be necessary for the DNO to assess the materiality of each DG contribution. If the conditions set out above are met for each DG, then the FCO is the outage of the largest Circuit and the process continues with the calculation of the system capacity under this outage condition. Note that the above relationships are general for several identical units of the same size. If all units are different sizes then the relationship will need to be tested for all DG plants individually, and N_1 will be equal to unity in each case.~~

If the first condition is not met (i.e. the DG/DSR Scheme/ES~~generation~~ would otherwise dominate), then the ~~generation~~ capacity used to assess the security contribution must be Capped~~ (to C_g)~~ so that the DG/DSR Scheme/ES does not dominate and hence an outage of the largest Circuit can be taken to be the FCO. The process then continues with the calculation of the system capacity under this outage condition which is:

- the Circuit~~cyclic~~ C~~c~~apacity of the remaining Circuit(s); plus
- any Transfer Capacity; plus
- the appropriate DG/DSR Scheme/ES contribution determined in Clauses 7 and 8~~from Approach 1, 2 or 3~~.

A similar Capping process is used to ensure that the SCO relates to the outage of the second largest Circuit.

~~**A.4 CWhere the determination of System Security includes the contributions of numbers of DG plants of several types, the materiality conditions become:**~~

~~**A.5**~~ $\cancel{\left[C_{gt}\right]_1^n \leq C_{c1} \cdot \left[\frac{1}{F_t \cdot N_{tt}}\right]_1^n}$ ~~**for FCO**~~

~~**A.6**~~

~~**A.7**~~ $\cancel{\left[C_{gt}\right]_1^n \leq (C_{c1} + C_{c2}) \cdot \left[\frac{1}{F_t \cdot (N_{tt}+1)}\right]_1^n}$ ~~**for SCO**~~

~~**A.8 where there are n different types and sizes of DG plants, i.e. types as listed in Tables 2-2 and 2-3.**~~

~~A.9~~B.2 ~~C~~Common mode failures

~~Implicit in ER P2/5 is the assumption that generation will not be subject to common mode failures. Given the growth of DG and its inherently different character to ex-CEGB plant, it is necessary to deal with the risk of common mode failure explicitly.~~

Common mode failure of DG, DSR Schemes and ES can occur for a variety of reasons. EREC P2/7 [N1] requires that common mode failure of any active network management ~~network~~, protection, or control system associated with DG and DSR is considered. Other types of common mode failure are as follows.~~The following is illustrative but not exhaustive.~~

- Fuel Source (DG) Failure of common fuel supply such as the gas supply to several landfill generating units on the same site; mains gas supply to CCGTs etc. should there be a gas network security problem, etc.
- Connection (DG, DSR Scheme, ES) It is possible that significant DG/DSR Scheme/ES contribution to Group Demand is connected via a single Circuit. It is necessary to check that loss of this Circuit would not trigger materiality considerations, although this is unlikely to happen in practice.
- Stability (DG, ES) Inability of certain types of DG/ES or types of protection to remain stable and/or ride through a system disturbance.

To avoid common mode failures of DG/DSR Scheme/ES degrading System Security beyond that expected in EREC P2/7~~5~~ [N1] it is appropriate to cap DG/DSR Scheme/ES that is subject to common mode failure~~ under the same arrangements~~ as provided in Annex B.1~~ 6.3 above~~. Each type of DG/DSR Scheme/ES ~~that~~ could be subject to common mode failure ~~should be aggregated and this aggregate capacity tested for dominance and Capped accordingly~~as provided in Annex B.1.

~~This can be expressed as:~~

$$\left[\sum_{j=1}^{m} C_{gij}\cdot F_{ij}\cdot N_{1ij}\right]_{i=1}^{n} \leq C_{e1} \; and \; \left[\sum_{j=1}^{m} C_{gij}\cdot F_{ij}\cdot N_{1ij}\right]_{i=1}^{n} \leq (C_{e1}+C_{e2})$$

~~for FCO and SCO respectively, and where there are *n* types of common mode failures, and within each type there are *m* DG of different types and sizes to be aggregated.~~

~~If these inequalities are not satisfied, it will be necessary to cap each DG plant pro-rata to its contribution such that the Capping criteria are met.~~

~~Annex B~~Annex C
(~~normative~~informative)

Technical check list

Commented [AMC9]: Needs to be reviewed – some initial suggestions added.

~~B.1~~C.1 Introduction

This Annex contains checklists for the various phases of the assessment process, as outlined in the main document. These checklists are intended as an aide-memoir for the network designer rather than being a definitive activity list.

~~B.2~~C.2 Establish Group Demand

	Complete
Recorded maximum demand	
~~Connected~~ Latent ~~d~~Demand for contracted DG/DSR Scheme/ESF ~~capacity~~	
De-minimis test for N~~n~~on-~~c~~Contracted DG/DSR Scheme/ESF and hence any Latent Demand	
~~½ hourly demand profile~~	
~~½ hourly DG export profile~~	
~~Data re sites with on-site generation~~	

~~B.3~~C.3 Establish network capability

	Complete
Circuit Capacity of individual Circuits appropriate to time of year	
Time of year of recorded maximum Group Demand	
~~Cyclic rating factor appropriate to time of year~~	
Network Transfer Capacity	
Time within which Transfer Capacity is available	

C.4 Establish C~~c~~ontracted DG/DSR Scheme/ES ~~capability~~security contribution

	Complete
Assess ~~Contracts with~~ DG contracted security contribution	
Consider general DG issues in accordance with Annex C.6	
DSR Scheme contract~~s~~ed security contribution	
ES~~F~~ contracted security contributions	

C.5 Establish Non-C~~c~~ontracted DG security contribution

	Complete
Assess non-contracted security contribution in accordance with Annex D	
Consider general DG issues in accordance with Annex C.6	

~~B.4~~C.6 General DG considerations ~~information~~

	Complete
For each DG ~~installation~~facility:	
C~~A~~.6~~4~~.1 General	
~~Number of DG installations~~	
Capacity of ~~each~~ DG ~~unit~~	
Type of DG ~~– Prime mover~~	
~~Type of DG – Fuel source~~	
~~Type of DG – Intermittent / Non-intermittent~~	
~~Operating period if less than 24 h~~	
½ hourly output profile	
Merchant or process linked?	
C~~A~~.6~~4~~.2 Technical	
~~Compliant with G59~~	
Interface protection • operating parameters and settings • ride through capability	
DG stability	
Status of the technology (proven/experimental)	
Evidence of good management procedures	
Proven performance track record, consistent capacity factor	
What are the cold start/warm start/reconnection times for generation?	
C.6~~A.4~~.3 Fuel	
Contracted fuel supply	
Uninterruptible fuel supply (gas)	
Fuel stocks available	
C.6~~A.4~~.4 Commercial	
Ability for DNO to request operation	

Contracted repair and maintenance	
Coordination of network and DG planned outages	
Expected lifespan of the DG plant	
C.6~~A.4~~.5 Contract (where appropriate)	
Contracts in place	
Ability to operate on demand	
Appropriate communications with Generator/DG plant to be in place	
C.6~~A.4~~.6 Network & DG related issues	
Will generation under outage overload any remaining plant	
Does the generation need to run to a different loading pattern immediately - can the governor cope	
Can the AVR cope with the required PF under outage conditions etc.	
Will protection for remaining network still work/discriminate with generation	
~~Will an island result (if so - longer checklist required)~~	
Is the DG exposed to any common mode failure (e.g. gas supplies; drought)	
Will the DG cause voltage violations during outages	
Communication arrangements between DNO and Generator	

C.7 ~~Non-contracted~~Non-Contracted DSR Schemes

	Complete
Where the DNO is aware of ~~non-contracted~~Non-Contracted DSR S~~s~~chemes through liaison with third parties, the details should be acquired~~.~~	
Where the DNO is aware of time-of-use tariffs and price signals which affect consumer demand, the details should be acquir~~tt~~ed~~.~~	

C.8 ~~Non-contracted~~Non-Contracted ES

	Complete
Where the DNO is aware of ~~non-contracted~~Non-Contracted ES through liaison with third parties, the details should be acquired~~.~~	

Annex D
(normative)

Approaches for assessing the contribution from ~~non-contracted~~Non-Contracted DG to System Security

~~B.5~~D.1 General

This Annex~~clause~~ describes three approaches for assessing the security~~ potential~~ contribution from ~~Non-contracted~~Non-Contracted DG to System Security. Use of these approaches will form an integral part of the assessment process described in ~~sub-c~~Clause 8.3.~~4.5.3.~~

Approach 1 provides the simplest method to assess the contribution. Approach 2 provides an additional assessment method for ~~non-intermittent~~ DG which is more specific than~~that falls outside of the criteria for~~ Approach 1; and Approach 3 is used where it is necessary to carry out bespoke analysis using site specific data.

~~B.6~~D.2 Approach 1 – ~~Look-up table(s) approach~~Generic approach

Approach 1 is a simple method based on the use of look-up tables and graphs. The look-up tables (Tables D.2, D.2.~~-~~1~~,~~ and D.2~~2.2-2, 2-3 and 2-4~~) ~~-~~are based on the analysis of ~~actual~~ export data o~~n~~f typical DG facilities ~~installations~~ by Imperial College London [N8].~~ typical or average availability data relating to specific DG types. These tables have been derived from analysing data from operational DG plants (see [N2 – N4]).~~ The data represents:

a) export data at the point where the DG is connected to the DNO network;

NOTE: The data is based on DG technology type, i.e. the energy source associated with the DG facility~~ies~~. The number of separate generating units associated with a particular facility is not considered.

b) data sampled at 30 min intervals;

c) data collated over the period 2013-2018, inclusive.

It is valid to use Approach 1 in the following situations:

- where the DG type is one of those cited in Tables D~~2.-~~2.1~~1~~ or D~~2.-~~2.2; or~~and~~
- ~~where the average availability of the Non-intermittent Generation under consideration is not significantly different from that used to produce Table 2-1 (using the availability values cited in Table 5); or~~
- ~~where the average availability of the Intermittent Generation under consideration is not significantly different from that used to produce Table 2-2 (using the approach cited in Table 6); or~~
- where a ‘first pass’ assessment is required to determine if a particular DG facility~~plant~~ is likely to have sufficient capacity to provide a sufficient security contribution to satisfy a particular requirement.

~~Approach 1 is based on assessing the contribution from identical DG units on the same site. However, the approach may be expanded to cover non-identical units and DG on different sites within the same network.~~ Each DG facility~~unit~~ ~~may~~ should be assessed individually and the aggregate DG ~~capability~~ security contribution is the arithmetic sum of all the facility ~~individual~~ ~~DG~~ contributions~~ plus any additional contribution from DG having an operational~~

~~period less than 24 h, see Table 2~~. This summation gives a conservative assessment of the DG contribution.

Table D.2

~~Type of~~ Distributed Generation Technology Type	Contribution (see NOTE 1 below)
~~Generation~~ DG as listed in Tables D.2.~~-~~1~~A and 2-1B~~	F % of DNC
~~Generation~~ DG as listed in Tables D.2.~~-~~2~~A and 2-2B~~	F % of DNC ~~(see NOTE 2 below)~~
~~Plant operating for 8 hours (see NOTE 3 below)~~	~~Smaller of value derived from relevant row above; or 11% of Group Demand~~
~~Plant operating for 12 hours (see NOTE 3 below)~~	~~Smaller of value derived from relevant row above; or 12% of Group Demand~~

NOTE 1: The contributions derived from this table apply from the point of time when the DG is connected or reconnected to the demand group following the commencement of an outage. This may be immediately if the DG does not trip, otherwise it will be from the point of time when the DG is reconnected.

~~NOTE 2: The value derived applies to the complete DG plant irrespective of the number of units.~~

~~NOTE 3: The values in these two rows assume that the operating period is such that operation spans the peak demand, and the demand at start-up is the same as the demand at shut-down, i.e. operation is symmetrically placed on the daily load curve. If these conditions do not apply, the contribution could be optimistic (e.g. at one extreme, the contribution would be zero if the operating period did not span the peak demand at all), in which case the generation ought to be treated as a special case and therefore subject to detailed studies to assess the expected level of contribution – See ETR 130 [Ref 1].~~

Commented [TCL10]: Moved to E.2 along with Note 3.

Table D.2.~~-~~1 — F factors in % for Non-intermittent Generation

~~Table 2-1A — High confidence data~~

~~Type of generation~~	~~Number of units~~									
~~Landfill gas~~	~~63~~	~~69~~	~~73~~	~~75~~	~~77~~	~~78~~	~~79~~	~~79~~	~~80~~	~~80~~
~~CHP sewage treatment using a spark ignition engine~~	~~40~~	~~48~~	~~51~~	~~52~~	~~53~~	~~54~~	~~55~~	~~55~~	~~56~~	~~56~~

~~Table 2-1B — Sparse data~~

~~Waste to energy~~	~~58~~	~~64~~	~~69~~	~~71~~	~~73~~	~~74~~	~~75~~	~~75~~	~~76~~	~~77~~
~~CCGT~~	~~63~~	~~69~~	~~73~~	~~75~~	~~77~~	~~78~~	~~79~~	~~79~~	~~80~~	~~80~~
~~CHP sewage treatment using a Gas Turbine~~	~~53~~	~~61~~	~~65~~	~~67~~	~~69~~	~~70~~	~~71~~	~~71~~	~~72~~	~~73~~
~~NOTE: This table is provided for guidance, however the data sets used to create this table have limited statistical robustness and the DNO should take care when using these F factors for these types of generation. It is preferable to seek site specific data when looking to assess the contribution to System Security from the types of DG listed in this table.~~										

~~Author Note 8: Values in table to be validated against ICL report.~~

DG Technology Type ~~of generation~~ (NOTE 2)	Period of assessment (NOTE 3)	
	Winter	Summer
Biomass	30~~2~~%	25~~30~~%
Landfill gas	28~~2~~%	27~~0~~%
Waste	35~~2~~%	32~~24~~%

NOTE 1: The F factors for Non-intermittent Generation are ~~related directly to the number of units in the generating station~~not affected by the number of units at an individual site. It is assumed that the energy source for the prime mover is available on demand so that p~~P~~ersistence does not need to be considered.

NOTE 2: For DG technology types not listed in this table, it is preferable to seek site specific data to assess the contribution to System Security in accordance with EREP 131 [N2].

NOTE 3: Summer period refers to months May – August inclusive. Winter period refers to months November – February inclusive.

NOTE 4: The percentage values in this table are representative of the mean (M) minus 1 standard deviation (SD). Refer to commentary in Annex G~~below~~ for further explanation.

~~COMMENTARY ON: Standard deviation (SD)~~

~~A normal population distribution about a mean value, M, is shown. The percentage of population within a standard deviation (SD) of the M follows the values shown, Hence, for 1SD below M, this represents 84.1% of the population~~

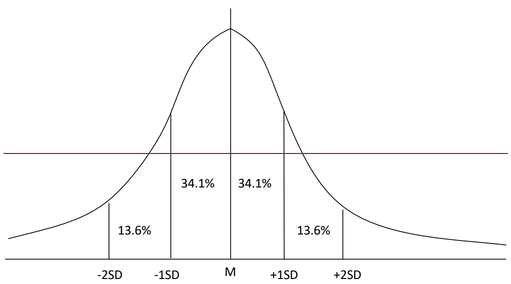

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Table D.2.~~-~~2 — F factors in % for Intermittent Generation

~~**Type of generation**~~	~~**Persistence, T_m (hours)**~~							
~~Wind farm~~	~~28~~	~~25~~	~~24~~	~~14~~	~~11~~	~~0~~	~~0~~	~~0~~

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~~**Table 2-2B — Sparse data**~~

~~**Type of generation**~~	~~**Persistence, T_m (hours)**~~							
~~Small hydro~~	~~37~~	~~36~~	~~36~~	~~34~~	~~34~~	~~25~~	~~13~~	~~0~~
~~NOTE 1: The "small hydro" DG plants used to produce Table 2-2B were all rated below 1 MW with water storage.~~ ~~NOTE 2: This table is provided for guidance, however the data sets used to create this have limited statistical robustness and the DNO should take care in establishing appropriate F factors for this type of generation. It is preferable to seek site specific data when looking to assess the contribution to System Security from a small hydro DG plant.~~								

~~Author Note 9: Values in table to be validated against ICL report.~~

DG Technology Type ~~**Type of generation**~~ **(NOTE 2 & 3)**	**Persistence, T_m (hours)**										
	½	**2**	**3**	**6**	**12**	**18**	**24**	**48**	**120**	**360**	**480**
Onshore wind (Winter)	17~~5~~%	15~~4~~%	16~~3~~%	14~~2~~%	11~~0~~%	9~~8~~%	7~~6~~%	4~~3~~%	2~~1~~%	1~~0~~%	1~~0~~%
Onshore wind (Summer)	13~~2~~%	12~~1~~%	11~~0~~%	9~~8~~%	8~~7~~%	6~~5~~%	4%	2%	0%	0~~1~~%	0~~1~~%
Offshore wind (Winter)	22%	21%	20%	19%	17%	15%	12%	7%	2%	1%	1%
Offshore wind (Summer)	16%	16%	15%	13%	11%	9%	7%	3%	0%	0%	0%
Hydro run-of-river (Winter)	19%	19%	18%	18%	17%	16%	15%	12%	5%	0%	0%
Hydro run-of-river (Summer)	7~~6~~%	7~~6~~%	7~~5~~%	7~~5~~%	6~~4~~%	5~~4~~%	4%	2~~1~~%	1~~0~~%	0%	0%
Hydro water reservoir (Winter)	12~~1~~%	12~~1~~%	10%	9~~8~~%	7%	4%	3~~4~~%	3%	2~~1~~%	0%	0%
Hydro water reservoir (Summer)	5~~4~~%	5~~4~~%	4~~3~~%	2%	1%	0%	0%	0%	0%	0%	0%
Solar (Winter)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Solar (Summer)	12%	11%	10%	9%	3%	2%	0%	0%	0%	0%	0%
NOTE 1: The F factors for Intermittent Generation are related directly to the period of continuous generation (i.e.											

Persistence)~~ and are not affected by the number of units at an individual site~~.

NOTE 2: For DG technology types not listed in this table, it is preferable to seek site specific data to assess the contribution to System Security in accordance with EREP 131 [N2].

NOTE 3: Summer period refers to months May – August inclusive. Winter period refers to months November – February inclusive.

NOTE 4: The percentage values in this table are representative of the mean (M) minus 1 standard deviation (SD). Refer to commentary below Table D.2.1 for further explanation.

NOTE 5: Recommended values of T_m are shown in Table D.22.3-4.

~~Table 2-2A — High confidence data~~

~~Table 2-3 — Number of DG units (N) equivalent to FCO~~

~~Type of generation~~	~~Number of units~~									
	~~1~~	~~2~~	~~3~~	~~4~~	~~5~~	~~6~~	~~7~~	~~8~~	~~9~~	~~10+~~
~~Landfill gas~~	~~1~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~3~~	~~3~~	~~3~~	~~3~~
~~CCGT~~	~~1~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~3~~	~~3~~	~~3~~	~~3~~
~~CHP sewage treatment using a spark ignition engine~~	~~1~~	~~2~~	~~3~~	~~4~~	~~4~~	~~5~~	~~5~~	~~6~~	~~6~~	~~7~~
~~CHP sewage treatment using a Gas Turbine~~	~~1~~	~~2~~	~~2~~	~~3~~	~~3~~	~~3~~	~~4~~	~~4~~	~~4~~	~~4~~
~~Waste to energy~~	~~1~~	~~2~~	~~2~~	~~2~~	~~3~~	~~3~~	~~3~~	~~3~~	~~4~~	~~4~~
~~Wind farm~~	~~1 (see NOTE below)~~									
~~Small hydro~~	~~1 (see NOTE below)~~									

~~NOTE: For Intermittent Generation N is assumed to be 1 in all cases because the DNC used to determine the contribution to System Security is the DNC of the complete plant.~~

Table D.2.~~-3~~4 — Recommended values for T_m

P2/7~~6~~ demand class	Switching (see NOTE 2~~1~~ below)	Maintenance	Other outage (see NOTE 3~~2~~ below)
A (FCO)	N/A	N/A	N/A
B (FCO)	15 mins / 3 hours	2 hours	24 hours
C (FCO)	15 mins / 3 hours	18 hours	15 days
D (FCO and SCO) (see NOTE 3 below)	60 s / 3 hours (see NOTE 4 below)	24 hours	90 days
E (FCO and SCO) (see NOTE 3 below)	~~N/A~~60 s	24 hours	90 days

NOTE 1: The~~is table provides~~ recommended values for Tm for the three system conditions ~~that~~ may be applied~~y~~ at the time that an infeed is lost. For example, “Switching” values apply where the DG contribution is only required for the time necessary to reconfigure the system by switching operations.

NOTE 2~~1~~: Switching values for T_m are only appropriate where sufficient Intrinsic network capacity and Transfer Capacity exist, as described in Clauses 6.2 and 6.3 respectively~~s within the times specified in ER P2/6 Table 1~~. 15 mins is only applicable for Class C supply as defined in Table 1 of EREC P2/7 [N1].

NOTE 3~~2~~: Examples of “other outage” are an unplanned outage or an outage as part of a major project.

NOTE 4~~3~~: SCO only applies for demands greater than 100 MW.

NOTE 5~~4~~: FCO only applies where compliance is achieved by automatic demand disconnection of 20 MW or less.

~~B.7~~D.3 Approach 2 – ~~Generic approach~~Using capability factors

This approach is applicable to N~~n~~on-intermittent ~~D~~Generation and offers a more in-depth assessment of the security contribution in comparison Approach 1.

Approach 2 uses the concept of a ‘capacity factor’ which is defined as:

Capacity factor = (DG energy output for the assessment period) / (DG DNC x number of hours in the assessment period)

The capacity factors in Table D.3~~5~~ are based on data collated by Imperial College London [N8] over the period 2013-2018, inclusive.

Commented [RP11]: New Approach 2 is now based on capacity factors. This requires the DNO to determine the capacity factor for the DG being considered

Table D.-3~~5~~ — F factors in % for Non-intermittent Generation for varying capacity factors

Capacity factor range % (NOTE 1)	Period of assessment (NOTE 2)	
	Winter	Summer
Biomass (NOTE 3)		
80-max.	49%	46%
60-80	36%	35%
40-60	26%	29%
20-40	3~~2~~%	6~~9~~%
2-20	0%	0%
Landfill gas		
80-max.	67%	62%
60-80	56%	57%
40-60	47%	50%
20-40	23%	21%
2-20	8~~6~~%	9~~7~~%
Waste		
80-max.	67%	63%
60-80	57%	51%
40-60	43%	40%
20-40	23%	27%
2-20	2~~1~~%	8%

NOTE 1: For DG technology types not listed in this table, it is preferable to seek site specific data to assess the contribution to System Security in accordance with EREP 131 [N2].

NOTE 2: Summer period refers to months May – August inclusive. Winter period refers to months November – February inclusive.

NOTE 3: The data analysis for biomass generators showed that capacity factors may vary more than 20% year to year, for more than 50% of the population. Hence, the F factors have been reduced accordingly to account for the variability. Refer to the report by Imperial College London [N8] for full details of the capacity factors.

NOTE 4: The percentage values in this table are representative of the mean (M) minus 1 standard deviation (SD). Refer to commentary below for further explanation.

~~AUTHOR NOTE 10: Values in table above to be validated against ICL report.This approach is an extension of Approach 1 based on the application of a series of tables and charts rather than the simple tables used in Approach 1. This approach means that the security contribution associated with a greater range of generation and fuel types can be assessed. Specifically Approach 2 can be used in the following situations:for all types of DG for which data is available, not just those types listed in Tables 2-1 or 2-2; or~~

~~where the average availability of the Non-intermittent Generation under consideration is considered to be significantly different to that used to produce Table 2-1 (using the availability values cited in Table 5); or~~

~~where consideration of a value of persistence other than that shown in Table 2-2 is required for Intermittent Generation and there is no reason to doubt that the average availability of the Intermittent Generation under consideration will be significantly different to that used to produce Table 2-2 (using the approach cited in Table 6).~~

~~For Non-intermittent Generation, Approach 2 takes the appropriate DG contribution from Table 2, using values of F selected from Table 3.~~

~~For Intermittent Generation, Approach 2 takes the appropriate DG contribution from Table 2, using values of F from Figure 6.1 for wind farms and from Figure 6.2 for small hydro generation.~~

~~For Non-intermittent Generation where it is necessary for the DG to be Capped the appropriate value of~~ $\cancel{N_1}$ ~~is taken from Table 4 and applied to the formulae in Clause 6.3. For Intermittent Generation the figure to use for~~ $\cancel{N_1}$ ~~is 1 (i.e. the whole plant) in all cases.~~

~~The treatment of non identical units on the same DG site and other DG units within the network is the same as Approach 1.~~

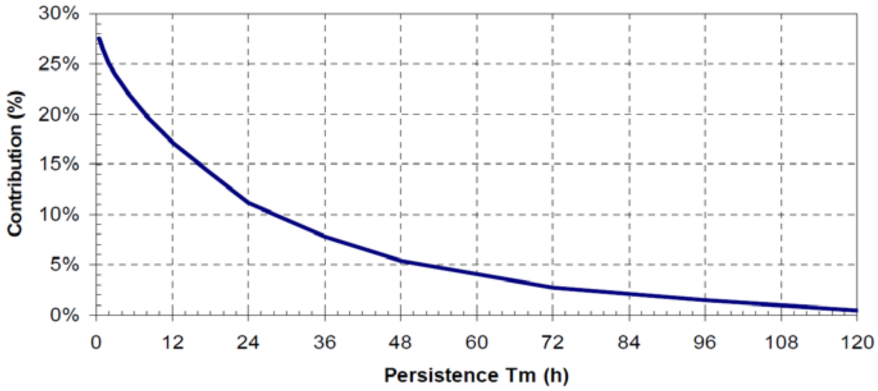
~~Table 3 — F factors in % as function of availability and number of DG units~~

~~Availability (%)~~	~~Number of units~~									
	~~1~~	~~2~~	~~3~~	~~4~~	~~5~~	~~6~~	~~7~~	~~8~~	~~9~~	~~10~~
~~5~~	~~3~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~
~~10~~	~~7~~	~~10~~	~~10~~	~~10~~	~~10~~	~~10~~	~~10~~	~~10~~	~~10~~	~~10~~
~~15~~	~~10~~	~~14~~	~~15~~	~~15~~	~~15~~	~~15~~	~~15~~	~~15~~	~~15~~	~~15~~
~~20~~	~~13~~	~~19~~	~~19~~	~~20~~	~~20~~	~~20~~	~~20~~	~~20~~	~~20~~	~~20~~
~~25~~	~~16~~	~~23~~	~~24~~	~~24~~	~~25~~	~~25~~	~~25~~	~~25~~	~~25~~	~~25~~
~~30~~	~~20~~	~~27~~	~~28~~	~~29~~	~~29~~	~~29~~	~~30~~	~~30~~	~~30~~	~~30~~
~~35~~	~~23~~	~~31~~	~~32~~	~~33~~	~~34~~	~~34~~	~~34~~	~~34~~	~~35~~	~~35~~
~~40~~	~~26~~	~~34~~	~~36~~	~~37~~	~~38~~	~~38~~	~~39~~	~~39~~	~~39~~	~~39~~
~~45~~	~~30~~	~~38~~	~~40~~	~~41~~	~~42~~	~~43~~	~~43~~	~~43~~	~~43~~	~~44~~
~~50~~	~~33~~	~~41~~	~~44~~	~~45~~	~~46~~	~~47~~	~~47~~	~~47~~	~~48~~	~~48~~

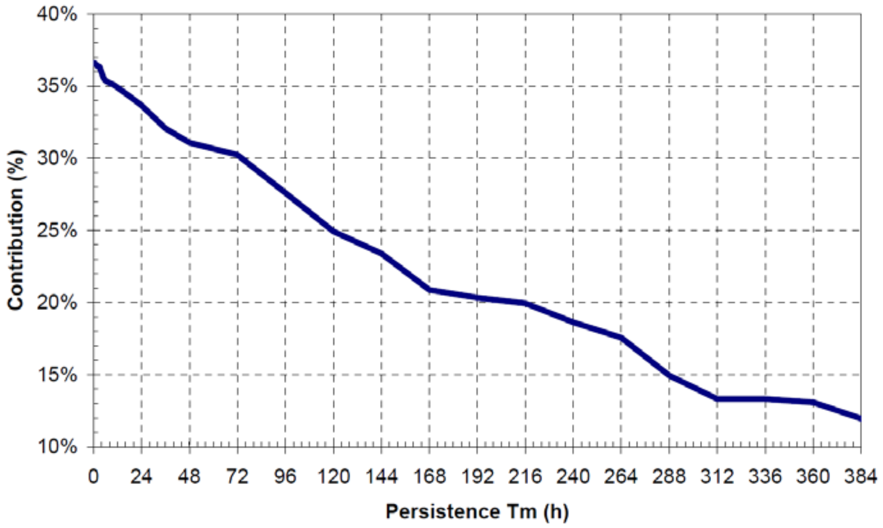
~~55~~	~~36~~	~~45~~	~~47~~	~~49~~	~~50~~	~~50~~	~~51~~	~~51~~	~~52~~	~~52~~
~~60~~	~~40~~	~~48~~	~~51~~	~~52~~	~~53~~	~~54~~	~~55~~	~~55~~	~~56~~	~~56~~
~~65~~	~~43~~	~~51~~	~~54~~	~~56~~	~~57~~	~~58~~	~~59~~	~~59~~	~~60~~	~~60~~
~~70~~	~~46~~	~~54~~	~~58~~	~~60~~	~~61~~	~~62~~	~~63~~	~~63~~	~~64~~	~~64~~
~~75~~	~~50~~	~~57~~	~~61~~	~~63~~	~~65~~	~~66~~	~~67~~	~~68~~	~~68~~	~~69~~
~~80~~	~~53~~	~~61~~	~~65~~	~~67~~	~~69~~	~~70~~	~~71~~	~~71~~	~~72~~	~~73~~
~~85~~	~~58~~	~~64~~	~~69~~	~~71~~	~~73~~	~~74~~	~~75~~	~~75~~	~~76~~	~~77~~
~~90~~	~~63~~	~~69~~	~~73~~	~~75~~	~~77~~	~~78~~	~~79~~	~~79~~	~~80~~	~~80~~
~~95~~	~~69~~	~~74~~	~~78~~	~~80~~	~~82~~	~~83~~	~~84~~	~~85~~	~~87~~	~~88~~
~~98~~	~~75~~	~~79~~	~~82~~	~~85~~	~~89~~	~~92~~	~~92~~	~~93~~	~~94~~	~~94~~

~~Table 4 – Number of DG units (N_1) equivalent to a FCO~~

~~Availability (%)~~	~~Number of units~~									
	~~1~~	~~2~~	~~3~~	~~4~~	~~5~~	~~6~~	~~7~~	~~8~~	~~9~~	~~10~~
~~30~~										
~~35~~										~~9~~
~~40~~								~~7~~	~~8~~	~~9~~
~~45~~							~~6~~	~~7~~	~~8~~	~~8~~
~~50~~						~~5~~	~~6~~	~~7~~	~~7~~	~~8~~
~~55~~						~~5~~	~~6~~	~~6~~	~~7~~	~~7~~
~~60~~					~~4~~	~~5~~	~~5~~	~~6~~	~~6~~	~~7~~
~~65~~					~~4~~	~~4~~	~~5~~	~~5~~	~~6~~	~~6~~
~~70~~				~~3~~	~~4~~	~~4~~	~~4~~	~~5~~	~~5~~	~~6~~
~~75~~				~~3~~	~~3~~	~~4~~	~~4~~	~~4~~	~~5~~	~~5~~
~~80~~			~~2~~	~~3~~	~~3~~	~~3~~	~~4~~	~~4~~	~~4~~	~~4~~
~~85~~			~~2~~	~~2~~	~~3~~	~~3~~	~~3~~	~~3~~	~~4~~	~~4~~
~~90~~			~~2~~	~~2~~	~~2~~	~~2~~	~~3~~	~~3~~	~~3~~	~~3~~
~~95~~		~~1~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~
~~98~~		~~1~~	~~1~~	~~1~~	~~1~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~
~~NOTE: Blank cells apply to 'all units'.~~										



~~Figure 6.1 — F Factors (%) as a function of Persistence T_m for wind farms~~



~~Figure 6.2 — F Factors (%) as a function of Persistence T_m for small hydro~~

~~NOTE 1: The "small hydro" DG plants used to produce Figure 6.2 were all rated below 1 MW with water storage.~~

~~B.8~~D.4 Approach 3 – Computer package approach

This approach uses a computerised model of the methodology which was used to create the tables used in Approaches 1 and 2. It offers the ability to accommodate a wide range of data and assumptions, and permits the underpinning conditions of the other approaches to be relaxed and modified. It is therefore appropriate for special studies and bespoke analyses.

Approach 3 may be used to assess the contribution to security associated with export from from ~~the generation from a~~ Non-Contracted ES.

Approach 3 relies on the DNO obtaining a set of input data. This data could be provided by the Generator or from other sources, such as the DNOs own records. The exact details of the data required and how to use the analysis package are described in EREP 131 [N2~~5~~]. The package is implemented in Microsoft Excel ® using the VBA environment and is available from the Energy Networks Association (ENA). The package calculates the security contributions from DG ~~only~~ and can be used for assessing for compliance with EREC P2/7~~6~~ [N1] in the same way as performed with either of the two previous approaches.

Annex E
(informative)

Influencing factors for DG Contribution

~~B.9~~E.1 ~~Generation~~ DG availabilities

~~The values cited in ER P2/6 [N1] for the effective contribution to System Security, as afforded by different types of modern DG plant, were derived from analysis (see [N3]) based on the historic performance of a small number of sampled plants. The analysis showed that the availability can vary significantly across the different types of plant and in some cases for different plants of the same type. In some cases a wide range of availabilities was observed. In other cases, although the range was narrow, the sample size was very small. The observed ranges of availabilities for Non-intermittent Generation (as used in [N3]) are shown in Table 5 below. The approach taken to determining average availabilities for Intermittent Generation is shown in Table 6.~~

E.1.1 General

The considerations in this Annex are relevant to both Contracted and ~~non-contracted~~Non-Contracted DG.~~Other aspects need to be considered, such as history of the availability, and whether this provides an accurate forecast of future availability, or indeed, the treatment of new plant where no history exists. Although it is preferable to use data specific to a particular plant, or similar plant operated in a similar manner, this may not be possible in practical terms because of paucity of data. In such cases use of generic data becomes necessary.~~

The contribution to capacity, stipulated in a contract with the DG, may be informed by the considerations in this Annex.

~~It may be acceptable to use the average availability from DG of a similar type to that which has been determined in the recent research referred to above and used in the preparation of Table 2 (and associated sub-tables) in ER P2/6 [N1]. Table 2-1 shows the type of generation split into 'high confidence' and 'sparse data' sub-groups. Landfill gas and sewage gas fuelled reciprocating engine CHP availabilities are based on good quality data, and these figures can be used with confidence. For the other generation types, the available data was sparse, and so the confidence in the average availability figures is lower.~~

~~It is recommended that the DNO should use t~~The F factors in Tables D.2~~2.~~-1 and D.2.2 are based on data taken from DG which is considered typical or average~~ and the availability~~. ~~values in Table 5 as the first indicator of the security contribution from DG plant connected to a specific network. For the high-confidence generation types (landfill gas and sewage gas CHP), where compliance is marginal, a closer examination of the specific availability would be required. For the 'sparse data' group, the average availabilities should be used as an initial check of contribution, and if possible better quality site-specific data should be sought.~~

When undertaking a site specific assessment of DG contribution, the DNO may be aware of issues affecting the average expected reliability of the facility~~Where measured data is available from a specific DG plant and is used to assess the observed availability, this should be checked against the~~: ~~-~~technical, commercial and fuel availability considerations described below may be relevant.~~ to ensure that the measured availability is sustainable for the timeframe being considered.~~ These considerations may also be relevant for new

~~The case of new~~ DG~~ plant~~ connecting to the ~~system~~ network ~~raises different issues as~~with no prior history~~ of overall availability will be available for the specific plant. The DNO will need to~~

Commented [TCL12]: Content taken from Issue 2 Clauses 6.2, 6.7, 6.8, 6.9

Commented [TCL13]: Majority of content deleted as no longer relevant (see Crib List item 3).

~~consider whether the plant is likely to fall into a range of performance that allows an average availability figure to be used~~.

~~If the plant type is well understood, technical availability may be judged. Fuel sources and commercial operation may be predictable. If these elements of overall availability cannot be assessed with some confidence, the DNO may choose a more conservative overall availability figure until some history can be developed, and/or seek to secure a desired availability through contract with the Generator.~~

Operation over the first year or two of a new DG facility could ~~then~~ be used to confirm the appropriateness of using the F-factors in Tables D.2.1 and D.2.2~~initial availability values~~.

~~Table 5 — Average availabilities for Non-intermittent Generation~~

~~**Non-intermittent Generation**~~	~~**Number of sampled sites**~~	~~**Range of availability %**~~	~~**Average availability %**~~
~~Landfill gas~~	~~32~~	~~60-99~~	~~90~~
~~CCGT~~	~~1~~	~~90~~	~~90~~
~~CHP sewerage treatment, spark ignition~~	~~16~~	~~35-85~~	~~60~~
~~CHP sewerage treatment, GT~~	~~4~~	~~60-99~~	~~80~~
~~Waste to energy~~	~~5~~	~~Wide (see NOTE below)~~	~~85~~

~~NOTE: From the Data Collection Report [N3]:~~

~~The performance of these plants shows a wide variation. The best plants may offer relatively high % of DNC when operating (planned down time (5%) and forced outages (usually related to municipal and industrial waste (MIW) handling) causes a further 15% downtime). At the other extreme, outages of several months can occur.~~

~~On the basis of the evidence gathered to date, it is difficult to suggest that any general guide about performance can be relied upon for planning purposes unless evidence of performance is available. It may be that evidence of site specific performance could be used to establish actual contributions. As an example it may then be reasonable to operate with the expectation that such plant could make 80% DNC delivery with a planned outage rate of two weeks per year and a forced outage rate of 1 week per year.~~

~~**Table 6 — Approach to average availabilities for Intermittent Generation**~~

~~**Intermittent Generation**~~	~~**Output profile (see NOTE 2 below)**~~
~~Wind~~	~~Average 6-month winter profile for three sites~~ ~~½ h and 1 min resolutions~~
~~Small Hydro~~	~~Average 6-month winter profile for three sites~~ ~~½ h resolution~~

~~NOTE 1: Values of T_m used in the approaches shown in Table 6: ½, 2, 3, 18 and 24 h, 5 days, and more than 5 days.~~

~~NOTE 2: Output profile – this describes the criteria used in [N3] to determine the average availability of Intermittent Generation plants to determine the F factors in Table(s) 2-2 and the graphs shown in Figures 6.1 and 6.2.~~

~~The overall average availability can be considered as the product of three specific elements: technical availability, fuel source availability and commercial availability. Each can be considered as 100% if fully available, providing a 100% overall availability. However, it will generally be difficult to separate out the three elements for a given plant, as was found in the data collection exercise (see [N3]), and an assessment will need to be made as to the level of the overall availability based on the observed output from the DG plant.~~

~~B.9.1~~E.1.2 Technical availability

Technical availability is constrained by planned or unplanned outages of the DG facility~~plant~~.

It can be ~~separately~~ observed that where the operator ~~Generator~~ allows the DG facility~~plant~~ to run continuously with full fuel being available, a good example being landfill gas, m~~.~~ ~~M~~odern DG ~~plant~~ demonstrates generally very high technical availability~~, often greater than the 86% figure that was used in the derivation of ER P2/5~~.

~~B.9.2~~E.1.3 Fuel source availability

Fuel source availability can be constrained by any restrictions in the primary energy source preventing the DG facility~~plant~~ from achieving expected output over any time period. The impact of fuel source constraints is greatest where the DG ~~plant~~ facility has high technical and commercial availability but where fuel is limited or variable. Wind farms are an obvious example of this.

Landfill Gas is also a good example, where there may be high technical availability and continuous running to burn off the gas. However, the output may be limited by the absolute fuel availability with, say, a 1.5 MW unit having a continuous output constrained at 1 MW.

Some plant, such as CCGT installations, will have interruptible gas supplies, and where invoked, would reduce the fuel availability element of the overall availability.

~~B.9.3~~E.1.4 Commercial availability

Commercial availability can be considered as being the result of the ~~Generator~~ operator choosing, for financial reasons, to run their plant below full output or to take the plant off-line for any time period.

For example, the primary factor normally influencing the running of a CHP plant, and hence its commercial availability, will be the need to provide heat for a process on the same site. This may result in export to the system only being available when process demand falls, and in the plant being taken off-line for periods within a 24 hr cycle. In this case the implications associated with estimation of Group Demand must be taken into account.

Similarly, CCGT plant is observed to have high technical availability, typically above 90%, together with good fuel availability. However, when operated as a merchant DG ~~plant~~ facility with its main objective being to meet energy contracts, or provide energy balancing services, the availability of its full output is under the control of the ~~Generator~~ o~~O~~perator and will be varied for purely commercial reasons.

~~B.10 Generation operating regime at maximum demand~~

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~~The operating régime of DG plant(s) at the time of Group Demand must be ascertained, e.g. whether it operates for 8 h or 12 h or whether it is continuously operated. Where the DG operates for at least 8 (or 12 h) the appropriate values for F in Table 2 can be applied. In the case of restricted operating times, it is assumed that the increasing demand at the start-up time is the same as the decreasing demand at shut-down time. If this is not so, then the contribution may be less than the approach suggests. In the extreme, if the operating period does not span the peak demand at all, the contribution from such generation is zero.~~

~~If the operating times are restricted, special studies will be required. Refer to EREP 131 [N5] for guidance.~~

~~B.11~~E.2 Remote generation

When assessing the security contribution from a DG facility that is electrically remote from the point on the network where the contribution is ~~traditionally~~ being assessed (e.g. the infeed substation busbars), the key issue relates to the reliability of the network assets between the DG facility and the network point where a security contribution is required; this may~~will~~ affect the actual contribution from the DG facility. ~~However, t~~This effect ~~has been taken account of in the probability analysis within the agreed methodology (see [N2]) and~~ need not be considered further unless there is particular reason to believe that the availability of the network assets is significantly less than that for a typical network.

Hence, if a DG ~~plant~~ facility is considered to be above the de-minimis level, then it should not be considered as being ‘too remote’ to provide a security contribution to a particular network and the security contribution should be assessed in accordance with the assessment procedures described in this report.

~~B.12~~E.3 Intermittent Generation and selection of T_m

Table 1 of EREC P2/7~~6~~ [N1] requires that some or all demand (depending on class of supply) should be restored within 15 mins or 3 hrs, or after the time to repair. Therefore, when looking to include a security contribution from DG facility a necessary part of the assessment process will be to ensure that the DG facility can contribute in the required restoration time and continue to contribute for the repair time or until demand transfers are effected. For example, following a forced FCO for a Group Demand in Class C, any contribution must be initially available in 15 min as required in Table 1 of EREC P2/7~~6~~ [N1]), and fully available by 3 hrs. Once available, it is assumed that the DG needs to remain available for the duration of the forced outage, which for Class C is assumed to be 15 days, based on an emergency repair time for a 132 kV transformer, or until sufficient Transfer Capacity can be made available.

NOTE: The considerations in the paragraph above are also relevant for DSR Schemes and ES.

Different values of T_m might be appropriate depending on network configuration and worst case repair time. Indicative values for T_m are shown in Table D.2.~~-3~~4 in Annex D~~Clause 5 above~~.

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Annex F
(informative)

Examples

F.1 Group Demand example

This example is intended to demonstrate the calculation of Group Demand.

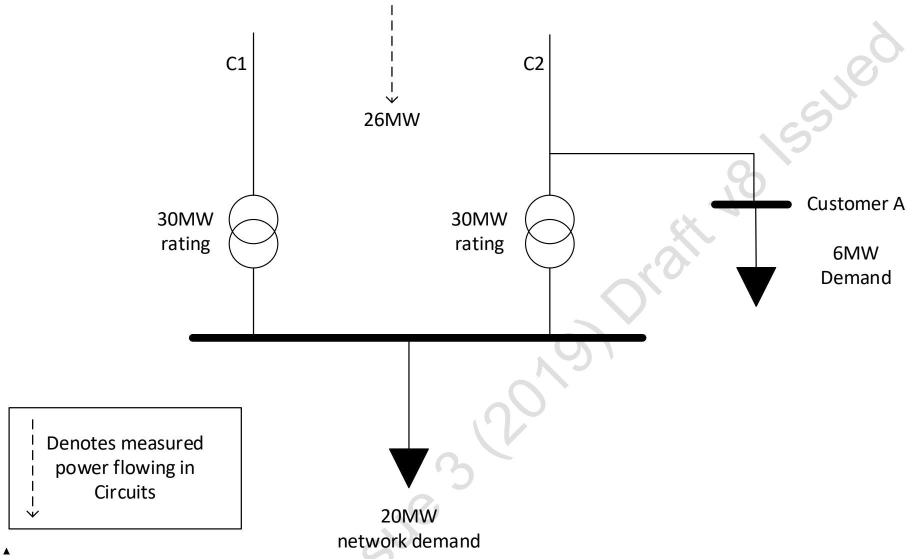

Figure F.1 – Establishing Group Demand

a) Determine Group Demand

i. Measured Demand = 26 MW

ii. Latent Demand

Contracted DG/DSR Schemes/ES – none

~~Non-contracted~~Non-Contracted DG/DSR Schemes/ES – none

iii. Cold Load Pickup = 0 MW

iv. Group Demand = 26 MW (Class C)

b) Determine Network Capacity

i. Intrinsic network capacity

FCO capacity = 30 MW, available immediately. (From Table 1 of EREC P2/7 [N1] under an FCO, there is a requirement to secure partial demand within 15 mins and all demand within 3 hrs, except Customer A who has agreement to a single circuit supply. The FCO capacity of 30 MW is sufficient to meet the Group Demand of 26 MW).

SCO capacity = 0 MW. (From Table 1 of EREC P2/7 [N1] under a SCO, there is no requirement to secure any demand).

The intrinsic network capacity of 30 MW under an FCO is sufficient to meet the 26 MW of Group Demand. There is no requirement to consider Transfer Capacity or contribution from DG/DSR Schemes/ES.

Given that intrinsic network capacity is greater than Group Demand: the system is compliant with Table 1 of EREC P2/7 [N1], regardless of an outage on Circuit C1 or C2. Note that for an outage of Circuit C2 (3-ended circuit), the supply to Customer A is considered to be immediately restored following an outage of the Circuit C2: the agreed single circuit connection agreement is equivalent to a DSR arrangement which is activated during loss of the Circuit C2 (see EREC P2/7 [N1] Table 1 note on 'minimum demand to be met').

F.2 Transfer Capacity

This example is intended to demonstrate consideration of Transfer Capacity (see F.6.1 and F.7.2 for other examples).

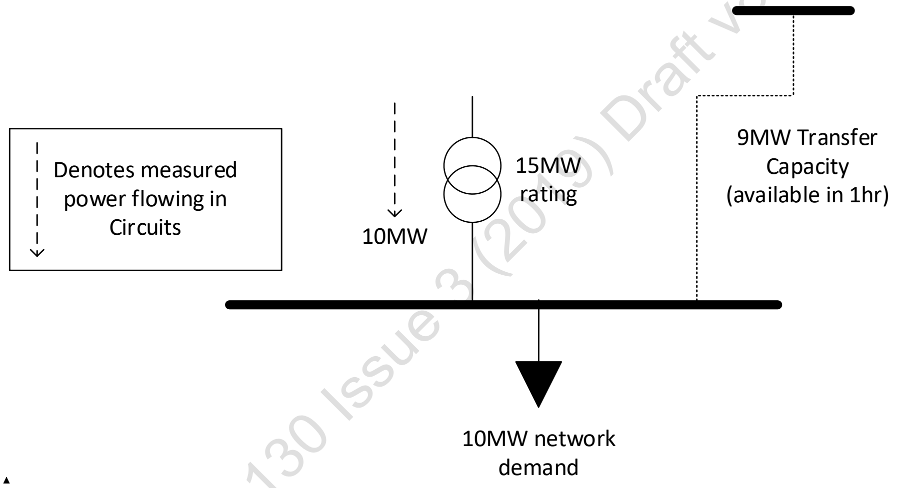

Figure F.2 – Transfer Capacity example

a) Determine Group Demand

i. Measured Demand = 10 MW

ii. Latent Demand

Contracted DG/DSR Schemes/ES – none

~~Non-contracted~~Non-Contracted DG/DSR Schemes/ES – none

iii. Cold Load Pickup = 0 MW

iv. Group Demand = 10 MW (Class B)

b) Determine Network Capacity

i. Intrinsic network capacity

FCO capacity = 0 MW (from Table 1 of EREC P2/7 [N1] under an FCO, Class B requires restoration for Group Demand minus 1 MW [9 MW] of

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demand within 3 hrs and restoration of the remaining demand within repair time

SCO capacity = 0 MW (from Table 1 of EREC P2/7 [N1] under a SCO, there is no requirement to secure any demand).

The intrinsic network capacity is insufficient to meet the requirements of EREC P2/7 [N1] and it is necessary to consider the Transfer Capacity.

ii. Transfer Capacity = 9 MW available within 1 hr under an FCO (and SCO)

In conclusion, the total System Security capacity under an FCO is 9 MW, available within 1 hr, which is sufficient for a Class B supply (the remaining 1 MW is restored in repair time). The distribution system is compliant with Table 1 of EREC P2/7 [N1]. For further development of this example, refer to F.5.1.

F.3 Contracted DG example

This example demonstrates how the System Security of, a distribution system containing DG which is contracted with the DNO, should be assessed.

An DG has a DNC of 8 MW and operates to an agreed contract with the DNO. The contract requires the DG to export 5 MW at an agreed time of the day.

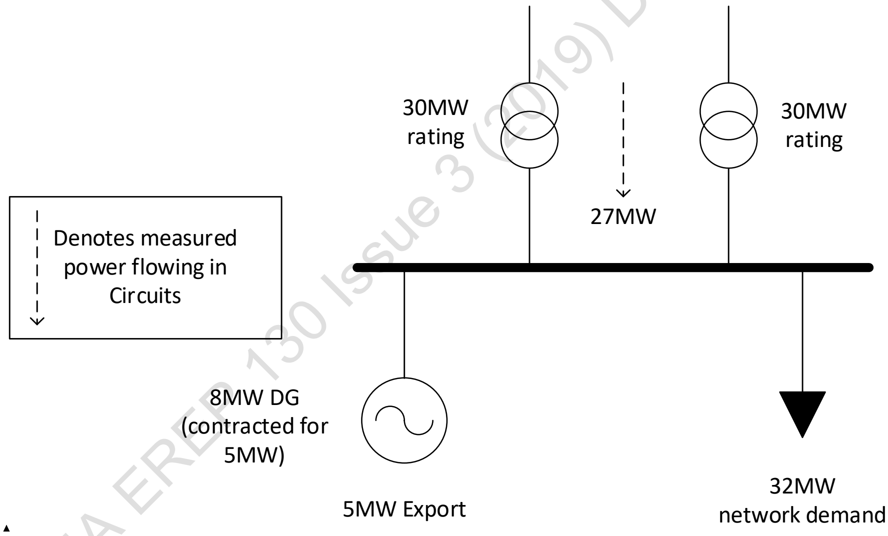

Figure F.3 – Contracted DG example

a) Determine Group Demand

i. Measured Demand = 27 MW

ii. Latent Demand

Contracted DG/DSR Schemes/ES – 5 MW (export from contracted DG)

Non-Contracted DG/DSR Schemes/ES – none

iii. Cold Load Pickup = 0 MW

iv. Group Demand = 32 MW (Class C)

b) Determine Network Capacity

i. Intrinsic network capacity

FCO capacity = 30 MW, available immediately. (From Table 1 of EREC P2/7 [N1] under an FCO, there is a requirement to secure partial demand within 15 mins and all demand within 3 h).

SCO capacity = 0 MW. (From Table 1 of EREC P2/7 [N1] under a SCO, there is no requirement to secure any demand).

The intrinsic network capacity of 30 MW under an FCO is insufficient to meet the 32 MW of Group demand i.e. there is a deficiency of 2 MW.

ii. Transfer Capacity = 0 MW available under an FCO or SCO

Given that Group Demand is greater the intrinsic network capacity and no Transfer Capacity is available, there is a deficiency in System Security of 2 MW. Hence, it is now necessary to consider contribution to security from other means: DG/DSR Schemes/ES.

iii. Security contribution from contracted DG = 5 MW, available immediately (the DG contract stipulates the contribution and includes a requirement to remain connected under a fault forming the FCO. The DG is not designed to run in island mode and hence, there is no contribution under an SCO).

The total System Security capacity under an FCO is 35 MW, compared to a Group Demand of 32 MW. There is no requirement to secure demand under an SCO. The distribution system is compliant with Table 1 of EREC P2/7 [N1].

F.4 Contracted DSR Scheme

The following examples demonstrates how the System Security of, a distribution system containing a DSR Scheme which is contracted with the DNO, should be assessed.

F.4.1 Constrained import

Customer A consists of a 5 MW Demand facility, whose connection agreement with the DNO stipulates that their load (import) is constrained to 2 MW at the time of peak demand on the distribution system.

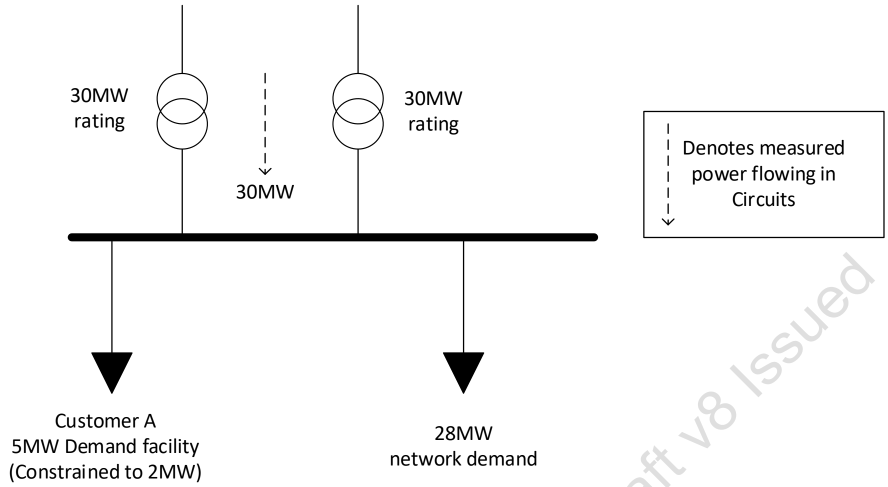

Figure F.4.1 – Constrained import

a) Determine Group Demand

i. Measured Demand = 30 MW

ii. Latent Demand

Contracted DG/DSR Schemes/ES – 3 MW (The DNO is aware, from specific load information, that Customer A 'would like' 5 MW at the time of peak load. Since the DSR Scheme is active it is constraining Customer A import to 2 MW).

~~Non-contracted~~Non-Contracted DG/DSR Schemes/ES – none

iii. Cold Load Pickup = 0 MW

iv. Group Demand = 33 MW (Class C)

b) Determine Network Capacity

i. Intrinsic network capacity

FCO capacity = 30 MW, available immediately. (From Table 1 of EREC P2/7 [N1] under an FCO, there is a requirement to secure partial demand within 15 mins and all demand within 3 hrs).

SCO capacity = 0 MW. (From Table 1 of EREC P2/7 [N1] under a SCO, there is no requirement to secure any demand).

The intrinsic network capacity of 30 MW under an FCO is insufficient to meet the 3~~2~~3 MW of Group demand i.e. there is a deficiency of ~~2~~3 MW.

ii. Transfer Capacity = 0 MW available under an FCO or SCO

Given that Group Demand is greater than the intrinsic network capacity and no Transfer Capacity is available, there is a deficiency in System Security of 3 MW. Hence, it is now necessary to consider contribution to security from other means: DG/DSR Schemes/ES.

iii. Security contribution from contracted DSR Scheme = 3 MW, available immediately under an FCO.

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In conclusion, the total System Security capacity under an FCO is (30+3) MW, compared to a Group Demand of 33 MW. There is no requirement to secure demand under an SCO. The distribution system is compliant with Table 1 of EREC P2/7 [N1].

F.4.2 Intertripping arrangement

Customer A consists of a 5 MW Demand facility, whose connection agreement with the DNO stipulates that the supply is automatically tripped during an outage of either feeding Circuit. Hence, Customer A can import 5 MW whilst the system is intact but they would be disconnected in the event of an FCO.

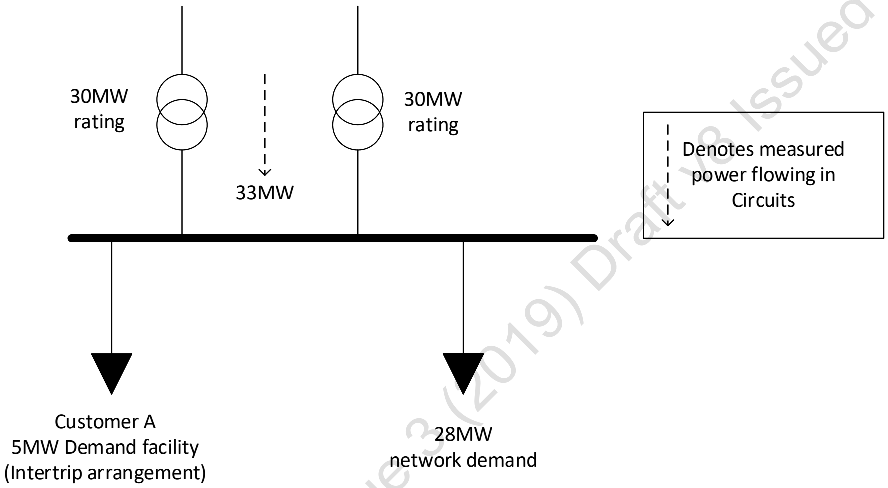

Figure F.4.2 – Intertripping arrangement

a) Determine Group Demand

i. Measured Demand = 33 MW (this includes 5 MW load to Customer A)

ii. Latent Demand

Contracted DG/DSR Schemes/ES – none i.e. the intertripping arrangement is not actively managing Customer A's demand in an intact system and hence there is no Latent Demand.

~~Non-contracted~~Non-Contracted DG/DSR Schemes/ES – none

iii. Cold Load Pickup = 0 MW

iv. Group Demand = 33 MW (Class C)

b) Determine Network Capacity

i. Intrinsic network capacity

FCO capacity = 30 MW, available immediately. (From Table 1 of EREC P2/7 [N1] under an FCO, there is a requirement to secure partial demand within 15 mins and all demand within 3 hrs).

SCO capacity = 0 MW. (From Table 1 of EREC P2/7 [N1] under a SCO, there is no requirement to secure any demand).

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The intrinsic network capacity of 30 MW under an FCO is insufficient to meet the 33 MW of Group demand i.e. there is a deficiency of 3 MW.

ii. Transfer Capacity = 0 MW available under an FCO or SCO

Given that Group Demand is greater than the intrinsic network capacity, and no Transfer Capacity is available, it is now necessary to consider contribution to security from other means: DG/DSR Schemes/ES.

iii. Security contribution from contracted DSR Scheme = 5 MW, available immediately under an FCO (Customer A tripped under an FCO).

The total System S~~s~~ecurity contribution capacity is 35 MW compared to a Group Demand of 33 MW; hence the system is compliant with Table 1 of EREC P2/7 [N1].

F.4.3 Active Network Management (ANM) system

Customer A consists of a 2 MW Demand Facility and Customer B consists of a 3 MW Demand Facility. The import by A and B are monitored and controlled by the same ANM system. The DNO's connection agreements with A and B stipulate that the load (import) is constrained to ensure the summated demand of both Customers (A+B) is not greater than 2 MW at the time of peak demand on the distribution system.

Figure F.3.3 depicts the power flows at the time of peak demand: it is assumed by the DNO that both Customers A and B wish to import their maximum demand (5 MW combined) but are constrained to 2 MW by the ANM i.e. ~~maximum~~the Latent Demand is assumed to be the maximum value of 3 MW. An alternative approach is for the DNO to assess the load profiles of Customer A and B and determine if both Customers actually require their maximum allowance at the time of peak i.e. diversified Latent Demand (see Annex A.1).

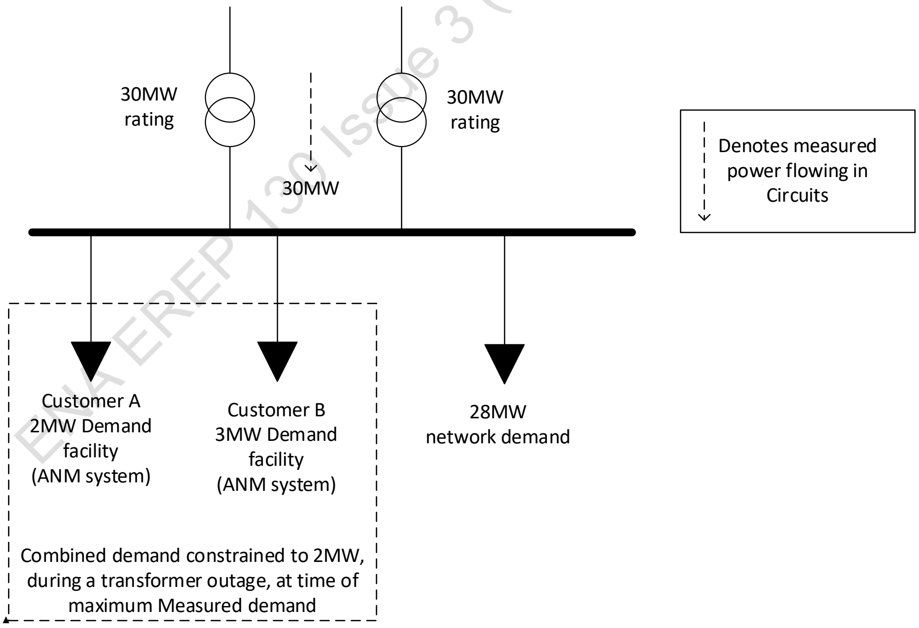

Figure F.4.3 – A~~M~~NM system

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a) Determine Group Demand

i. Measured Demand = 30 MW

ii. Latent Demand

Contracted DG/DSR Schemes/ES – 3 MW i.e. the ANM system is actively managing Customer A and B's demand and constraining to 2 MW, from an assumed maximum of 5 MW.

~~Non-contracted~~Non-Contracted DG/DSR Schemes/ES – none

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iii. Cold Load Pickup = 0 MW

iv. Group Demand = 33 MW (Class C)

b) Determine Network Capacity

i. Intrinsic network capacity

FCO capacity = 30 MW, available immediately. (From Table 1 of EREC P2/7 [N1] under an FCO, there is a requirement to secure partial demand within 15 mins and all demand within 3 hrs).

SCO capacity = 0 MW. (From Table 1 of EREC P2/7 [N1] under a SCO, there is no requirement to secure any demand).

The intrinsic network capacity of 30 MW under an FCO is insufficient to meet the 33 MW of Group demand i.e. there is a deficiency of 3 MW.

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ii. Transfer Capacity = 0 MW available under an FCO or SCO

Given that Group Demand is greater the intrinsic network capacity, and no Transfer Capacity is available, it is now necessary to consider contribution to security from other means: DG/DSR Schemes/ES.

iii. Security contribution from contracted DSR Scheme = 3 MW, available immediately under an FCO (Customer A and B constrained prior to an FCO event).

The total System Security contribution capacity is 33 MW compared to a Group Demand of 33 MW; hence the system is compliant with Table 1 of EREC P2/7 [N1].

F.4.4 Import constraint vs. operating regime

Two Demand Facilities (Customer A and B) each have a constraint imposed on their import via a contract with the DNO i.e. contracted DSR Scheme. The constraint applies at an agreed time of day.

The contracts have been in place for a number of years – the Demand Facilities are not necessarily operating as originally envisaged by the contracts.

The DNO is closely monitoring the import for each Customer, i.e. the DNO has an understanding of the operating regime at each Demand Facility. Hence, the DNO has sufficient information to undertake a detailed assessment of Latent Demand. The two customers are operating at the time of the Measured Demand as described in Table F.4.4.1.

Table F.4.4.1 —– Demand Facilities' operating regimes

Customer	Demand Facility operation
A	Importing 1.5 MW (DNO is aware that the Customer does not require any more import at the time of Measured Demand)
B	Importing 0 MW (DNO is aware that the Customer has changed its production and no longer runs plant at the time of Measured Demand)

The DNO has two options:

- Option 1: Treat the assessment of Latent Demand based on the measured data for Customers A and B. This assumes that the measured data is sufficiently reliable to reflect the operating regime of Customer A and B going forward; or
- Option 2: Treat the assessment of Latent Demand based on the contract it has with Customers A and B.

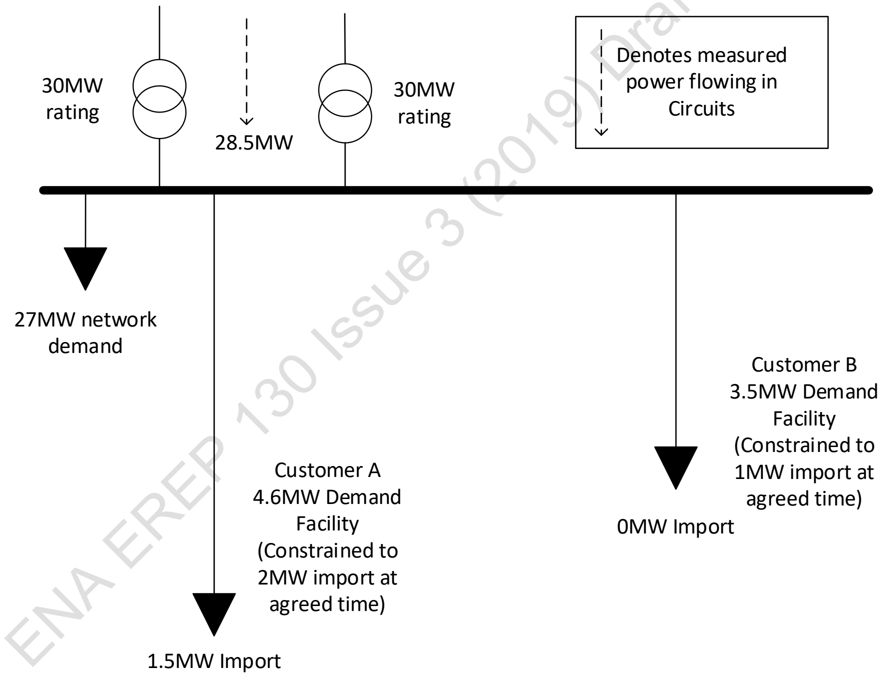

Figure F.4.4 —– DSR Scheme contracts

Instead of examining a thorough step-by-step assessment for Option 1 and Option 2, as for other examples, a summary of the Group Demand calculation and the contribution to security is compared in Table F.4.4.2.~~Non-Contractedi regarding these two scenarios:: the assessed security contribution, in accordance with EREP 131 would probably be significantly lower than 2MW~~

Field Code Changed

Table F.4.4.2 —– Summary comparison of Options 1 & 2

	Option 1	Option 2
Group Demand	28.5 + 0(A) + 0(B) = 28.5 MW	28.5 + 3.1(A) + 3.5(B) = 35.1 MW
Security Contribution	30 + 0 = 30 MW	30 + 2.6(A) + 2.5(B) = 35.1 MW
	Option 1 assessment allows the DNO to re-allocate the 1.5 MW of capacity which Customer A and B were originally expected to take when constrained. There are obviously risks to this approach as the Customers could change their operating regime. To address this risk, this may prompt the DNO to re-evaluate the contracts.	Option 2 assessment proves that the worst-case outcome works, i.e. the reason for the contracts.

F.5 Contracted ES

F.5.1 Export contract

An ES facility consists of 5 MW of installed battery storage and operates to an agreed contract with the DNO. The contract requires the ES facility to export 5 MW at an agreed time of the day.

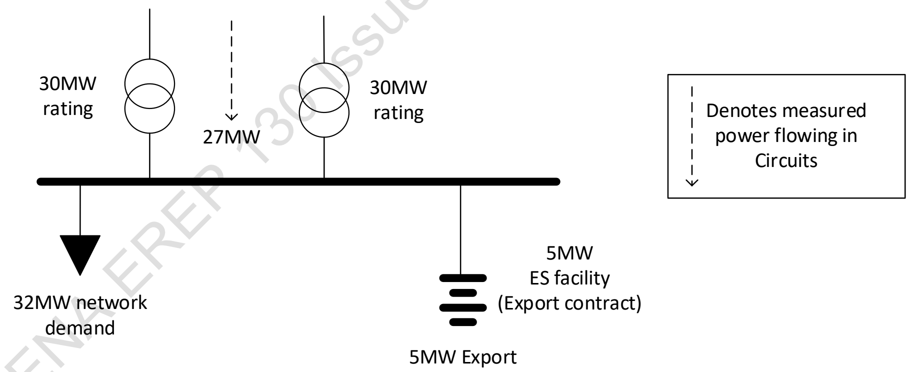

Figure F.5.1 – ES export contract

a) Determine Group Demand

i. Measured Demand = 27 MW

ii. Latent Demand

Contracted DG/DSR Schemes/ES – 5 MW (export from ES).

~~Non-contracted~~Non-Contracted DG/DSR Schemes/ES – none

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iii. Cold Load Pickup = 0 MW

iv. Group Demand = 32 MW (Class C)

b) Determine Network Capacity

i. Intrinsic network capacity

FCO capacity = 30 MW, available immediately. (From Table 1 of EREC P2/7 [N1] under an FCO, there is a requirement to secure partial demand within 15 mins and all demand within 3 hrs).

SCO capacity = 0 MW. (From Table 1 of EREC P2/7 [N1] under a SCO, there is no requirement to secure any demand).

The intrinsic network capacity of 30 MW under an FCO is insufficient to meet the 32 MW of Group demand i.e. there is a deficiency of 2 MW.

ii. Transfer Capacity = 0 MW available under an FCO or SCO

Given that Group Demand is greater the intrinsic network capacity and no Transfer Capacity is available, there is a deficiency in System Security of 2 MW. Hence, it is now necessary to consider contribution to security from other means: DG/DSR Schemes/ES.

iii. Security contribution from contracted ES = 5 MW, available immediately (the ES contract stipulates the contribution and includes a requirement to remain connected under a fault forming the FCO. The ES is not designed to run in island mode and hence, there is no contribution under an SCO).

The total System Security capacity under an FCO is 35 MW, compared to a Group Demand of 32 MW. There is no requirement to secure demand under an SCO. The distribution system is compliant with Table 1 of EREC P2/7 [N1].

F.5.2 Import contract vs. operating regime

Three ES facilities (Customer A, B and C) consist installed battery storage. The import by each ES is constrained, via contracts with the DNO, to 3 MW at an agreed time of day. The contracts with the DNO do not stipulate an export requirement.

The contracts have been in place for a number of years – the ES facilities are not necessarily operating as originally envisaged by the contracts.

The DNO is closely monitoring the export and import from each ES, i.e. the DNO has an understanding of the operating regime at each ES facility. Hence, the DNO has sufficient information to undertake a detailed assessment of Latent Demand. The three customers are operating at the time of the Measured Demand as described in Table F.5.2.1.~~ with the DNOwith the DNO~~

Table F.5.2.1 – ES operating regimes

Customer	ES operation
A	Importing 3 MW (DNO is aware that the ES would like to import 7 MW at the time of Measured Demand)
B	Importing 0 MW (DNO is aware that the ES has changed its operating regime and is no longer charging/discharging at the time of Measured Demand) NOTE 1
C	Exporting 2 MW (DNO is aware that the ES has changed operating regime from import to export at the time of Measured Demand)
NOTE 1: For an ES facility that is energised but not importing or exporting i.e. not	

charging/discharging, the DNO would expect a nominal current to be present.

The DNO has two options:

- Option 1: Treat the assessment of Latent Demand based on the measured data for Customers A, B and C. This assumes that the measured data is sufficiently reliable to reflect the operating regime of Customer A, B and C going forward; or
- Option 2: Treat the assessment of Latent Demand based on the contract it has with Customers A, B and C.

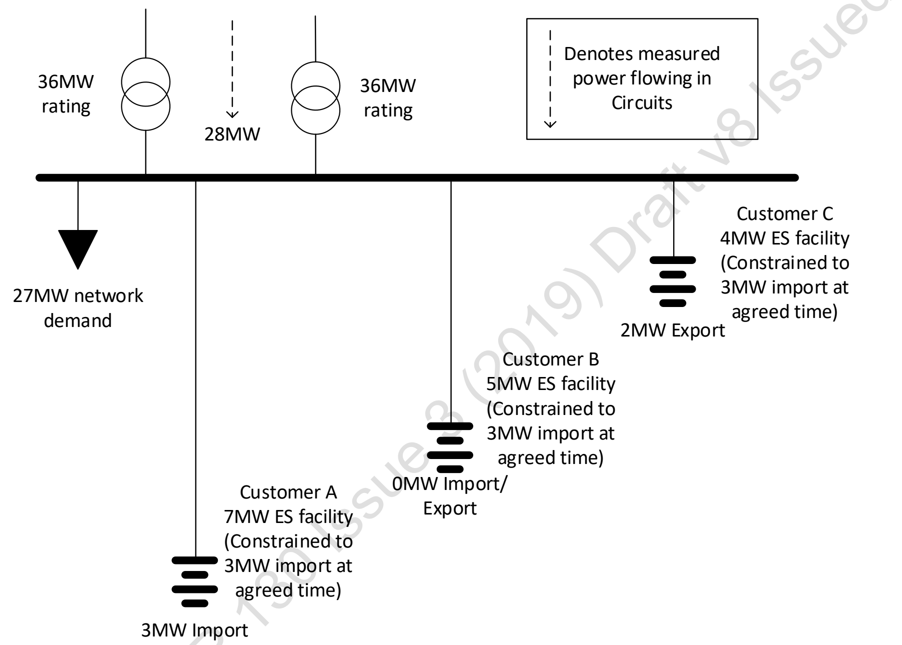

Figure F.5.2 – ES import only contract

Instead of examining a thorough step-by-step assessment for Option 1 and Option 2, as for other examples, a summary of the Group Demand calculation and the contribution to security is compared in Table F.5.2.2.~~Non-Contractedi regarding these two scenarios:: the assessed security contribution, in accordance with EREP 131 would probably be significantly lower than 2MW~~

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Table F.5.2.2 –– Summary comparison of Options 1 & 2

	Option 1	Option 2
Group Demand	28 + 4(A) + 0(B) + 2(C) = 34 MW	28 + 4(A) + 5(B) + 6(C) = 43 MW NOTE 1
Security Contribution	36 + 4 (A) = 40 MW NOTE 2	36 + 4(A) + 2(B) + 1(C) = 43 MW NOTE 2
	Option 1 assessment allows the DNO to re-allocate the 6 MW of capacity which Customer B and C were originally expected to take when constrained. There are obviously risks to this approach, as the Customers could change their operating regime. To address this risk This may prompt the DNO to re-evaluate the contracts.	Option 2 assessment proves that the worst-case outcome works, i.e. the reason for the contracts.

NOTE 1: The worst case for the ES at Customer C is 'changing' its normal operation at the time of Measured Demand from export to import within the DNO's network planning period. Hence, worst case Latent Demand is 6 MW.

NOTE 2: The ES at Customer C is exporting 2 MW outside of a contract with the DNO. Hence, any security contribution would be based on an analysis using EREP 131, which would be lower than 2 MW. It is assumed to be 0 MW.

F.6 ~~Non-contracted~~Non-Contracted ES

F.6.1 New ES connection consideration

A DNO is considering a connection application for an ES facility which will consist of 3 MW of storage and requires to charge (import) full capacity at the time of distribution system peak demand. Prior to ES connection, the network is as shown in Figure F.2. The expected arrangement with the ES facility connected is shown in Figure F.6.1.

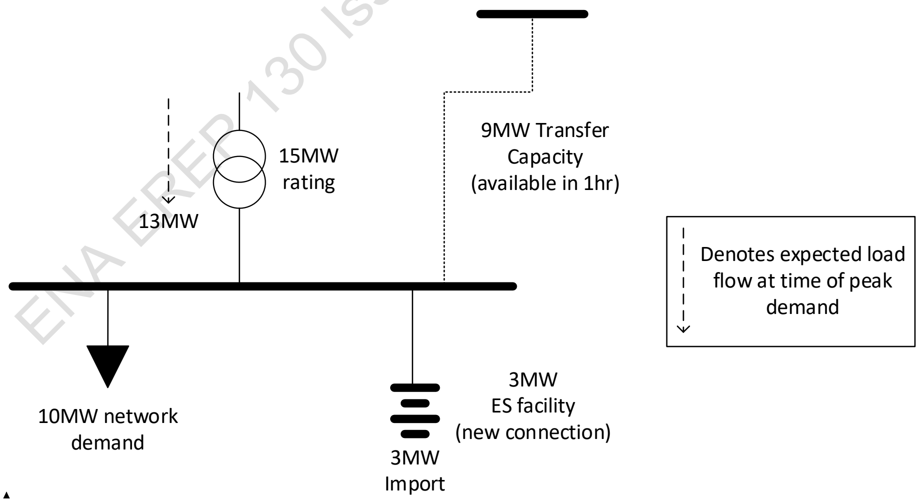

Figure F.6.1 – New ES connection consideration

a) Determine Group Demand

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i. Measured Demand = 13 MW (expected at time of maximum demand after ES connection)

ii. Latent Demand

Contracted DG/DSR Schemes/ES – none

~~Non-contracted~~Non-Contracted DG/DSR Schemes/ES – none

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iii. Cold Load Pickup = 0 MW

iv. Group Demand = 13 MW (Class C)

b) Determine Network Capacity

i. Intrinsic network capacity

FCO capacity = 0 MW. (From Table 1 of EREC P2/7 [N1] under an FCO, there is a requirement to secure ‘the smaller of Group Demand - 12 MW or 2/3 Group Demand’, i.e. 1 MW within 15 mins and all demand within 3 hrs).

SCO capacity = 0 MW. (From Table 1 of EREC P2/7 [N1] under a SCO, there is no requirement to secure any demand).

The intrinsic network capacity of 0 MW under an FCO is:

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- insufficient to meet the 15 mins requirement to restore 1 MW, i.e. there is a deficiency of 1 MW.
- insufficient to meet the 3 hrs requirement to restore Group Demand (13 MW), i.e. there is a deficiency of 13 MW.

ii. Transfer Capacity = 9 MW available within 1 hr under an FCO

There is a deficiency in System Security of 1 MW within 15 mins and 4 MW [13-9] within 3 hrs. There is no available contribution from DG/DSR Schemes/ES – the ES is not contracted with the DNO to provide system security and the assessed security contribution assessed in accordance with EREP 131 is negligible. Hence, with the proposed ES connection, the distribution system is not compliant with Table 1 of EREC P2/7 [N1].

It should be noted that without the ES connection (as described in F.3), the Group Demand would be 10 MW (Class B): from Table 1 of EREC P2/7 [N1] under an FCO, Class B requires restoration for 9 MW of demand within 3 hrs and restoration of the remaining demand within repair time – this can be satisfied without the ES connection.

The next step is for the DNO to undertake a review of the options (see Clause 9.2) to address the deficiency, such as:

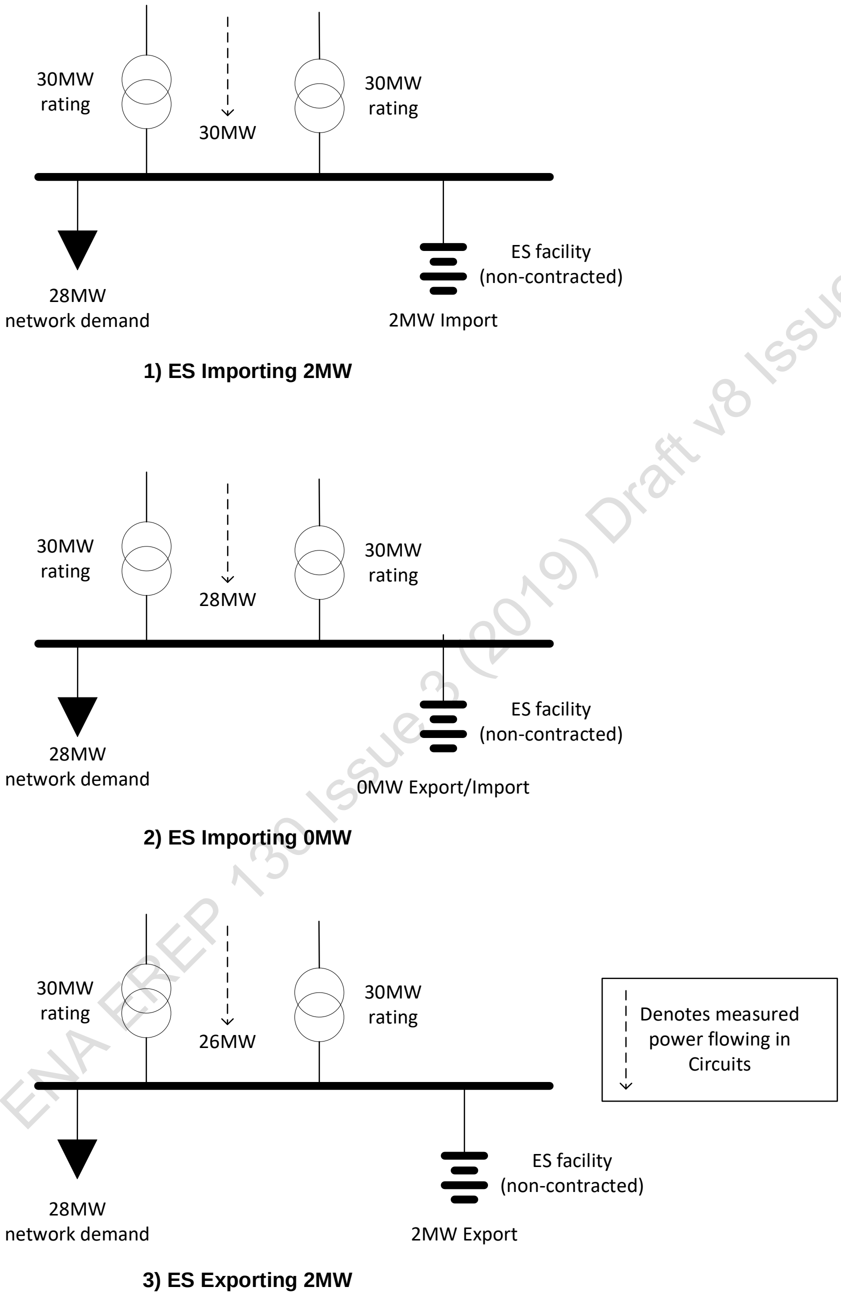
- network asset reinforcement; and
- establishing a contract with the ES facility

The most efficient solution is likely to be for the ES facility to be offered a connection with a constrained import to manage the customer related risk of not complying with the requirements of Table 1 of EREC P2/7 [N1].

However, a supplementary CBA (see Clause 11) may be required when the DNO’s high-level review indicates that the options are not economically viable and/or align with the asset management strategy.

F.6.2 Established ES facility

An ES facility consists of 5 MW of installed battery storage and operates outside of any contract with the DNO. Three scenarios are considered as depicted in Figure F.6.2.



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1996 **Figure F.6.2 – ~~Non-contracted~~Non-Contracted ES**

Field Code Changed

a) Determine Group Demand

i. Measured Demand

- Scenario 1 = 30 MW
- Scenario 2 = 28 MW
- Scenario 3 = 26 MW

ii. Latent Demand

Contracted DG/DSR Schemes/ES – Latent Demand associated with ES.

- Scenario 1: Latent Demand = 0 MW
- Scenario 2: Latent Demand = 0 MW
- Scenario 3: Latent Demand = 2 MW (ES export)

~~Non-contracted~~Non-Contracted DG/DSR Schemes/ES – none

iii. Cold Load Pickup = 0 MW

iv. Group Demand

- Scenario 1: Group Demand = 30 MW (Class C)
- Scenario 2: Group Demand = 28 MW (Class C)
- Scenario 3: Group Demand = 28 MW (Class C)

b) Determine Network Capacity

i. Intrinsic network capacity

FCO capacity = 30 MW, available immediately. (From Table 1 of EREC P2/7 [N1] under an FCO, there is a requirement to secure partial demand within 15 mins and all demand within 3 hrs).

SCO capacity = 0 MW. (From Table 1 of EREC P2/7 [N1] under a SCO, there is no requirement to secure any demand).

Given that intrinsic network capacity is greater than or equal to the Group Demand for all scenarios, no consideration of the security contribution assessment from ES is necessary and the system is compliant with Table 1 of EREC P2/7 [N1]. However, for completeness, the contribution from ES for all scenarios is determined:

ii. Security contribution from ~~non-contracted~~Non-Contracted ES

- Scenario 1: There is no contribution to security from the ES.~~, although previous profile data may indicate a likelihood of export.~~
- Scenario 2: There is no contribution to security from the ES, although previous profile data may indicate a likelihood of export.
- Scenario 3: The 2 MW export from the ES should be subject to an assessment using the methodology described in ENA EREP 131, i.e. contribution should be based on appropriate data analysis. Otherwise the contribution to security shall be assumed to be 0 MW.

~~B.13 Non-Contracted~~

~~B.14~~F.7 Distribution system with multiple ~~Introduction~~~~non-contracted~~Non-Contracted DG

Th~~ese three~~is example~~s~~ ~~of the application of ER P2/6 [N1]~~ have been designed to demonstrate the assessment of security contribution from multiple ~~non-contracted~~Non-~~c~~Contracted DG facilities, in accordance with this EREP~~processes described in this EREP~~. ~~The concepts captured in these examples include the following.~~

~~a) Establishing the system capacity.~~

~~b) Establishing the contribution to System Security from Intermittent and Non- intermittent Generation.~~

~~c) Application of Approach 1 and 2.~~

~~d) Establishment of Group Demand where there are various types of DG, e.g. merchant DG plant and/or CHP plant.~~

~~e) De-minimis issues.~~

~~f) Aggregation DG contributions to System Security.~~

~~g) DG response under outage conditions.~~

~~h) System capacity under FCO and SCO conditions.~~

The distribution system used~~ in the first two examples~~ is illustrated in Figure F9.7.~~1 and described below.~~

~~a) A network is supplied by two 100 MW transformers.~~

~~b) The existing Measured Demand is 70 MW.~~

~~c) The existing transfer capability available in 30 min is 10 MW.~~

~~d) New load is to be connected in the group which will increase the Measured Demand by 10 MW.~~

~~e) The network power factor is assumed to be unity and all ratings are expressed in MW.~~

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The DNO knows that the system~~network~~ contains:

- an onshore wind farm having a DNC of 35 MW;
- a landfill gas DG installation having a DNC of 8 MW~~comprising 2 x 0.5 MW identical units~~;
- ~~landfill~~a waste ~~gas~~ DG installation having a DNC of 1 MW ~~comprising 4 x 2 MW identical units~~;
- Fifty 1 kW microgeneration units at various locations in the demand group;
- an industrial site that has a b~~B~~iomass DG installation ~~CHP plant comprising a 7 MW gas turbine and a 3 MW steam turbine powered unit~~ which operates 24 hrs per day at an output of 10 MW.~~ The site details are as follows.~~

- ~~The actual site demand is 15 MW.~~
- ~~The generation output at the time of the recorded maximum Measured Demand is 10 MW.~~
- ~~The site import at the time of maximum Measured Demand is 5 MW.~~
- ~~The Authorised Supply Capacity (i.e. the import limit of the site) is 7 MW.~~

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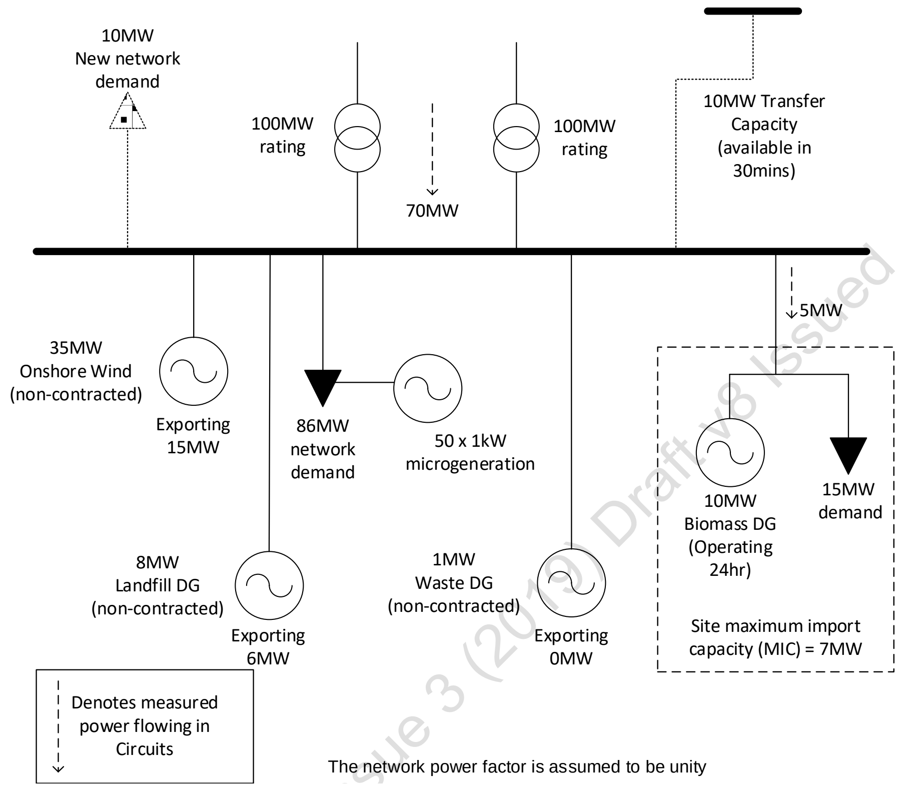

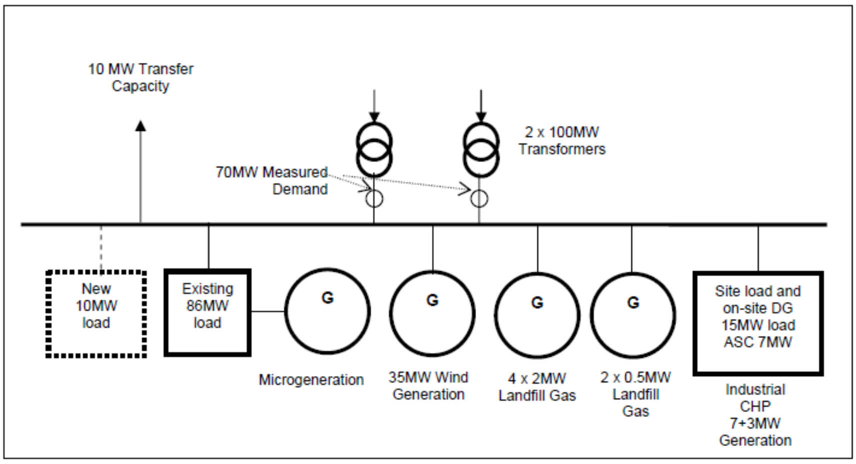

Figure F~~9.7~~1 ~~—~~ — ~~Example system~~Multiple ~~non-contracted~~Non-~~c~~Contracted DG

There are two scenarios considered:~~The DNO has to assess whether the network is ER P2/6 [N1] compliant once the new load is connected. Example 1 is used to assess the network compliance with the existing demand, Example 2 develops this example to analyse the ER P2/6 [N1] compliance in the scenario that the demand increases by 10 MW.~~

i. Scenario 1 (see F.7.1) – an assessment which ignores the new demand of 10 MW

ii. Scenario 2 (see F.7.2) – the assessment which includes the new demand of 10 MW

~~It illustrates how the generation that is connected in the group can, under ER P2/6 [N1], contribute to compliance.~~

~~The example is structured to follow the process set out in Clause 4 of this EREP. Each step of the process is cross-referenced to the appropriate sub-clause of the EREP.~~ For simplicity the examples~~it~~ use~~s~~ Approach 1 of Annex D~~Clause 5~~ to determine the contributions from the sources of generation where relevant.~~possible.~~

~~B.15~~F.7.1 Scenario 1 – Assessment which ignores new network demand~~Example 1~~

~~B.15.1 Step 1 – Determine the Group Demand and class of supply~~

~~NOTE 1: This first step is exactly the same in ER P2/6 [N1] as it was in ER P2/5.~~

~~NOTE 2: See also sub-clause 4.2.~~

a) Determine Group Demand

i. Measured Demand: 70 MW.

ii. Latent Demand

Contracted DG/DSR Schemes/ES – none

~~Non-contracted~~Non-Contracted DG/DSR Schemes/ES – Capacity of downstream generation: (35) + (~~2 x 0.5~~1) + (~~4 x 2~~8) + 10) = 54 MW.

The sum of the downstream generation is > 5% of the Measured Demand, hence it is necessary to analyse the generation to establish the Latent Demand contribution to Group Demand.

Using the approach in ~~Clause 6.6~~Annex A, Equation 1.

- ~~The output from the wind farm at time of maximum Measured Demand~~Onshore wind = 15 MW.
- ~~Measured Demand~~Waste DG = 0 MW.
- ~~The output from the larger landfill gas installation at time of maximum Measured Demand~~Landfill gas DG = 6 MW.
- There are only a small number of microgeneration units with a low aggregate capacity, hence their impact on the Group Demand can be neglected.
- ~~In this example there~~For the industrial site, there is sufficient information about the load and generation ~~on the CHP site~~ to apply the simple analysis in ~~Clause 6.6.2~~Annex A.2, i.e. the smaller of the expected generation output at a time of maximum Measured Demand (10 MW), and the ASC (7 MW) minus the import at the time of the maximum Measured Demand (5 MW), should be added to the Measured Demand, i.e. 2 MW, the smaller of (10) and (7 – 5).

iii. Cold Load Pickup = 0 MW

~~iii.~~iv. ~~Therefore the~~ Group Demand = 70 + 15 + 0 + 6 + 2 = 93 MW (Class D).

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~~f) The network falls into class of supply D in ER P2/6 Table 1 [N1].~~

NOTE: The Group Demand is subtly different from the actual connected demand of 86 MW of existing load plus the 5 MW of net demand from the industrial ~~CHP~~ site. This is because the Group Demand includes ~~an allowance of 5 MW to cater for the latent effect of the CHP generation plus the additional~~ 2 MW of Latent Demand associated with the industrial site, i.e. demand that would appear if the generation at the industrial site was not running.~~that might need to be supplied at this site should it take up to its authorized capacity.~~

~~**B.15.2 Step 2 – Establish the capacity of network assets**~~

~~NOTE: See also sub-clause 4.3.~~

b) Determine Network Capacity

i. Intrinsic network capacity

FCO capacity = 100 MW, available immediately. (From Table 1 of EREC P2/7~~6~~ [N1] under a FCO, there is a requirement to secure all the demand immediately ~~(~~[assuming that there is no automatic disconnection]~~)~~[4]. The FCO capacity of 100 MW is sufficient to meet the 93 MW of demand.)

SCO capacity = 0 MW (From Table 1 of EREC P2/76 [N1] under a SCO, there is a requirement to secure all the demand within the time to restore the arranged outage)

~~iv.~~ii. Transfer Capacity – not necessary to assess as intrinsic network capacity is sufficient to secure the Group Demand. For completeness,

10 MW available within 30 min under FCO or SCO conditions.

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Given that ~~I~~intrinsic network capacity is greater than Group Demand, the system is compliant with Table 1 of EREC P2/7 [N1].

~~a) The relevant network assets are the two transformers supplying the network, i.e. the capacity of each network Circuit = 100 MW.~~

~~b) FCO capacity = 100 MW, available immediately.~~

~~c) SCO capacity = 0 MW immediately available & 10 MW available within 30 min.~~

~~d) From Table 1 of ER P2/6 [N1] under a FCO, there is a requirement to secure all the demand immediately (assuming that there is no automatic disconnection)[5]. The FCO capacity of 100 MW is sufficient to meet the 93 MW of demand.~~

~~e) From Table 1 of ER P2/6 [N1] under a SCO, there is a requirement to secure all the demand within the time to restore the arranged outage, i.e. capacity under SCO conditions is not required.~~

~~f) In conclusion, the network assets are sufficient to ensure that the network is compliant with ER P2/6 [N1], and no further analysis is required.~~

[4] Strictly EREC P2/7~~6~~ [N1] permits of the automatic disconnection of up to 20 MW of demand in this scenario. However, many DNO networks are not currently designed to automatically disconnect demand, and this example is based on the assumption that all demand should be supplied immediately.

~~[5] Strictly EREC P2/76 [N1] permits of the automatic disconnection of up to 20 MW of demand in this scenario. However, many DNO networks are not currently designed to automatically disconnect demand, and this example is based on the assumption that all demand should be supplied immediately.~~

~~B.15.3~~F.7.2 Scenario 2 – assessment which includes new network demand~~Example 2 (additional network demand)~~

In order to continue to demonstrate the application of EREC P2/7~~6~~ [N1], this example develops ~~Example~~ Scenario 1 but with additional demand connected such that the Measured Demand increases by 10 MW.

a) ~~Step 1 –~~ Determine the Group Demand ~~and class of supply~~

i. Measured Demand: (70 + 10) = 80 MW.

~~v. NOTE: See also sub-clause 4.2.~~

ii. Latent Demand

Contracted DG/DSR Schemes/ES – none

~~Non-contracted~~Non-Contracted DG/DSR Schemes/ES – Capacity of downstream generation: (35) + (~~2 x 0.5~~1) + (~~4 x 2~~8) + 10) = 54 MW.

The sum of the downstream generation is > 5% of the Measured Demand, hence it is necessary to analyse the generation to establish the Latent Demand contribution to Group Demand.

Using the approach in ~~Clause 6.6~~Annex A, Equation 1.

- ~~The output from the wind farm at time of maximum Measured Demand~~Onshore wind = 15 MW.
- ~~Measured Demand~~Waste DG = 0 MW.
- ~~The output from the larger landfill gas installation at time of maximum Measured Demand~~Landfill gas DG = 6 MW.
- There are only a small number of microgeneration units with a low aggregate capacity, hence their impact on the Group Demand can be neglected.
- ~~In this example there~~For the industrial site, there is sufficient information about the load and generation ~~on the CHP site~~ to apply the simple analysis in ~~Clause 6.6.2~~Annex A.2, i.e. the smaller of the expected generation output at a time of maximum Measured Demand (10 MW), and the ASC (7 MW) minus the import at the time of the maximum Measured Demand (5 MW), should be added to the Measured Demand, i.e. 2 MW, the smaller of (10) and (7 – 5).

~~vi.~~iii. Cold Load Pickup = 0 MW

~~vii.~~iv. ~~The gross network maximum demand (~~Group Demand~~):~~ = ~~(~~80 + 15 + 0 + 6 + 2~~)~~ = 103 MW (Class D).

~~b) The network falls into class of supply D in ER P2/6 Table 1 [N1].~~

~~c) Step 2 – Establish the capacity of network assets~~

~~d) NOTE: See also sub-clause 4.3.~~

b) ~~The relevant network assets are the two transformers supplying the network, i.e. the capacity of each network Circuit = 100 MW.~~Determine Network Capacity

i. Intrinsic network capacity

FCO capacity = 100 MW, available immediately (From Table 1 of EREC P2/7 [N1] under a FCO, there is a requirement to secure all the demand immediately [assuming as before that there is no automatic disconnection]. ~~Considering the security provided by network assets,~~Hence, there is a FCO deficiency of (103 - 100) = 3 MW.)

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SCO capacity = 0 MW~~, immediately available & 10 MW available within 30 min~~ (From Table 1 of EREC P2/7 [N1] under a SCO, as the Group Demand exceeds 100 MW, there is a requirement to secure the smaller of; ~~[~~Group Demand minus 100 MW, and 1/3 of Group Demand~~]~~, i.e. 3 MW within 3 hrs. As 10 MW Transfer Capacity is available within 30 min, there are sufficient network assets to meet the SCO requirements, there being an excess of 7 MW. There is a further requirement to secure all the demand within the time to restore the arranged outage.

ii. Transfer Capacity

Available immediately = 0 MW

Available within 30 minutes = 10 MW

As 10 MW Transfer Capacity is available within 30 min, there are sufficient network assets to meet the SCO requirements, there being an excess of 7 MW.

~~In summary, considering the network assets alone,~~ However, there is a FCO deficiency of 3 MW (required immediately) and ~~a SCO surplus of 7 MW and hence~~ the network is non-compliant with EREC P2/7~~6~~ [N1].

It is now necessary to consider contribution to security from other means: DG/DSR Schemes/ES.

c) Security contribution capacity from DG/DSR Schemes/ES

~~viii.~~ Security contribution from ~~non-contracted~~Non-Contracted DG

iii.

~~**B.15.4** Step 3 – Assessing the potential security contribution from DG~~

~~NOTE: See also sub-clause 4.4.~~

~~Step 2 indicates that the network assets alone are insufficient to ensure compliance with ER P2/6 [N1] and hence further assessment is required. This next step assesses whether there is the potential for the connected DG to meet the security deficiency.~~

~~ix.~~ The aggregate of the DNCs of the ~~non-contracted~~Non-Contracted DG in the network can be calculated. If this aggregate is less than the capacity deficit revealed in Step b) above,~~2~~ then there is no possibility that the DG capacity will make the network compliant. If the aggregate exceeds the deficit then further analysis is required.

iv.

~~In this example, T~~the aggregate of all the ~~non-contracted~~Non-Contracted DG connected in the network = 35 + 1~~(2 x 0.5)~~ + 8~~(4 x 2)~~ + 10 = 54 MW.

v. Hence there is the potential for the connected ~~non-contracted~~Non-Contracted DG to meet System Security deficiency, and the analysis therefore continues with step i.1~~: to Step 4.~~

~~**B.15.5** Step 4 – Assessing the contribution from DG~~

~~NOTE: See also sub-clause 4.5.~~

~~The following steps establish the security contribution from the DG in the network.~~

- Step i.1~~4a~~ – Check each DG source against the de-minimis criterion

NOTE: See also ~~sub-clauses 4.5.1 & 6.4.~~Clause 8.2.

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The microgeneration units are excluded from the compliance assessment as they are, even in aggregate, less than 100 kW.

The onshore wind farm (35 ~~-~~MW) is approximately~~.~~ 33% of the Group Demand, i.e. above the de-minimis criterion, and therefore the security contribution should be assessed.

The ~~first landfill gas installation~~waste DG (1 ~~2 x 0.5~~ MW) is less than 5% of the Group Demand (103 MW), i.e. below the de-minimis criterion, and is therefore not considered further.

The ~~second landfill gas installation~~landfill DG (8 ~~4 x 2~~ MW) is approximately~~.~~ 7% of the Group Demand, i.e. above the de-minimis criterion, and therefore the security contribution should be assessed.

The biomass DG (10 MW) is approximately 10% of the Group Demand, i.e. above the de-minimis criterion, and therefore the security contribution should be assessed.

- Step i.4~~2b~~ – Fault ride-through capability

NOTE: See also ~~sub-clause 4.5.2~~Clause 8.3.1.

The behaviour of each DG ~~unit~~ rated above the de-minimis limit, under the relevant outage conditions should be assessed. In this example, it is assumed that ~~both the onshore wind farm DG and CHP biomass DG will remain~~system studies have been carried out to demonstrate that the onshore wind farm and biomass facility remain connected under a fault forming the FCO condition and that the landfill DG will disconnect under fault conditions (e.g. owing to the sensitivity of its protection systems), ~~but has the capability to be reconnected to the~~and the DNO has agreed with the DG that they will automatically reconnect to the system within 30 ~~-~~min. DG contribution under SCO conditions can only be provided in practice in the event that the DG has been designed to run in island mode, or alternatively that there is sufficient interconnection to the rest of the total system to allow the DG to resynchronise.

- Step i.4~~3c~~ – ~~Taking account of availability~~Establish security contributions

NOTE: See also ~~sub-clauses 4.5.3 and Clause 5~~Clause 8 and Annex D.

At this point in the process the contribution from each DG facility~~unit~~ can be established. In this example, Approach 1 (~~-~~Table D.2.1 and Table D.2.2) in Annex D are ~~of ER P2/6 [N1] (i.e. Approach 1) is~~ used to establish the contributions from the ~~wind farm and landfill gas installation~~DG. The time of year relevant for this example is winter.~~ The CHP installation is a gas powered unit, with a steam turbine, and establishing the F factor is outside the scope of Approach 1, hence Approach 2 has been used.~~

~~Larger~~ Landfill DG ~~gas installation~~

– ~~From ER P2/6 Table 2-1A [N1], t~~The F factor for the ~~larger~~ landfill gas ~~installation~~ DG = 22~~75~~%.

– ~~From ER P2/6 Table 2 [N1], t~~The security contribution from the landfill ~~gas installation~~DG = ((22~~75~~/100) x 8) = 1.7~~6~~ MW.

Onshore w~~W~~ind farm DG

The security contribution from the wind farm is dependent upon the required value of T_m. In this example, the most onerous FCO relates to an outage of one of the two 100 MW network Circuits for a major reconstruction project.

– From ~~ER P2/6~~ Table D.2.~~-~~3~~4 [N1]~~, the required value of T_m = 90 days.

– From ~~ER P2/6~~ Table D.2.~~-~~2~~A [N1]~~, the F factor for the wind farm = 0.

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– From ~~ER P2/6~~ Table D.2 ~~[N1]~~, the security contribution from the onshore wind farm = (0/100 x 35) = 0 MW.

However, in this example the wind farm has the capability to provide continuity of supply under FCO conditions in the time period between the inception of the FCO and the time when the Transfer Capacity of the network can be utilised, in this case 30 min. A T_m value of 30 mins is used to assess this capability.

– From ~~ER P2/6~~ Table D.2.~~-3~~4 ~~[N1]~~, the required value of T_m = 30 mins.

– From ~~ER P2/6~~ Table D.2.~~-~~2~~A [N1]~~, the F factor for the onshore wind farm = 15%~~28~~.

– From ~~ER P2/6~~ Table D.2 ~~[N1]~~, the security contribution from the onshore wind farm = ((15~~28~~/100) x 35) = 5.2~~9.8~~ MW.

- *~~CHP units~~Biomass DG*

~~– The availability of the CHP units, based on examination of several years operating data provided by the CHP operator, shows the availability to be 95%.~~

~~– **Gas turbine generation**~~

– ~~From EREP 130 Table 3, t~~The F factor for the ~~CHP gas turbine generation~~Biomass DG = 32~~69~~%.

– T~~From ER P2/6 Table 2 [N1], t~~he security contribution from the ~~CHP generation~~biomass DG = ((32~~69~~/100) x 10~~7~~) = 3.2~~4.8~~ MW.

- ~~**Steam turbine generation**~~
- ~~From EREP 130 Table 3, the F factor for the CHP steam turbine generation = 69%.~~
- ~~From ER P2/6 Table 2 [N1], the security contribution from the CHP generation = ((69/100) x 3) = 2.1 MW.~~
- ~~The aggregate contribution from the gas turbine and steam turbine can be determined by summating these individual contributions, so that the contribution from the CHP installation is 6.9 MW.~~
- Step i.4~~4d~~ – Checking for dominance

NOTE: See also ~~sub-clause 4.5.4~~Clause 8.2.3 and Annex B.

By inspection, it can be seen that the contribution to System Security from each of the DG ~~plants~~ facilities is less than the capacity of one of the incoming Circuits, and hence the DG is not dominant and Capping is not required.

- ~~Table 7 summarises the security contribution from each DG plant and the time after the FCO when the contribution is available. The contribution to System Security after the SCO will depend upon the ability of the DG to synchronise under the depleted network conditions.~~
- Step i4.~~5e~~ – Time durations

NOTE: See also ~~sub-clause 4.5.5~~Clause 8.3.

Table F.6~~7~~ summarises the security contribution from each DG ~~plant~~ facility and the time after the outage when the contribution is available. The security contribution after the SCO will depend upon the ability of the DG to synchronise with the depleted network conditions.

Table F.6~~7~~ — Scenario~~Example~~ ~~-~~2 – DG contribution after a FCO

Distributed Generation	Security	Time in which the DG is

	contribution (MW)	available post a FCO
Onshore w~~W~~ind farm (35~~50~~ MW)	5.2~~9.8~~	Immediately (but only for 30 mins)
~~Landfill~~ Waste ~~gas installation~~ (1 ~~2 x 0.5~~ MW)	0	N/A
Landfill ~~gas installation~~ (8 ~~4 x 2~~ MW)	1.7~~6.0~~	After 30 mins
~~CHP generation~~Biomass (10 MW)	3.2~~6.9~~	Immediately

- Step i.6~~5~~ – Checking for ~~ER P2/6~~ compliance with ~~DG~~EREC P2/7 [N1] Table 1

NOTE: See also ~~sub-clauses 4.5.6 and 4.6~~Clause 9.

The relevant network assets are the two transformers supplying the network, i.e. the capacity of each network infeed Circuit = 100 MW. The contribution to System Security from the generation established in Step i.3~~4~~ is combined with the contribution from the network assets for both the FCO and SCO condition in each of the relevant time periods, i.e. immediately, within 3 hrs and within the time to restore the arranged outage.

FCO capacity (t~~T~~ime period: inception of FCO to 30 mins)

From Table 1 of EREC P2/7~~6~~ [N1] under FCO, there is a requirement to secure all the demand immediately (assuming that there is no automatic disconnection). Considering the security provided by network assets and ~~generation~~DG facilities, there is a FCO capacity of (100 + 5.2~~9.8~~ + 3.2~~6.9~~) = 108.4~~16.7~~ MW, i.e. a surplus of (108.4~~16.7~~ - 103) = 5.4~~13.7~~ MW.

FCO capacity (t~~T~~ime period: 30 mins from inception of FCO to 3 hrs~~ours~~)

From Table 1 of EREC P2/7~~6~~ [N1] under FCO, there is a requirement to secure all the demand immediately (assuming that there is no automatic disconnection). Considering the security provided by network assets and generation, there is a FCO capacity of (100 + 10 + 1.7~~6~~ + 3.2~~6.9~~) = 114~~22~~.9 MW, i.e. a surplus of (114~~22~~.9 - 103) = 11~~9~~.9 MW. The change in capacity arises due to the fact that the onshore wind farm contribution has been replaced by the T~~t~~ransfer Capacity~~capability~~ that is switched within 30 min of the inception of the fault and the resynchronisation of the ~~larger~~ landfill gas installation. The 10 MW Transfer Capacity can be sustained indefinitely, whilst the contribution provided from the wind farm will reduce with time.

The FCO capacity is the lower of these two figures, i.e. 108.4 ~~16.7~~ MW.

SCO capacity (Time period: from inception of SCO to 30 mins)

SCO capacity immediately available = 3.2~~6.9~~ MW (~~of~~ Biomass~~CHP~~) plus 5.2 ~~9.8~~ MW (onshore wind farm), although unless island mode operation is viable, this contribution can only be utilised if the transfer capability provides a Circuit to which the ~~generation~~ DG can be synchronised. Hence this capacity is zero in the event that no facility for island operation exists.

SCO capacity (Time period: 30 mins from inception of SCO to 3 hrs~~ours~~)

SCO capacity available within 30 min = 10 MW (~~network~~ Transfer Capacity) + 1.7~~6~~ MW (Resynchronised ~~landfill gas installation~~landfill DG) + 3.2 MW~~6.9~~ (~~CHP~~ Biomass~~installation~~) = 114~~22~~.9 MW, i.e. a surplus of (114.9 - 103) = 11.9 MW~~.~~. This condition could persist for extended periods and hence it would be inappropriate to consider any contribution from the onshore wind farm as T_m could be in excess of 120 h. It is worth noting that the contribution to System Security from DG could only be realised if the generation could be synchronised to the system supplied~~ assets~~ from the~~providing the network~~ Transfer Capacity Circuit. If this were not the case, the SCO capacity would be limited to the Transfer Capacity (10 -MW).

In summary, by considering the contribution to System Security from the network assets alone, there is a FCO deficiency of 3 -MW and a SCO surplus of 7 -MW. Hence the network is non-compliant with ER P2/7~~6~~ [N1].

Taking the contribution to System Security from ~~generation non-contracted~~Non-Contracted DG into account produces a FCO surplus of 5.4 ~~10.7~~ MW. The increase in FCO capability arises due to the output from the onshore wind farm covering the period between the inception of the outage and the Transfer Capacity becoming available.

The SCO surplus may increase to 11~~9~~.9 MW due to the contribution from the reconnected landfill ~~gas installation~~DG, the ~~CHP~~ biomass ~~output~~ DG and the Transfer Capacity, but may be limited to 7 -MW provided by the Transfer Capacity. In either case, the system can be considered to be EREC P2/7~~6~~ [N1] compliant.

The DNO would need to consider whether a contract was required with the ~~CHP~~ Biomass ~~generation~~DG (see Clause 7)~~, based on the guidance in Clause 7~~.

Annex G
(normative)

Interpretation of Imperial College London Report [N8] findings

G.1 General

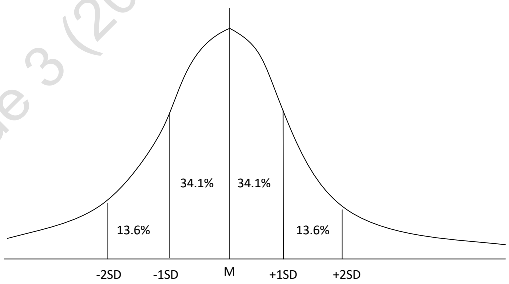
The Imperial College London report ‘Review of EREP 130 F Factors’ [N8] presents the full results of the analysis carried out by Imperial College London. These results have been used to produce the following tables in Annex D:

- Table D.2.1
- Table D.2.2
- Table D.3

The Imperial College London analysis calculates the Average, Minimum, Maximum and Standard Deviation of the F Factors of a large number of DC cases. In order to produce a single F Factor value for each technology type (for each season and capacity factor band where appropriate) in EREP 130 Annex D, the Average F Factor (more specifically the mean, M) minus 1 Standard Deviation (SD) is used. This means that there is a probability of 84.1% that the delivered DG security contribution is the calculated value (i.e. F Factor x DG DNC) or higher. This is considered to be a reasonable planning value to use.

The commentary below provides further explanation.

A normal population distribution about a mean value, M, is shown. The percentage of population within a standard deviation (SD) of the M follows the values shown, Hence, for 1SD below M, this represents 84.1% of the population



The following sections shows how the information from the Imperial College London report has been used to establish the values in EREP 130 Annex D.

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References to Tables 5, 6, 9 and 10 in the following sections refer to tables in the Imperial College London report [N8].

G.2 Derivation of F Factors in Table D.2.1 for non-intermittent renewable DG types

Technology Type	Winter						Summer					
	Number	Average	Min	Max	St Dev	Ave-1 St Dev	Number	Average	Min	Max	St Dev	Ave-1 St Dev
Biomass	76	52%	4%	86%	22%	30%	75	46%	4%	83%	21%	25%
CHP	13	29%	4%	60%	22%		14	25%	6%	55%	16%	
Fossil Gas	31	17%	2%	70%	20%		19	25%	2%	82%	29%	
Fossil Oil	8	33%	5%	56%	22%		6	44%	5%	83%	25%	
Gas	11	24%	3%	49%	19%		9	25%	7%	39%	13%	
Geothermal	2	4%	3%	4%	1%							
Marine - Tidal	3	16%	8%	29%	11%		2	15%	7%	23%	11%	
Mixed	27	38%	5%	79%	26%		26	42%	2%	81%	22%	
Other Generation	17	9%	2%	18%	6%		12	10%	4%	17%	5%	
Other, CHP	62	27%	2%	80%	24%		63	26%	3%	75%	23%	
Landfill Gas	74	51%	3%	83%	23%	28%	73	50%	4%	100%	23%	27%
Waste	71	54%	2%	82%	19%	35%	69	48%	5%	78%	16%	32%
NOTE 1: Replicated from Table 5. Seasonal statistical parameters of F Factors for non-intermittent DG in the Imperial College London Report [N8]												
NOTE 2: Data items in red font are used in EREP 130 Table D.2.1												
NOTE 3: Other technology types are considered to either insufficiently well-defined or too small sample size for inclusion in EREP 130												

G.3 Derivation of F Factors in Table D.2.2 for intermittent renewable DG types

Technology Type	Season	Values	Persistence, h											Comments
			0.5	2	3	6	12	18	24	48	120	360	480	
Onshore wind	Winter	Average (%)	26	24	24	22	19	16	14	9	4	3	3	
		Min (%)	6	6	5	5	4	3	2	1	1	1	1	
		Max (%)	59	58	57	56	54	52	48	38	18	16	16	
		St Dev (%)	9	9	8	8	8	7	7	5	2	2	2	
		Ave - 1 St Dev	17	15	16	14	11	9	7	4	2	1	1	
	Summer	Average (%)	19	18	17	15	13	11	9	6	3	3	3	
		Min (%)	5	5	4	4	3	2	2	1	1	1	1	
		Max (%)	40	38	37	35	31	28	27	26	22	18	14	
		St Dev (%)	6	6	6	6	5	5	5	4	3	2	1	
		Ave - 1 St Dev	13	12	11	9	8	6	4	2	0	0	0	Values for T_m 360, 480 set to zero as F Factors can't increase
Offshore wind	Winter	Average (%)	32	31	30	29	26	23	20	13	6	4	4	
		Min (%)	6	5	5	4	4	3	2	1	1	1	1	
		Max (%)	51	49	48	46	43	40	37	26	19	19	18	
		St Dev (%)	10	10	10	10	9	8	8	6	4	3	3	
		Ave - 1 St Dev	22	21	20	19	17	15	12	7	2	1	1	
	Summer	Average (%)	24	23	22	20	17	15	13	8	4	3	3	
		Min (%)	3	2	2	2	1	1	1	1	1	1	1	
		Max (%)	35	34	33	31	30	30	29	28	25	20	12	
		St Dev (%)	8	7	7	7	6	6	6	5	4	3	2	
		Ave - 1 St Dev	16	16	15	13	11	9	7	3	0	0	0	Values for T_m 480 set to zero as F Factors can't increase

(continued)

Technology Type	Season	Values	Persistence, h											
			0.5	2	3	6	12	18	24	48	120	360	480	Comments
Solar	Winter	Average (%)	6	6	5	4	2	2	2	2	2	2	2	
		Min (%)	3	3	3	2	1	1	1	1	1	1	1	
		Max (%)	13	12	12	10	5	5	5	4	4	4	4	
		St Dev (%)	2	2	2	1	1	1	1	1	0	0	0	
		Ave - 1 St Dev	0	0	0	0	0	0	0	0	0	0	0	Values set to zero as Solar can't contribute to security if demand peak is after dusk
	Summer	Average (%)	16	15	14	12	5	2	2	2	2	2	2	
		Min (%)	3	3	3	2	1	1	1	1	1	1	1	
		Max (%)	22	22	21	20	9	3	3	3	3	3	3	
		St Dev (%)	4	4	4	3	2	0	0	0	0	0	0	
		Ave - 1 St Dev	12	11	10	9	3	2	0	0	0	0	0	Values for T_m >18 set to zero as Solar can't contribute to security overnight
NOTE 1: Replicated from Table 9. F Factors for intermittent renewables DG types in the Imperial College London Report [N8]														
NOTE 2: Data items in red font are used in EREP 130 Table D.2.2														
NOTE 3: Where F Factors are adjusted from the (Ave - 1St Dev) formulae, justification is provided in the comments														

G.4 Derivation of F Factors in Table D.2.2 for intermittent hydro DG types

Technology Type	Season	Values	Persistence, h											Comments
			0.5	2	3	6	12	18	24	48	120	360	480	
Hydro run-of-river and poundage	Winter	Average (%)	36	36	35	35	34	33	31	28	21	10	9	
		Min (%)	6	6	6	6	6	5	5	4	2	1	1	
		Max (%)	74	74	74	74	74	74	73	73	69	56	52	
		St Dev (%)	17	17	17	17	17	17	16	16	16	13	12	
		Ave - 1 St Dev	19	19	18	18	17	16	15	12	5	0	0	
	Summer	Average (%)	17	17	16	16	15	14	13	11	8	3	3	
		Min (%)	3	3	2	1	1	1	1	1	1	1	1	
		Max (%)	41	41	41	41	41	41	40	39	33	12	8	
		St Dev (%)	10	10	9	9	9	9	9	9	7	3	2	
		Ave - 1 St Dev	7	7	7	7	6	5	4	2	1	0	0	
Hydro water reservoir	Winter	Average (%)	29	29	28	27	26	23	22	21	18	12	10	
		Min (%)	4	4	4	2	1	1	1	1	1	1	1	
		Max (%)	76	76	76	75	74	72	70	70	68	60	56	
		St Dev (%)	17	17	18	18	19	19	19	18	16	13	12	
		Ave - 1 St Dev	12	12	10	9	7	4	3	3	2	0	0	
	Summer	Average (%)	16	16	15	14	13	12	11	10	9	6	5	
		Min (%)	3	3	3	3	2	1	1	1	1	1	1	
		Max (%)	70	70	70	70	70	69	69	67	61	52	52	
		St Dev (%)	11	11	11	12	12	12	12	12	11	8	7	
		Ave - 1 St Dev	5	5	4	2	1	0	0	0	0	0	0	Values for Tm >18 set to zero as F Factors can't increase

(continued)

NOTE 1: Replicated from Table 10. F Factors for intermittent hydro DG types in the Imperial College London Report [N8]
NOTE 2: Data items in red font are used in EREP 130 Table D.2.2
NOTE 3: Where F Factors are adjusted from the (Ave - 1St Dev) formulae, justification is provided in the comments

G.5 Derivation of F Factors in Table D.3 for non-intermittent renewable DG types

Capacity Factor	Winter					Summer						
	Number	Average	Min	Max	St Dev	Ave - 1St Dev	Number	Average	Min	Max	St Dev	Ave - 1St Dev
Biomass												
90%	22	76%	64%	86%	6%	49%	15	72%	61%	83%	7%	46%
70%	20	60%	42%	78%	11%	36%	18	58%	30%	77%	12%	35%
50%	11	45%	32%	57%	9%	26%	19	42%	30%	55%	7%	29%
30%	18	30%	23%	37%	4%	3%	12	32%	28%	36%	3%	6%
10%	5	7%	4%	14%	4%	0%	11	13%	4%	20%	7%	0%
Other, Landfill Gas												
90%	22	74%	50%	83%	7%	67%	21	72%	53%	100%	10%	62%
70%	14	65%	41%	75%	9%	56%	14	66%	43%	78%	9%	57%
50%	15	51%	43%	57%	4%	47%	13	54%	42%	58%	4%	50%
30%	12	29%	20%	36%	6%	23%	14	29%	11%	40%	8%	21%
10%	11	13%	3%	19%	5%	8%	11	13%	4%	19%	4%	9%
Waste												
90%	7	73%	64%	82%	6%	67%	4	71%	60%	78%	8%	63%
70%	39	64%	40%	75%	7%	57%	26	59%	44%	72%	8%	51%
50%	14	50%	37%	58%	7%	43%	26	45%	36%	54%	5%	40%
30%	5	26%	22%	28%	3%	23%	8	31%	22%	36%	4%	27%
10%	6	7%	2%	15%	5%	2%	5	14%	5%	20%	6%	8%

(continued)

NOTE 1: Replicated from Table 6. F Factors of non-intermittent generation for different capacity factors and seasons in the Imperial College London Report [N8]
NOTE 2: Data items in red font are used in EREP 130 Table D.3
NOTE 3: The data analysis for biomass generators showed that capacity factors may vary more than 20% year to year, for more than 50% of the population. To accommodate this to some extent the F factors have been reduced by applying that of the next lowest capacity factor value. For example rather than use a 70% F Factor (76-6) for a biomass plant with a 90% capacity factor, a 49% F Factor (60-11) is used

~~Example 3 Capping and common mode failure~~

~~B.15.6 Checking for Capping~~

~~Consider a section of network supplied by two 10 MW Circuits and containing two landfill gas sites with the following mix of generation types:~~

	~~**Site A**~~	~~**Site B**~~
	~~2 x 1 MW~~	~~2 x 1 MW~~
	~~2 x 1.5 MW~~	~~3 x 1.5 MW~~
	~~1 x 2 MW~~	
	~~1 x 5 MW~~	
~~**Total**~~	~~**12 MW**~~	~~**6.5 MW**~~

~~**For Site A**~~

~~Applying the Capping criterion,~~ $\cancel{C_g \leq \frac{C_{ct}}{F \cdot N_t}}$

~~then provided the inequality is true, it is not necessary to cap.~~

~~C_{ga} = 1 MW ≤10/(69% x 2)~~
~~= 1 MW ≤ 7.25 MW~~
~~i.e. for the two 1 MW DG units at Site A the inequality is true hence there is no need to cap~~

~~C_{gb}…~~
~~C_{gc}…~~
~~C_{gd} = 5 MW ≤ 10/(63% x 1)~~
~~= 5 MW ≤ 15.9 MW~~
~~i.e. the inequality is true hence there is no need to cap~~

~~For Site A no Capping is required because the DG is not dominant.~~

~~For Site B~~

~~C_{ga} = 1 MW ≤10/(69% x 2)~~
~~= 1 MW ≤ 7.25 MW~~
~~i.e. for the two 1 MW DG units at Site A the inequality is true hence there is no need to cap~~

~~C_{gb} = 1.5 MW ≤ 10/(73% x 2)~~
~~= 1.5 MW ≤ 6.8 MW~~
~~i.e. the inequality is true hence there is no need to cap~~

~~Again, for Site B no Capping is required because the DG is not dominant.~~

~~B.15.7 Common mode failure~~

~~Now consider that for common mode failure at Site A, the following contributions must be less than the largest Circuit, i.e. 10 MW.~~

~~a) 1 x 69% x 2~~

~~+ b) 1.5 x 69% x 2~~

~~+ c) 2 x 63% x 1~~

~~+ d) 5 x 63% x 1~~

~~= 7.86 MW ≤ 10 MW~~

~~i.e. the inequality is true hence there is no need to cap~~

~~Hence no Capping is required for common mode failure. Had Capping been required it would be appropriate to cap each DG plant in groups a) to d) in the example pro-rata the contribution in the summation to the extent that the inequality becomes satisfied.~~

Bibliography

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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~~[5] SAVE (Solent Achieving Value from Efficiency) Report 1 – Lessons learnt on Energy Efficiency & Behavioural Change project, SSE Networks, June 2014~~

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