Scottish & Southern Electricity Networks

THAMES VALLEY VISION

New Thames Valley Vision
Learning Outcome Report
DNO Training & Policies Review

Bracknell Forest Council

ea technology

DNV·GL

Honeywell

University of Reading

University of Oxford

© Scottish and Southern Electricity Networks

Scottish and Southern Electricity Networks (SSEN) is the new trading name of Scottish and Southern Energy Power Distribution (SSEPD), the parent company of Southern Electricity Power Distribution (SEPD), Scottish Hydro Electricity Power Distribution (SHEPD) and Scottish Hydro Electricity Transmission. SEPD remains the contracted delivery body for this LCNF Project.

Prepared by

Document Owner(s)	Project / Organisation Role
Joe McNeil	NTVV Project Manager
Sarah Rigby	NTVV Project Officer
Richard Potter	EA Technology

Page intentionally blank

Contents

List of Tables

List of Figures

Executive Summary

This Successful Delivery Reward Criteria (SDRC) report meets the criterion defined in the New Thames Valley Vision (NTVV) full bid submission [Ref. 1] for the Distribution Network Operator (DNO) Training & Policies Review.

The policy and training material delivered captures the knowledge and experience gained during the development, deployment and operation of the solutions trialled within the NTVV project. The policy decisions have influenced the training material required, and so this report presents the policy review and new policy documentation, before addressing the training material delivered.

The two key aspects of this work regarding DNO policy are:

- A comprehensive review of existing policy documentation to identify where amendments will be required for the application of the new technologies within Business as Usual (BaU); and
- The development of twelve new policy documents relating to the technologies trialled within the NTVV project, as preparation for the transition of new Low Voltage (LV) network solutions and approaches into BaU.

The new policy documents cover the five themes of: LV Monitoring, LV Design, LV Network Storage, Capacity Response and Customer Engagement, as shown in Figure 1.

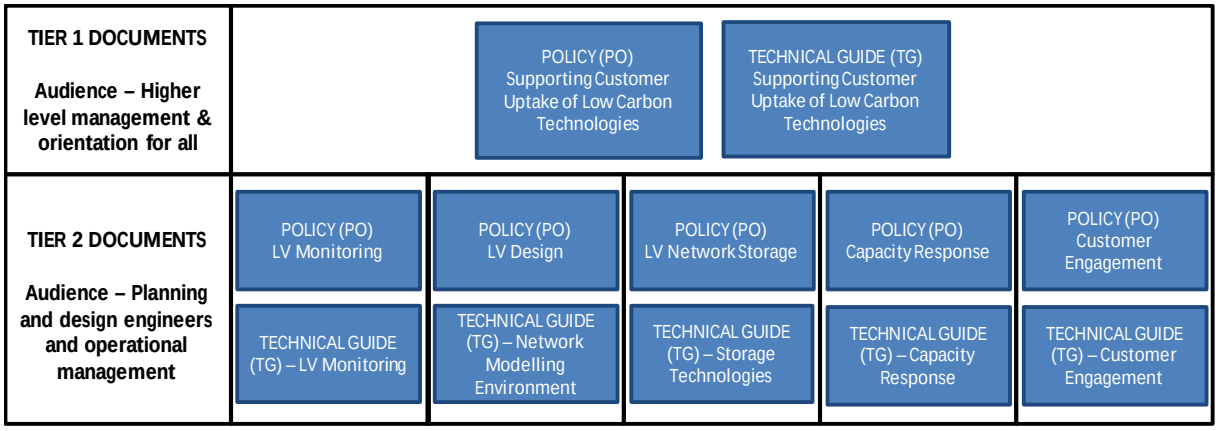

Figure 1: NTVV Policy Documentation

These new policy documents have been created in such a way that they may be adopted where appropriate, adapted in light of further research or wider external factors, or used as a basis to incorporate and develop policy for other new, innovative solutions as technologies are transitioned from innovation trials to BaU application at scale. Adopted policy documentation is issued to the business through the standard approval, release and review processes.

In addition to providing a suite of project deliverables of use within the business, the documents are available externally to industry stakeholders, including other DNOs and the regulator, to inform policy development across the industry and support the effective future operation of these solutions at scale.

With regard to DNO training, the following training packages have been delivered:

- **LV Monitoring:** Covers the business drivers for LV monitoring, the installation of LV monitoring devices, and the utilisation of LV monitoring data;
- **LV Design:** Covers the need for decision support tools for LV Planners and Designers, the functionality provided by the new tools developed within the NTVV project, new ways of working as a result of the learning generated by NTVV, and how to assess the suitability of alternative, smart solutions for accommodating LV network load growth due to customer adoption of Low Carbon Technologies (LCTs); and
- **LV Battery Storage:** Specifically covers the Energy Storage and Management Unit (ESMU) devices trialed within the NTVV project, including how to deploy, commission, control, manage and maintain them.

One further training package will be developed and delivered for publication by project Close Down:

- **Overall NTVV Learning:** Providing an introduction to the changing environment for electricity distribution networks due to increased customer uptake of LCTs, and the alternative approaches to planning, operating and managing them, in addition to presenting the overall key learning from NTVV project.

These training packages have been designed for the effective transferral of knowledge obtained through the NTVV project. The suite of material can be used to embed an understanding of the practical application of new concepts, systems and procedures at a suitable level for each of the target audiences identified. The four training packages comprise sixteen individual training modules, as shown in Figure 2.

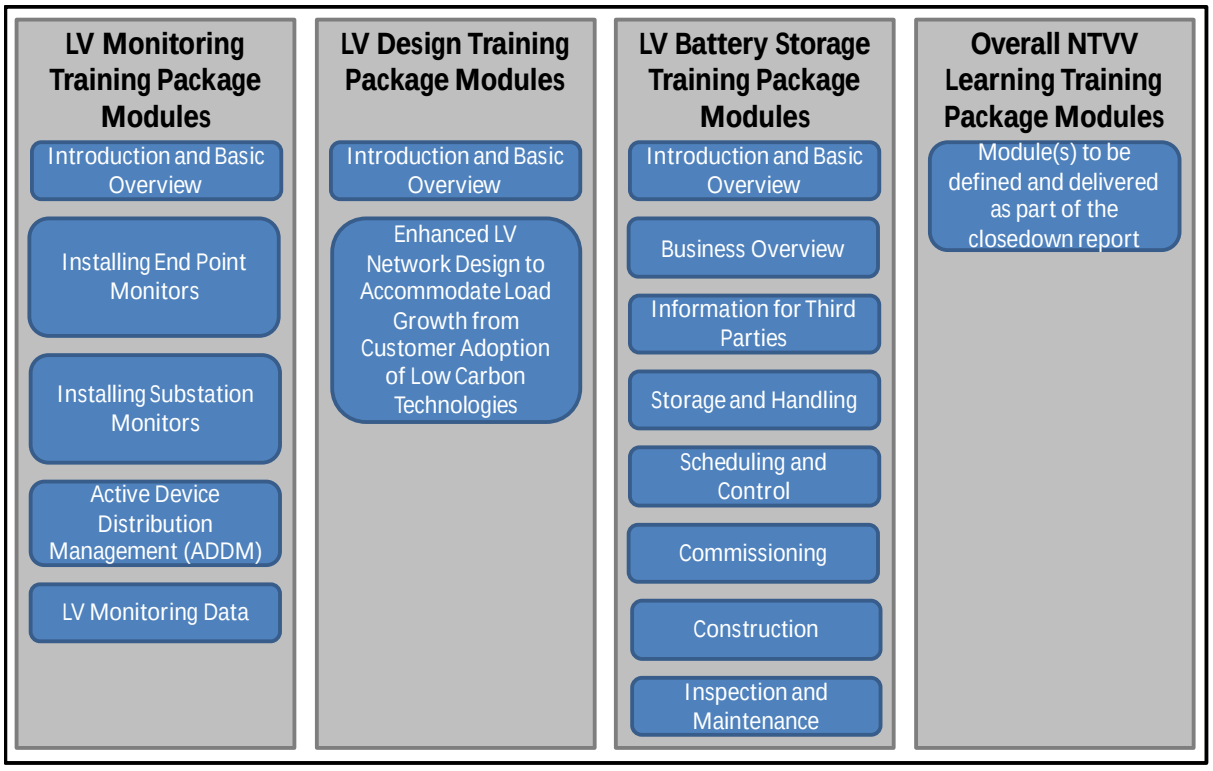

Figure 2: NTVV Training Packages & Modules

The training packages that have been developed are both versatile and modular, with the individual modules targeted at specific staff groups. As a result, the material can be used to train a small group of staff in a specific area, for example Bracknell in the case of NTVV, but can also be used to train staff groups across the regions that comprise Scottish and Southern Electricity Networks' two licence areas. Through the NTVV project dissemination activities, the training modules developed are also freely available to other DNOs. These provide a framework of training material that can be adapted as required to provide training during the adoption of similar technologies or working processes.

In addition to creating useful, practical outputs from the project, the process of developing the policy and training material was valuable as a means of building and consolidating the project team's thinking on applying the project's technologies within BaU, taking into consideration the current industry environment (regulatory framework, market development, etc.). Where wider industry and market factors are set to influence the BaU adoption of innovative network solutions, the technical trials and policy development work undertaken within NTVV provide a wealth of evidence and experience for evaluation to inform these broader decisions.

1. Overview

1.1. Successful Delivery Reward Criteria 9.8(c) Part 3 - DNO Training & Policies Review

The New Thames Valley Vision (NTVV) full bid submission [Ref. 1] defines the Successful Delivery Reward Criteria (SDRC) that must be met for the DNO Training & Policies Review (SDRC 9.8c(3)).

The key topics covered within this report, as defined by the SDRC evidence requirements, are as follows, with the policy review informing the development of the training material:

Policies:

- Identification of areas where new policies are required;
- Issues associated with the implementation of policies; and
- Factors relevant to scalability and wider use of the material within Business as Usual.

Training:

- Identifying areas where training is required;
- Ensuring the effectiveness of training; and
- Factors relevant to scalability and wider use of the material within Business as Usual.

Scottish and Southern Electricity Networks (SSEN) confirms that the above SDRC criteria have been met.

1.2. Link to Methods and Learning Outcomes

The NTVV project has developed new policies and training material based on the relevant learning shared in the SDRC reports delivered to date, together with subsequent learning and experience gained over the duration of the NTVV project. Each of the SDRC reports issued have been completed in line with the NTVV methods and learning outcomes outlined in the full bid submission [Ref. 1].

1.3. Report Structure

The structure of this report is as follows:

- **Section 2: NTVV Project Overview & Transfer to Business as Usual (BaU) Methodology** - Provides a high level overview of the project and outlines the approaches taken in order to assess the policy and training requirements associated with the technologies trialled, and to develop relevant, new policy documentation and training packages;
- **Section 3: Review of Existing Policy Documentation** - Provides the key findings from the review of existing internal policy documentation;
- **Section 4: New Policy Documentation** - Outlines the new policy documents that have been developed as part of the project;
- **Section 5: Implementation of New Policies** - Outlines the potential issues regarding the adoption of the new policy documents into BaU;
- **Section 6**: **NTVV Training Material** - Provides an overview of the training requirements identified, and explains how the training packages were developed to provide effective training material;
- **Section 7: Summary** - Provides a summary of the key points from the DNO Training & Policies Review.

2. NTVV Project Overview & Transfer to BaU Methodology

2.1. NTVV Project Overview

The New Thames Valley Vision (NTVV) project seeks to revolutionise the way DNOs utilise their existing networks and is a £29.9 million, Tier 2 Low Carbon Network (LCN) Fund project, running from January 2012 until March 2017. The key themes of the project are as follows:

- Understanding: To gain a better understanding of the LV distribution network through the collection and subsequent analysis of both end point and substation monitoring data;
- Anticipating: Provide supporting systems to anticipate networks which may come under constraint by the uptake of LCTs or by increased demand and the actions that are required to manage the distribution network more effectively via operational control systems and network design and planning support tools; and
- Supporting: The implementation of technologies to help manage network constraints and facilitate the connection of renewables on the LV network, which include:
    - Commercial Demand Side Response (DSR);
    - Hot and cold thermal storage;
    - Energy storage; and
    - Smart control of power electronics

  to help manage voltage performance, thermal limitations, efficiency and emergency response on the LV network.

Details of the NTVV technology trials have been published in Successful Delivery Reward Criteria (SDRC) Reports, available on the NTVV website [Ref. 2].

2.2. NTVV Technology Overview

The NTVV project has trialled a number of innovative solutions for the enhanced monitoring and management of LV networks, with supporting systems implemented to enable these trials. The high level systems architecture for the project is shown in Figure 3. This architecture brought a new level of visibility and functionality to an LV network that has not previously been available under traditional network operation.

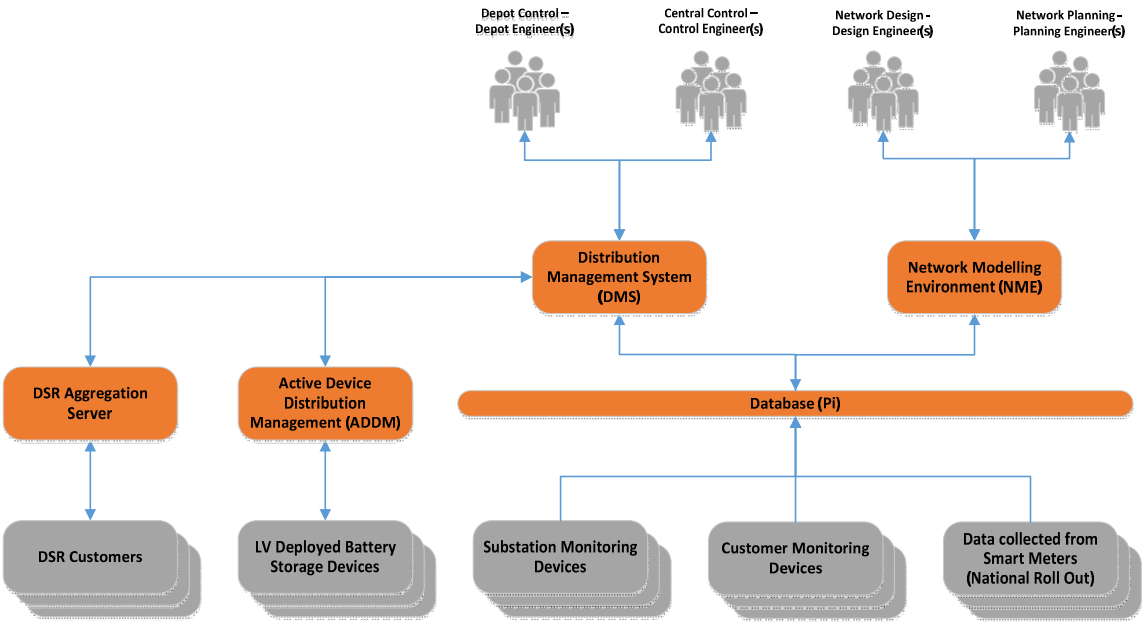

Figure 3: NTVV High Level Architecture

The solutions deployed during the NTVV project are as follows:

- **Commercial Demand Side Response:** The NTVV project trialled a form of DSR called Automated Demand Response (ADR), whereby signals sent to participating commercial customers' premises triggered automated responses from the existing Building Management System (BMS) at the premises to turn down or switch off building systems such as air conditioning, thereby reducing network loading during a 'load shed' event;
- **LV Network Connected Battery Storage:** The Energy Management and Storage (ESMU) devices connected to the LV network are capable of storing electrical energy and exporting this energy at times of local peak demand, and also provide phase balancing functionality;
- **LV Substation Monitoring:** Sensors and logging devices were installed in secondary substations to collect voltage and current measurements for each phase of each feeder, in addition to readings for neutral current; and

- **End Point Monitoring:** Devices were installed on the network side of the tariff meter at participating customers' premises to collect energy usage data (import and export where

embedded generation was present) and provide demand profiles for different types of properties, where such data is not available from **Smart Meters**.

The central systems of the architecture, shown in orange in Figure 3, are described below:

- **Distribution Management System (DMS):** The DMS applies the principles of Supervisory Control And Data Acquisition (SCADA) management and control to the LV network. Access to the DMS was provided to depot staff and a dedicated LV Control Engineer to enable the project to trial new technology solutions;
- **Network Modelling Environment (NME):** The NME combines a Geographical Information System (GIS) with a power flow analysis tool to enable the LV network to be modelled and the effects of LCT uptake scenarios to be studied;
- **Database (Pi Historian):** The Pi Historian database was used to collate all the data from the substation and end point monitoring devices and enabled this LV monitoring data to be available to both the DMS and NME;
- **Demand Response Aggregation Server (DRAS) Server:** The DRAS Server enabled the ADR trials to be undertaken with participating DSR commercial customers; and
- **Active Device Distribution Management (ADDM):** The ADDM system enabled the control strategies to be put in place for the LV battery storage devices that were implemented.

In addition, the following autonomous technologies were deployed within customers' premises as part of the NTVV project:

- **Hot Thermal Storage:** Devices were installed in domestic customer premises to enable excess power generated by household Photovoltaics (PV) to be diverted to hot water tanks, rather than exported to the LV distribution network; and
- **Cold Thermal Storage:** Devices were installed in commercial customer premises to shift the electrical demand associated with commercial Air Conditioning (AC) units from peak periods to off-peak periods by creating ice banks over night to provide cooling the following day.

Further information on the project technical trials can be found in the published SDRC reports available on the NTVV project website [Ref. 2].

2.3. Transfer to BaU Methodology

The policy and training material created through the NTVV project has been developed to inform and support the transition of the technologies trialled within the NTVV project into BaU.

The policy documentation and training packages delivered reflect the associated learning generated from the project. Insight is also drawn from wider research programmes, including other recent LCN Fund project outputs, where appropriate.

The approach taken in order to identify the requirements for new policy documentation and training packages comprised the following four stages, as illustrated in Figure 4:

- **Phase A - Review:** Relevant documentation was reviewed to enable the new policy and training requirements to be determined, including: 1) NTVV trial documentation, 2) Existing SSEN policy documentation and 3) NTVV SDRC documentation;
- **Phase B - Hypothesise:** A hypothesised list of policy documentation and training material requirements was completed based on the findings of the Phase A review process;
- **Phase C - Monitor & Review:** During the course of the technology trials the hypothesised list of policy documentation and training material was reviewed and amended as necessary in response to the learning gained; and
- **Phase D - Outputs:** The new policy documentation and training material was developed and delivered.

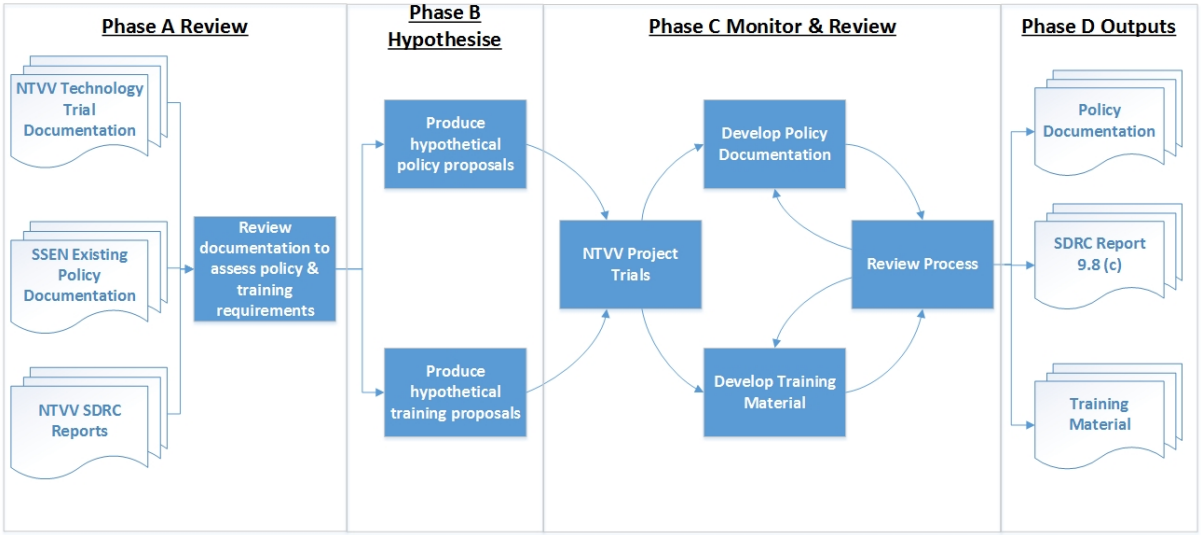

Figure 4: Development of Policy & Training Material for Transfer to BaU

3. Review of Existing Policy Documentation

3.1. Introduction

The review of existing SSEN policy documentation was completed to identify the current scope of the suite of internal documents and assess any changes that may be required to implement the new technologies trialled within the NTVV project within BaU. In total 58 existing documents were identified as relevant for review at the start of the project.

3.2. Policy Documentation Review Outputs

The key findings from the internal policy review process were as follows:

- New policies would be required to cover the following innovative solutions:
  - Demand Side Response; and
  - Energy Storage technologies, including: battery storage on the LV network, cold thermal storage at commercial customers' premises and hot thermal storage at domestic customers' premises.
- New policies for LV Design would be needed to allow the Network Modelling Environment (NME) to be taken into BaU, these would need to supplement the following existing policies:
  - TG-PS-101 - Low Voltage Planning Manual Volt Drop and Maximum Demand;
  - TG-PS-123 - Technical Guide for Load Rating of Underground Cables; and
  - TG-PS-886 - Planning and Design Guidance for Low Voltage and 11kV Secondary Distribution Networks.
- New policies for LV Monitoring, including substation monitoring and end point monitoring at domestic and commercial premises, would be needed to allow LV monitoring be taken into BaU, these would need to supplement the following existing policies:
  - PR-PS-328 - Procedure for Working on the LV Side of Distribution Transformers; and
  - FO-PS-305 - PQS New Substation Form.

3.3. Review Outcomes

The nature of the new technologies and innovative solutions trialled as part of the NTVV project resulted in a relatively small overlap with existing policy documents. In light of this, the decision was taken to develop a new set of policy documents based on the learning from the project. Further information on the suite of new policy documentation delivered is included in Section 4 of this report.

4. New Policy Documentation

4.1. Introduction

The new policy documentation created through the NTVV project was developed in line with the Company (SSEN) standards for documentation [Ref. 3]. At the time of writing the standard document types used within the business's document library are as described in Table 1 below.

Table 1: Policy/Procedure Document Types

Document Type	Description
Policy (**PO**)	Defines what the Company approach to a subject will be. This is a high level document, usually comprising a brief statement on a key area of corporate conduct or responsibility.
Procedure (**PR**)	Describes a process to be followed to comply with a business or regulatory requirement or policy. A complex process may need to reference a number of tasks which can be described in more detail in Work Instructions. References to other documents such as Work Instructions or Forms are hyperlinked. Usually authorised by a senior manager in the business area.
Work Instruction (**WI**)	Provides detailed instruction on how to perform a specific task, or may contain information that needs to be controlled but that is subject to regular change, e.g. lists of authorised people, account codes, etc. Work Instructions should be referenced and hyperlinked from the related Procedure(s). Authorised by a line manager.
Form (FO)	Standard form, template or letter that is used in a process or task. There is no standard template but the form title; number and issue dates must be included in the header or footer. Forms should be referenced and hyperlinked from the related Procedure(s) or Work Instruction(s).
Manual (MA)	A folder reference used to hold a group of documents specific to a subject, e.g. Power Systems Jointing manuals. Can either be used as a document reference in its own right, i.e. for a single large document, or as an indexing reference in the document library to tag a number of related documents.
Reference (REF)	Any other document types not included above which the business wants to hold electronically in the document library area (e.g. system generated letters, job descriptions, logos or art work, toolbox talks, etc.). These are stored in an appropriate folder within the "Reference / Uncontrolled Documents" section of the document library.
Technical Guide (TG)	These proved design guides, guidance on choice of plant, etc.

The new policy documentation is structured into three tiers, as follows:

- **Tier 1 Documents:** The audience for the tier one documents is senior level management. These documents also provide orientation for the overall set of new policy documents;
- **Tier 2 Documents:** The audience for the tier two documents is Planning Engineers, Design Engineers and Operational staff; and
- **Tier 3 Documents[1]:** The audience for the tier three documents is Field staff. This includes both Depot staff and installation contractors.

The documentation has also been developed under five categories to reflect the different aspects of the NTVV technology trials, as follows:

- **LV Monitoring & Control:** These documents cover the LV monitoring aspects of the project. This includes the implementation of substation monitoring and end point monitoring, and the associated management of the LV Network utilising the DMS;
- **LV Design:** These documents cover the LV design processes developed within the project. This includes the use of LV monitoring data within the NME to model the impacts of future demand on the LV network and assess the suitability of innovative solutions as alternatives to traditional reinforcement;
- **LV Network Storage:** These documents cover the storage technologies deployed during the project. This includes hot thermal storage, cold thermal storage and battery storage devices;
- **Capacity Response:** These documents cover the non-storage related technologies that can be used to manage network capacity. This includes Demand Side Response (DSR), the phase balancing functionality provided by the battery storage devices implemented as part of the NTVV project, and Demand Side Management (DSM); and
- **Customer Engagement:** These documents cover the customer engagement processes required to support the introduction of new network and customer based technologies.

Figure 5 provides an overview of the new policy documentation that has been developed through the NTVV project.

[1] Note that the Tier 3 documentation does not form part of this SDRC report as these documents relate specifically to the implementation of the devices and systems trialled within the NTVV project, and BaU application may involve the use of alternative devices or technologies from different product vendors.

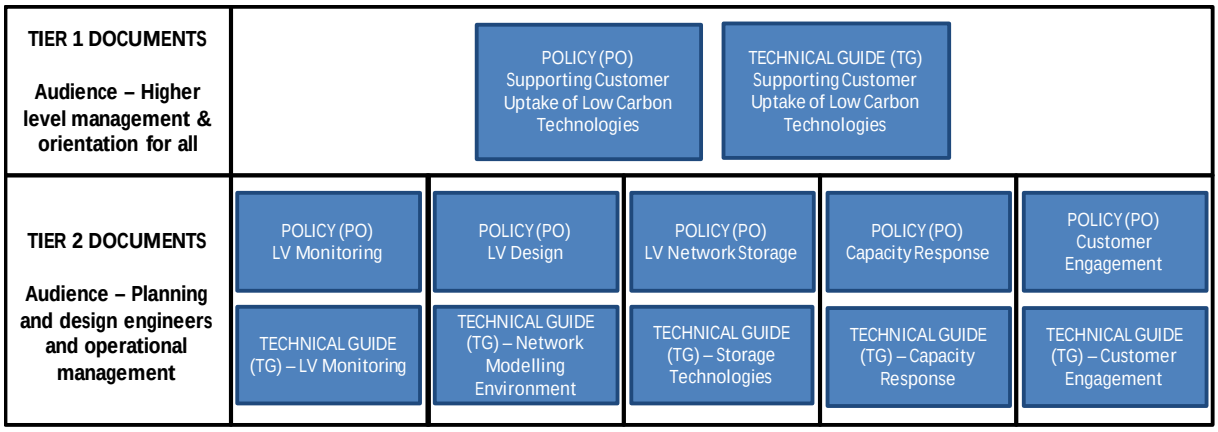

Figure 5: New Policy Documentation Overview

The following subsections of this report provide a short description of each of these policy documents. The full list of new policy documents is provided in Appendix A.

4.2. Tier 1 - High Level Policy Documents

The tier one Policy and Technical Guide provide a high level overview of the approaches that DNOs can use to support customer uptake of LCTs on the LV network, as described below.

4.2.1. Tier 1 Policy - Supporting Customer Uptake of Low Carbon Technologies

The purpose of this document is to outline how the new systems, technologies and working processes trialled within the NTVV project may be implemented to support the adoption of LCTs by customers. This document is provided in Appendix B.

4.2.2. Tier 1 Technical Guide - Supporting Customer Uptake of Low Carbon Technologies:

The purpose of this document is to provide an overview of the technologies trialled as part of the project and provide guidance for those faced with making the decisions as to whether to deploy new smart solutions. This document will be delivered and available for publication by project Close Down.

4.3. Tier 2 - LV Monitoring Policy Documents

4.3.1. LV Monitoring Policy

The purpose of this Policy is to outline the Company's approach to the deployment of monitoring equipment on the LV network. This includes the deployment of substation monitoring and end point monitoring devices. This document is provided in Appendix C.

4.3.2. LV Monitoring Technical Guide

The purpose of this Technical Guide is to provide key information to support the implementation of LV monitoring as part of BaU. The information presented reflects the relevant learning generated from trialling LV monitoring equipment during the NTVV project. This document also supports the LV Monitoring & Control training package developed within NTVV regarding the implementation of LV monitoring equipment. This document is provided in Appendix C.

4.4. Tier 2 - LV Design Policy Documents

4.4.1. LV Design Policy

The purpose of this Policy is to outline the Company's approach to LV network design and investment planning which will support customers in the adoption of new LCTs.

The policy draws on the experience gained through the NTVV project of the technologies trialled and the new processes developed. This document is provided in Appendix D.

4.4.2. LV Design Technical Guide

The purpose of this Technical Guide is to support staff in implementing the new LV Design Policy. It provides guidelines on the application of innovative solutions as alternatives to traditional reinforcement, and details how the new decision support tools developed during the NTVV project can be used to identify potential LV network issues and assess the suitability of alternative solutions.

It is of relevance to those who assess new connections on LV networks and those with responsibilities for LV network constraint management and investment planning. This document also supports the LV Design training package developed to facilitate the transfer of these approaches into BaU. This document is provided in Appendix D.

4.5. Tier 2 - LV Network Storage Policy Documents

4.5.1. LV Network Storage Policy

The purpose of this Policy is to outline the Company's approach to the deployment of storage technologies on low voltage networks. For the purposes of this policy, storage technologies include hot and cold thermal storage in addition to electrical energy storage. This document is provided in Appendix E.

4.5.2. LV Network Storage Technical Guide

The purpose of this Technical Guide is to provide key information regarding the implementation of storage technologies on LV networks. This document also supports the LV Battery Storage training package developed for the deployment of LV network connected battery storage as part of the NTVV Project. This document is provided in Appendix E.

4.6. Tier 2 - Capacity Response Documents

4.6.1. Capacity Response Policy

The purpose of this Policy is to define the Company's approach to the implementation of a number of 'Capacity Response' technologies, as informed through their deployment during the NTVV project. For the purposes of this policy, Capacity Response includes the following techniques: Demand Side Response (DSR), Phase Balancing and Demand Side Management (DSM). This document is provided in Appendix F.

4.6.2. Capacity Response Technical Guide

The purpose of this Technical Guide is to provide key information to support the implementation of the Capacity Response techniques considered within the NTVV project. This document is provided in Appendix F.

4.7. Tier 2 - Customer Engagement Documents

4.7.1. Customer Engagement Policy

The purpose of this Policy is to inform the delivery and implementation of Customer Engagement for both innovation and BaU activities. The document reflects the learning gained from the NTVV project on the customer interactions required both to recruit participants to schemes to and inform stakeholders of specific plans and activities. This document is provided in Appendix G.

4.7.2. Customer Engagement Technical Guide

The purpose of this Technical Guide is to provide best practice approaches for customer engagement when introducing new technologies or undertaking similar projects or programmes of work. This document is provided in Appendix G.

5. Implementation of New Policies

5.1. Introduction

The following subsections of this report outline the current status regarding the adoption of the NTVV technologies into BaU, and the associated implications for implementation of the new policies. It should be noted that the policy documentation has been written from the perspective that the Policies and associated Technical Guides are to be issued into BaU which, at the time of reporting, is not the case. However, by taking this approach the documents prepared are suitable for formal adoption into BaU when appropriate, with minimal revision. At this point in time, the Policies and Technical Guides therefore represent strategic documents to inform the transition of technologies into BaU as part of SSEN's wider Innovation and Asset Management programme, drawing on the learning and recommendations delivered through the NTVV project.

5.2. LV Monitoring & Control

The strategic use of LV substation monitoring devices has been adopted into BaU, and is supported by a Tier 3 Work Instruction for the installation of substation monitors [Ref. 4]. The widespread deployment of end point monitoring (EPM) devices, in contrast, has not been transitioned into BaU, primarily due to the national roll-out of smart meters which are expected to provide data that can be used by DNOs for planning purposes.

The key points relating to the implementation of the policy material to support the transition of the technologies into BaU are as follows:

- Both substation and EPM monitoring devices are available from a number of product vendors as Commercially Off The Shelf (COTS) products. LV monitoring technology is therefore sufficiently mature and cost effective for the implementation of the LV Monitoring policy;
- Similarly, cellular network services using GSM and UMTS signals are widely available, and established communications media, such as radio, can offer a suitable alternative for sites with low mobile coverage;
- The Work Instruction developed within the NTVV project to define how to install, commission, operate, maintain and decommission substation monitors has already been adopted into the Company's BaU policy documentation. The learning and experience gained through the project is therefore directly available to the Company for deploying substation monitoring within BaU activities;
- Whilst the strategic deployment of EPM devices is supported in the short term, it is not expected that the Company will deploy large numbers of EPM devices. In the longer term, it is expected that relevant data will be available from the national roll-out of smart meters. The availability of EPM data through the NTVV project has allowed the Company to develop

approaches for incorporating half hourly customer demand patterns into the network planning and design tools created, and the analysis approaches have been designed such that smart meter data can be utilised in place of end point monitoring data. This is reflected in both the LV Monitoring and LV Design policy documents; and

- The project has enabled the Company to collect and store LV monitoring data from substation monitoring devices, EPM devices and smart meters in a single database. This database (Pi Historian) is already in use as a BaU system. As a result, the Company has learnt how to upgrade existing systems, or how to specify functionality requirements for new systems, to enable this data to be collected, stored and made available to other systems (such as the DMS and NME) to successfully integrate LV monitoring data into the BaU environment. The implementation of the centralised systems required to provide this functionality within a BaU context falls under the remit of SSEN's wider IT Transformation programme, and the NTVV policy material is available to inform this work.

The information needed to support the adoption of LV monitoring devices is provided in the LV Monitoring Policy [Ref. 5] and Technical Guide [Ref. 6] documents.

5.3. LV Design

The NTVV project created a Network Modelling Environment (NME) which combines a geographical information system, equipment database and power flow analysis tool to allow network models to be created and used for detailed LV network studies. A key innovation of the NME is the ability to apply half hourly demand profiles to individual customers across the network to be modelled, allowing the impact of potential future LCT uptake scenarios to be investigated. In addition, the decision support methodologies developed within the project provide a staged approach for identifying and assessing the networks that require detailed investigation, to ensure the efficient use of resources.

The NTVV project has demonstrated that the functionality provided by the NME has the potential to provide significant benefits to a DNO. In keeping with the introduction of any enterprise level system, however, detailed systems analysis will be required prior to the commissioning of such a system within BaU. As such, whilst the NTVV NME is not yet suitable for immediate roll-out at scale across the business, it is the intention is to bring this functionality into BaU in time. In line with business practices this will fall under the remit of the IT Transformation programme.

The guidelines on the functionality provided by the NME and the use of LV decision support tools are provided in the LV Design Policy [Ref. 7] and Technical Guide [Ref. 8] documents.

5.4. LV Network Storage

This section firstly address the implementation of LV network connected electrical energy storage devices, and then considers the policy for thermal energy storage technologies installed within customers' premises.

The learning and experience gained from the deployment of ESMUs within the NTVV project demonstrates the value in DNOs owning and operating energy storage assets to provide flexibility in network management. LV network connected energy storage devices represent a viable solution both for managing intermittent network constraints, and for allowing networks to be operated safely and securely where there is uncertainty over how energy usage patterns will change through time. At present, however, three key barriers exist to the BaU deployment of such technologies by DNOs, namely:

- Technological maturity - the availability of COTS devices which apply defined standards and protocols for safety, communications and data exchange;
- Economics - the cost of such devices at this stage of market development; and
- Regulatory issues - uncertainty over possible future restrictions on DNO ownership of batteries.

These factors are reflected in the policy for implementation of LV network connected electrical energy storage, as follows:

- The ESMU devices trialled within the NTVV project contain battery modules which can be used to import and export electricity as required to support the LV network, in addition to a Power Electronics Units that can be used for phase balancing;
- The units were developed specifically for the project, and Technology Readiness Level (TRL) of these devices has been taken from TRL2 (concept) to TRL7 (prototype and demonstration). As they are not yet a COTS product, they are not suitable for deployment in a BaU environment at this point in time;
- Energy storage is a growing market, and the costs for lithium ion batteries (the technology used within the ESMUs as well as some electric vehicles), is falling. Within ED1 it is feasible that the availability of suitable, cost effective COTS products will increase;
- A number of factors associated with DNO ownership and operation of battery storage are currently under consideration within the wider industry and regulatory framework, and the outcomes of these may influence DNO use of LV network storage technologies; and
- When deploying any devices to be installed in public areas, environmental aspects must be considered. With the ESMUs trialled in the NTVV project the size of the devices and the noise

generated when the cooling fans were operational needed to be taken into account when identifying suitable locations for roadside installation in residential areas.

The NTVV policy documents, together with the training material developed through the project, will support the transition of battery storage technologies into BaU should the three key barriers to the wide scale adoption of LV battery storage devices be addressed.

The NTVV project also trialled thermal storage devices installed within participating domestic and commercial customers' premises. SSEN supports customer uptake of these technologies, however it will not finance, install, maintain or operate thermal or electrical energy storage devices installed on the customer side of the meter as BaU. The following key points relate to the policy for adoption of such technologies on the LV Network:

- The NTVV project demonstrated two thermal storage solutions to meet different network requirements, both of which are installed within the customers' premises:
    - EMMA units - hot thermal storage devices for residential customers with solar PV generation which reduce the electricity exported to grid by diverting PV generation to heat water stored within a domestic hot water cylinder
    - Ice Bears - cold thermal storage units for commercial customers with air conditioning load that delivers a reduction in summer peak demand by creating ice at off-peak times for use to provide cooling during peak times
- These technologies provide direct benefits to the customers who have them installed, as well as demonstrating benefits for the local LV network. However, since not all premises are suitable for the installation of such technologies, some customers receive direct financial benefit from the technologies where others will not. In addition, significant resources are required to manage the relationships associated with the installation and ongoing maintenance of devices owned within customers' premises;
- As such, at present it is not the business's intention to install, own or operate such thermal energy storage devices beyond the customer's meter. This policy similarly applies to domestic or commercial electricity storage technologies; and
- SSEN will, however, accept the use of these technologies where they form part of a service provided by a third party, such as Demand Side Response aggregator, which is procured by SSEN in keeping with the Capacity Response policy to manage network constraint(s) and meet Security of Supply requirements [Ref. 9].

The guidelines on the deployment of LV storage devices are provided in the LV Network Storage Policy [Ref. 10] and Technical Guide [Ref. 11] documents.

5.5. Capacity Response

The term Capacity Response comprises a range of technologies or solutions that can be applied to cost effectively optimise the use of existing LV network assets. Such approaches enable the distribution network to accommodate additional load without the requirement for traditional network reinforcement. SSEN supports the adoption of these techniques into BaU.

The key points relating to the use of the policy material in supporting the transition of Capacity Response technologies into BaU are as follows:

- The NTVV project trialled a form of DSR called Automated Demand Response (ADR). This demand reduction technology involved the automated control of electricity use at participating commercial customers' premises during scheduled 'load shed' events via signals sent from the DNO to the Building Management System (BMS) at the premise. On receipt of the control signal, the BMS then initiated a programmed response which turned down or switched off building systems such as air conditioning to reduce demand. These trials utilised commercially available systems, specially configured for the project;
- The learning generated from this aspect of the NTVV project, as reflected in the policy material developed, has supported SSEN in developing the Constraint Managed Zone (CMZ) schemes implemented directly into BaU. A CMZ is a geographic region served by an existing network where network requirements related to peak electrical demand under fault conditions are met through the use of Demand Side Response (DSR) techniques (including customer demand reduction and export from third party owned generation and storage), provided as a managed service to SSEN by a CMZ service provider. The DSR technologies used to provide this service may include demand reduction from commercial or aggregated domestic premises, or export from third party owned electricity storage or stand-by generation;
- The phase balancing technology incorporated within the ESMU devices demonstrated the suitability of this functionality as a new solution for addressing phase imbalance, as identified through the project's installation of LV substation monitoring. Whilst the ESMU devices cannot be adopted into BaU at the current time, the policy material reflects SSEN's support for the application of power electronics to provide real time phase balancing, thereby making efficient use of existing network capacity and reducing losses on the LV network; and
- The learning captured within the new policy material developed through the NTVV project will support the transition of Capacity Response techniques into BaU in the future.

The guidelines on the application of Capacity Response techniques are provided in the Capacity Response Policy [Ref. 12] and Technical Guide [Ref. 13] documents.

5.6. Customer Engagement

The Customer Engagement policy material captures the learning gained from engaging with a wide range of stakeholder groups during the NTVV project. These documents set out the key considerations when engaging with customers to both recruit participants to schemes or trials, and to inform stakeholders of business plans and activities. These documents will be utilised by SSEN as key reference material for the development of Customer Engagement Strategies when engaging with customers regarding the implementation of new technologies on the LV network. Further, the experience captured in these documents will inform broader aspects of the business's BaU customer engagement activities.

The guidance on Customer Engagement is provided in the Customer Engagement Policy [Ref. 14] and Technical Guide [Ref. 15] documents.

5.7. Scalability

A range of factors must be considered when assessing and planning the deployment of technologies at scale. These will inform decisions on the transition of solutions from trials into BaU.

During the development of the NTVV policy documentation, consideration has been given to a list of key factors which reflect circumstances, characteristics or considerations that will have an influence on the scalability or replicability of a solution, as identified through SSEN's participation[2] in the European collaborative project DISCERN - Distributed Intelligence for Cost-Effective and Reliable Distribution Network Operation[3]. These factors provide an assessment framework to highlight where detailed consideration would be of value to ensure the feasibility of scaling or replicating a solution in a different network environment.

[2] To leverage the work undertaken in the NTVV project, SSEN participated in the European Seventh Framework Programme (FP7) project DISCERN. Through the DISCERN NIA project , SSEN shared experience and information drawn from NTVV to access the range of additional knowledge and expertise represented by the DISCERN project participants themselves, together with information on the solutions implemented by the DNO/DSOs partners in their smart grid demonstration site projects. The DISCERN NIA Close Down Report is available on the ENA's Smarter Networks Portal www.smarternetworks.org/NIA_PEA_Docs/NIA_Project_Closed_Down_Report_-_DISCERN_-_final_p_160729134722.pdf.

[3] The DISCERN EU FP7 project ran from February 2013 to April 2016, and the project consortium comprised eleven project partners drawn from Distribution System Operator (DSO), technology provider, research and consultancy fields across Germany, Great Britain, Spain and Sweden. The DISCERN Final Report and accompanying deliverables can found on the project's website www.discern.eu/project_output/finalreport.html.

The following text summarises the key points of relevance regarding the scalability of technologies such as those trialled within the NTVV project.

- **Interoperability** - The use of common technical standards and communications protocols supports interoperability between systems and devices, and is therefore key to ensuring the efficient and cost effective deployment of monitoring and control technologies. When implementing active network management solutions at scale, and integrating these with existing systems, detailed consideration must be given to the adoption of appropriate standards and protocols and choice of compatible technologies. The deployment of the solutions trialled within NTVV was shaped by existing standards and protocols used within the business, however for the roll-out of a range of new technologies at scale, it may be appropriate to review the standards used across both new and existing technologies, to ensure ease of integration and 'future proofing'. Similarly, the creation of the Network Modelling Environment (NME) within NTVV has demonstrated the benefits of applying the Common Information Model (CIM)[4] for specifying the data to be exchanged between solutions, and this is reflected in the Tier 1 Policy document. Decisions related to standards for interoperability would need to be made at enterprise level, for example as part of the business's wider IT Transformation programme.
- **Software Design Flexibility, Interface Design Flexibility and Version Compatibility** - Each of these is relevant when ensuring that technologies deployed at a given point in time will remain viable over time. To ensure that such factors are addressed, the implementation of supporting systems associated with the BaU roll-out of technologies such as LV monitoring and the LV design decision support tools developed within NTVV would be integrated into the business's IT Transformation programme.
- **Modularity** - The modular design and deployment of technologies can ensure the flexible and cost effective roll-out of solutions. This principle has been applied in the development of technologies and policies within NTVV where appropriate, such as LV substation monitoring and the ESMU LV network connected energy storage devices.

  Increment on Device/System Inventory - To provide cost effective benefits to network operation and management, the BaU roll-out of technologies need not equate to a full-scale roll-out across all sites. The technical experience from NTVV has informed the development of guidance for LV monitoring and LV design that can be applied across all LV networks. This allows resources to be targeted at prioritised networks, and allows the assessment of

[4] The Common Information Model (CIM) is a standard data model for specifying the format of the messages that allow information relating to electrical networks to be exchanged between systems within a solution. It has been formally adopted by the International Electrotechnical Commission (IEC) - IEC 61968 is the CIM standard for Distribution Management and IEC 61970 is the CIM standard for Energy Management.

innovative solutions as alternatives to traditional reinforcement. These approaches are reflected in the Policy and Technical Guides developed during the project.

- **Simplicity/Ease of Installation & Integration** - The selection of equipment to be deployed for the NTVV trials took into consideration the associated installation process, the time and resources required, and any training requirements necessary. For equipment to be installed within existing spaces, such as LV substation monitoring, the availability of two (or more) types of device for deployment under BaU will ensure that the majority of potential installation situations can be accommodated with regard to space for installation, configuration with existing equipment, etc. Where equipment to be deployed is relatively new and innovative, such as the ESMU electrical energy storage devices, the early development and use of Technical Guides and training material supports the ease of installation and integration at scale.
- **Economies of Scale, Technology Evolution and Availability of Alternatives** - These factors are relevant for the uptake of any technology at scale, and can be driven by both the technological maturity of components and the numbers of competitors in the market. Whilst the energy storage and ADR trials undertaken within NTVV align with emerging markets for storage and DSR, the ESMU devices were specially commissioned for the project as no suitable solutions were available from the market. Similarly, the range of systems available for implementing DNO initiated DSR is relatively low at present. The future potential development of these markets will influence the implementation of such technologies at scale by DNOs, and this is reflected in the Policies and Technical Guides developed through NTVV. In contrast, LV monitoring devices and sensors are readily available off the shelf, from a range of product vendors.
- **Stakeholder Interaction** - The level of stakeholder interaction and/or customer engagement required for the implementation of some solutions may have significant implications for business processes and resources. These factors must be taken into account when assessing the costs and implications of the potential roll-out of technologies at scale, and the experience gained through NTVV has informed the development of the associated policy documents.

  Technical Abstraction (physical characteristics - user experience) and Level of Acceptance - The level of interaction that a user may need to have with a technology may influence its optimal use. As such, when rolling out innovative technologies at scale consideration may need to be given to the Use Case(s) for the technology, how best to achieve the aims of its deployment, and how best to promote acceptance of the new approach. For business systems, this has implications for the introduction of active network management technologies and the use of manual or automated control. Similarly, with regard to DSR technologies, automation may suit some customers, whilst others may prefer to make all decisions regarding participation in a DSR event. These factors will also be of relevance for commercial and domestic customer acceptance and uptake of technologies which will be

outside a DNO's control but which will influence the demand patterns seen on LV networks, such as thermal energy storage, domestic batteries, etc.

- **Regulatory and Legal Issues** - The scale of future uptake by DNOs of the technologies trialled within NTVV may be influenced by regulatory or legislative factors and their implications for market developments. At present, such considerations include uncertainties over possible future restrictions on DNO ownership of storage, in addition to the need for clarity over how different DSR market actors will interact, and how issues at different levels of the network/electricity supply chain will be coordinated and prioritised. Similarly, there is a need for further consideration as to how the potential introduction of time of use tariffs may sit alongside commercial arrangements for active network management, such as DSR services procured from a third party. The approaches for assessing security of supply and/or measuring the outputs delivered by innovative solutions under the RIIO price control framework may also need to be considered to ensure that no artificial barriers are created. For example, the metrics associated with Health Indices and Load Indices must allow equitable comparison between innovative solutions and traditional reinforcement. Further considerations include the possible transition from DNO to DSO, and whether there is a need to consider additional mechanisms within the RIIO price control framework for supporting the deployment of technologies required as enablers for such a transition.
- **External Constraints** - With regard to the technologies trialled within the NTVV project, this includes factors such as space for installation of chosen equipment, and considerations with regard to the siting of equipment, such as the roadside cabinets for the ESMU electrical energy storage devices. It also relates to the specific characteristics of the network in a given area, and the solutions best suited to the different situations to be addressed. Guidance on these factors is provided in the Policies and Technical Guides developed during the project. Additionally, although technical standards and communications protocols were available for the system interactions required to implement the NTVV architecture, it is recognised that European or International standards organisations may need to develop new, or enhance existing, technical, communications or data security standards to support the increased implementation of active network management technologies by DNOs as BaU.
- **Skills and Training** - Relevant staff will need to be introduced to and familiarised with new equipment, systems and working processes. The development of formal training and reference documents such as Technical Guides supports the implementation of policy as technologies are rolled out at scale. This is the basis for the policy and training material developed within the NTVV project to support the deployment of technologies that will provide enhanced functionality and flexibility to the operation and management of LV networks.

The following key points relate to the scalability of the new NTVV policy documentation when transitioning the technologies trialled into BaU.

- The new policy documentation has been designed to be informative and clear in reflecting the experience gained from the NTVV project. The documents draw specific examples from the NTVV trials to provide the context for the conclusions presented in the policies, however the strategic policy statements adopt a "technology/supplier neutral approach" to ensure that the documentation is applicable regardless of the devices to be procured through the Company's standard BaU procurement processes for a scaled deployment;
- The suite of new policy documents has been structured to cover each of the new technologies trialled within the NTVV project. Whilst the various technologies have different levels of suitability for BaU deployment at present, and the scale of their future uptake by DNOs may be influenced by external factors such as market developments and regulation, these documents can be readily used as the basis for future policy documents to be issued as and when the technologies are adopted into BaU;
- Each of the documents has been produced from the perspective that the Policies are to be adopted into BaU, with clear policy statements given reflecting the applicability of the solutions at scale. As already outlined, these new policy documents have not been adopted into BaU by SSEN as part of the NTVV project, however this approach ensures that the documents prepared are suitable for formal adoption into BaU;
- The five categories identified for the set of new documentation will enable additional smart solutions or technologies to be incorporated into the policies in the future; and
- Where the new policy documents are to be issued under BaU, their integration with SSEN's existing policies will need to be considered again at that point in time. The existing policies in place when the NTVV policy work was undertaken have been reviewed and those that will either need to be amended or superseded have been identified, however the business's regular review processes may mean that this have changed through time.

In summary, the new documents have been created in such a way that they may be adopted where appropriate, adapted in light of further research or wider external factors, or used as a basis to incorporate and develop policy for other new, innovative solutions as technologies are transferred from innovation trials and scaled to the BaU environment.

6. NTVV Training Material

6.1. Introduction

In order to support the transition of new technologies to BaU, and to provide material to disseminate the key learning from the NTVV project, the following four training packages will be available to the business:

- **LV Monitoring:** Covers the business drivers for LV monitoring, the installation of LV monitoring devices, and the utilisation of LV monitoring data. This training package is provided in Appendix H;
- **LV Design:** Covers the need for decision support tools for LV Planners and Designers, the functionality provided by the new tools developed within the NTVV project, new ways of working as a result of the learning generated by NTVV, and how to assess the suitability of alternative, smart solutions for accommodating LV network load growth due to customer adoption of LCTs. This training package is provided in Appendix I;
- **LV Battery Storage:** Specifically covers the ESMU devices trialed within the NTVV project, including how to deploy, commission, control, manage and maintain them. This training package is provided in Appendix J; and
- **Overall NTVV Learning:** Providing an introduction to the changing environment for electricity distribution networks due to increased customer uptake of LCTs, and the alternative approaches to planning, operating and managing them, in addition to presenting the overall key learning from NTVV project. This will be developed and delivered for publication by project Close Down.

The themes for training differ slightly from the themes for policy to reflect the requirements of the project and ensure the relevance of the material produced for the business.

With regard to LV Network Storage, the training material developed relates specifically to the ESMU LV Battery Storage devices to support the implementation and trialling of these technologies within the NTVV project. However, the material has been prepared such that it can be amended and utilised should SSEN deploy other LV storage devices in the future. No training material has been developed to cover the implementation of storage technologies on the customer side of the meter, such as the hot and cold thermal storage devices trialled within the NTVV project. This reflects the policy established for these technologies, as the business will not finance, install, maintain or operate such devices on the customer side of the meter.

The different aspects of Capacity Response technologies, coupled with the fact that the DSR market is in its infancy, lead to the decision that it would not be appropriate to develop Capacity Response training at this stage. Rather, within the NTVV project, training related to Capacity Response simply comprised the introduction provided to a number of project staff on the use of the DRAS system to schedule ADR events. However, the increasing interest within the industry (DNOs, TSOs, regulators and governments around the world) in the flexibility offered by such services, together with increasing awareness amongst potential DSR participants, mean that training on specific aspects of the implementation and use of various Capacity Response technologies is likely to be required at some future point.

At this stage, to ensure the learning from NTVV can be effectively transferred to the business, the Customer Engagement policy documents provide a useful, central point of reference for anyone considering the Customer Engagement aspects of their project or BaU activities. These documents are available to inform thinking and support the development of a bespoke Customer Engagement Strategy which meets the specific needs of the planned activities. As such, rather than provide training at a given point in time, it became clear during the project that the value here is in having the policy documentation available for reference by any member of staff at any future point as required.

As an additional training theme, however, it was recognised that there would be value in developing an Overall Learning training package to provide an introduction to the challenges and solutions considered within the NTVV project. This training package will provide a means of raising awareness of the issues faced by DNOs due to changing energy usage patterns, and the innovative technologies and approaches being considered to address these. The material to be developed will be suitable for use with any interested parties across the business, and be available for use by other DNOs and external stakeholders, including Independent Distribution Network Operators (IDNOs) and Independent Connection Providers (ICPs).

A ‘training needs analysis’ has been completed for the first three of the training packages listed above. This analysis:

1. Identified the staff group(s) that would be involved with the new technologies;
2. Identified the training needs for each of the staff groups;
3. Defined training modules suitable for different staff groups under each of the training packages; and
4. Provided a matrix outlining which training modules were relevant for each staff group.

The creation of training modules targeted at different staff groups provides maximum flexibility in the use of the training resources developed. These modules can be mixed and matched as applicable to the staff groups involved, and avoids unnecessary customisation where requirements are similar.

The more general modules provide a resource for use by other DNOs, and the more SSEN specific material provides a template for modification by others.

The following subsections of this report set out the training modules identified through the training needs analysis, present the training matrices which set out the intended audiences for each of the modules, and describe how the training modules were subsequently developed to provide effective training material. Each reflects the strategic thinking presented in the new policy documentation developed through the NTVV project. The final subsection on scalability addresses considerations relating to the use of this training material as the associated technologies are rolled out at scale within BaU.

6.2. LV Monitoring

The specific modules developed under the title of LV Monitoring are as follows:

- **LVMON1 - Introduction and Business Overview:** Provides an overview of what LV monitoring is, why monitoring devices will be deployed, where the monitoring devices will be deployed, and the high level architecture of the supporting systems required to capture and draw value from the data.
- **LVMON2 - Installing End Point Monitors:** Provides training for the installation and commissioning of end point monitors;
- **LVMON3 - Installing Substation Monitors:** Provides training for the installation and commissioning of secondary substation monitors;
- **LVMON4 - Active Device Distribution Management (ADDM):** Outlines the ADDM system architecture established within the NTVV project and used to control the deployed LV network battery storage devices; and
- **LVMON5 - LV Monitoring Data:** Outlines the range of uses for LV monitoring data.

The training matrix for the LV Monitoring training package is shown in Table 2.

Drawing on the expertise of those involved with the deployment of substation and end point monitoring during the NTVV project, this suite of modules provides effective training targeted at the different aspects of LV monitoring, ensuring that the experience gained through the NTVV project is captured and can be applied by other who may be involved in the BaU deployment of LV monitoring.

Table 2: LV Monitoring Training Matrix

		LVMON1	LVMON2	LVMON3	LVMON4	LVMON5
		Introduction and Business Overview	Installation, Commissioning & Decommissioning of EPMs	Installation, Commissioning & Decommissioning of SS Monitors	Active Device Distribution Management (ADDM)	LV Monitoring Data
A	Maintenance staff	ü	ü	ü		ü
B	Rapid Response Operatives, Standby Engineers, Substation Inspectors	ü	ü	ü		ü
C	Control Engineers, Real Time System Engineers	ü	ü	ü	ü	ü
D	Construction Engineers, Installation staff and contractors	ü	ü	ü		ü
E	Team managers, Regional Depot managers, other senior managers	ü				ü
F	LV Design and Planners	ü				ü
G	IT Staff	ü			ü	ü

The LV Monitoring training modules are provided in Appendix H.

6.3. LV Design

The modules that have been defined for development under the title of LV Design are as follows:

- **LVDES1 - Introduction and Business Overview:** Outlines the need for decision support tools, the tools developed through the NTVV project that are now available for network planners and connection designers, and the high level features of these tools that will help SSEN achieve their business objectives.
- **LVDES2 - Enhanced LV Network Design to Accommodate Load Growth resulting from Customer Adoption of Low Carbon Technologies:** This module covers:
    - The anticipated growth of domestic demand and the need for new decision support tools at the LV level;
    - The range of new smart solutions which can be considered as alternatives to traditional reinforcement;
    - How new alternative solutions can be deployed and where they are most likely to offer a technically viable alternative to network reinforcement;
    - The decision support tools developed within the NTVV project and the insights that these can provide to network planners and connection designers to ensure that consistent, best-value investment decisions are made;
    - The sources of relevant data to feed into the decision support tools;
    - How to determine whether the area of network under consideration has sufficient capacity for the anticipated load growth over the agreed planning period;
    - How to determine whether alternative solutions should be considered alongside traditional reinforcement for the types of constraints identified; and
    - How to identify the best value solution for deployment on constrained networks.
- **LVDES3 - Performing Studies using the NME:** This module will provide training on the practical use of the NME to undertake network studies (systems access, user interface, assessment processes, etc.). As previously outlined, the NTVV NME is not yet suitable for immediate roll-out at scale across the business, therefore this module is to be developed once the system to be commissioned for BaU has been finalised.

The training matrix for the LV Design training package is shown in Table 3.

In keeping with the associated policy documentation, through engagement with network designers and planners during development of this material, these modules provide an effective means for introducing the new concepts and approaches developed through the NTVV project. Sufficient detail is given to promote acceptance and confidence in applying the approaches across the range of relevant staff groups.

Table 3: LV Design Training Matrix

		LVDES1	LVDES2	LVDES3
		Introduction and Business Overview	Accommodating LCTs in LV Design	Performing Studies using the NME
A	Network Planners	ü	ü	This will be produced when the final version of the NME has been commissioned.
B	Connection Designers	ü	ü	
G	Team managers, Regional Depot managers, other interest groups	ü		

The LV Design training modules are provided in Appendix I.

6.4. LV Battery Storage (ESMU)

The modules defined for development under the title of LV Battery Storage relate specifically to the ESMU devices trialled within the NTVV project, as outlined below:

- **ESMU1 - Introduction and Basic Overview:** Describes an ESMU and its constituent parts, how they operate, why they would be deployed, where they would be deployed, and the overall systems overview;
- **ESMU2 - Business Overview:** This provides a process overview, the case for deployment of storage, the safety case and safety considerations, information on the lifecycle of an ESMU, the responsibilities of different staff groups, and the supporting documentation available;
- **ESMU3 - Operational Safety:** This module was identified in recognition of the need to provide training on the hazards and safety procedures associated with storage technologies. However, during the course of training development the decision was taken to incorporate safety specifically within each of the relevant ESMU training modules, tailored for each topic area and audience. As such, no standalone Operational Safety module has been developed.
- **ESMU4 - Information for Third Parties:** Sets out the third parties to be informed of the units (including the Fire Service), the information that they are to be provided with, likely reasons for calls to the SSEN Emergency Service Centre (ESC), questions to ask callers who are reporting an issue, and appropriate ESC & Control Room actions and responses;
- **ESMU5 - Storage and Handling:** Presents the storage, transportation, handling, offloading and positioning considerations for ESMUs;

- **ESMU6 - Scheduling and Control:** Covers how the battery storage devices are presented in the DMS, how the devices are scheduled to operate, what happens if communication is lost, the need for cycling of the battery (charging and discharging), battery health, the online monitoring available, and failure modes and corrective strategies;
- **ESMU7 - Commissioning:** Outlines how the devices are commissioned, the required protection schemes, and the records that will need to be completed/updated;
- **ESMU8 - Modelling and Solution Selection:** This was identified to set out where and when storage would be considered, the network constraints it can be used to manage, and how the solution can be modelled to determine efficacy. However, during the course of training development it became apparent that information on modelling and solution selection is addressed in detail in the LV Design training work package. As such, no specific ESMU modelling and solution selection module has been developed;
- **ESMU9 - Construction:** Covers site selection, how the devices are installed, how to connect the devices to the network, and how the devices are decommissioned; and
- **ESMU10 - Inspection and Maintenance:** Explains how the devices are maintained.

The training matrices for the LV Battery Storage training modules are shown in Table 4 and Table 5 respectively.

The effectiveness of this training material was demonstrated through its direct use within the project to deliver training to operational staff engaged with the deployment and use of the ESMUs.

For the ongoing maintenance aspects of the ESMU trials, a series of monthly internal 'ESMU Maintenance Reports' were created to document the work undertaken and the level acceptance of the new equipment by the depot engineers. These reports also documented how well the training was received and how well the instructions were subsequently followed, to capture learning that would allow the training material to be refined where necessary.

The first three sessions of the maintenance programme incorporated training for the SSEN depot engineers who would be responsible for the maintenance of the equipment (two engineers from each of three depots - Reading, Slough and West London). The training material was delivered by the NTVV project team, and comprised the relevant training modules in addition to practical sessions regarding the Work Instruction for the installation, maintenance and decommissioning of the units [Ref. 16]. The monthly reports show that the material was well understood and accepted, as detailed here.

The depot engineers engaged well with the training, however expressed apprehension over some of the unfamiliar electrical components contained within the ESMUs, such as the inverter unit and programmable logic controller. The training material supported the NTVV Project team in explaining the equipment and how to interact with it, to provide confidence and assurance to staff.

The sessions also allowed the depot engineers to ask questions, and where challenges were raised regarding the approaches to be taken, these could be addressed directly by the project team delivering the training. In these cases, the training material provided useful reference for explaining the reasons for the approaches to be taken, and the issues that may occur should these not be followed, ensuring acceptance of the process.

The depot engineers were closely supervised by the project team during their first session, however worked as teams on their own during the second session, with the project team on hand to prompt if required. The depot engineers reported that they felt comfortable working on the ESMUs after the first session, and completed the maintenance work in half the time during the second session.

The training material was therefore well received by the depot engineers, who understood the requirements and procedures such that they were able to successfully complete work without requiring the presence of a member of the NTVV project team.

The feedback from the training sessions was that the content and format of the training material was well thought out, and pitched at the right level. As well as introducing the equipment, the material provided context as to the purpose and use of the technology, and how it integrates with both the LV network and the operational control systems. However, some trainees felt that the material could have been shortened by a few slides in some cases, whilst still delivering the required information. This feedback was taken into account in subsequent revisions of the material.

Overall the training was found to be very effective. The training material contained the relevant information required to engage staff prior to the practical sessions, and prepare them with information on the equipment and safety aspects of the work. The training embedded a good understanding and acceptance of the technology amongst the depot staff responsible for managing, operating and working on the area of the network where the ESMU devices were deployed.

The benefit of tailoring the presentations to specific audiences, such as the Maintenance staff and Rapid Response Operatives, was also clear.

Table 4: LV Battery Storage Training Matrix (part one)

		ESMU1	ESMU2	ESMU3	ESMU4	ESMU5
		Introduction and Basic Overview	Business Overview	Operational Safety	Information for Third Parties	Storage and Handling
A	Maintenance staff	ü		Safety information has been provided in each of the relevant ESMU training modules and tailored for each topic area and audience.		
B	Rapid Response Operatives, Standby Engineers, Substation Inspectors	ü				
C	Control Engineers, Real Time System Engineers	ü			ü	
D	Emergency Services Centre staff	ü			ü	
E	Construction Engineers, Installation staff and contractors	ü				ü
F	Storage, handling, delivery, offloading & positioning contractors	ü				ü
G	Team managers, Regional Depot managers, other senior managers	ü	ü			

Table 5: LV Battery Storage Training Matrix (part two)

		ESMU6	ESMU7	ESMU8	ESMU9	ESMU10
		Scheduling and Control	Commissioning	Modelling and Solution Selection	Construction	Inspection and Maintenance
A	Maintenance staff			Modelling and solution selection is covered by the LV Design training package.		ü
B	Rapid Response Operatives, Standby Engineers, Substation Inspectors					
C	Control Engineers, Real Time System Engineers	ü	ü			
D	Emergency Services Centre staff					
E	Construction Engineers, Installation staff and contractors		ü		ü	
F	Storage, handling, delivery, offloading & positioning contractors					
G	Team managers, Regional Depot managers, other senior managers					

The LV Battery Storage training modules are provided in Appendix J.

6.5. Scalability

The following key points relate to the use of the new training packages when scaling the deployment of the various technologies trialled within NTVV into BaU as appropriate.

- The training material has been developed to be suitable for use during the transition of the associated technologies into BaU;
- The **LV Monitoring** training packages focus on the deployment of LV monitoring devices. Further training modules which cover the user's interaction with the systems providing access to the data, or the use of monitoring data for active network management and control, will need to be developed once the centralised systems (Pi Database and DMS, or equivalent systems) to be used to successfully integrate the LV monitoring data into the BaU environment have been agreed and defined as part of SSEN's wider IT Transformation programme;
- The **LV Monitoring** training packages have been designed to be "technology agnostic". This enables the core material to be used, and easily amended if required, in the event that differing LV monitoring devices are procured from multiple product vendors over time;
- The **LV Design** training packages focus on the new techniques developed through the use of the NME within the NTVV project. Whilst the principles of the approaches will stand, variations between the NTVV NME and the system to be procured to bring this functionality into BaU at scale across the business make it likely that revisions to these training modules will be required;
- The **LV Battery Storage** training material has been developed to specifically support the implementation and trialling of the ESMU devices deployed within the NTVV project. However, should SSEN deploy other such LV storage devices in the future, this material can be utilised and amended accordingly; and
- It should be noted that a number of the modular training courses developed within the project need to be supported by practical, hands on training around the devices to be deployed. Such sessions must be delivered by competent, authorised personnel as appropriate. Due to the nature of these training sessions, no specific practical training material has been produced. The training material developed, however, makes reference to the use of practical sessions, which would then be coordinated by the manager in charge of providing the training as relevant to the device specification. Within the project the practical aspects were delivered by the project team in keeping with the associated Work Instructions.

Overall the training packages that have been developed are both versatile and modular, with the individual modules targeted at specific staff groups. As a result, the material can be used to train a small group of staff in a specific area, for example Bracknell in the case of NTVV, but also to train staff groups across SSEN's licence areas.

Through the NTVV project dissemination activities, the training modules are also available to other DNOs as a framework of training material that can be adapted as required to support the adoption of similar technologies or working processes.

When developing and delivering any training, it should be remembered that there are three different recognised learning styles which different individuals have different preferences for, as follows:

- **Visual:** Visual learners primarily learn through seeing. With their perceptual preference being sight, they can typically recall what they have read or observed. They prefer to look at illustrations, or watch others doing something, rather than listening only.
- **Kinesthetic/Tactile:** Kinesthetic learners like to engage their fine motor skills, and to try things out for themselves. They like to take notes as they listen, and physically participate with learning activities. They need to 'do', not just watch or listen, to gain understanding.
- **Auditory:** Auditory learners prefer to listen. They are usually able to memorize what they hear, and tend to be attentive when information is presented in this way. They search for meaning and interpretation in speech by listening to tone of voice, pitch, and other audible signals. These learners like to hear information and instruction, rather than read it.

The above learning styles have been considered in developing the NTVV training material, and should be taken into account when determining how to deliver training to the identified staff group(s).

A consistent approach must be taken for all training sessions delivered across the business at the scale required for BaU deployment of the technologies covered, and training records must be kept and maintained to ensure that all staff receive the appropriate training.

7. Summary

In addition to creating useful, practical outputs from the project, the process of developing the policy and training material was valuable as a means of building and consolidating the project team's thinking on applying the technologies deployed within the NTVV project as BaU, taking into account the current industry environment (regulatory framework, market development, etc.). The consideration of this context adds more to the learning than simply demonstrating whether a solution works technically and provides the required functionality. It is recommended that future projects consider some element of BaU 'strategy development' as a deliverable. This may take the form of the production of BaU style 'Policy' & 'Technical Guide' documents as with NTVV. Alternatively the output may suit the creation of a strategy document that concisely summarises the project's conclusions on technology implementation, and identifies how future industry or market changes may influence those conclusions.

The adoption of the technologies trialled under each of the policy areas is summarised below:

- **LV Monitoring:**
  - The use of **substation monitors** has been adopted into BaU [Ref. 4];
  - The **end point monitors** deployed as part of the NTVV project have provided SSEN with the learning required to integrate data from the national roll out of smart meters into BaU systems as it becomes available. The LV Monitoring policy [Ref. 5] also supports the strategic implementation of end point monitoring devices in the short term;
  - The **LV monitoring database** (Pi Historian) will be retained by SSEN as the central store for data collected from LV monitoring devices. The functionality provided by the Pi Historian database for the NTVV project is actively informing SSEN's wider IT Transformation programme; and
  - The new functionality that has been deployed within the **DMS** will be retained by SSEN, however further work is required to enable the new functionality to be adopted at scale into BaU. Again, the functionality developed within the NTVV project is actively informing SSEN's wider IT Transformation programme.
- **LV Design:** SSEN plans to retain the new functionality provided by the **Network Modelling Environment** (NME) as the value of this is clear as an LV network design and planning decision support tool. However, further work is required to enable the NME, or an equivalent system, to be deployed in a BaU environment. The approaches created through the NTVV project are actively informing SSEN's wider IT Transformation programme.

- **LV Network Storage:**
  - The deployment of **LV battery storage devices** has demonstrated that this technology is viable as a solution for managing LV networks. However, in order for SSEN to own and deploy LV storage devices like the ESMUs trialled within the NTVV project, a number of factors need to be resolved. These include regulatory issues regarding the ownership of storage technologies, increased levels of technological maturity, and the reduction of costs associated with battery storage devices; and
  - SSEN supports customer adoption of **hot and cold thermal technologies** or electrical energy storage installed within the customers' premises, where these bring benefit to the customer, but will not actively finance or manage the deployment of these technologies.
- **Capacity Response:** The learning generated from the NTVV project has supported SSEN in developing CMZ schemes for implementation directly into BaU, where network requirements are met through the procurement of DSR services (including customer demand reduction and export from third party owned generation and storage) from third party CMZ service providers.
- **Customer Engagement:** SSEN will utilise the Policy [Ref. 14] and Technical Guide [Ref. 15] developed through the NTVV project when designing Customer Engagement Strategies across the innovation portfolio. These documents have also been shared with colleagues to inform engagement activities within BaU.

For some innovative network solutions, certain aspects associated with the BaU adoption of these technologies as cost effective alternatives to traditional reinforcement will be influenced by wider industry and market developments. The technology trials and policy development work undertaken within the NTVV project provide a wealth of information and experience to inform the debate and development of policy across the industry. For example, it supports the case for DNO owned and operated energy storage, and the continued development of the DSR market.

The documents developed through the NTVV project set out the strategic thinking informed by the NTVV trials, and can be readily used as the basis for future policy documentation to be issued under BaU. They also provide useful output that can be shared with relevant individuals within SSEN to inform BaU activities, and are available to external stakeholders, including other DNOs, IDNOs, ICPs and the regulator, to support the effective adoption of similar technologies.

A number of the training modules developed within the NTVV project have been used directly to provide training to relevant staff. Others capture the experience and expertise gained through the NTVV project to ensure that this can be applied by other individuals involved with the BaU deployment of such technologies. These, together with the Overall NTVV Learning training package to be developed by project Close Down, will be available for SSEN and other network operators to use to introduce new concepts for LV network planning and operation, or provide detailed instruction.

8. References

1) 'New Thames Valley Vision Full Bid Submission', Scottish and Southern Energy Power Distribution, November 2011.
2) NTVV Website: www.thamesvalleyvision.co.uk.
3) WI-COR-001 'Development Issue and Control of Company Documentation', Rev. 4.10, December 2013.
4) WI-PS-912 'Installation of Low Cost Substation Monitoring Equipment', Rev. 1.01, July 2016.
5) T2-LVMON-PO-001 'LV Network Monitoring Policy', Rev. 1.0, November 2016.
6) T2-LVMON-TG-002 'LV Network Monitoring Technical Guide', Rev. 1.0, November 2016.
7) T2-LVDES-PO-001 'LV Network Design Utilising the Network Modelling Environment (NME) Policy', Rev. 1.0, November 2016.
8) T2-LVDES-TG-002 'LV Design and Planning Using the Network Modelling Environment (NME) Technical Guide', Rev. 1.0, November 2016.
9) 'Engineering Recommendation P2/6 - Security of Supply', Energy Networks Association, Engineering Directorate, July 2006.
10) T2-LVSTOR-PO-001 'LV Network Storage Policy', Rev. 1.0, November 2016.
11) T2-LVSTOR-TG-002 'LV Network Storage Technical Guide', Rev. 1.0, November 2016.
12) T2-CAPRES-PO-001 'Capacity Response Policy', Rev. 1.0, November 2016.
13) T2-CAPRES-TG-002 'Capacity Response Technical Guide', Rev. 1.0, November 2016.
14) T2-CUSENG-PO-001 'Customer Engagement Policy', Rev. 1.0, November 2016.
15) T2-CUSENG-TG-002 'Customer Engagement Technical Guide', Rev. 1.0, November 2016.
16) WI-PS-1184 'Installation, Maintenance and Decommissioning of Energy Storage and Management Units', Rev. 1.0, March 2016.

9. Appendices

The following appendices are available upon request – please contact futurenetworks@sse.com

Appendix A **List of New Policy Documents**

Appendix B **Tier 1 Policy Documentation**

Appendix C **Tier 2 LV Monitoring Policy Documentation**

Appendix D **Tier 2 LV Design Policy Documentation**

Appendix E **Tier 2 LV Network Storage Policy Documentation**

Appendix F **Tier 2 Capacity Response Policy Documentation**

Appendix G **Tier 2 Customer Engagement Policy Documentation**

Appendix H **LV Monitoring Training Package**

Appendix I **LV Design Training Package**

Appendix J **LV Battery Storage Training Package**

Scottish & Southern
Electricity Networks