ENA Smart Metering System Use Cases

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Related Documents

Reference 1	ENA Smart Metering Project Initiation Document (ENACR004-001-1.0)
Reference 2	ENA Smart Metering Requirements Update (ENACR006-002-1.0)
Reference 3	DECC – "Towards a smarter future: Government response to the Consultation on Electricity and Gas Metering".

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1 Introduction

Since their production of an initial set of ENA Requirements for Smart Metering which formed part of their response to the DECC consultation on smart metering, the ENA and its member companies have recognised the importance of further developing their original functional specification in order to fully support the objectives of the ENSG Smart Grid Vision and Route map, and in recognition of the importance that DECC has placed on the development of Smart Grids. In order to achieve this objective, ENA has commissioned Engage Consulting Limited (Engage) to undertake a project (PID – Reference 1) to address 4 key areas of work as follows:

- **Workstream 1 – ENA Smart Metering System Requirements:** Update and enhance key network requirements needed to support current network businesses and the future needs of Smart Grids;
- **Workstream 2 - Development of Appropriate Use Cases:** To fully articulate the key aspects of the ENA requirements it is intended that specific Use Cases will be developed for critical areas related to energy network businesses and smart grids.
- **Workstream 3 – Performance Standards & Communication Requirements:** This workstream will develop appropriate scenarios for each Use Case and undertake a data traffic analysis to assess the impact this will have on the smart metering communications infrastructure.
- **Workstream 4 - Privacy & Security Considerations -** This activity will provide an overview of the scope, principles and concepts that need to be considered when developing a secure smart metering system solution to take account of the Energy Networks additional requirements.

This report provides the output of Workstream 2.

1.1 Background

The Government's response to the DECC smart metering consultation process (Reference 3) included a number of statements emphasising the importance of developing a smart grid in Great Britain and of ensuring that Network businesses were able to contribute by specifying the functional requirements of a smart metering system that would be required to support that objective.

It is therefore imperative that the correct level of factual and detailed information is fed into Ofgem E-Serve's Phase 1 work. This will ensure that in developing the smart meter functionality and communications infrastructure requirements, full account can be taken of the short, medium and long term needs of network operators such that the key functionalities can be incorporated in an appropriate manner and within the relevant timescales.

1.2 Purpose

The purpose of this report is to:

- Document the ENA smart metering functional requirements using the Use Case methodology

1.3 Scope

This project is focused on ensuring that the requirements of energy networks – in respect of the short, medium and longer term functionality required of smart metering, and associated communication infrastructure - are clearly defined and aligned with work being undertaken by the DECC/Ofgem E-Serve Smart Metering Implementation Project. This particular report is focused on the clear and precise articulation of the business need and benefits that Smart Metering functionality will fulfil for the ENA members in a format that can be fully understood by Ofgem E-Serve and DECC and factored into the scoping work currently being undertaken.

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2 Introduction to Use Cases

This section describes the methodology that is known as Use Cases.

2.1 What Use Cases are

The main purpose of use cases is to articulate simply and clearly the functional requirements of a system.

Use cases describe how a system behaves to provide functionality of benefit (goals) to "actors" which may be people, systems or organisations. Each use case identifies a goal and how that goal is achieved for an actor.

As much as possible, this should be done avoiding the use of specialist or technical terminology. Use cases use natural language and put the requirements in context to allow the requirements to be easily comprehensible to a wide audience including the non technical and allow a common understanding between people with different interests and experience. This has benefits of bridging the gap between various stakeholders – the people who understand the problem, and people who are sponsoring or building the solution.

Use cases may be written at different levels for different purposes. High level or summary use cases may collect a number of more detailed uses and are useful to give an overview of requirements or more strategic goals. More detailed user level use cases describe an individual use of a system to achieve a more immediate goal. Very low level sub use cases can be written to detail programming level requirements.

In documenting a use case it is helpful to address further information that supports the understanding of the goal and how it is achieved as follows:

- **Scope** - identifies the system (the boundaries of the system) being described.
- **Use case (Goal)** - the objective of the system that gives benefit to an actor.
- **Actor** - anyone outside the system that interacts with the system to achieve the goal.
- **Primary actor** - usually the actor that initiates the use case.
- **Preconditions and Post conditions** - what must be true before and after the use case runs (note: preconditions almost invariably point to the existence of another use case where the condition is established).
- **Basic Flow** - the main success scenario and a description of the steps in a straightforward case where the goal is achieved.
- **Alternative flows** - other ways in which the flow may happen.

A reasonably full use case would contain the information above.

Use cases can capture other useful information such as:

- The key information involved in an interaction;
- Relationships with other use cases;
- Business rules;

- Frequency and performance requirements;
- Assumptions;
- Outstanding issues.

By documenting the functional requirements as use cases it is possible to avoid the technical solution, or particular perception of it, driving the requirements. Often the perception of the solution is difficult to resist so assumptions of the solution may be recorded in a notes section of a use case allowing later assessment but these should not become central to the documentation.

2.2 The benefits and use of use cases

Use cases provide some very clear benefits to the Analysis Phase. One important benefit of use case driven analysis is that it helps manage complexity, since it focuses on one specific usage aspect at a time. Use cases start from the very simple viewpoint that a system is built first and foremost for its users.

2.2.1 Avoiding early solution design constraint

Use case modelling is a proven method to effectively describe the required behaviour of a system. Functional requirements should be central to the understanding of a system and should largely drive development of that system. An early focus on the functional requirements of a system can avoid technical solutions leading and constraining their use.

2.2.2 Cost benefit analysis

Since use cases describe the benefit of a system, and the solution provides the cost they are a vital part of cost benefit analysis.

2.2.3 Uncovering further expectations

Use cases may be used in an iterative process:

- as understanding of the uses of a system is gained more uses may be revealed;
- as understanding of costs and benefits is gained – the set of use cases may be refined.

Since early use cases may be expected to be discarded they should be written only to an appropriate level of detail.

2.2.4 Uncovering misaligned expectations

Use cases describe expected uses of a system. Different stakeholders may have assumed this use and prior to the production of clear documentation the different stakeholders may also assume the same requirements. Simple documentation of the requirements often uncovers where different stakeholders have different expectations and allows early reconciliation of these differences in the eventual solution.

2.2.5 Providing a central point for other requirements

Use cases are not all the requirements of a system. They do not capture, non functional requirements, data formats, user interface requirements and so on. Use cases are, however, central to the requirements and can be used to connect other requirement details. Use case development is a good way to capture information relating to other requirements; for example although data formats would be part of the technical solution, use cases can be used to capture the key information involved in an interaction and drive the requirements for information exchanges and analysis of data traffic.

Use cases describe achieving a goal. These requirements are testable and use cases can be mapped to requirements for testing the most important part of a system to test whether it delivers the functional requirements.

2.3 Use case sets and use case diagrams

Use cases can be gathered into sets for different purposes – a set of summary use cases summarises the high level expectations of a system.

Sets of more detailed use cases can show how each of the summary objectives are achieved.

Use cases may be gathered into sets to illustrate other groupings such as phasing of delivery or other prioritisation.

Use case diagrams are a useful way to depict sets of use cases and the simple relationships with actors. Use case diagrams do not substitute for the use cases themselves but provide a useful summary of requirements or sets of requirements.

Actors are shown as stickmen with the name of the actor written underneath and use cases are shown as ellipses with the name of the use case written inside. The system boundary is a rectangle enclosing the use cases.

2.4 Use of the documentation

Although the use cases and use case diagrams are gathered into a single document here, both each use case and each diagram should be able to be used reasonably independently depending on what is to be illustrated.

2.5 Explanation of the template

There is no single template for use case documentation, indeed, projects should be encouraged to create a template that suits their purpose. There is, however, much agreement on the key information to be captured for a use case, although it is important to capture information appropriate to the level addressed.

For example a summary use case would not present much, or any, information to depict a flow of interaction – simply a summary level use case, although perfectly valid, is not started and completed by a series of interactions but might be carried out by the employment of more detailed use cases.

The elements of the template that are used here will be familiar to anyone experienced with use cases. The elements used are as follows:

2.5.1 Use case name, level and ID

Unique identification of the use case and indication of its use and relationship.

2.5.2 Description

Identifies the goal – and how the system delivers that goal.

2.5.3 Actors

Identification of the Actors involved:

- the primary actor is usually the actor that starts the use case and or gains benefit;
- Secondary actors – are other actors involved in the fulfilment of the use case.

2.5.4 Scenarios

Provide an illustration of the achievement of the goal and contain the following sections:

2.5.4.1 Pre conditions

These are conditions that must be true before the use case starts.

2.5.4.2 Post conditions

These are conditions that are true when the use case is completed – note that these should cover the successful completion and unsuccessful completion of a use case.

2.5.4.3 Trigger

The reason for the use case starting.

2.5.4.4 Basic Flow

A sequence of interactions that achieves the successful completion of the use case.

Note here these are frequently illustrative rather than definitive.

2.5.4.5 Alternative flows

Descriptions of other paths the use case may take.

2.5.5 Additional Information

Used to capture additional pertinent information not already noted.

2.5.5.1 Related Information

Used to detail other information, such as other use cases, that relate to the current use case.

2.5.5.2 Notes and Issues

Used to capture other information or issues not already captured. Also can be used to capture questions or areas the author is unsure of and requires further clarity. This section is often extensively used in collaborative production of use cases.

3 Overall approach

The Use Case workstream ran in parallel (with a slight lag) to the Requirements workstream.

3.1 Process

The ENA Smart Metering requirements as provided to DECC were taken and the functional reasons for their inclusion were assessed in an iterative process. The requirements were distilled into some initial high level summary use cases that attempted to capture the high level Network activities – planning, actively managing the network, and ensuring network safety and security – these were expanded as further uses were discovered.

3.2 The use case levels

Use Cases may start at high summary levels that all stakeholders can agree on, and then drill down to more detailed levels as required. For this analysis we have provided high level summary use cases and then a more detailed system level set of use cases that fulfil the summary level. Production of further more detailed levels is possible but would be spurious at this point.

3.3 The workshops

Use Cases were introduced to the ENA members at the first Requirements workshop, which was then followed by a full day workshop on Use Cases. Draft detailed Use Case names and brief descriptions were then drafted and issued to the members for review. The detailed Use Cases were then developed based on these and comments received. A further workshop was held on 22nd March where the detailed draft Use Cases were discussed and developed further.

3.4 Review process

The Use Cases included a full internal review by Engage staff and then a subsequent review by a network expert Engage associate. The documents were then issued to the ENA members for review.

Various iterations of the use cases were produced from the review cycle, including new use cases written by the ENA members themselves.

4 Scope of the Smart Metering System

4.1 Introduction

The purpose of this exercise is to describe the functional requirements of networks businesses involving smart metering in the context of a mandated roll out of that metering and in the expectation that this metering may facilitate the operation of smart grids. The intention is not to describe smart grids themselves (although this may be a useful exercise later).

Network businesses are already expected to operate efficiently and provide a reliable service. There is the expectation that there will be new challenges to providing this service and that this will result in new demands being placed on Network businesses to maintain, improve and demonstrate this efficiency and reliability.

The challenges and the opportunities to make use of smart metering may be more obvious for electricity than gas; however the major business objectives of planning the efficient and reliable use of the network apply to electricity and gas so both are considered.

Use cases describe the functional requirements that Actors have of a system. It is critical that the scope of that system is clearly understood.

4.2 Statement of System Scope

The scope of the system under discussion is as follows:

A set of smart metering systems and the associated communications infrastructure each of which provide:

- measurement of the supply (and export where applicable) of Gas or Electricity at their metering points;
- remote interaction with the smart metering systems; and
- interaction with particular devices installed at consumers' premises.

The next two figures provide a diagrammatic representation of the system scope for electricity and gas.

Figure 1- Electricity networks smart metering system scope

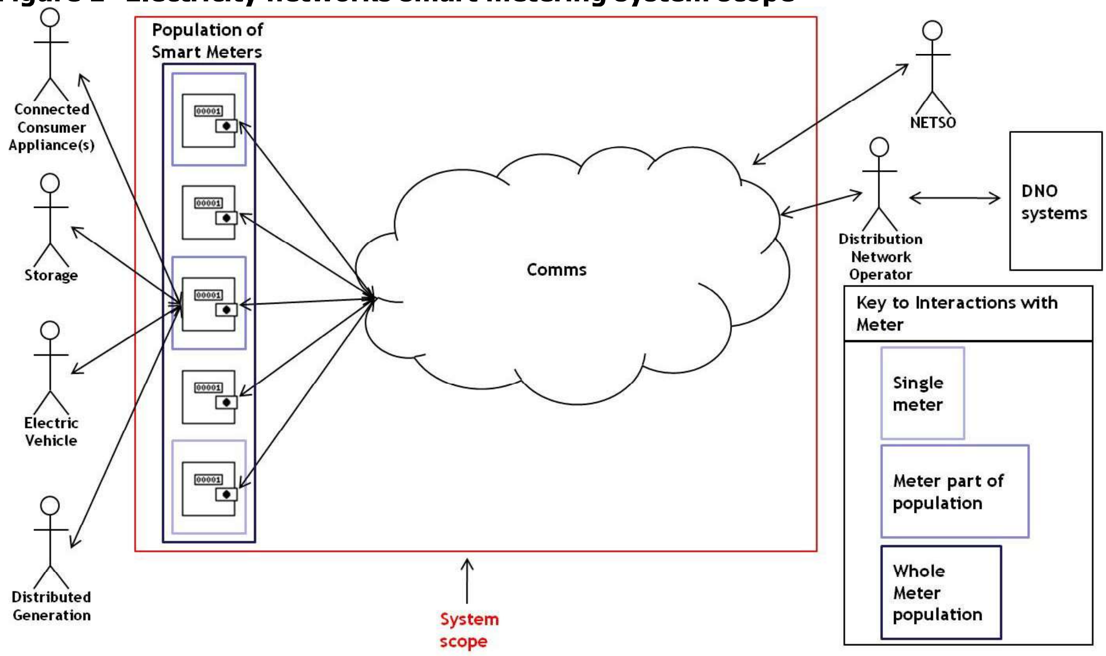
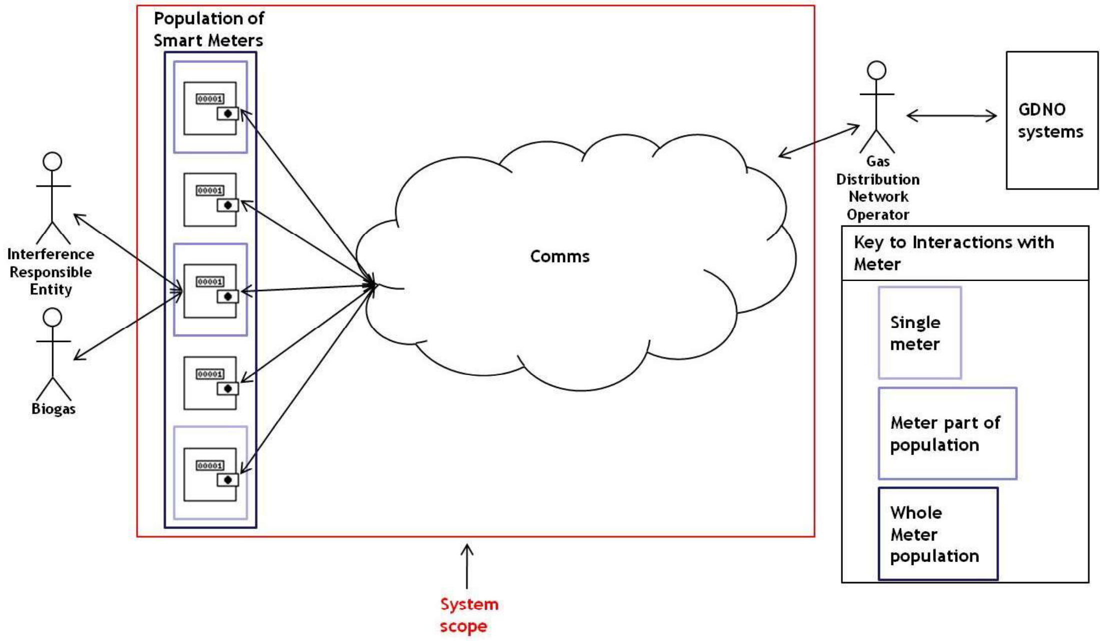


Figure 2 - Gas networks smart metering system scope



The focus of this analysis is the requirements that energy networks businesses may have of that system.

The Government's approach to smart metering for GB is set out in the document published by DECC on 2nd December 2009: TOWARDS A SMARTER FUTURE: GOVERNMENT RESPONSE TO THE CONSULTATION ON ELECTRICITY AND GAS SMART METERING. This analysis considers only the smart metering for Domestic and Small and Medium Enterprise businesses under a roll out as set out in that document and assumes that the approach DECC outlined is followed. It considers potential use of smart metering and not the transitional arrangements that may be needed to achieve that use.

The communications to the smart meters are to be provided as a central service. This central service means that some additional communications services are possible but the breadth of other central services are currently unknown. Networks will need to interact, with singular, groups, or sample populations of supply points, which may involve utilising the central communications service, or additional currently undefined communications services. This work does not assume additional smart functionality external to the supply point metering system will be required to support this interaction. For the purpose of the use case analysis the system under discussion is treated as a "black box".

No assumptions are made within this analysis as to how the various Smart Metering functionalities will be delivered. For example, a complete system may be composed of a number of components within the same "box" or in a number of interoperating "boxes". The components may be dedicated to the Smart Metering System or could be shared with other systems.

Any single Smart Metering System will be in place to measure aspects of the import and, where relevant, the export of Electricity or Gas in GB.

Any network operator is responsible for a discrete part of a Gas or Electricity network, so each will have a set of meter points relevant to them.

The Smart Metering System has further functionality in addition to the measurement of the commodity:

- Interfaces - three levels of interface are available providing:
  - two way remote communication – the ability to communicate with parties remote from the Smart Metering System;
  - local communication – the ability to communicate with devices local to the metering system, generally within the same premises; and
  - a human interface - allowing an amount of data to be provided displayed and input or selected.
- Hardware which may include some of the following:
  - additional sensors;
  - means to control the delivery (or export where relevant) of the commodity; and
  - the meter has its own clock and a source of power which might be taken from an external source or provided by batteries.
- Software, firmware and memory required to operate the metrology and other hardware and to perform required processes and calculations.

The scope of the system under discussion does not include the following:

- The network businesses own internal systems e.g. Asset Management System, GPRS System etc.;
- Devices local to the metering system with which the metering system can interact, such as a display, home appliances, domestic generation or storage devices.

These are actors that interact with the system but are not within the system. As actors they may be relevant to the analysis, but are not part of the system.

It is recognised that new requirements may be determined during the roll out that lead to a new generation of smart metering. Any rollout superseding that described in the DECC smart metering consultation response is not specifically included in the scope of this analysis. However, use cases can be captured as required for later fulfilment.

This analysis is not concerned with the timing of roll out although some functions may only be relevant given a particular number or concentration of smart meters and this may be considered in the timing of the realisation of any functional requirement.

4.3 Out of Scope

The following items are outside the scope of this analysis:

- I&C customers;
- Within grid metering;
- Unmetered supply;
- Other remote parties – such as suppliers, meter operators and their use of smart metering;
- The roll out of smart meters or any other transitional arrangements.

5 Use Cases in Context

The future smart grid is expected to involve Network Operators taking data from various sources, including from metering installed at premises, to inform actions to be taken at points on the network; or using smart metering as a gateway to effect demand side management.

For the interactions with the smart metering to take place the Network Operators will need to have the smart meters mapped to the network within their systems, and to run network models for planning and operational purposes. They will need to identify individual meters and groups for configuration, data retrieval and action.

Generally, the activities that are taken through, or at, the smart metering as described in this document will have corresponding functions within the Network systems. Although these systems will need to be developed to make the most effective use of smart metering, any such analysis is out of scope of this exercise.

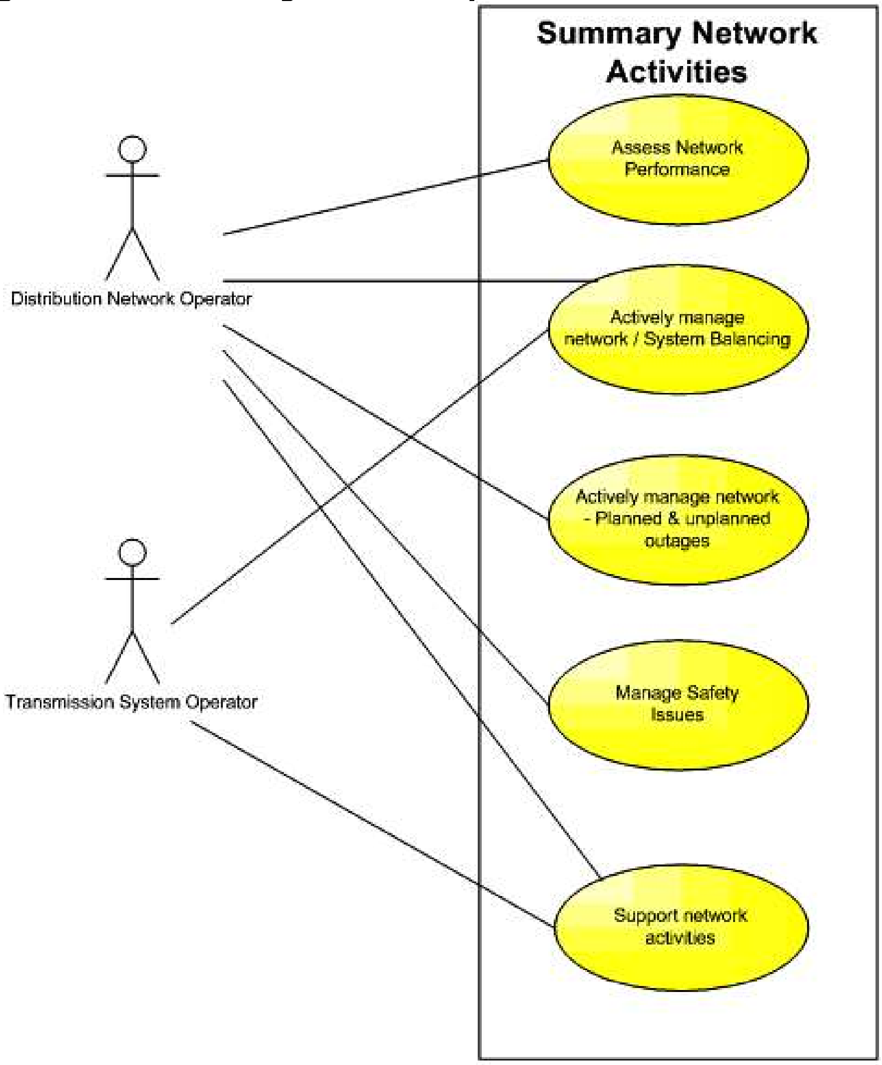
6 Electricity Use Cases

This section includes the documented functional requirements captured from our discussions with the electricity ENA members. The detailed Use Cases are grouped under several high level summary Use Cases:

- Assess network performance;
- Actively manage network;
- System balancing;
- Actively manage network – planned and unplanned outages;
- Manage safety issues; and
- Support network activities.

The following diagram displays the relationship that the primary actors have with the high level use cases.

Figure 3 - Use Case diagram summary of network activities



6.1 Use Case Actors

Each Use Case refers to participants who are referred to as 'Actors'. The 'Actors' referenced in the Detailed Use Cases are described in Figure 4 - Use Case Actors and descriptionsFigure 4 below.

Figure 4 - Use Case Actors and descriptions

Actor Name	Actor Role Description
Distribution Network Operator	Organisation responsible for managing the distribution network that delivers electricity to the premises.
Network Operator	Organisation responsible for carrying out actions to manage load on the network **Note:** This role is used for convenience and these actions may actually be carried out by NETSO, a Distribution Network Operator, a Supplier, an Aggregator, or any other party providing a Demand Response to Networks Businesses
Micro-generation	Sources of power from domestic properties or small-to-medium enterprises that are attached to the Smart Metering System, such as PV, micro-wind turbines or micro-CHP.
Consumer	Organisation, or person, consuming or generating the electricity at the premises. The Consumer may also be the organisation or person contracted with the Supplier for the provision of energy.
In Home Display	A display provided to Consumers to enable them to monitor their energy usage and the charges levied for that energy under a tariff.
Energy Management System	A device which uses information taken from the smart meter (including energy prices and signals) and other monitoring devices (such as thermostats) to manage the usage of appliances or generation at a premises.
Interference Responsible Entity	A party that attempts to interfere with and/or defraud the Metering System and/or illegally abstract energy at the point of supply.

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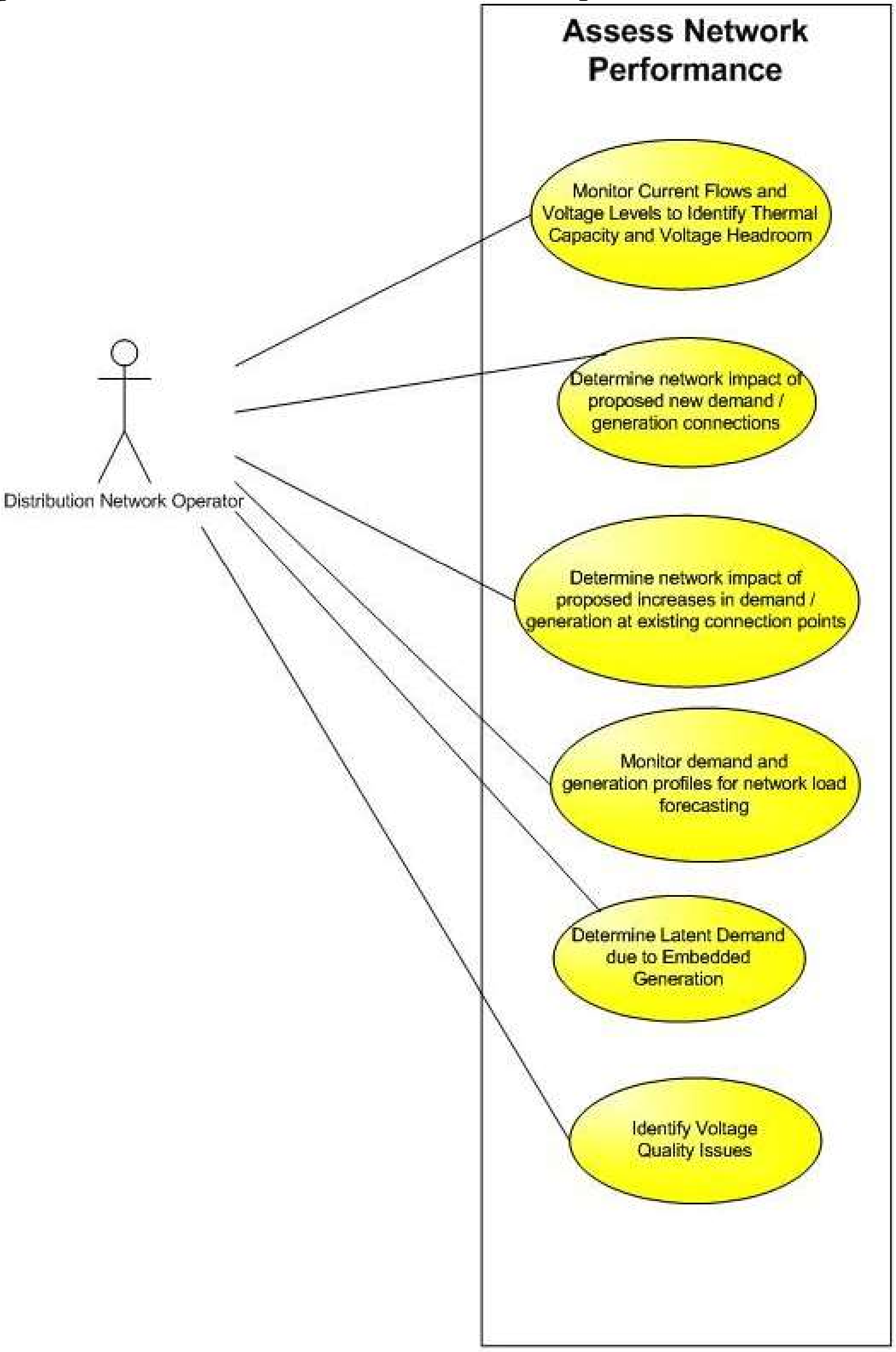
6.2 Assess Network Performance

Use Case ID	ANP	**Level**	Summary
		Role	Electricity
Use Case Name	Assess Network Performance		

Description
Distribution Network Operators have a requirement to use data from Smart Metering Systems to aid in monitoring their networks. Once they have the location of the Smart Metering Systems mapped to their networks, Distribution Network Operators will be able to check the capacity and voltage headroom of specific parts of their network. This assessment will identify needs for future reinforcement and active management. The information will also facilitate assessment of the impact of additional demand / generation, or new network connections, calculation of latent demand and improvement of the effectiveness of customer profiles used in network forecasting. Smart Metering functionality will also monitor voltage quality, logging voltage events that breach a set threshold. The information will enable DNOs to improve the reliability of power quality delivered to end users.

Figure 5 - Assess Network Performance Use Case diagram



6.2.1 Monitor power flows and voltage levels to identify thermal capacity and voltage headroom

Use Case ID	01	**Level**	Detailed
		Role	Electricity
Use Case Name	Monitor Power Flows and Voltage Levels to Identify Thermal Capacity and Voltage Headroom		

Description

Business Need

Distribution Network Operators have a requirement to use data from Smart Metering Systems to aid in proactively monitoring their networks. Once they have the location of the Smart Metering Systems mapped to their networks, Distribution Network Operators will be able to check the capacity and voltage headroom of specific parts of their network, i.e.:

- That the thermal duty imposed on plant and equipment is within its rating
- That the High Voltage (HV) network in particular, complies with the redundant capacity requirements of Engineering Recommendation P2/6
- All customers are supplied within statutory voltage limits.

This assessment will identify the need for future reinforcement or some other form of intervention. The information will also be required to assess the impact of requests for additional demand / generation or new network connections and to test future load growth scenarios to ascertain the critical timing and potential quantum of future reinforcement actions or interventions.

Low Voltage (LV) networks, and to some extent High Voltage (HV) radial networks, have traditionally been designed as 'tapered' networks to match capacity to the lower level of loading experienced further from the source of supply. In future, new loads associated with electric vehicles, heat pumps, and micro-generation have the potential to give rise to either loads exceeding the rating of smaller capacity conductors or result in voltages at customers premises rising above / falling below statutory limits. Given the very sparse nature of loading and voltage information currently available at distribution substations and especially LV networks, there will be an increasing risk of undetected thermal capacity or voltage transgressions.

As the uptake of electric vehicles, heat pumps, and micro-generation increases, the daily load shape will change and the overall energy distributed by the networks will increase – giving rise to a need for greater granularity of voltage and loading information. Data available from Smart Metering Systems has the potential to meet that need and will allow Distribution Network Operators to optimise the use of existing network capacity (thereby avoiding or delaying infrastructure costs or targeted infrastructure investment) and make more informed planning decisions.

For Distribution Network Operators to gain the maximum benefit from the additional planning data available from Smart Metering Systems the meters must provide:

- Real and reactive / import and export power flow data (in terms of half-hourly averaged values)
- Real and reactive / generation power flow data (in terms of half-hourly averaged values)
- Voltage data (in terms of half-hourly averaged values)
- Phase connectivity information

Note that where potentially exporting generation is installed, both import and export power flow measurements need to be recorded separately in order to assess the direction of (real/reactive) power flow and hence allow aggregated (half-hourly average) feeder power flows to be derived. Reactive as well as real power flow measurements are required so that the impact of new non-linear loads such as heat pumps, air cooling compressors, compact fluorescent lamps, and some types of generation on reactive power flows can be measured and the power factor calculated. This is important since correcting adverse power factor will generally be a more cost effective solution to a voltage or thermal capacity problem than simple reinforcement.

To permit aggregated power flows on the network to be derived and monitored it will be important for every Smart Metering System to provide the required data. For voltage profile monitoring, it will be generally sufficient to derive information from meters close to the substation and at the far end of LV feeders. However, where micro-generation is installed which might export at certain times of the day (e.g. potentially Photo-Voltaic cells (PVs) during the working day when houses may be unoccupied), additional strategic measurements of voltage may be necessary to detect potential statutory voltage transgressions other than at the extremities of LV feeders. It is therefore important that the Distribution Network Operators are able to configure specific Smart Metering Systems to provide the required measurements. The configuration will ideally include the ability for DNOs to refine the need to transmit meter data through the Smart Meter System to meet the requirements of the network.

The Distribution Network Operators may require up to two or three years of power flow and voltage data tagged by MPAN with an acceptable lag time of three months after the date the last data item was recorded. It is envisaged that archive data storage requirements beyond the three months of data stored in the smart meter will be addressed through Distribution Network Operators' own systems. This data will then be used with other network planning data (e.g. from substations and SCADA) to inform planning decisions.

Business Benefit

- Higher utilisation / more efficient use of existing networks
- More informed, efficient and timely network investment
- Faster better informed responses to requests for additional demand / generation and new connections

- Earlier identification of potential network stresses – enabling mitigating interventions before thermal loading or statutory voltage transgressions occur
- Improved forecasting of future reinforcement need

Actors		
Name	**Type**	**Role Description**
Distribution Network Operator	Primary	Organisation responsible for managing the distribution network that provides electricity to the premises.
Micro-generation	Secondary	Sources of power from domestic properties or small-to-medium enterprises that are attached to the Smart Metering System, such as PV, micro-wind turbines or micro-CHP.

Scenario 1 – Data is sent periodically from the Smart Metering System

Scenario Descriptions
Pre Conditions
Smart Metering Systems are installed and configured to receive and respond to messages from the Distribution Network Operator The Distribution Network Operator's system maintains information relating to the location (including the phase to which it is connected) of the Smart Meter and can position it on a network connectivity model (e.g. to permit aggregation of data to drive total feeder / substation loading) The Smart Metering System has an accurate internal clock (and will receive a periodic synchronisation signal to ensure continued accuracy) Smart Metering Systems have been configured to measure, record and store half-hourly power flow and voltage data Smart Metering Systems are able to collect generation data where micro-generation is installed Distribution Network Operators have available sufficient archive data storage configured to download information held in smart meter data stores at a maximum frequency of three month intervals
Post Conditions
The Distribution Network Operator is able to extract Smart Metering System data from archive stores for monitoring network power flows and voltage levels.
Trigger
The configured time period to send data has been reached
Basic Flow Note this flow will be repeated across all required Smart Metering Systems within a Distribution Network

1. The Smart Metering System determines that the DNO configured time period that has been set to send data has been reached and sends the half-hourly data to the Distribution Network Operator 2. The Distribution Network Operator receives the data and loads it into its system to use in monitoring power flows and voltage levels 3. The Smart Metering System continues to make available data to the DNO at the predetermined interval until the DNO configures it to stop
Alternative Flow
2. At Basic Flow step 2 2a1 The Distribution Network Operator does not receive the data 2a2 The Distribution Network Operator checks and takes steps to ensure that the Smart Metering System has been configured correctly and is working properly 2a3 Go back to Basic Flow step 1

Scenario 2 – DNO requests data

Scenario Descriptions
Pre Conditions
Smart Metering Systems are installed and configured to receive and respond to messages from the Distribution Network Operator Smart Metering Systems are installed and configured to permit data extraction by Distribution Network Operators The Distribution Network Operator's system maintains information relating to the location of the Smart Metering System and its electrical connectivity to their network Smart Metering Systems have been configured to measure, record and store half-hourly power flow and voltage data Smart Metering Systems are able to collect generation data where micro-generation is installed
Post Conditions
The Distribution Network Operator has Smart Metering System data available for monitoring power flows and voltage levels
Trigger
The Distribution Network Operator has a requirement to gather Smart Metering System data to use in monitoring power flows and voltage levels
Basic Flow Note this flow will be repeated across all required Smart Metering Systems within a Distribution Network
1. The Distribution Network Operator sends a message to the Smart Metering System requesting the stored half-hourly power flow (including that of any generation data) and

voltage data

2. The Smart Metering System receives the message and validates it
3. The Smart Metering System retrieves the stored half-hourly power flow (including that of any generation data), and voltage data
4. The Smart Metering System sends the data to the Distribution Network Operator
5. The Distribution Network Operator receives the data and loads it into its system to use in monitoring power flows and voltage levels

Alternative Flow

2. At Basic Flow step 2
   - 2a1 The Smart Metering System rejects the message as invalid
   - 2a2 The Smart Metering System sends notification to the Distribution Network Operator detailing error type along with date/time stamp
   - 2a3 The Distribution Network Operator receives the message and takes the required steps to resolve the error
   - 2a4 Once error is resolved go back to Basic Flow step 1
3. At Basic Flow step 3
   - 3a1 The Smart Metering System does not have any measured data stored
   - 3a2 The Smart Metering System sends a no data found message to the Distribution Network Operator
   - 3a3 The Distribution Network Operator checks and takes steps to ensure that the Smart Metering System has been configured correctly and is working properly
   - 3a4 End flow
5. At Basic Flow step 5:
   - 5a1 The Distribution Network Operator does not receive the data from the Smart Metering System
   - 5a2 The Distribution Network Operator checks and takes steps to ensure that the Smart Metering System has been configured correctly and is working properly
   - 5a3 Go back to Basic Flow step 1

Additional Information

Related Information

Notes and issues

The scope of the Smart Metering System incorporates comms and the potential for some central data services. It may be that these services store the required data and packages it to be sent to the DNO rather than the meter itself.

It has been noted that the meters may be configured to send data periodically or on request for this use case; either may be valid depending on circumstances pertaining to the network concerned.

6.2.2 Determine network impact of proposed new demand / generation connections

Use Case ID	02	**Level**	Detailed
		Role	Electricity
Use Case Name	Determine network impact of proposed new demand / generation connections		

Description
Business Need Distribution Network Operators (DNOs) have a requirement to use Smart Metering System data to determine the network impact of requests for new connections. The new connection may comprise demand only, generation only or a mixture of demand and generation at the new premises. The new load may include demand from new technologies, such as Electric Vehicles (EV) or heat pumps, or generation from micro-generation. As take up of these technologies increases, the load profile of networks will alter and may become less predictable. The Distribution Network Operator needs to be able to determine whether the existing distribution network has sufficient capacity headroom to cope with the additional demand / generation, whether infrastructure reinforcement is required, or whether a form of active network management will be sufficiently effective to cater for the extra demand / generation. The Distribution Network Operators can use measurements of exported and imported electricity from smart metering in the same area of the network as the proposed new connection (two - three years worth of half-hourly real and reactive power flow and voltage data is suggested as suitable to give confident assessment). This data will be used alongside the knowledge of the proposed new connection and data from the Distribution Network Operator's Supervisory Control And Data Acquisition (SCADA) system to assess the requirements of the new connection. The data should be available to the Distribution Network Operator at the latest a week after the data is requested. Where the power flow and voltage data is not transmitted and stored routinely, or where more up to date information is required, the Distribution Network Operator will need to be able to choose the specific Smart Metering Systems from which they require information, based on their location on the network. In this event Distribution Network Operators will only be able to configure the specified Smart Metering Systems when they have received

the request for the new connection. Data from a high proportion of Smart Metering Systems in the relevant area will be required for this analysis.

Business Benefit

- The information enables DNOs to comply with Guaranteed Standards of Performance timescales for provision of LV connections
- Enables DNOs to accurately determine the reinforcement or active network management requirements, together with the associated costs, to allow the proposed new demand / generation connections to be provided (costs will include those funded by the user and the DNO)
- Avoidance of unnecessary reinforcement or active network management costs due to enhanced assessment of capacity headroom
- Enables DNOs to accurately determine the reinforcement or active network management requirements, together with the associated costs, to allow the proposed new connection to be connected to the network (costs will include those funded by the user and the DNO)
- Enhance the customer experience of new connections

Actors		
Name	**Type**	**Role Description**
Distribution Network Operator	Primary	Organisation responsible for managing the distribution network that provides electricity to the premises.
Micro-generation	Secondary	Sources of power from domestic properties or small-to-medium enterprises that are attached to the Smart Metering System, such as PV, micro-wind turbines or micro-CHP.

Note: the following scenario could equally be met by the Distribution Network Operator using extracted smart metering power and voltage data residing in a DNO archive storage system where this information is considered to be sufficiently up to date.

Scenario Descriptions
Pre Conditions
Smart Metering Systems are installed and configured to receive and respond to messages from the Distribution Network Operator The Distribution Network Operator's system maintains information relating to the location of the Smart Meter and can position it on a network connectivity model The Smart Metering System has been measuring, recording and storing half-hourly average power flow and voltage data for a predetermined period of time and the Distribution Network Operator has received confirmation of this The Smart Metering System is able to collect generation data where micro-generation is installed
Post Conditions

The Distribution Network Operator can use Smart Metering System data to determine available network capacity
Trigger
The Distribution Network Operator receives a request for a new connection on their network and targets specific Smart Metering Systems on that network to extract half-hourly average power flow and voltage data
Basic Flow Note this flow will be repeated across all required Smart Metering Systems within a Distribution Network
1. The Distribution Network Operator sends a message to the Smart Metering System requesting the stored half-hourly power flow and voltage data (and micro-generation data where available) 2. The Smart Metering System receives the message and validates it 3. The Smart Metering System retrieves the stored half-hourly power flow and voltage data 4. The Smart Metering System sends the data to the Distribution Network Operator 5. The Distribution Network Operator receives the data and loads it into its system / procedure for determining network capacity
Alternative Flow
5. At Basic Flow step 5 5a1 The Distribution Network Operator does not receive the data 5a2 The Distribution Network Operator checks and takes steps to ensure that the Smart Metering System has been configured correctly and is working properly 5a3 Go back to Basic Flow step 1

Additional Information
Related Information
Notes and issues
The Smart Metering System incorporates comms devices while there are other Comms Services that may be provided centrally. It may be that these central services store the required data and packages it to be sent to the DNO rather than the meter itself.

6.2.3 Determine network impact of proposed increases in demand / generation at existing connection points

Use Case ID	03	**Level**	Detailed
		Role	Electricity
Use Case Name	Determine network impact of proposed increases in demand / generation at existing connection points		

Description
Business Need
Distribution Network Operators have a requirement to use Smart Metering System data to determine the impact on their network of increased levels of demand or generation at existing connection points. The new load may be increased demand from new technologies, such as Electric Vehicles (EV) or heat pumps, or generation from micro-generation. As take up of these technologies increases, the load profile of networks will alter and may become less predictable.
Distribution Network Operators can use Smart Metering System data to create load profiles that can then be used to model the impact of increased levels of demand or generation at existing connections.
The Distribution Network Operator then needs to be able to determine whether the existing distribution network has sufficient capacity headroom to cope with the additional demand / generation, whether infrastructure improvement is needed, or whether a form of active network management will be sufficiently effective to cater for the extra demand / generation. To calculate this, the Distribution Network Operators require two to three years worth of half-hourly real and reactive power flow and voltage data. This data will be used alongside the knowledge of the proposed new connection and data from the Distribution Network Operator’s Supervisory Control and Data Acquisition (SCADA) system to assess the requirements of the new connection. The data should be available to the Distribution Network Operator at the latest a week after the date the last data item has been recorded.
Where the power flow and voltage data is not transmitted and stored routinely, or where more up to date information is required, the Distribution Network Operator will need to be able to choose the specific Smart Metering Systems from which they require information, based on their location on the network. In this event Distribution Network Operators will only be able to configure the specified Smart Metering Systems when they have received the request for the new connection. Data from a high proportion of Smart Metering Systems in the relevant area will be required for this analysis.
Business Benefit

- The information enables DNOs to comply with Guaranteed Standards of Performance timescales for dealing with additional demand / generation enquiries
- Enables DNOs to accurately determine the reinforcement or active network management requirements, together with the associated costs, to allow the proposed demand / generation to be connected to the network (costs will include those funded by the user and the DNO)
- Avoidance of unnecessary reinforcement or active network management costs due to enhanced assessment of capacity headroom
- Enhanced data from mart Metering System permits higher levels of demand / generation to be connected to the network
- Enhance the customer experience of adding new equipment

Actors		
Name	**Type**	**Role Description**
Distribution Network Operator	Primary	Organisation responsible for managing the distribution network that provides electricity to the premises.
Micro-generation	Secondary	Sources of power from domestic properties or small-to-medium enterprises that are attached to the Smart Metering System, such as PV, micro-wind turbines or micro-CHP.

Note: the following scenario could equally be met by the Distribution Network Operator using extracted smart metering power and voltage data residing in a DNO archive storage system where this information is considered to be sufficiently up to date.

Scenario Descriptions
Pre Conditions
Smart Metering Systems are installed and configured to receive and respond to messages from the Distribution Network Operator The Distribution Network Operator's system maintains information relating to the location of the Smart Meter and can position it on a network connectivity model The Smart Metering System has been measuring, recording and storing half-hourly average power flow and voltage data for a predetermined period of time and the Distribution Network Operator has received confirmation of this The Smart Metering System is able to collect generation data where micro-generation is installed
Post Conditions
The Distribution Network Operator can use Smart Metering System data to determine the network impact of new loads on existing connections
Trigger
The Distribution Network Operator receives a request for a proposed increase in demand / generation

at an existing connection on their network and targets specific Smart Metering Systems on that network to extract half-hourly average power flow and voltage data
Basic Flow Note this flow will be repeated across all required Smart Metering Systems within a Distribution Network
1. The Distribution Network Operator sends a message to the Smart Metering System requesting the stored half-hourly power flow and voltage data (and micro-generation data where available) 2. The Smart Metering System receives the message and validates it 3. The Smart Metering System retrieves the stored half-hourly power flow and voltage data 4. The Smart Metering System sends the data to the Distribution Network Operator 5. The Distribution Network Operator receives the data and loads it into its system / procedure for determining network capacity
Alternative Flow
5. At Basic Flow step 5 5a1 The Distribution Network Operator does not receive the data 5a2 The Distribution Network Operator checks and takes steps to ensure that the Smart Metering System has been configured correctly and is working properly 5a3 Go back to Basic Flow step 1

Additional Information
Related Information
Notes and issues
It may be that some central services store the required data and packages it to be sent to the DNO rather than the meter itself.

6.2.4 Monitor demand and generation profiles for network load forecasting

Use Case ID	04	**Level**	Detailed
		Role	Electricity
Use Case Name	Monitor demand and generation profiles for network load forecasting		

Description
Business Need The uptake of new technologies such as electric vehicles, heat pumps, compact fluorescent lights and domestic air cooling units, will change the currently observed diversity of demand – affecting total energy distributed, power factor, voltage levels, peak demands, and the overall shape of the daily and seasonal cyclic demand profile. The increased installation of micro-generation in domestic properties, such as photo-voltaic cells, micro-wind turbines, micro-Combined Heat and Power, etc. will lead to increased generation diversity and bi-directional flows of electricity. These developments present a new set of challenges to Distribution Network Operators, who will need to forecast their effect on the network in order to take timely action to maintain system integrity (with regard to thermal ratings, statutory voltage limits and ER P2/6 requirements for redundant capacity). These actions could include network reinforcement or actively managing networks to make better use of existing capacity by encouraging demand reduction at forecast times of peak load. Distribution Network Operators use generic profiles to model the effects of new connections and changes in the type and quantity generation and demand on the networks. By using smart metering data it will be possible to assess the accuracy of these generic profiles, their adequacy for use and create new ones for emerging demand and generation technologies. It is likely that with the advent of new demand and new generation technologies a much greater number of these profiles will be needed to effectively model the network. Smart metering data can be used to measure changes in existing profiles at a granular level (for example individual distribution substations and LV feeders) - thereby increasing the accuracy of forecasting and helping to maintain system integrity through timely planned interventions. As part of the routine load forecasting procedure, Distribution Network Operators will require to be notified of proposed significant future demand or generation connections in order to identify whether the historic power and voltage profile data stored in their archived data stores can be used for forecasting if or the Smart Metering Systems needs be configured to begin recording the half-hourly real and reactive power flow, generation export profiles and voltage profiles.

Business Benefit

- Improved network load forecasting capability
- Informed network investment / intervention decisions resulting in reduced capital costs
- Enables DNOs to accurately determine the reinforcement or active network management requirements, together with the associated costs, associated with the increase in demand / generation at an existing connection point based on a sound understanding of the diversity between the new demand / generation and the existing network power flows, and hence the impact of the superimposed new demand / generation on the existing load cycle.

Actors		
Name	**Type**	**Role Description**
Distribution Network Operator	Primary	Organisation responsible for managing the distribution network that provides electricity to the premises.
Micro-generation	Secondary	Sources of power from domestic properties or small-to-medium enterprises that are attached to the Smart Metering System, such as PV, micro-wind turbines or micro-CHP.

Note: the following scenario could equally be met by the Distribution Network Operator using extracted smart metering power and voltage data residing in a DNO archive storage system where this information is considered to be sufficiently up to date.

Scenario Descriptions
Pre Conditions
Smart Metering Systems are installed and configured to receive and respond to messages from the Distribution Network Operator The Distribution Network Operator's system maintains information relating to the location of the Smart Meter and can position it on a network connectivity model The Distribution Network Operator is aware of the proposed significant future loads or generation connections to be installed on the network and the premises at which the Smart Metering System data needs to be accessed to determine the aggregate impact of the new and existing load on the network The Smart Metering System has been measuring, recording and storing half-hourly power flow and voltage data for a predetermined period of time and The Distribution Network Operator has received confirmation of this The Smart Metering System is able to collect generation data where micro-generation is installed
Post Conditions
The Distribution Network Operator has Smart Metering System data available for use in creating generic profiles

Trigger
The Distribution Network Operator wants to use accurate generic profiles in network load forecasting
Basic Flow Note- this flow will be repeated for every Smart Metering System meeting the DNO criteria
1. At the defined interval the Smart Metering System collects the data and sends it to the Distribution Network Operator 2. The Distribution Network Operator receives the data and loads it into their systems
Alternative Flow
2. At Basic Flow step 2 2a1 The Distribution Network Operator does not receive the data from the Smart Metering System 2a2 The Distribution Network Operator checks and takes steps to ensure the Smart Metering System is configured correctly and had data to send 2a3 The Distribution Network Operator requests the Smart Metering System resends the data 2a4 The Smart Metering System resends the data 2a5 Back to Basic Flow step 2

Additional Information
Related Information
Notes and issues

6.2.5 Determine Latent Demand due to Embedded Generation

Use Case ID	05	**Level**	Detailed
		Role	Electricity
Use Case Name	Determine Latent Demand due to Embedded Generation		

Description
Business Need One of the emerging challenges for Distribution Network Operators is to obtain a true view of the potential peak demand on their network with increased micro-generation and distributed generation. Dependent on local conditions network load will be greatly affected by distributed generation. This will vary depending on the various technologies e.g. Photo Voltaic cells (PVs) are unlikely to affect the system peak whereas micro Combined Heat and Power (CHP) and potentially micro wind turbines are likely to reduce the measured system peak. It is feasible that the true peak demand may never be directly measureable under normal conditions. This provides a challenge for Distribution Network Operators, as they will need to assess whether their network has sufficient spare capacity to cope with the theoretical maximum demand that would be presented should all the distributed generation connected to a given section of network cease generating (for example due to a network fault resulting in operation of its 'loss-of-mains' protection). The decision then for Distribution Network Operators is whether to reinforce their network to cope with a theoretical peak load that is unlikely to occur when the network is operating normally or plan on the basis of a lower peak load and put in place contingency plans to cater for post fault scenarios when the actual load is higher. When a distribution circuit is re-energised after a prolonged outage the initial load can be greater than previously observed, this is known as 'cold load pickup' and arises from appliances such as refrigeration and heating plant simultaneously drawing power as soon as supplies are restored (i.e. because normal diversity of demand has been temporarily lost). This issue will be exacerbated where there is distributed generation connected to the network and as the penetration of electricity based heat pumps increases. During outages it is expected that all distributed generation will cease to operate – this is a requirement of the present connection standards (and in any case is likely to happen due to the almost inevitable mismatch between generation capacity and network demand). The Distribution Network Operator will then need to be aware of the gross network demand that will be presented when power is restored in order to ensure that the network has sufficient capacity to meet this demand until such time that generation is able to recommence. The demand effectively 'hidden' by the presence of distributed generation is termed 'latent demand'. While 'cold load pick up' demand can generally be estimated in the absence of generation, 'latent demand' is less easy to identify as assessment depends on knowing the aggregate output from all generators connected to the section of network concerned.

Distribution Network Operators could use the Smart Metering System data to obtain a better estimate of both the potential 'cold load pickup' and especially the 'latent demand' due to any generation present. To do this they will need to determine the latent demand at each connected Smart Metering System that has micro-generation installed, as well as the normal connected demand. This can be calculated by obtaining, from the Smart Metering System, the half hourly average real and reactive power flow from each individual premises, and the half hourly generation output from the generation meter if fitted (i.e. the Feed-in Tariff or 'FIT' meter).

Where the power flow and voltage data is not transmitted and stored routinely, or where more up to date information is required, the Distribution Network Operator will need to be able to choose the specific Smart Metering Systems from which they require information, based on their location on the network and configure the Smart Meter System accordingly. They must also be able to request the information on an ad-hoc basic whenever it is required.

Once the Distribution Network Operators have determined the 'latent demand' and/or the normal 'cold load pickup' they can determine the network capacity required. If sufficient network capacity is not available there may be a need to perform a 'rolling restoration' of customer supplies so that the return of demand is staggered allowing generation plant time to pick up production to meet some of the demand. In order to do this there may be a need to disconnect individual premises so that not all supplies are restored when the network is restored; these customer supplies would be restored soon afterwards once micro-generation connected on the network had recommenced electricity generation. It should be noted however that this will not always be practical; for example auto-reclose operations will result in all the disconnected demand and latent demand being presented at the moment the network is re-energised.

Network Benefit

The benefit of this approach is that the DNO will be able to better understand and manage the risks associated with latent demand. If the latent demand is not understood, then in certain network conditions there will be a risk of overloading the circuits resulting in interruptions to customer supplies and potentially damaged assets.

Actors		
Name	**Type**	**Role Description**
Distribution Network Operator	Primary	Organisation responsible for managing the distribution network that provides electricity to the premises.
Micro-generation	Secondary	Sources of power from domestic properties or small-to-medium enterprises that are attached to the Smart Metering System, such as PV, micro-wind turbines or micro-CHP.

Note: the following scenario could equally be met by the Distribution Network Operator using extracted smart metering power and voltage data residing in a DNO archive storage system where this information is considered to be sufficiently up to date.

Scenario Descriptions
Pre Conditions
Smart Metering Systems are installed and configured to receive and respond to messages from the Distribution Network Operator The Distribution Network Operator's system maintains information relating to the location of the Smart Meter and can position it on a network connectivity model The FIT meter (generator output) data is accessible through the Smart Metering System in the form of half-hourly average power readings The Distribution Network Operator is aware of micro-generation installed at the Smart Metering System premises (either through notification or through information received from the FIT meter via the Smart Metering System) The Distribution Network Operator identifies the premises and Smart Metering System it wishes to obtain data from The Smart Metering System has been measuring, recording and storing half-hourly power flow, voltage data for a predetermined period of time and the Distribution Network Operator has received confirmation of this
Post Conditions
The Distribution Network Operator has Smart Metering System data available for use in determining latent demand
Trigger
The Distribution Network Operator wants to determine latent demand
Basic Flow Note- this flow will be repeated for every Smart Metering System meeting the DNO criteria
1. At the defined interval the Smart Metering System sends the data to the Distribution Network Operator 2. The Distribution Network Operator receives the data and loads it into their systems
Alternative Flow
2. At Basic Flow step 2 2a1 The Distribution Network Operator does not receive the data from the Smart Metering System 2a2 The Distribution Network Operator checks and takes steps to ensure the Smart Metering System is configured correctly and had data to send 2a3 The Distribution Network Operator requests the Smart Metering System resends the data 2a4 The Smart Metering System resends the data

2a5	Back to Basic Flow step 2

Additional Information
Related Information
Notes and issues
It is assumed that the maintenance of the Micro-generation meter will be the Consumer's responsibility and that the DNO will not be able to communicate directly with the Consumer if the DNO detects a fault with it. 'Rolling restoration' of supplies will require the facility for DNOs to prevent some customers from having their supplies restored immediately upon supply restoration. Such customers would need their Smart Meter configured during the outage period. Following the initial supply restoration information on network demand would need to be collected in short timescales (5 minutes) to detect the re synchronisation of generation that would permit commands to be issues to restore the remaining customer supplies.

6.2.6 Identify Voltage Quality Issues

Use Case ID	06	**Level**	Detailed
		Role	Electricity
Use Case Name	Identify Voltage Quality Issues		

Description
Business Need As part of the day to day operation of distribution and transmission networks there is a requirement to ensure that voltage quality is maintained to an acceptable level (as set out in BS EN 50160:2000 (Voltage characteristics of electricity supplied by public distribution systems)). To ensure that the connection of new demand and generation does not result in degradation of voltage quality to the extent that it breaches prescribed limits of acceptability there are Distribution Code requirements that need to be complied with when new equipment is connected to the network. The key aspects of voltage quality are Harmonic Distortion and Voltage Flicker. Engineering Recommendations G5/4 and P28 respectively provide guidance on acceptable emissions from demand / generation connected to networks.

With the anticipated increases in LV connected non-linear loads (such as heat pumps equipped with motor soft-start mechanisms, Compact Fluorescent Lights, and DC/AC converters associated with Photo Voltaic micro-generation and in the future Vehicle-to-Grid (V2G)) and potentially disturbing loads (such as heat pumps equipped with direct-on-line starting mechanisms) it will be particularly important to monitor power quality on the low voltage network.

Smart meters will provide the opportunity to record voltage fluctuations and date / time stamp such events so that Distribution Network Operators will be able to identify any parts of their networks where poor voltage quality is a recurring issue. Threshold limits for recording of events will be specified.

Distribution Network Operators will use the Smart Metering System information to monitor voltage sags and swells and, in the event of excessive activity, initiate root cause investigations, and take appropriate corrective actions to keep the networks operating within the prescribed limits.

While it is also feasible for smart meters to monitor Harmonic Distortion, typically measured as Total Harmonic Distortion (THD), it is anticipated that THD might be more economically monitored at distribution substation level where regularly occurring excessive levels of THD would trigger further root cause investigations.

Once corrective actions have been taken, Distribution Network Operators will continue to monitor the Smart Metering System to confirm that the corrective actions have been effective.

Business Benefits

The benefits of using these actions include the following:

- The presence of excessive voltage fluctuations determined at an early stage improving the chances of identifying the root cause (for example a recent installation or change of use) and securing agreement by the customer to rectify the issue
- Early identification and resolution of the issue would provide affected customers with earlier relief from the nuisance of voltage flicker
- Early identification of any general increase in voltage quality issues that might require a change in the process surrounding connections of disturbing loads and/or to the standards governing equipment (such as heat pumps) so that the issue is designed-out.

Actions might include one or more of the following:

Actions on DNO Assets

- Actions to reduce source impedance (for example install a lower impedance transformer) to increase fault level and reduce the depth of the voltage sag.

Actions within Customers premises

- Advise customers to carry out remedial actions to eliminate the issue at the point of connection.
- In the event of refusal, invoke powers under the ESQC Regulations to disconnect

supply until the issue had been resolved.

Other Actions

- Engagement with manufacturers (or their trade associations - e.g. BEAMA) and/or authorities governing standards for electrical equipment to agree any necessary changes.

Actors		
Name	**Type**	**Role Description**
Distribution Network Operator	Primary	Organisation responsible for carrying out actions to manage voltage quality on the distribution network

Scenario Description

Pre Conditions

A Smart Metering System is installed and configured to identify voltage quality transgressions in respect of threshold limits prescribed by the Distribution Network Operator that are broadly consistent with BS EN 50160[1]

The Smart Meter has the capacity to record the voltage quality events (defined as transgressions beyond configurable thresholds) occurring over a period of 3 months and is configured to transmit that data to the Distribution Network Operator at defined intervals

The Distribution Network Operator is aware of the location of the Smart Meter and can 'position' it on a network connectivity model

The Smart Meter can be configured to record the time and date of voltage quality events that exceed the prescribed thresholds

The Distribution Network Operator is able to access the Smart Metering System to identify the recorded events

Post Conditions

The Distribution Network Operator interrogates the data from the Smart Metering System to identify any voltage quality events (and from other electrically adjacent Smart Meters) to determine the geographic extent of the voltage quality issue and to help isolate the locality of the root cause.

In receiving the data from the Smart Metering System the Distribution Network Operator identifies an excessive (limits to be determined by the Distribution Network Operator) number of voltage quality events.

Trigger

[1] note: ER P28 sets out the permissible voltage fluctuation requirements from equipment to be connected to the distribution network and it is not anticipated that the meter would have the capability to undertake a P28 compliance test; the intention is that the meter would time and date stamp events that might indicate non-compliance

The voltage quality of the electricity supplied to the premises varies outside of the prescribed thresholds resulting in voltage quality events
Basic Flow
1. The Smart Metering System accumulates time and date stamped voltage quality events 2. The Smart Metering System stores the recorded events for a period of three months (after which time the meter continues to record events but overwrites the most historic events) 3. The Distribution Network Operator receives the information from the Smart Metering System at the intervals required 4. The information is analysed to determine if further follow-up investigation is required.
Alternative Flow

Additional Information
Related Information
Notes and issues
The voltage quality issue having been resolved, the Distribution Network Operator is able to access the Smart Metering System to confirm that recorded voltage quality events have been eliminated or fallen to an acceptable level.

6.3 Actively manage networks

Use Case ID	AMN	**Level**	Summary
		Role	Electricity
Use Case Name	Actively Manage Networks		

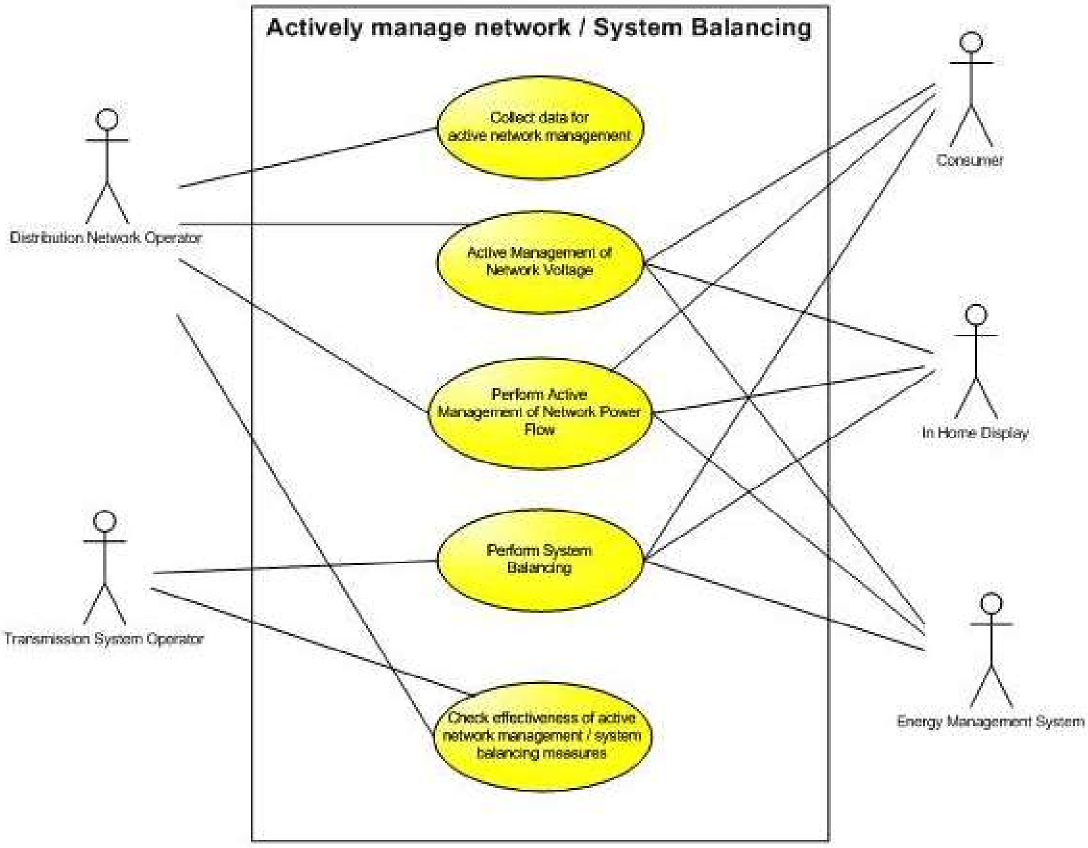
Description
As part of the day to day operation of distribution networks there is a need to ensure that they are managed so that power flows and voltages are maintained within prescribed operating limits at all times. Smart Metering Systems will enable DNOs to monitor network conditions in near-real time enabling rapid identification and rectification of issues. The range of actions a DNO may take are varied, incorporating changing DNO assets,

Demand Side Management or changing the settings of demand or generation equipment.

The scale and amount of control involved in the intervention will vary dependent on the situation. Some actions may be taken with a long term view and looking for a proportional behavioural response, such as load shifting tariffs, while short term actions may be quite controlling looking for more certain / immediate response, such as initiating maximum threshold cut-off settings on the meters.

In each case it will be important to understand the location on the network that the response is wanted, and the amount, immediacy and reliability of response. It will be important to measure the effectiveness of actions to feed into future planning.

Figure 6 - Actively Manage Network / System Balancing Use Case diagram



6.3.1 Collect data for active network management

Use Case ID	07	**Level**	Detailed
		Role	Electricity
Use Case Name	Collect data for active network management		

Description

Business Need

As part of the day to day operation of distribution networks there is a need to ensure that they are managed so that power flows and voltages are maintained within prescribed operating limits at all times. Distribution networks are managed by Distribution Network Operators, and are currently not managed as proactively or in real time, as transmission networks are, however there is an expectation that this will change in the near future.

The Distribution Network Operators will face a variety of challenges in the future. Increasing quantities of generation will be connected to the distribution networks and there will be new types of demand, such as electric vehicles, heat pumps and domestic air cooling units, which will change the characteristics of consumer demand. It is expected that there will be a need to build on the present systems for managing power flows and voltages on distribution networks.

Distribution Network Operators will use Smart Metering System information to monitor real and reactive power flow and voltages within their network to identify, or predict, where actions are required to keep the networks operating within the prescribed limits. Implementing active network management techniques as an alternative, or to supplement, network reinforcement is expected to be used increasingly in the future. The information required will be similar to that in Use Case 01, but the information will be required with a much lower latency.

The same monitoring systems will be used to check that the rectifying actions have been successful.

Business Benefits

This use case allows Distribution Network Operators to identify parts of the network where rectifying actions are needed in real time to maintain appropriate power flows and network voltages.

The use of Smart Metering Systems allows increased monitoring so that the requirement for real time interventions can be identified. Potential benefits include:

- Increased efficiency of network operation
- Reduced need for network reinforcement
- Improved reliability and quality of supply.

Actors		
Name	**Type**	**Role Description**
Distribution Network Operator	Primary	Organisation responsible for managing the distribution network that provides electricity to the premises.

Scenario Descriptions

Pre Conditions

Smart Metering Systems are installed and configured to receive and respond to messages from the Distribution Network Operator

The Distribution Network Operator's system maintains information relating to the location of the Smart Meter and can position it on a network connectivity model

Strategically located Smart Metering Systems have been identified configured to measure, record and provide the power flow and voltage data at high granularity

Post Conditions

The Distribution Network Operator has Smart Metering System data available that will help identify locations where active network management is needed.

Trigger

This use case may be running continually

Basic Flow

This use case is carried out at each selected Smart Metering System

1. The Smart Metering System measures real and reactive power flow and voltage data
2. The Smart Metering System sends the data to the Distribution Network Operator
3. The Distribution Network Operator receives the data and loads it into its system along with data from sensors within networks and other information to identify whether actions are needed or actions that have been carried out have been successful.

Alternative Flow

At Basic Flow step 2:

2a1 The Smart Metering System fails to send the message

2a2 The Distribution Network Operator's systems identify the missing data, the Distribution Network Operator, investigates the cause of the failure and may

	reconfigure the meter
2a3	The use case returns to Basic Flow step 1.

Additional Information
Related Information
Use Case 08 – Active management of network voltage Use Case 09 – Perform active management of network power flow
Notes and issues

6.3.2 Active management of network voltage

Use Case ID	08	**Level**	Detailed
		Role	Electricity
Use Case Name	Active Management of Network Voltage		

Description
Business Need As part of the day to day operation of distribution networks there is a need to ensure that they are managed such that power flows, voltages and frequency are maintained within prescribed operating limits at all times. Distribution networks are managed by Distribution Network Operators, however they are currently not managed proactively, in real time. There is however an expectation that this will change in the near future. The Distribution Network Operators will be facing a variety of challenges to undertake both these responsibilities in the future. Increasing quantities of generation will be connected to the distribution networks and there will be new types of demand, such as electric vehicles, heat pumps and domestic air cooling units, which will change the characteristics of consumer demand. It is expected that there will be a need to build on the present systems for managing network voltages on distribution networks. Distribution Network Operators will use Smart Metering System information to monitor voltages within their network enabling them to identify, or predict, where actions are required to keep the networks operating within the prescribed limits. Rectifying actions would be implemented by the Distribution Network Operator and systems would be developed to check that the rectifying actions have been successful.

Actions may be taken directly on assets owned and operated by the Distribution Network Operator e.g. operation of:

- primary or distribution transformer tap changing equipment
- HV or LV voltage regulators
- Capacitor / Distribution Static Compensator (DStatcom)

Alternatively, or in addition, actions may be requested on equipment within the consumer's premises e.g. initiating control actions to:

- change the load on the network by decreasing or increasing demand
- change the operation of in-premises generation

These actions are expected to be used in various combinations to resolve the observed voltage issues on distribution networks. A further description of these actions is provided below. It should be noted that although actions on DNO equipment are outside the Smart Metering System Scope, there may be a need for communications from the Smart Meter System to the DNO equipment to initiate action and confirm its effectiveness.

Business Benefits

The benefits of using these actions include the following:

- efficiently ensuring that voltages on the distribution network are maintained at all times within the prescribed limits
- helping to avoid or defer investment in reinforcement of the network

Actions on DNO Assets

Examples of actions carried out directly on DNO assets include:

<u>A Transformer tap changers</u>

The Distribution Network Operator currently effects a change in network voltage by real time voltage control via tap changers at primary substations. In the future, in addition to this, it is likely that voltage adjustments will be necessary at lower levels of the network hierarchy, for example at distribution substation transformers or via voltage regulators or capacitors. These latter actions may only be required to cover relatively long periods (e.g. each morning / evening or at the start of the summer / winter), however operation of the tap changer at the primary substation transformer would, as at present, need to continue to be controlled in real time.

<u>B Power factor control</u>

Due to the non-linear load characteristics of certain types of appliances (for example: heat pumps, air cooling compressors, some types of generation, and Compact Fluorescent Lamps (CFLs)) it is anticipated that there will be a general degrading of power factor as these appliances become increasingly popular. Poor power factor leads to higher currents on distribution systems than are necessary to supply the real power required (hence reducing thermal rating capacity headroom) and especially gives rise to poor voltage regulation due to the high reactance component of HV overhead lines and (especially) transformer impedance. Correcting power factor by switched capacitors or DStatcoms can be a far more cost effective means of increasing capacity and improving voltage control than reinforcement; it will also beneficially reduce losses. Voltage sourced converters (VSCs) associated with battery storage also have the ability to correct PF.

Actions within Customers premises

On the demand side, actions will normally be with the agreement of Consumers. There are three key approaches:

A Increase or decrease network voltages by decreasing or increasing consumer demand.

The mechanisms for changing customer demand may range from "softer" controls intended to gain a behavioural response such as by Time of Use, Critical Peak Price (CPP) or dynamic Tariffs, through direct control of appliances but allowing Consumer override, to "firm control" such as direct control of use without Consumer override. Tariff signals could be given to encourage consumers to either increase or decrease demand.

Actions may be effected at any of the following groups:

- Electric vehicles
- Domestic appliances, especially 'wet' appliances[2]
- Immersion heaters
- Air cooling units
- Heat pumps and/or back-up electric heating systems
- Specific circuits within premises
- Home area networks

The "control" may be via combinations of pricing mechanisms or other incentives. Pricing mechanisms include:

- Time of Use Pricing
- Critical Peak Pricing
- Real Time Pricing (dynamic)

These may be used in conjunction with control of consumption by appliances including frequency response appliances (such as refrigerators), smart appliances that communicate with the Smart Metering System or an energy management system, or by control of circuits or the whole premises. The mechanisms may include allowing the Consumer to override the control or not.

These mechanisms would need to be widely adopted over populations of equipment and premises supplied via defined parts of a distribution network in order to have sufficient effect.

B Increase or decrease network voltages by increasing or decreasing generation / storage

In addition to demand response mechanisms, there may be corresponding mechanisms to incentivise or curtail export power from micro-generation or returned from storage. Again,

[2] Examples of 'wet' appliances are dishwashers, washing machines, etc.

this may be influenced by pricing measures at different granularity or by direct control allowing or prohibiting input under particular conditions. Again these actions would be carried out within contracts with Consumers.

C Change the operating parameters of generation / storage plant

In addition to influencing the export from micro-generation, there may be mechanisms to change their operating parameters e.g. to increase the reactive power exported to help support network voltages. Again, this may be influenced by pricing measures at different granularity or by direct control allowing or prohibiting input under particular conditions. Again these actions would be carried out within contracts with Consumers.

Different types of mechanism will produce responses of different latency and predictability. For example a Time of Use tariff might be useful for reducing traditional peaks (but will be ineffective for providing response to short term stress) whereas, depending on the commercial arrangements, direct control of demand or generation can be used to provide immediate response to stress.

In addition, it should be noted that the effect of any action may be masked or enhanced by other actions and commercial arrangements (at the same premises or in the same part of the network) or by external factors such as the weather or television schedules.

Although some of the examples above may require changes of Customer behaviour and an acceptance of greater external intervention into their use of electricity, they have the potential to avoid major investment in network reinforcement and hence potentially significant increases in Use of System prices. Hence they should all be considered as legitimate mechanisms that may increasingly be used to balance networks and should therefore be supported by the functional specification of the Smart Metering System.

Note

Given that the focus here is on the management of voltages on the distribution network the commercial arrangements for the demand management options could be directly between the Distribution Network Operator and the Consumer. However, in practice, for domestic sized metering it may be more likely that the Distribution Network Operator would offer products to Suppliers or Aggregators in order that these parties could then provide the demand management service for them. If this were the case, the actual interaction with the Smart Metering System would be by another party and therefore requirements to interact with the Smart Metering Systems would belong to those other parties. The use case would then strictly be reduced to using voltage information from smart meters to determine trigger points for the interaction to commence, however there would be a corresponding Use Case for these other parties.

The mechanisms that could be used are virtually limitless and exhaustive documentation is beyond the scope of this Use Case. However the following scenarios are provided to illustrate a range of mechanisms and actions from the longer term pricing mechanisms, through short term pricing, to direct control of appliances or generation.

Further analysis could develop the use cases included in this summary use case depending on which mechanisms the parties genuinely expect to use or are interested in exploring. For this same reason alternative flows are not explored.

Actors		
Name	**Type**	**Role Description**
Distribution Network Operator	Primary	Organisation responsible for managing the distribution network that provides electricity to the premises.
Consumer	Secondary	Organisation, or person, consuming or generating the electricity at the premises. The Consumer may also be the organisation or person contracted with the Supplier for the provision of energy.
In Home Display	Secondary	A display provided to Consumers to enable them to monitor their energy usage and the charges levied for that energy under a tariff.
Energy Management System	Secondary	A device which uses information taken from the smart meter (including energy prices and signals) and other monitoring devices (such as thermostats) to manage the usage of appliances or generation at a premises.

Scenario 1 **Operation of (Distribution Use of System) Time of Use Tariff** Note this use case would be carried out at a number of premises Note for this scenario it is assumed that the prices are also relayed to a display in the premises
Pre Conditions
A Smart Metering System is installed and configured to receive and respond to messages from the Distribution Network Operator The Distribution Network Operator is aware of the location of the Smart Meter and can 'position' it on a network connectivity model The Distribution Network Operator has systems that can generate the appropriate Time of Use tariffs and bill the Supplier accordingly The Distribution Network Operator has a contract with the Consumer including the operation of a Time of Use tariff for all, or part, of the consumption at the premises The Smart Metering System has been configured with the Time of Use tariff The Smart Metering System has been configured to provide register readings according to the Time of Use tariff at set periods
Post Conditions

The Time of Use Tariff is operational; load has been influenced and changed according to the Consumer's response The Supplier can be billed according to the Customer's usage and Time of Use tariff
Trigger
This use case is continuous through out the life of the contractual arrangement The Consumer uses power influenced by the Time of Use tariff
Basic Flow
1. The Smart Metering System accumulates readings for registers according to the Time of Use tariff 2. The Smart Metering System periodically (according to the schedule) provides readings for the registers associated with the Time of Use tariff to the Distribution Network Operator 3. The Distribution Network Operator receives the readings and loads them into their system
Alternative Flow

Scenario 2 **Operation of (Distribution Use of System) Real Time Pricing** Note for this scenario it is assumed that the prices are also relayed to a display in the premises
Pre Conditions
A Smart Metering System is installed and configured to receive and respond to messages from the Distribution Network Operator The Distribution Network Operator is aware of the location of the Smart Meter and can position it on a network connectivity model The Distribution Network Operator has systems that can generate the appropriate Real Time Use of System (UoS) tariffs and bill the Supplier accordingly The Distribution Network Operator has a contract with the Consumer including the operation of a Real Time UoS Pricing tariff for all or part of the consumption at the premises The Smart Metering System has been configured to accept regular price updates some time in advance of their being in effect The Smart Metering System has been configured to provide register readings according to every price period
Post Conditions
The Real Time UoS Pricing Tariff is operational, load has been influenced and changed according to the Consumer's response

The Consumer can be billed according to their usage and the prices used
Trigger
This use case is continuous through out the life of the contractual arrangement The Consumer uses power influenced by the Real Time Price regime
Basic Flow
1. The Distribution Network Operator periodically sends prices to the Smart Metering System 2. The Smart Metering System validates the prices and forwards them to the In Home Display (or other display device) 3. The Consumer uses the information on their In Home Display to influence their consumption behaviour either directly or via an Energy Management System 4. The Smart Metering System periodically sends consumption readings to the Distribution Network Operator 5. The Distribution Network Operator receives the consumption readings and loads them into their system
Alternative Flow

Scenario 3 **Power Sharing by Maximum Power Thresholds** Note thresholds could be used to limit supply or export in a variety of ways for example there could be a maximum in a period, a maximum instantaneous consumption with cut offs where thresholds are exceeded. For this illustration a maximum instantaneous power consumption is used
Pre Conditions
A Smart Metering System is installed and configured to receive and respond to messages from the Distribution Network Operator The Distribution Network Operator is aware of the location of the Smart Meter and can position it on a network connectivity model The Distribution Network Operator has a contract with the Consumer including the operation of maximum thresholds for power use The Smart Metering System is configured with a maximum power consumption threshold
Post Conditions
Power is returned to a premises
Trigger
The consumption through a Smart Metering System reaches the maximum power threshold
Basic Flow

1. The Smart Metering System recognises that power consumption has reached the threshold configured in the meter
2. The Smart Metering System sends a message to the In Home Display advising of excessive power use and warning that the supply will be interrupted unless consumption is reduced
3. The In Home display receives and displays the message
4. The Consumer notes the message and turns off some appliances
5. The Smart Metering System recognises that power consumption has dropped below the threshold configured in the meter
6. The Smart Metering System sends a command to the In Home Display to replace the previous message with one stating consumption has reduced below threshold
7. The Consumer notes the message and acknowledges it at the In Home Display

Alternative Flow

At Basic Flow step 4:

4a1 The Consumer does not turn off some appliances

4a2 After a predetermined time the Smart Metering System cuts supply and logs the event

4a3 The Smart Metering System sends a message to the In Home Display stating supply has been interrupted due to excessive power use

4a4 The Consumer notes the message and acknowledges it at the In Home Display

4a5 The Consumer turns off some appliances

4a6 The Consumer restarts supply with an action at the meter (such as pressing a button)

4a7 The Smart Metering System restarts supply and logs the event

Scenario 4

Direct Control, by DNOs, of appliances or micro-generation

This scenario assumes that the direct control is carried out by event messages sent through the Smart Metering System and that there is an Energy Management System in the premises

It is assumed that the events are of predetermined duration

Pre Conditions

A Smart Metering System is installed and configured to receive and respond to messages from the Distribution Network Operator

The Distribution Network Operator is aware of the location of the Smart Meter and can position it on a network connectivity model

The Distribution Network Operator has a contract with the Consumer including the operation of a Direct Control tariff

Post Conditions
Direct control events have happened and load or generation has changed
Trigger
A control event is recognised as required by the Distribution Network Operator
Basic Flow
1. The Distribution Network Operator sends a message to the Smart Metering System of an event requiring greater or less demand or greater or less generation for a known duration 2. The Smart Metering System validates the message 3. The Smart Metering System acknowledges to the Distribution Network Operator that the event has been received 4. The Smart Metering System forwards the message to the Energy Management System which co-ordinates the change to demand event 5. The Energy Management System recognises the end of the change to demand event and allows consumption or generation to return to unfettered use.
Alternative Flow

Additional Information
Related Information
This use case includes a variety of actions that may be performed to actively manage networks; they will not be performed in isolation. Some of the mechanisms are quite direct and may have immediately observable responses whereas others are long term and the response is less directly measurable by the state of the network. Although some measures may be continuously in force it may be considered as preceded and followed by "07 Collect data for active management". This use case identifies that actions are needed and checks the effect on the network. Particularly where actions do not directly control load but rely on a proportion of response from a population it will be important to gauge the amount of response achieved, this will be done by using the "11 Check effectiveness of network management / system balancing".
Notes and issues

6.3.3 Perform active management of network power flow

Use Case ID	09	**Level**	Detailed
		Role	Electricity
Use Case Name	Perform Active Management of Network Power Flow		

Description

Business Need

As part of the day to day operation of distribution and transmission networks there is a need to ensure that they are managed such that power flows and voltages are maintained within prescribed operating limits at all times. Distribution networks are managed by Distribution Network Operators, however they are currently not managed as proactively in real time, as transmission networks. There is however an expectation that this will change in the near future.

The Distribution Network Operators will be facing a variety of challenges to undertake these responsibilities in the future. Increasing quantities of generation will be connected to the distribution networks and there will be new types of demand, such as electric vehicles, heat pumps and domestic air cooling units which will change the characteristics of consumer demand. It is expected that there will be a need to build on the present systems for managing network voltages on distribution networks.

Distribution Network Operators will use Smart Metering System information to monitor real and reactive power flows on their network to identify or predict where actions are required to keep the networks assets, and potentially those in the transmission network, operating within their capability.

Rectifying actions would be implemented by the Distribution Network Operator or the National Electricity Transmission System Operator (NETSO) in the case of managing power flows at the interface between the transmission and distribution networks, and systems would be developed to check that the rectifying actions have been successful.

Actions may be taken directly on assets owned and operated by the Distribution Network Operator e.g. operation of

- storage device
- capacitors / Distribution Static compensator (DStatcom)

Alternatively, or in addition, actions may be requested on equipment within the consumers premises e.g. initiating control actions to:

- change the load on the network by decreasing or increasing demand

- change the operation of in premises generation

These actions are expected to be used in various combinations to resolve the observed power flow issues on distribution networks. A further description of these actions is provided below. It should be noted that although actions on DNO equipment are outside the Smart Metering System Scope, there may be a need for communications from the Smart Meter System to the DNO equipment to initiate action and confirm its effectiveness.

Business Benefits

The benefits of using these actions include the following:

- efficiently ensuring that power flows on the distribution network are maintained at all times within the prescribed limits
- helping to avoid or defer investment in reinforcement of the network

Actions on DNO Assets

The Distribution Network Operator effects a change in power flow, e.g. using capacitors. These actions may only be required to cover relatively long periods (e.g. each morning / evening or at the start of the summer / winter), however the use of DStatcoms and storage devices would need to be controlled in real time. Correcting network power factors using switched capacitors or DStatcoms can be a far more cost effective means of increasing capacity and improving voltage control than reinforcement; it will also beneficially reduce losses. Voltage sourced converters associated with battery storage also have the ability to correct PF.

Actions within Customers premises

On the demand side, actions will normally be with the agreement of Consumers. There are two key approaches:

A Increase or decrease network power flows by changing consumer demand.

The mechanisms for changing customer demand may range from “softer” controls intended to gain a behavioural response such as by Time of Use, Critical Peak Price (CPP) or dynamic Tariffs, through control of appliances but allowing Consumer override, to “firm control” such as direct control of use without Consumer override. Tariff signals could be given to encourage consumers to either increase or decreased demand.

Actions may be effected at any of the following groups:

- Electric vehicles
- Domestic appliances, especially ‘wet’ appliances
- Immersion heaters
- Air cooling units
- Heat pumps and/or back-up electric heating systems
- Specific circuits within premises
- Home area networks

The "control" may be via combinations of pricing mechanisms or other incentives. Pricing mechanisms include:

- Time of Use Pricing
- Critical Peak Pricing
- Real Time Pricing

These may be used in conjunction with control of consumption by appliances including frequency response appliances (such as refrigerators), smart appliances that communicate with the Smart Metering System or an energy management system, or by control of circuits or the whole premises. The mechanisms may include allowing the Consumer to override the control or not.

These mechanisms would need to be widely adopted over populations of equipment and premises supplied via defined parts of a distribution network in order to have sufficient effect.

B Increase or decrease network power flows by changing generation / storage

In addition to demand response mechanisms, there may be corresponding mechanisms to incentivise or curtail export power from micro-generation or returned from storage. Again, this may be influenced by pricing measures at different granularity or by direct control allowing or prohibiting input under particular conditions. Again these actions would be carried out within contracts with Consumers.

Different types of mechanism will produce responses of different latency and predictability. For example a Time of Use tariff might be useful for reducing traditional peaks but is not good for providing response to short term stress, whereas, depending on the commercial arrangements, direct control of demand or generation can be used to respond to immediate stress.

In addition, it should be noted that the effect of any action may be masked or enhanced by other actions and commercial arrangements (at the same premises or in the same part of the network) or by external factors such as the weather or television schedules.

Although some of the examples above may prove inoperable or ineffective in reality, currently they should all be considered as possible mechanisms that may be used to balance networks. Hence the Smart Metering System is expected to cater for all examples.

Note

It is possible that the commercial arrangements for these actions could be directly between the Transmission or Distribution Network Operator and the Consumer. For domestic sized metering it may be more likely that the Network Operator would offer products to Suppliers or Aggregators in order that these parties provide the service for them. If this were the case, the actual interaction with the Smart Metering System would be by another party and therefore requirements to interact with the Smart Metering Systems would belong to those other parties. The use case would then be reduced to strictly using demand information from smart meters to determine trigger points for the interaction to commence.

Simply for the purpose of describing the actions to a useful level, this analysis uses the generic title Network Operator as the party that has a contract with the Consumer and carries out the actions. In practice this actor may actually be the Transmission Network Operator, the Distribution Network Operator, the Supplier or an agent such as an aggregator.

The mechanisms that could be used are virtually limitless and exhaustive documentation is beyond the scope of this Use Case. However the following scenarios are provided to illustrate a range of mechanisms and actions from the longer term pricing mechanisms, through short term pricing, to direct control of appliances or generation.

Further analysis could develop the use cases included in this summary use case depending on which mechanisms the parties genuinely expect to use or are interested in exploring. For this same reason alternative flows are not explored.

Actors		
Name	**Type**	**Role Description**
Network Operator	Primary	Organisation responsible for carrying out actions to manage load on the network **Note:** This role is used for convenience and these actions may actually be carried out by NETSO, a Distribution Network Operator, a Supplier, an Aggregator, or any other party providing a Demand Response to Networks Businesses
Consumer	Secondary	Organisation, or person, consuming or generating the electricity at the premises. The Consumer may also be the organisation or person contracted with the Supplier for the provision of energy.
In Home Display	Secondary	A display provided to Consumers to enable them to monitor their energy usage and the charges levied for that energy under a tariff.
Energy Management System	Secondary	A device which uses information taken from the smart meter (including energy prices and signals) and other monitoring devices (such as thermostats) to manage the usage of appliances or generation at a premises.

Scenario 1 **Operation of (Distribution Use of System) Time of Use Tariff** Note this use case would be carried out at a number of premises Note for this scenario it is assumed that the prices are also relayed to a display in the

premises
Pre Conditions
A Smart Metering System is installed and configured to receive and respond to messages from the Network Operator The Network Operator is aware of the location of the Smart Meter and can position it on a network connectivity model The Network Operator has systems that can generate the appropriate Time of Use tariffs and bill the Supplier accordingly The Network Operator has a contract with the Consumer including the operation of a Time of Use tariff for all, or part, of the consumption at the premises The Smart Metering System has been configured with the Time of Use tariff The Smart Metering System has been configured to provide register readings according to the Time of Use tariff at set periods
Post Conditions
The Time of Use Tariff is operational, load has been influenced and changed according to the Consumer's response The Supplier can be billed according to their usage and the Time of Use tariff
Trigger
This use case is continuous through out the life of the contractual arrangement The Consumer uses power influenced by the Time of Use tariff
Basic Flow
1. The Smart Metering System accumulates readings for registers according to the Time of Use tariff 2. The Smart Metering System periodically (according to the schedule) provides readings for the registers associated with the Time of Use tariff to the Network Operator 3. The Network Operator receives the readings and loads them into their system
Alternative Flow

Scenario 2 **Operation of Real Time Pricing** Note for this scenario it is assumed that the prices are also relayed to a display in the premises
Pre Conditions
A Smart Metering System is installed and configured to receive and respond to messages from the Network Operator The Network Operator is aware of the location of the Smart Meter and can position it on a

network connectivity model The Network Operator has systems that can generate the appropriate Real Time tariffs and bill the Supplier accordingly The Network Operator has a contract with the Consumer including the operation of a Real Time Pricing tariff for all or part of the consumption at the premises The Smart Metering System has been configured to accept regular price updates some time in advance of their being in effect The Smart Metering System has been configured to provide register readings according to every price period
Post Conditions
The Real Time Pricing Tariff is operational, load has been influenced and changed according to the Consumer's response The Consumer can be billed according to their usage and the prices used
Trigger
This use case is continuous through out the life of the contractual arrangement The Consumer uses power influenced by the Real Time Price regime
Basic Flow
1. The Network Operator periodically sends prices to the Smart Metering System 2. The Smart Metering System validates the prices and forwards them to the In Home Display (or other display device) 3. The Consumer uses the information on their In Home Display to influence their consumption behaviour either directly or via an Energy Management System 4. The Smart Metering System periodically sends consumption readings to the Network Operator 5. The Network Operator receives the consumption readings and loads them into their system
Alternative Flow

Scenario 3 **Power Sharing by Maximum Power Thresholds** Note thresholds could be used to limit supply or export in a variety of ways for example there could be a maximum in a period, a maximum instantaneous consumption with cut offs where thresholds are exceeded. For this illustration a maximum instantaneous power consumption is used
Pre Conditions
A Smart Metering System is installed and configured to receive and respond to messages

from the Network Operator The Network Operator is aware of the location of the Smart Meter and can position it on a network connectivity model The Network Operator has a contract with the Consumer including the operation of maximum thresholds for power use The Smart Metering System is configured with a maximum power consumption threshold
Post Conditions
Power is returned to a premises
Trigger
The consumption through a Smart Metering System reaches the maximum power threshold
Basic Flow
1. The Smart Metering System recognises that power consumption has reached the threshold configured in the meter 2. The Smart Metering System sends a message to the In Home Display advising of excessive power use and warning the supply will be interrupted unless consumption is reduced 3. The In Home display receives and displays the message 4. The Consumer notes the message and turns off some appliances 5. The Smart Metering System recognises that power consumption has dropped below the threshold configured in the meter 6. The Smart Metering System sends a command to the In Home Display to replace the previous message with one stating consumption has reduced below threshold 7. The Consumer notes the message and acknowledges it at the In Home Display
Alternative Flow
At Basic Flow step 4: 4a1 The Consumer does not turn off some appliances 4a2 After a predetermined time the Smart Metering System cuts supply and logs the event 4a3 The Smart Metering System sends a message to the In Home Display stating supply has been interrupted due to excessive power use 4a4 The Consumer notes the message and acknowledges it at the In Home Display 4a5 The Consumer turns off some appliances 4a6 The Consumer restarts supply with an action at the meter (such as pressing a button) 4a7 The Smart Metering System restarts supply and logs the event