LCNF Tier 1 Close-Down Report

Orkney Energy Storage Park

SSET1007

Prepared By

<table>
<thead>
<tr>
<th>Document Owner(s)</th>
<th>Project/Organization Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew Urquhart</td>
<td>Project Manager</td>
</tr>
<tr>
<td>David MacLeman</td>
<td>Research and Development Manager</td>
</tr>
</tbody>
</table>

Employment Manual Version Control

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Author</th>
<th>Change Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>27/11/12</td>
<td>Andrew Urquhart</td>
<td>Initial version submitted to Ofgem</td>
</tr>
</tbody>
</table>
Page intentionally blank
Contents
Executive summary ..........................................................................................................................3
1 Project background ....................................................................................................................5
  1.1 Project approach ..................................................................................................................5
  1.2 Business case ......................................................................................................................6
  1.3 Budget cost and timescales .................................................................................................6
2 Scope and objectives ................................................................................................................7
3 Success criteria .........................................................................................................................7
4 Details of the work carried out ................................................................................................8
  4.1 Method trialled .....................................................................................................................8
    4.1.1 Selection of trial location ...............................................................................................8
    4.1.2 Constraint management service specification ............................................................11
    4.1.3 Contract creation process ...........................................................................................15
  4.2 Trialling methodology ........................................................................................................17
    4.2.1 Commercial Tender Process ......................................................................................17
    4.2.2 Safety case .................................................................................................................20
5 Outcomes of the project ..........................................................................................................24
  5.1 Commercial ........................................................................................................................24
    5.1.1 Contract key principles ...............................................................................................24
    5.1.2 Contract commercial and pricing terms ......................................................................25
  5.2 Supplier identification ........................................................................................................29
  5.3 Safety ................................................................................................................................29
    5.3.1 Definitive codes and standards reference text ...........................................................29
    5.3.2 Review of operational track record ............................................................................32
    5.3.3 Top Level Risk Assessment .......................................................................................33
    5.3.4 Review of Suitability of Fire Suppression System ......................................................35
    5.3.5 Safety conclusions ......................................................................................................36
  5.4 Technical ...........................................................................................................................37
  5.5 Business analysis ..............................................................................................................38
    5.5.1 Use cases ...................................................................................................................39
    5.5.2 Component model ......................................................................................................40
6 Performance compared to original project aims, objectives and success criteria ..............41
7 Required modifications to the planned approach during the course of the project .................42
8 Significant variance in expected costs and benefits ...............................................................42
  8.1 Costs ..................................................................................................................................42
  8.2 Benefits ..............................................................................................................................43
    8.2.1 Connection process ....................................................................................................44
    8.2.2 Lithium Ion hazards ...................................................................................................45
9 Lessons learnt for future projects ................................................................. 46
9.1 Further trialling – follow on project .......................................................... 46
9.2 Technology selection process ..................................................................... 46
9.2.1 Designing tender process for novel service contract .......................... 46
9.2.2 Risk assessment of service-based contracts ......................................... 47
9.3 Service delivery system ............................................................................. 47
9.3.1 Future contract applications ............................................................... 47
10 Planned implementation .............................................................................. 49
11 Project replication and intellectual property ................................................. 50

Appendices
Appendix I Contract ...................................................................................... 51
Appendix II Sample risk assessment developed during safety case ............. 75
Appendix III ANM / ESS Interface Requirements ........................................ 78

List of Tables
Table 1 Zonal constraint effects ........................................................................ 11
Table 2 Tested scenarios (high wind) ................................................................. 14
Table 3 Ancillary service terms & conditions .................................................. 16
Table 4 Pre-qualification questions ................................................................. 18
Table 5 EA Technology’s safety-related engagement ...................................... 20
Table 6 Availability periods ............................................................................ 27
Table 7 Monthly scalars .................................................................................. 28
Table 8 Objective Progress ............................................................................. 41
Table 9 Project costs ....................................................................................... 42
Table 10 Relevant Foreground IPR ................................................................... 50

List of Figures
Figure 1 Orkney 33kV network ......................................................................... 9
Figure 2 ANM zonal structure showing zones on geographical map of Orkney 10
Figure 3 Payments made to ESP against time and network conditions .......... 26
Figure 4 Energy Curtailed in Core Zone ......................................................... 28
Figure 5 Orkney Storage Park operations use cases ....................................... 39
Figure 6 Component Model ............................................................................ 40
Figure 7 Approach selection .......................................................................... 48
Executive summary

Project scope
The scope of this project was the creation of commercial incentives to encourage an Energy Storage Provider (ESP) to locate an Energy Storage System (ESS) where it would provide real benefits to a Distribution Network Operator (DNO).

Aims
To achieve the scope the project aimed to create a commercial and physical incentive that encouraged 3rd party Energy Storage Providers (ESPs) to locate on a constrained network. The incentives were then tested by running a commercial tender process to identify if suitable ESPs were enticed to apply for the contract.

Activities
1. Creation of a contract that encouraged the provision of energy storage tailored to manage a network constraint.
2. Preparation of a competitive tendering process that allowed best value to be delivered for the customer and established a localised energy storage market.
3. Ensuring commercial arrangements would minimise the contracted restrictions to the ESPs particularly in Short Term Operating Reserve (STOR), Arbitrage and Power Purchase Agreements (PPAs).
4. Design of connections required for up to two ESPs to install their systems outside Kirkwall Power Station (KPS). This gave the ESPs confidence that Scottish and Southern Energy Power Distribution (SSEPD) was treating this project seriously and at the same time shortened the time frame for getting the ESSs installed.
5. Analysis of the tenders and award to an ESP that fulfilled the predefined success criteria.

Outcomes and key learning
There were a number of key outputs from this project:
- Creation of novel commercial contract
- An ESP being identified to take forward into a new project to extend the learning from this project
- A better understanding of the Safety, Health and Environmental issues surrounding Lithium Ion technologies
- Interfacing the Active Network Management System with the ESS
- Definition of the business processes supporting the project
Through the project a number of lessons have been learned. In addition to the main finding that the contract created is credible and has attracted interest from suitable potential suppliers, the project has defined a need for further trialling to investigate how the contract works. As part of the process of selecting a relevant supplier and technology, lessons were learnt concerning how to run a fair tender and how best to appraise the tender technologies. The final lesson concerns the service contract approach taken for this project and how this could be applied to further projects.

**Conclusions and future work**

This project has been a success as it has created the commercial arrangements necessary to attract ESPs with appropriate ESSs. Further success has been demonstrated as an ESP has been identified to take forward to a further Tier 1 Project to develop the learning gained from this project by servicing the contract over a period of time.

**Intellectual property**

The project made use of products and services available on the market on commercial terms. It did not require the development of new products. As such no Relevant Foreground intellectual property (IP) has been registered for this project. Relevant products and suitable alternatives are available on the market to other network operators.

The main benefits and knowledge delivered by the project relate to learning around developing and tendering for a service contract for constraint management, and risk assessment relating to ESSs, particularly Lithium Ion technologies. Details necessary to allow the project to be replicated by other GB DNOs are set out in this report. Any additional information required can be requested through jenny.1.rogers@sse.com.
1 Project background

Previous work: An RPZ has been established on Orkney using Active Network Management technology to facilitate the connection of new renewable generation to a constrained 33kV network. SSEPD has experience of operating a 100kW Zinc Bromide flow battery and is installing a 1MW Sodium Sulphur NAS battery.

In contrast to our existing energy storage installations, this project is aimed principally at demonstrating that it is possible for a DNO to create commercial incentives and infrastructure to encourage third party ESP (energy storage providers) to locate their storage in areas where it can be used to alleviate network constraints. These commercial arrangements will benefit Energy Storage Systems (ESS) owners/operators who provide systems that exhibit charging/discharging characteristics that are tuned to that particular network constraint.

This Tier 1 project will create the commercial contracts necessary to incentivise the 3rd party ESPs, prepare a tender process that will select the most suitable 3rd party ESP, design the installation for up to 2ESSs outside Kirkwall Power Station (KPS) and select up to the 2 most suitable ESPs that fulfil the success criteria.

If 2 suitable ESPs are selected, then a follow on Tier 1 Project will be registered that will construct the connection points and trial the commercial arrangements. However if no suitable ESPs are identified from the bidding process then the follow on Tier 1 Project will not be registered.

The 33kV network on Orkney has constraints that are limiting the number of renewable generators able to connect to the distribution network. To remove this constraint would require a high capital cost, which due to the insufficient number of consented renewable developments, is not yet justified. Thus renewables are trapped between the current network configuration and future reinforcement.

This project aims to tackle this problem by allowing third party storage devices to be installed and managed within the existing ANM scheme. This will defer asset replacement in a cost effective and expedient way. The storage systems will not be owned by SSEPD, the only investment will be to facilitate the connection of the third parties and service the commercial arrangements put in place. This would defer the next incremental method of reinforcement which would be a new 33kV or 132kV submarine cable between Thurso and Orkney.

1.1 Project approach

This project takes a novel approach to developing energy storage capacity on the distribution network. The main aim was to demonstrate that it is possible for a DNO to incentivise third party
ESP to locate their storage in areas where it can be used to provide network benefits. A service contract based approach was chosen.

This approach also fits in well with the main question affecting storage at the moment, namely “What services are storage devices best suited to provide and where does the business case come from?” It is widely recognised by storage operators that no single revenue mechanism will create the business case for storage; instead it looks likely that similar services will be operated in unison to allow revenue to be stacked up to make any storage business viable.

1.2 Business case

To fulf the aim of the project it was necessary to try and gain an understanding of what revenue a distribution-connected ESS could hope to attract. A good place to start with this is the business case that is understood by the host DNO, in this case SSEPD, i.e. the deferment of reinforcement to the Orkney Islands. With this known and understood then other revenue streams can then be built on top of that value.

Orkney is electrically connected to the mainland by two 33kV submarine cables which run from Thurso Primary Substation to Scorradale Primary Substation on Orkney. Each cable is run at a maximum rating of 20MW. The first reinforcement method that would be considered would be to install a 30MW 33kV subsea cable between Thurso and Scorradale and an overland circuit to deliver this new capacity to Kirkwall. This would cost in total around £30 million. Using the agreed regulated lifecycle for the cable, 20 years, allows a figure to be calculated per MW and can be used to judge any offers during the project.

1.3 Budget cost and timescales

The budgeted cost for this project was listed as £175 000 and was to be spent by the end of August 2012.
2 Scope and objectives

The scope of this project is the creation of commercial incentives to encourage an ESP to locate an ESS where it would provide real benefits to a DNO.

Objectives:
1 - Create commercial contracts that will incentivise 3rd Party ESPs to locate on a constrained distribution network
2 - Prepare a tender process that will ensure that the ESPs selected will fulfil the success criteria
3 - Design up to 2 connection points for ESSs outside KPS
4 - Award up to 2 ESPs

3 Success criteria

For this project to be a success the commercial arrangements will be identified that are shown to attract ESPs with suitably tuned ESSs. Further success will be demonstrated if it’s decided to have a follow Tier 1 Project to develop the learning gained from this project.
4 Details of the work carried out

4.1 Method trialled
The method trialled by this project was to create a service contract to procure energy storage as a constraint management service from a third party provider. Previous trials of ESSs for constraint management by GB DNOs have involved the DNO procuring and operating the ESSs. The service contract based approach is therefore a novel method.

This method required development of a service contract specific to the constraint management function required. An initial review was carried out by SSEPD to ascertain what energy service markets had similar service requirements and thus have contracts that could be used. The closest market available was the Ancillary Services Market managed by National Grid. This market covers various activities including frequency response, reserve services and others. However this market did not have enough similarities of service requirements to the constraint management service addressed by this project. Thus the contracts would not have been suitable for direct use. It did however provide a rough template for what terms and conditions could be employed. It was decided that if the final contract included terms and conditions similar to this well established market it would add credibility and aid understanding of the finished contract.

4.1.1 Selection of trial location
It was decided that the Orkney Islands were the best place to investigate this question. The Orkney Islands are a rich source of renewable energy in the form of wind and wave energy. Windfarm operators claim upwards of 40% capacity factor per annum. Comparison against the average 25 to 30% available on the mainland shows the potential penetration of renewable generation. The Orkney Islands are served by a distribution network which reached its capacity for generation connection prior to 1998. In 2009, following the prior development of an intertripping generation management scheme, SSEPD designed, installed and commissioned an ANM system, under the Distribution Innovative Funding Incentive (IFI) Project 2005_14 Orkney RPZ.

To facilitate the ANM system development, power system analysis was carried out on the 33kV network on Orkney (Fig. 1) to identify thermal constraint points on the network. The cable at the bottom left of Fig. 1 represents the two main subsea interconnectors to the mainland.
These thermal constraints are pinch points on the network; if subjected to excessive current, they have the potential to sag below their allowed Health & Safety Executive Guidance Note GS6 clearance conditions. This in turn means that SSEPD would be in breach of network conditions. The ANM system monitors these points on the network as well as the metering circuit breakers that connect the generators, called New Non Firm Generators (NNFGs), to the 33kV network. When a constraint point is threatened with an excessive level of power, the ANM sends either a trim or trip instruction to the lowest affected NNFG on the priority stack. This way the thermal constraints are not breached and the lines do not infringe their GS6 clearance values.

Further to the monitoring points and the actions to be taken, there was also a need to have a fair way in which to allocate curtailments to the NNFGs. Upon investigation and stakeholder engagement involving the NNFGs, it was decided to operate a Last In First Off (LIFO) stack system. This means that the last NNFG to connect to the network was allocated the lowest point on the stack and is the first to be curtailed. However not every constraint affects every generator so a zonal system was created that used each constraint point as the boundary between zones, shown below.
Figure 2 ANM zonal structure showing zones on geographical map of Orkney
The zonal structure meant that Core Zone constraints affected all the other zones but that any other zone only affects itself.

Table 1 Zonal constraint effects

<table>
<thead>
<tr>
<th>Constrained Zone</th>
<th>Zone(s) Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>Core, 1, 2, 3 &amp; 4</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Thus using the LIFO stack and the zonal structure, the ANM system has a consistent method to manage the constraints on the 33kV network. Currently, if all contracted NNFGs connect, then 25MW will have been connected under the ANM system.

By introducing energy storage, this project aimed to further develop the ANM scheme to allow energy that would otherwise be constrained from the network to be imported by an ESS and thus allow more renewable generation onto the network.

4.1.2 Constraint management service specification

Before the contract could be drafted it was essential that the service required was well understood. This would enable the contract to specifically target the required behaviours. To do this Smarter Grid Solutions (SGS), the original designer and implementer of the ANM system, were engaged. SGS were commissioned to calculate how much energy would be available to be absorbed by any ESS installed on Orkney, in the Core Zone, for any given year. To enable this it was necessary for SSEPD to specify the following to SGS:

- Where the ESS would be located
- What network and ESS operation assumptions were necessary
- NNFG profiles
- Orkney demand profiles.

With this information SGS could populate their curtailment assessment tool. SGS and SSEPD then decided on a series of scenarios to be run by the curtailment assessment tool, which in turn calculated how much energy would be potentially available to the ESPs to import. These decisions are all explained in section 4.1.2.1

4.1.2.1 Location selection

Selecting the location was relatively simple due to the zonal structure of the ANM system. As all energy generated by NNFGs has to pass through the Core Zone to get to the mainland, i.e. a
Core Zone constraint affects all generators on the ANM scheme; it was decided to locate the device within the Core Zone. Kirkwall Power Station (KPS) was chosen as the installation location. It was selected due to its Core Zone location, its proximity to an existing unused 11kV circuit breaker; and to the central controller. This meant that connection costs would be minimised, it would have a better effect on ANM system constraints and could only be subjected to a minimum of communication faults.

4.1.2.2 Assumptions

Alongside the location of the ESS it was also necessary to make a set of assumptions about the network and the ESS operation, which would allow the study to take place. The assumptions are split into two sets, Dynamic Line Ratings (DLRs) and ESS. The reason for this split is that a DLR project is currently underway on Orkney, funded under the Distribution IFI project 2009_11 Dynamic Line Rating. It is planned to implement DLR to reduce constraints between the Core Zone and zone 1. If DLR is implemented during this project, it would have a significant impact on the amount of energy potentially available for import by the ESS.

The DLR assumptions were selected based on what had been learnt through the project to date and were qualified through data available to the ANM scheme. The ESS assumptions were important as they governed the characteristics of ESS operation and thus how much energy it would be able to absorb. These assumptions were based on an ESS only operating the constraint management contract. To try and include other behaviours would have been too complex and would have resulted in energy estimates being less accurate. The lists of assumptions are shown below.

1. Dynamic Line Ratings:
   a. A DLR system is in operation on the circuit that defines the Zone 1 boundary of the ANM Scheme (at Finstown Tee).
   b. The increased flow of power through circuits currently unmonitored by the ANM scheme, due to DLR deployed at Zone 1, does not result in the thermal ratings of those circuits being exceeded.
   c. A circuit’s DLR will at its maximum be 50% higher than its static rating and at its minimum be equal to its static rating.
   d. The static rating at the Zone 1 boundary, from which the dynamic line rating will be based, is 14 MVA.
   e. At each half hour time step a circuit’s dynamic line rating is calculated as a simple linear function of the normalised output from the wind farm closest to that circuit and the maximum dynamic line rating e.g.
      i. When the wind farm is exporting at 100% rated output the dynamic line rating will be equal to 150% of its static seasonal rating.
      ii. When the wind farm is exporting at 50% rated output the dynamic line rating will be equal to 125% of its static seasonal rating.
2. **Energy Storage System (ESS):**
   a. ESS charges during times when energy export from the Core Zone of the ANM scheme is constrained leading to curtailment of generation. The role of ESS is to relieve curtailment on NNFGs within the ANM scheme, and is not a function of other variables such as electricity price or time of day. This assumption is made purely for the purposes of this study. Although not studied within the scope of this project, there are other network support roles that may be fulfilled by an ESS.
   b. ESS charges at a rate equal to the minimum of the following: rated power, required curtailment, and remaining storage capacity. A remaining storage capacity of 1 MWh equates to a maximum charging rate of 2 MW on average across a half-hourly period.
   c. ESS discharges as soon as export capacity becomes available. ESS discharging is not a function of other variables such as electricity price or time of date.
   d. ESS discharges at a rate equal to the minimum of the following: rated power, available network capacity, and stored energy. A stored capacity of 1 MW h equates to a maximum discharge rate of 2 MW on average across a half-hourly period.
   e. ESS operates with a round-trip efficiency of 90%, which is equally distributed between the charging and discharging processes. This is equivalent to a separate charging and discharging efficiency of 94.87%.

4.1.2.3 **Generation and demand profiles**
Generation profiles of the NNFGs and the Orkney demand profiles were loaded into a planning tool; existing NNFGs generation profiles in the LIFO stack; load profiles for the islands; and wind data for a high and a low wind profile. These data sets provided the backdrop for all scenarios run to assess what amount of energy would be available for import by the ESS.

4.1.2.4 **Development of testing scenarios**
All that remained was to determine what the scenarios were that needed to be tested. There were four main variables, which when run in all relevant combinations resulted in 48 sets of results. Half of those scenarios are shown below for the high wind scenario (Table 2).
Table 2 Tested scenarios (high wind)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Wind Profile</th>
<th>Connected Generation (kW)</th>
<th>ESS Technical Parameters</th>
<th>Circuit Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High</td>
<td>Low</td>
<td>0 MW, 0 MWh</td>
<td>DLR on Zone 1</td>
</tr>
<tr>
<td>2</td>
<td>High</td>
<td>Low</td>
<td>0 MW, 0 MWh</td>
<td>No DLR</td>
</tr>
<tr>
<td>3</td>
<td>High</td>
<td>Medium</td>
<td>0 MW, 0 MWh</td>
<td>DLR on Zone 1</td>
</tr>
<tr>
<td>4</td>
<td>High</td>
<td>Medium</td>
<td>0 MW, 0 MWh</td>
<td>No DLR</td>
</tr>
<tr>
<td>5</td>
<td>High</td>
<td>High</td>
<td>0 MW, 0 MWh</td>
<td>DLR on Zone 1</td>
</tr>
<tr>
<td>6</td>
<td>High</td>
<td>High</td>
<td>0 MW, 0 MWh</td>
<td>No DLR</td>
</tr>
<tr>
<td>7</td>
<td>High</td>
<td>Low</td>
<td>2 MW, 0.5 MWh</td>
<td>DLR on Zone 1</td>
</tr>
<tr>
<td>8</td>
<td>High</td>
<td>Low</td>
<td>2 MW, 0.5 MWh</td>
<td>No DLR</td>
</tr>
<tr>
<td>9</td>
<td>High</td>
<td>Medium</td>
<td>2 MW, 0.5 MWh</td>
<td>DLR on Zone 1</td>
</tr>
<tr>
<td>10</td>
<td>High</td>
<td>Medium</td>
<td>2 MW, 0.5 MWh</td>
<td>No DLR</td>
</tr>
<tr>
<td>11</td>
<td>High</td>
<td>High</td>
<td>2 MW, 0.5 MWh</td>
<td>DLR on Zone 1</td>
</tr>
<tr>
<td>12</td>
<td>High</td>
<td>High</td>
<td>2 MW, 0.5 MWh</td>
<td>No DLR</td>
</tr>
<tr>
<td>13</td>
<td>High</td>
<td>Low</td>
<td>3 MW, 10 MWh</td>
<td>DLR on Zone 1</td>
</tr>
<tr>
<td>14</td>
<td>High</td>
<td>Low</td>
<td>3 MW, 10 MWh</td>
<td>No DLR</td>
</tr>
<tr>
<td>15</td>
<td>High</td>
<td>Medium</td>
<td>3 MW, 10 MWh</td>
<td>DLR on Zone 1</td>
</tr>
<tr>
<td>16</td>
<td>High</td>
<td>Medium</td>
<td>3 MW, 10 MWh</td>
<td>No DLR</td>
</tr>
<tr>
<td>17</td>
<td>High</td>
<td>High</td>
<td>3 MW, 10 MWh</td>
<td>DLR on Zone 1</td>
</tr>
<tr>
<td>18</td>
<td>High</td>
<td>Low</td>
<td>4 MW, 6 MWh</td>
<td>DLR on Zone 1</td>
</tr>
<tr>
<td>19</td>
<td>High</td>
<td>Low</td>
<td>4 MW, 6 MWh</td>
<td>No DLR</td>
</tr>
<tr>
<td>20</td>
<td>High</td>
<td>Medium</td>
<td>4 MW, 6 MWh</td>
<td>DLR on Zone 1</td>
</tr>
<tr>
<td>21</td>
<td>High</td>
<td>Medium</td>
<td>4 MW, 6 MWh</td>
<td>No DLR</td>
</tr>
<tr>
<td>22</td>
<td>High</td>
<td>High</td>
<td>4 MW, 6 MWh</td>
<td>DLR on Zone 1</td>
</tr>
<tr>
<td>23</td>
<td>High</td>
<td>High</td>
<td>4 MW, 6 MWh</td>
<td>No DLR</td>
</tr>
<tr>
<td>24</td>
<td>High</td>
<td>High</td>
<td>4 MW, 6 MWh</td>
<td>No DLR</td>
</tr>
</tbody>
</table>

1. **Wind Profile**: assessment used either a High or Low wind year profile. These wind profiles are scaled to create profiles for all wind generators on the network, and define the dynamic line rating profile.

2. **Connected Generation**: assessment featured three levels of connected generation capacity:
   - Low – generation connected by October 2012 (18250 kW);
   - Medium – all committed generation (23830 kW);
   - High – all committed generation plus an additional 5MW of wind generation (28830 kW), which is treated as a single unit.

3. **ESS**: rating in MW and storage capacity in MWh.

4. **Circuit Ratings**: A static (No DLR) or a dynamic line rating profile (DLR) is used for the circuit that defines the boundary of ANM Zone 1.

These scenarios were chosen to give a range of generation amounts reflecting various potential futures, which would give an indication of what the most appropriate size of ESS would be and how much energy would require absorption in the Core Zone.
4.1.3 Contract creation process

The required service was now specified in terms of how often it could be required in a year, what amount of energy could be available for import and how the ESS would be notified of service requirement. What remained was how to define a credible contract that would be understood by potential ESPs and would allow them to raise the necessary capital to take part. To achieve this, the process was as follows:

1. SSEPD reviewed existing markets for similarities in service provision
2. SSEPD engaged Redpoint Energy, commercial consultants, to assess the existing markets for similarities in service
3. Redpoint advised on similar contractual terms and conditions from existing markets to include in drafted contract
4. SSE Legal drafted contract using service requirement and advised terms from Redpoint

Redpoint’s first task was to investigate what similar services were available on any existing markets. They confirmed SSEPD’s conclusion from the initial market review, that the National Grid Ancillary Services market provided the most similar service to that required by this project. This identification meant that the contracts used within the Ancillary Services market could be assessed for suitable terms and conditions and procurement methods. Thus if suitable terms were found then they could be replicated within the draft contract. This would allow the contract to gain credibility by duplicating an existing well established market.

The Ancillary Services Market comprises a number of sub markets. Of these, the Balancing Services Market was identified as having the most similar services to the proposed Constraint Management Service. Relevant services in this sub market include the STOR (Short Term Operating Reserve), Fast Reserve and Firm Frequency Response services (Table 3). For each of these services Redpoint defined the following:

- who would provide the service to National Grid
- minimum size entry criteria
- response time
- required duration of service
- procurement method
- payment terms
### Table 3 Ancillary service terms & conditions

<table>
<thead>
<tr>
<th>Service description</th>
<th>STOR</th>
<th>Fast Reserve</th>
<th>Firm Frequency Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service for the provision of additional active power from generation and/or demand reduction</td>
<td>Service to control frequency changes that might arise from sudden, and sometimes unpredictable, changes in generation or demand.</td>
<td>Service is firm provision of either a dynamic or non-dynamic response to changes in the system frequency</td>
<td></td>
</tr>
<tr>
<td><strong>Who</strong></td>
<td>• Generation Balancing Unit Mechanism (BMU) / Non BMU • Demand BMU / non BMU</td>
<td>• Generation Balancing Unit Mechanism (BMU) / Non BMU • Demand BMU / non BMU</td>
<td>• Generation Balancing Unit Mechanism (BMU) / Non BMU • Demand BMU / non BMU</td>
</tr>
<tr>
<td><strong>Entry requirements</strong></td>
<td>3 MW</td>
<td>50 MW</td>
<td>10 MW</td>
</tr>
<tr>
<td><strong>Response time</strong></td>
<td>240 mins</td>
<td>2 mins</td>
<td></td>
</tr>
<tr>
<td><strong>Minimum delivery period of service</strong></td>
<td>2 hours</td>
<td>15 mins</td>
<td></td>
</tr>
<tr>
<td><strong>Procurement method</strong></td>
<td>Competitive tender (3 / year)</td>
<td>Optional Service - Agreement</td>
<td>Firm Service – Monthly Tender</td>
</tr>
<tr>
<td><strong>Payment Structure</strong></td>
<td>• Availability (£/MW/hour) Utilisation (£/MWh)</td>
<td>• Availability (£/hour) • Utilisation (£/MWh)</td>
<td>• Availability (£/hour) • Window Initiation Payment (£) • Positional Fee (£) • Utilisation (£/MWh)</td>
</tr>
</tbody>
</table>

The procurement method and the payment structures show a high level of similarity across the three services (Table 3). Their common features were therefore deemed appropriate for use in this context. Thus it was decided to run an open competitive tender process to identify the true market value for service provision. This was taken forward by SSEPD Procurement as they ran a competitive tender process which is described in section 4.2.

The other features replicated were some of the payment terms: Availability and Utilisation. These terms had to be included as they incentivised a supplier to make their system available for this service and to import energy upon request. A full explanation of the payment terms is contained in 4.1.3.

Redpoint concluded their portion of the work by issuing a report with their suggested commercial and pricing terms. This information formed the basis of the service related terms in the contract, with the service specification forming the remainder of the technical portion of the contract. SSE Legal contributed the rest of the required legal terms, i.e. duration, obligations etc. in part 1 of the contract and drafted it into one cohesive legal contract, Appendix I.
4.2 Trialling methodology

In order to define whether the contract created was credible and deemed commercially viable by ESPs, a tender process was necessary. If a supplier was simply appointed then the true current market price of the service could not be understood because there would be no competition. Also by running a tender it ensured that best value could be derived for the GB customer as they ultimately fund the Low Carbon Networks Fund. However as well as the commercial tendering process, SSEPD also wanted to ensure that whatever system was accepted under the commercial process was also safe. Thus once the commercial process was finished, the winner of the process had their design pack analysed by an external contractor to assess its safety. The methodology is described in section 4.2.2, with the results in Section 5.2.

At the same time as the tender process was being completed, SSEPD started work on the design process of the project, i.e. how the ANM system could account for this work. This was to give any potential suppliers confidence that SSEPD were treating this as a serious project and there would be a follow up if suitable systems were found. However as there was no guarantee that there would be a follow on project, the design works were kept at a high level and remained so until there was confidence that a follow on project would be initiated.

4.2.1 Commercial Tender Process

The tender process started in November 2011. The Achilles Utilities Vendor Database (UVDB) was used to select a list of companies best suited to provide the service required by the project. There is no specific UVDB code for energy storage services, therefore codes (1.8.10 Primary Cells and Chargers; 1.10.1 Electricity; 1.11.4 Generators – Power Stations) were used to compile the list of potential suppliers. The list comprised 129 potential suppliers. Of this list, 125 suppliers were identified through the UVDB search and the remaining four suppliers were identified as a result of direct discussions with interested parties prior to the project starting.

A Pre-Qualification document was issued to the suppliers to establish their interest in submitting a full tender. This asked the potential suppliers to answer thirteen questions designed to identify the most suitable companies to be selected to move forward to full tender. The questions were geared to assess the competence, capability and interest of the suppliers in undertaking the work (Table 4).

---

1 The UVDB is hosted by Achilles Information Ltd, an independent company, and is used by many utility companies including all GB DNOs. It contains information on suppliers of a wide range of goods and services. Utilities use the database to search for suppliers of goods and services relevant to a particular tender. The UVDB is structured under a number of codes for different goods and services.

2 No suppliers are named other than the successful bidder (SSEG) for commercial sensitivity reasons.
Responses to the Pre-Qualification document were received from 26 suppliers. 16 either answered that they weren’t interested or removed submission. The responses from the final ten suppliers were then evaluated using a consistent scoring matrix. The matrix scores each potential supplier according to their ability to deliver and install a correctly sized system by the proposed energisation date and their previous experience of similar sized installations. A minimum score of eight was required from questions one, two, four, five, six, seven, & eight. Following this assessment three suppliers were removed leaving seven to receive the full Invitation To Tender (ITT).

Table 4 Pre-qualification questions

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Is the project of interest to your organisation? (Yes = 1, No = 0)</td>
</tr>
<tr>
<td>2</td>
<td>The project requires the system to be installed and commissioned by October 2012. Please confirm you have the resources to meet this time frame. (Yes = 2)</td>
</tr>
<tr>
<td>3</td>
<td>If no for Q2 advise when you could achieve this? (If &lt; 12 months = 1 else = 0)</td>
</tr>
<tr>
<td>4</td>
<td>Can your organisation supply a battery storage and PCS either directly or with a partner, with a min of 500kWH? (Yes = 1, No = 0)</td>
</tr>
<tr>
<td>5</td>
<td>Can your organisation supply a battery storage and PCS either directly or with a partner, with a min of 1MW? (Yes = 1, No = 0)</td>
</tr>
<tr>
<td>6</td>
<td>Can your organisation install a battery storage and PCS either directly or with a partner, with a min of 500kWH? (Yes = 1, No = 0)</td>
</tr>
<tr>
<td>7</td>
<td>Can your organisation install a battery storage and PCS either directly or with a partner, with a min of 1MW? (Yes = 1, No = 0)</td>
</tr>
<tr>
<td>8</td>
<td>Have you any previous experience of carrying out installations on this scale either directly or with a partner? (Yes = 1, No = 0)</td>
</tr>
<tr>
<td>9</td>
<td>If you answered yes to Q8 could you please provide contract details specifically including the technology, the capacity, the contract value and the date. (All = 0 as info only)</td>
</tr>
<tr>
<td>10</td>
<td>Can you give a reference for previous similar sized installations? (Yes = 1, No = 0)</td>
</tr>
<tr>
<td>11</td>
<td>If you answered yes to Q10, please provide summary details specifically including the technology, the capacity, contract value and date? (All = 0 as info only)</td>
</tr>
<tr>
<td>12</td>
<td>Do you or your proposed partner have any experience of carrying out work within the UK under CDM regulations? (Yes = 1, No = 0)</td>
</tr>
<tr>
<td>13</td>
<td>If you answered Yes to Q12 please provide details including what was installed, contract value and date. (All = 0 as info only)</td>
</tr>
</tbody>
</table>

In January 2012, the qualifying seven suppliers were sent an ITT containing in depth information about the project and the detail of the requirements for the supplier and/or operator role.
On review of the ITT, four suppliers withdrew from the process. This was because full understanding of the requirements enabled them to judge they were either unable to fulfil the role or to meet the timescales. The remaining three suppliers submitted full tenders in February 2012 and were then invited to attend pre-tender presentations to discuss their submissions. SSEPD engaged two storage expert consultants (Swanbarton Ltd. and EA Technology Ltd.) to attend the presentation and form part of the SSEPD assessment panel.

Swanbarton were also asked to analyse the submissions and provide a score for each party, as they were felt best placed to judge the commercial portion of the bids. Following the presentations, the two consultant groups then scored the presentations and provided additional qualitative feedback on all three suppliers with the two most suitable suppliers recommended as preferred suppliers.

The SSEPD Project Manager and another Project Manager, who had been involved with the project, then reviewed the scoring by the two consultants alongside our own internal scoring. All three sets of scores were broadly aligned. Two preferred suppliers were selected accordingly in March 2012. Following this both remaining potential suppliers were given a 3 week extension to when they had to submit their safety case information. This was to ensure that they had a sufficiently detailed design folder to submit to EA Technology Ltd. (EATL) for a safety appraisal. Both suppliers submitted their design folders in March 2012.

However, following an SSEPD LCNF budget review it became clear that there was insufficient LCNF budget to cover both installations. Therefore, to assess who would provide the best value to the project the best and final prices submitted by the two preferred suppliers were revisited. This falls in line with standard procurement process where submitted tenders are qualified in terms of technical viability and then from that group of bids that are technically valid, a final bid is selected based on the best value to the project.

The prices submitted covered two basic prices; £/kWh/hour for availability and £/kWh for activity³. The SSEPD Project Manager calculated the total cost assuming that both suppliers were available for every period of every day for the total project duration with a nominal activity of 100MWh of imports. This showed that for completing the same activities and declaring the same amount of availability SSE Generation’s (SSEG’s) bid would cost 13% less than the other supplier’s over the proposed course of the project. SSEG also had the best technical submission, being 10% ahead of the second party on the scoring matrix.

³ These terms are explained in Section 5.1
The party selected on the basis of this knowledge, and the above assessment, to complete the safety appraisal, which is the final part of the tender process, was SSEG.

4.2.2 Safety case

EA Technology Ltd (EATL), were engaged to assess the safety of the tendered systems. Their engagement comprised a small series of anticipated Work Packages, as shown in Table 5, below.

Table 5 EA Technology’s safety-related engagement

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WP1</td>
<td>Reference Text on Codes, Standards and Legislative Requirements</td>
</tr>
<tr>
<td>WP2</td>
<td>Tender Support Activities</td>
</tr>
<tr>
<td>WP3</td>
<td>Review of Technical Documentation/Production of “Top Level” Operational Risk Assessment(s)</td>
</tr>
<tr>
<td>WP4</td>
<td>Development of Operational Safety Case Material; Production of Site Specific Operational Risk Assessment(s) and Method Statements</td>
</tr>
<tr>
<td>WP5</td>
<td>Supplementary Technical Support Services</td>
</tr>
<tr>
<td>WP6</td>
<td>Project Management</td>
</tr>
</tbody>
</table>

The work packages are detailed in the remainder of Section 4.2.2 and the conclusions detailed in Section 5.3.

4.2.2.1 WP1: Development and production of reference text on codes, standards and legislative requirements

Work Package 1 (WP1) represented the essential starting point for the assignment, via the production of a definitive reference text (available to GB DNOs upon request), which set out and described the relevant codes, standards and legislative requirements, which could be applicable to the electrical ESSs, to be trialled on Orkney.

Although this reference text aimed to be broadly “technology neutral”, it was developed principally in relation to electrochemical storage systems (i.e. battery and flow cell systems); reflecting EATL’s understanding that this reflected the three candidate technologies, as short-listed for consideration by the Tender Assessment Panel. It is however worth noting that the development of the WP1 reference text preceded any insight into make-up and construction of the short-listed candidate technologies. For completeness, the reference text also made some limited reference to systems based on other modus operandi, principally in relation to mechanical systems, based either on the storage of kinetic energy or on thermodynamic cycles.

The WP1 reference text therefore set out and described the relevant considerations and their potential applicability in relation to the following:

---

4 Note: WP4 represents a proposed activity, to be performed in the anticipated follow on Project
• The management of Health & Safety at Work, in the UK;
• Codes and Standards, including:
• Specific battery/flow cell related considerations
  o Chemical design and safety aspects
  o Electrical design and safety aspects
  o Mechanical design and safety aspects
• Civil engineering and construction
• CE Marking; and
• Licensing and consenting.

Findings from this are described in Section 5.3.1.

Note: The subsequent descriptions of the work performed follow the chronological sequence in which the individual Work Packages (WPs) were sanctioned and discharged. As such the description of WP5.1 is presented ahead of that of WP2.

4.2.2.2 WP5.1: Review of operational track record of candidate storage technology groupings

WP5.1 was commissioned ahead of the Tender Assessment Panel meetings to inform the procurement process as to the previously observed operational track record of the candidate technology groupings under consideration (available to GB DNOs upon request). At the time this work was commissioned, 1st February 2012, it was envisaged that the candidate technology groupings would comprise Pb-Acid and Li ion battery ESSs, together with an offering, based on a Vanadium:Vanadium flow cell system. In the event, and as reported under WP2, the third offering was based on the use of a Sodium Metal Halide battery system, rather than the flow cell system that had been anticipated.

This change in the vendor proposition occurred too late to impact on the discharge of the WP5.1 review, with this being conducted in relation to the two battery systems, plus the Vanadium:Vanadium flow cell system, as envisaged at the outset of the assignment. In the event, the absence of a review of the track record of the Sodium Metal Halide system was not significant, as the offering based on this technology did not form one of the two preferred bidders selected for further consideration. Details of the findings from this report are described in Section 5.3.2.

4.2.2.3 WP2: Tender support activities

WP2 covered EATL’s support to SSEPD’s Tender Assessment process, via its participation in the Tender Assessment Panel meetings, held at SSEPD’s offices in Perth, February 2012. EATL’s contribution here specifically related to an initial assessment of the vendors’ attention to safety
related aspects, based on their presentations on the day and on EATL’s background knowledge and experience of the subject matter only. At this stage of the procurement process, EATL had not been presented with any vendor documentation or supporting material. Offers based on three systems technologies were presented by three short-listed bidding consortia:

- A Pb-Acid Battery ESS;
- A Li Ion Battery ESS; and
- A Sodium Metal Halide Battery ESS.

EATL’s contribution to the Tender Assessment Panel activities therefore comprised the following:

- A review of the operational track record of the candidate storage technology groupings (conducted via WP5.1, prior to the Tender Assessment Panel meetings, in themselves, and as previously described);
- Questions posed to the vendors, in relation to:
  - General considerations, including the opportunity for the vendors to describe the essential design, make-up and construction of their offerings;
  - Detail/technology specific questions;
  - Operational track record;
  - Codes & Standards; and
  - Construction & Project Management.
- Participation in the Tender Assessment Panel Meetings, via the provision of two expert personnel, such as to pose the questions to each of the vendors; and,
- Following on from the Tender Assessment Panel, the numerical scoring of each of the three short-listed bidding consortia offerings, relative to the considerations in the Aide Memoire. (These are not included within the report due to the required confidentiality required by the procurement process.)

The latter numerical scorings of the three short-listed bidding consortia then formed an input to SSEPD’s wider procurement considerations, addressing performance, commercial, timescales and other aspects.

4.2.2.4 WP3: Review of technical documentation/production of “Top Level” Operational Risk Assessment(s)

WP3 concerned the safety case assessment of the submitted design files of the two preferred bidders and comprised two discrete elements, namely:
The review of the Technical Files, as submitted by the two preferred bidders selected for further consideration for application in the Orkney Energy Storage Park; and

The subsequent development of “Top Level” Operational Risk Assessments, complete with comprehensive supporting commentarities, for the systems as proposed by the two preferred bidders.

At the outset of WP3, SSEPD had identified two preferred bidders from the Tender Assessment process, with these offering systems based on:

- A Pb-Acid Battery ESS; and
- A Li Ion Battery ESS.

Subsequently, SSEPD indicated to EATL that the Pb-Acid based option was no longer under consideration, for commercial reasons, as defined in section 4.2.1, and with EATL being requested to cease work in relation to its review and assessment. The WP3 work therefore comprised, in practice:

- An initial review of the technical documentation provided by the vendor offering the Pb-Acid battery based ESS;
- An initial review, followed by a further in-depth review of the technical documentation provided by the vendor offering the Li Ion battery based ESS;
- The subsequent development of a “Top Level” Operational Risk Assessment and associated supporting commentary, for this latter system only. (This is based on proprietary information that is not essential to implement this contract and as such the full detail is not included in this report. However a small sample is available in Appendix II.)

The review of the vendor technical documentation covered both gaining a more detailed insight into the system offering(s) proposed and, specifically, the assimilation and review of the vendors’ attention to safety related aspects; i.e. a de facto review of the vendors’ safety case material.

Details of the findings are described in Section 5.3.3.

**4.2.2.5 WP5.2: Review of fire suppression system; comment on SSEG/MHI response to questions**

The central focus of WP5.2 was to review and qualify the Fire Suppression System, as proposed for installation and application in the SSEG/MHI Li Ion Battery ESS. The opportunity was also taken to utilize the same WP assignment to comment on the SSEG/Mitsubishi Heavy Industries (MHI) response to the various queries and specific questions of clarification, as identified from the previous WP3 assignment. Details of the findings are listed in Section 5.3.4.
5 Outcomes of the project

There were a number of key outputs from this project which have been organised into the following categories: Commercial; Supplier Identification; Safety; Technical; and Business Process.

5.1 Commercial

The main outcome of this project, the design of the contract, can be seen in Appendix I. The contract describes the terms and conditions for providing the constraint management service. This contract covers a unique service and has a new term, described below in Section 5.1.2.3, not previously seen in any similar contracts investigated during SSEPD’s or Redpoint’s market investigation. It was deemed suitably credible that three separate suppliers submitted full tenders in order to win it. This contract, if shown to be suitable, will be able to be reused for other DNO required services.

The following sections explain the terms of the contract and the behaviours they are designed to instigate, highlighting the contract’s novel features.

5.1.1 Contract key principles

Two basic principles were established at the outset of contract development:

- **That operation of this contract is not mandatory**
  If the contract was mandatory the investigation into other revenue streams would be skewed. Any conflict with other services would not be resolved by market forces. Instead the contract service would always be provided over other services simply because it was mandatory, thus an unbiased investigation into commercial viability would not be possible. By making the contract optional the ESP is able to make operating decisions purely on market economics.

  In order to aid the supplier in identifying as many other markets as possible, SSEPD facilitated a contact within National Grid (NG). Prior to the tender issue SSEPD spoke with NG to ascertain what their appetite was to allowing a sub-sized ESS entering into some of their Ancillary Service Market. They agreed to have discussions around the project with any potential suppliers and thus the contact’s details were included within the ITT.

- **That the ESS type is not important**
  This principle was adopted because SSEPD did not want to rule out any technology due to ignorance or lack of experience. To avoid this no technology was specified, instead
minimum requirements were set for MW and MWh and the service requirement (Section 4.1.2) specified how any system should operate and communicate with the ANM. This was sufficient information for any potential supplier to understand whether any given ESS (electrical/thermal/etc.) would meet the requirements.

The project also showed what technologies were ready to be installed at this scale on the open market. Each of the three tenders covered a different technology from the well known to the novel: Advanced Lead Acid, Lithium-Ion and Sodium Metal Halide. They were also understood to be able to satisfy the requirements of the service.

5.1.2 Contract commercial and pricing terms

The various commercial and pricing terms define the incentive for suppliers to provide the required service. The terms defined by Redpoint in their report (Section 4.1.3) advising on terms and conditions are explained below.

5.1.2.1 Availability term

Under the Availability Term the supplier receives payment for making their system available to import energy. The requirement for this term is that the supplier would not make their system available without being rewarded for it. Thus this term ensures the supplier receives a reward and SSEPD receive the guarantee of the ESS being available. The payment is made in £/kWh/hour so the larger the system made available to the DNO over a longer period of time, the higher the reward for the supplier. The supplier then decides, using the service specification, when to make their system available and the cost of making their system available; what other markets could make them money; the capital available to finance their project and the best size of system. This term was submitted as part of the tender from each of the potential suppliers.

The ESP must notify their intention to be available a week before any given day, they will then firm this up the day before. Currently there is no planned penalty for non compliance, however if this becomes an issue then measures will be devised and put in place.

5.1.2.2 Utilisation term

The Utilisation term is required since no supplier will import energy unless they can cover their costs and receive a reward for it. This is because operating the system will incur operation, maintenance and ultimately replacement costs. Thus this payment must be large enough to offset whatever the wear and operation and maintenance costs are for the system. The unit for this payment is £/kWh so the more energy imported by the system, the higher the Utilisation payment received. This term was submitted as part of the tender from each of the potential suppliers.
5.1.2.3 Nominal availability term

Redpoint suggested one further payment term, the Nominal Availability Payment. This term was developed to address the unique situation created by the ANM system potentially constraining NNFGs’ exports. It was recognised that the ESS may become full due to instructions from the ANM system, but then not allow the ESS to export due to a network constraint. This is due to the ESS being treated as an NNFG for export purposes to ensure that the distribution system is run within its operational parameters. Thus the supplier could lose out on potential income as they were not available because they were full, but were unable to empty their system to become available due to the export constraint. This was deemed unfair; hence the nominal availability term was introduced. This term was set at 50% of the Availability Payment and is measured in £/kWh/hour. 50% was used as a best guess as to what value would be required to incentivise discharge and thus innovative ways of discharging the system whilst generating revenue. It will be paid monthly at the same time as all the other terms.

Fig. 3 shows how the ESS starts at zero state of charge and then upon receiving instruction fills up. During this time it receives the Availability and Utilisation Payments. Once the ESS has filled up and is not able to discharge due to the presence of a network constraint, it will receive the Nominal Availability Payment. However if the constraint disappears and the ESP does not discharge their system, they will receive nothing. When the ESP does start to discharge the ESS, they will receive the Availability payment again.

![Figure 3 Payments made to ESP against time and network conditions](image-url)
5.1.2.4 Availability periods

In order to operate an Availability Payment scheme there is also a need to define when the service is required. This takes the form of Availability Periods, which are defined in the table below.

Table 6 Availability periods

<table>
<thead>
<tr>
<th>Availability Period</th>
<th>Time Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP1</td>
<td>00:00:00 until 07:30:00</td>
</tr>
<tr>
<td>AP2</td>
<td>09:00:00 until 17:00:00</td>
</tr>
<tr>
<td>AP3</td>
<td>22:00:00 until 23:59:59</td>
</tr>
</tbody>
</table>

The reason for the clear gaps between AP1 and AP2, and AP2 and AP3 is because these periods are the traditional demand peaks. As such there is not expected to be a requirement for the constraint management service any generation coming from the NNFGs will be absorbed locally (as shown by the constraint analysis carried out in Section 4.1.2). This also allows the supplier to complete arbitrage\(^5\) at the most lucrative periods of the day. During these traditional periods of high demand, prices paid for generated energy are at their highest. The final function of the time gaps is to give the suppliers time to empty their ESSs in preparation for the next Availability Period.

5.1.2.5 Monthly scalars

The final term used to calculate supplier payments are the monthly scalars. The scalars were introduced as a result of SGS’s analysis of energy curtailment in the Core Zone to estimate how much energy would be available for import. The analysis revealed that the months April to September have the greatest amount of energy to import (Fig. 4).

\(^5\) Arbitrage is the practice of taking advantage of a price difference between two markets, in this case the energy buying and selling markets.
Energy Curtained in Core Zone (MWh)

Figure 4 Energy Curtained in Core Zone

Curtailment levels are higher in these months not because they are typically the windiest months, resulting in larger volumes of generation; instead, this is when generation coincides with lower demand. This is because the days are warmer and lighter, thus there is less need for electrical lighting and heating.

These findings from Figure 4 were translated into scalars as per Table 6 below.

Table 7 Monthly scalars

<table>
<thead>
<tr>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>0.7</td>
<td>0.6</td>
<td>1</td>
<td>1.1</td>
<td>1.5</td>
<td>1.4</td>
<td>1.3</td>
<td>1.2</td>
<td>0.9</td>
<td>0.6</td>
<td>0.8</td>
</tr>
</tbody>
</table>

These scalars were then used to multiply the Availability and Nominal Availability Fees for each month. The aim is to give a clear signal to the ESP when the service will provide best value to the DNO, i.e. when there will be the higher chance of Utilisation Payments being made. Thus the supplier can look to target other markets during this time which would provide higher revenues.

5.1.2.6 Settlement

The service being requested by SSEPD operates in a real time manner, meaning that energy imported or exported from the ESS could be settled on a quicker time frame that half hourly. This could restrict the amount of markets that the ESS could operate in as ancillary services are generally settled on a half hourly basis. However having investigated this possibility it is clear that as long as a high enough specification of meter is installed, then the timeframe required by the
specific settlement mechanism won’t be an issue. This is because shorter timeframes can be aggregated together to give the half hourly resolution required.

5.2 Supplier identification

A key outcome of the project was the identification of a suitable supplier following the tender process. SSEG were shown to have a commercially and technically valid bid which was passed forwards for the full safety case appraisal. This ensured development of a follow on project, SSET1009 Trial of Orkney Energy Storage Park, which will service this contract over a three year period. This project has been registered and will look to finalise the safety case, allow the supplier to install their system and connect to the 11kV network at Kirkwall, Orkney.

5.3 Safety

The principal deliverables and outputs from the safety case related work included the provision of technical support, advice and assessment services to SSEPD, which were delivered in the following form:

- A definitive reference text (available to GB DNOs upon request), which set out and described the relevant codes, standards and legislative requirements, which could be applicable to the electrical ESSs, to be trialled on Orkney;

- A review of the operational track record of the candidate storage technology groupings (available to GB DNOs upon request);

- The provision of expert input to the Tender Assessment Panel meetings and the subsequent structured safety related assessment and ranking of the vendor offerings;

- The development of a “Top Level” Operational Risk Assessment and associated supporting Commentary, for the preferred Li Ion Battery ESS. (This is based on proprietary information that is not essential to implement this contract and as such the full detail is not included in this report. However a small sample is available in Appendix II.)

- A review that qualified the Fire Suppression System, as proposed for installation and application in the SSEG/MHI Li Ion Battery ESS (Not included in report as purely based on proprietary information from MHI about their specific system.)

5.3.1 Definitive codes and standards reference text

The definitive reference text made some salient points as described below.
5.3.1.1 Directly applicable codes, standards and regulations, pertaining to power utility network connected electrical energy storage systems

Complete Electrical ESSs, by their very nature, represent a complex amalgam of technologies and sub-systems. Notwithstanding the various Codes, Standards and Regulations that are applicable at the component level, there are a relatively limited number of relevant codes, standards and regulations at the system level:

- BS EN 50272-2:2001 “Safety Requirements for Secondary Batteries and Battery Installations – Part 2: Stationary Batteries”, which addresses the safety requirements associated with stationary secondary (re-chargeable) Pb-Acid and NiCd batteries and battery installations with a maximum voltage of 1,500 V DC (nominal); and
- The Batteries and Accumulators Directive and the Waste Batteries and Accumulators Directive, notwithstanding that these obligations fall on the ESPs themselves.

More general guidance in relation to battery safety aspects is provided in HSE’s “good practice” document INDG139(rev1), 05/06 “Using Electric Storage Batteries Safely”. A developing CENELEC Workshop Agreement on Flow Batteries was also identified, although it is not intended that this will address safety aspects, per se.

5.3.1.2 Chemical, electrical and mechanical design and safety

Perhaps unsurprisingly, there is a considerable range of Codes, Standards and Regulations that are potentially applicable to Electrical ESSs, either in whole or in part, dependent on the reference storage technologies involved and the design, make-up and construction of individual systems. WP1 therefore identified and provided summary descriptions on these, with the range of material addressed including:

- Chemical, including:
  - COSHH (Control of Substances Hazardous to Health)
  - CLP Regulations (Classification, Labelling & Packaging)
  - CHIP Regulations (Chemicals (Hazard Information & Packaging for Supply))
  - REACH (Registration, Evaluation, Authorisation & Restriction of Chemicals)
  - DSEAR Regulations (Dangerous Substances & Explosive Atmospheres)
  - ATEX Directive/equipment categories
- Electrical, including:
  - Electricity at Work Regulations
  - EMC Directive/Regulations
  - Low Voltage Directive

6 Enshrined in UK Legislation as SI 2008 No.2164 and SI 2009 No.890
The relatively limited number of directly applicable codes, standards and regulations at the complete system level, as noted in (4.2.2.1), above, combined with the multiplicity of potentially applicable considerations at the sub-system and component levels, does imply that special attention needs to be paid to such latter aspects, in assessing the compliance of any Electrical ESSs, intended for UK market applications.

5.3.1.3 CE Marking/essential requirements

A further aspect of the WP1 work addressed the requirement for CE Marking, as an indication of compliance with the essential requirements of the New Approach Directives\(^7\) and, specifically, the following:

- Low Voltage Equipment
- Simple Pressure Vessels
- Pressure Equipment
- Electro-magnetic compatibility
- Machinery

WP1 noted that the overriding rationale of such directives relates to the free circulation of goods within European Union markets. The application of the CE Mark (supported by the Declaration of Conformity and the Technical File) represents a declaration by the manufacturer (or his authorized representative) that a product meets all the applicable provisions of the relevant legislation implementing several European directives. A particular consideration here relates to a product being deemed to be placed on the (Community) market, when it is made available for the first time.

5.3.1.4 Construction, Design & Management (CDM) Regulations

The CDM Regulations apply to the regulation of health and safety on-site, until such time as the site is handed over to the customer. Notwithstanding the novel and often unfamiliar nature of

\(^7\)http://www.newapproach.org/Directives/DirectiveList.asp
many of the Electrical ESSs in themselves, the DNO/TSO sector and their turnkey contractors are generally well versed in the application of the CDM Regulations, as a routine part of their business activities.

5.3.1.5 Licensing and consenting

A further part of WP1 addressed the subject of safety/environmental related licensing and consenting issues (i.e. other than compliance with Local Authority planning requirements, for visual impact etc), which could have the potential to impact on an Electrical ESS development. Specifically, three pieces of legislation were identified and reviewed here, namely:

- The COMAH Regulations;
- The Planning (Control of Major Accident Hazard) Regulations; and

The essence of these instruments was therefore reviewed, including for the COMAH Regulations and the Planning (Control of Major Accident Hazard) Regulations the qualifying limits, or thresholds, for various specified substances. Likewise, the review of the Integrated Pollution (Prevention) Control Directive noted that, for installations which fall within the Directive, any “substantial changes” require either a “notification of a change” or an “application to vary conditions” to be submitted to SEPA, the Scottish Environment Protection Agency (as the relevant authority for the application on Orkney).

5.3.2 Review of operational track record

The main conclusions from this literature review were:

- The hazard associated with electrical shorting, in the presence of unplanned water ingress, is noted to have caused a number of safety related incidents, for both Lead acid and Li Ion battery systems, leading in a number of occasions to fires.

- The Li Ion battery system is recognised by the industry as being prone, to a greater or lesser extent, to the phenomenon of thermal runaway, depending on the design of any individual system. This has lead to a number of well-publicised fires of small scale batteries and, in the extreme, to the total loss of a unique special forces submarine⁸.

- The hydraulic integrity of circulating flow cell electrical storage systems represents a particular challenge that must be addressed, in these systems.

5.3.3 Top Level Risk Assessment

The Li Ion based system was offered by a bidding consortium comprising SSEG and MHI ("SSEG/MHI"), based upon the application of a 2MW/500kWh MHI containerized Li Ion Battery ESS.

The documentation review was based on the technical file provided by SSEG/MHI (via the offices of SSEPD), principally comprising their Design Package and supporting material. The proprietary nature of the SSEG/MHI offering precludes the provision of any specific details here, other than to note the information presented was comprehensive in its nature and well documented. The documentation review was conducted relative to EATL’s accumulated knowledge and experience in relation to ESSs and technologies in general, Li Ion technology, in particular, and also with reference to the WP1 and WP5.1 outputs, as reported herein. Key facets of the review comprised the following elements:

- General review of the technology and its modus operandi;
- Details of operational regime;
- Inventory of active reagents;
- Layout and dimensions;
- Basis of Supplier Safety Case;
- Supplier Failure Modes & Effects Analyses;
- Details of:-
  - Relevant codes & standards to which designed & constructed;
  - Relevant codes & standards to which to be supplied for UK application
- Test records & documentation, including those in relation to abuse testing and any testing to failure/destruction; and
- Details of any documented in-service failures, identification of root causes and remedial measures.

The principal aim of the documentation review was to assess the system safety case in terms of the identification of the inherent hazards present in the technology and its associated systems and sub-systems, the risks presented by these hazards, the relevant design, construction, monitoring and control measures implemented, such as to either eliminate or mitigate the impact of the risks identified and finally, the re-assessment of the risk(s), post the application of such control measure(s). Various questions of clarification and technical queries were identified in the execution of this review, with these being fed back to SSEG/MHI via SSEPD.

The outputs from the review of the SSEG/MHI technical file formed one of the principal inputs to the development of a “Top Level” Operational Risk Assessment for the system, complemented...
and supported by an associated in-depth commentary, which collated and referenced the supporting evidence base. The development of such a “Top Level” Operational Risk Assessment enabled objective assessment of the operational safety case for the system in isolation, i.e. without considering any site or installation specific effects. It was the intent (as subsequently realized in practice) that site/installation specific aspects would be addressed when Ofgem’s authorisation was received to proceed with the follow-on Project.

The development of the “Top Level” Operational Risk Assessment was conducted in a format consistent with SSEPD’s existing Risk Assessment documentation sets, involving the structured identification of hazards, their risk ratings prior to the application of any mitigation measures, a summary description of the mitigation measures (countermeasures) planned or envisaged and finally, a re-assessment of the risk, after the application of the mitigation measures. A structured scoring and assessment methodology was adopted for this purpose, based on the assessment of risk to People, the Environment, Assets and to Reputation (i.e. a PEAR methodology). Appendix II shows an excerpt from such a Risk Assessment.

The range of hazards identified for the system embraced some of the more generic hazards, as would be expected for an electrical installation of this type, and also those specific to Li Ion technology, including the phenomenon of thermal runaway and the associated possibility of a series of cascading cell failures, leading to a major battery fire\(^9\),\(^10\). Whilst it is worth emphasizing that an appropriately designed Li Ion battery storage system should address such facets, the consequences of such a failure can be severe.

The complementary supporting commentary provided a summary of the make-up and construction of the SSEG/MHI Li Ion Battery ESS and presented a critique of this, relative to the prevalent and applicable UK Codes, Standards and Licensing considerations, as identified and described under WP1.

Overall, it was concluded that the proposed system represented a technically credible product offering, for application in the UK market context (but excluding any site/installation specific aspects, at this stage of the assessment), with a considerable degree of effort devoted to the design, including its safety related aspects. No fundamental barriers were identified in relation to potential application in the UK, in terms of compliance with relevant and applicable codes and standards. The development of the commentary did however identify a number of further queries and specific questions of clarification, for submission to SSEG/MHI.

---

\(^9\) Lithium Ion Safety Concerns. Battery University; 
[http://batteryuniversity.com/learn/article/lithium-ion_safety_concerns/3](http://batteryuniversity.com/learn/article/lithium-ion_safety_concerns/3)

As for Li ion based battery ESSs in general, the proposed system was noted to be potentially susceptible to the phenomenon of thermal runaway and with the associated possibility of a subsequent series of cascading cell failures. The incorporation of various design, manufacturing, quality control, testing and system control measures was noted to be such as to reduce the possibility for any such initiating thermal runaway events occurring, although could not be guaranteed to eliminate it/them completely.

The incorporation of a Fire Suppression System was noted to form a further safeguard in the design of the system, although it was not possible to qualify the efficacy of this system within the context of the WP3 assignment, the information provided and the atypical characteristics of any Li Ion battery fire. A recommendation was therefore made for this aspect of the system design to be addressed in a subsequent Work Package, namely WP5.2.

5.3.4 Review of Suitability of Fire Suppression System

The majority of the WP5.2 assignment therefore focused on the qualification of the efficacy (or otherwise) of the Fire Suppression System, as proposed for the implementation of the SSEG/MHI Li Ion Battery ESS on Orkney. The major part of this work sought to qualify the characteristics of Li Ion battery fires, review the current state-of-knowledge in the area and then assess the Fire Suppression System, as proposed for the candidate battery system.

The assessment of the proposed approach to the Fire Suppression System, in the context of the atypical characteristics of Li Ion battery fires and the available state-of-knowledge in this area, was able to support the rationale, as stated by MHI, for the incorporation of the Fire Suppression System, as the primary means for extinguishing any non-directly battery related fire before such time this could impinge on cell/battery packs and cause them to enter a thermal runaway mode. As such, this finding could also be considered in the context of the incorporation of various design, manufacturing, quality control, testing and system control measures, such as to reduce the possibility of any thermal runaway reaction(s) occurring in the first instance.

The work also established that should, for whatever reason or reasons, a genuine battery fire occur (i.e. involving a cascading series of cell failures), then there was evidence, from MHI's own in-house fire suppression testing, that such a fire could be extinguished by an inert gas Fire Suppression System, such as proposed for the candidate Orkney installation. However, it equally noted a number of caveats and uncertainties in this respect, in relation to the representation of the battery installation and packaging, the unique and atypical characteristics of Li Ion battery fires and the uncertainties in the underlying knowledge base.
It was therefore concluded that the management of the residual risk should include the development of appropriate post-fire procedures, such as to mitigate against any re-ignition and, ultimately, the preparation of a robust emergency plan, in the unlikely event of all the safeguards identified, failing to suppress and contain any battery fire. A further and potentially significant consideration identified in the WP5.2 work related to the atypical possibility of a (container level) battery explosion, such as is reported to have occurred at the General Motors Technical Centre, in Warren, Michigan, April 2012\(^\text{11}\). Although this event would appear to be contrary to previously documented events (and as identified in the WP5.1 report), which indicated the possible development of battery fires, rather than explosions, per se, it did serve to indicate that further attention should be paid to this possibility, in the anticipated follow-on Site Specific Risk Assessment. Equally, it is worth noting that the atypical battery explosion in the GM Technical Centre is reported to have occurred under conditions of “extreme over-charge testing”, which the various safeguards provided in the SSEG/MHI system are intended to prevent.

### 5.3.5 Safety conclusions

The overall findings from the EATL work are as shown below:

1. With the exception of BS EN 50272 for Pb-Acid and NiCd based systems, there is a relative absence of effective Standards, directly applicable to the implementation of complete Electrical ESSs, for power distribution network applications.

2. The inherent nature of integrated Electrical ESSs, suitable for connection onto the electricity network, has the potential to invoke various individual design standards, codes and legislation, for application in the UK.

3. The review of the operational track record of the candidate technology groupings for the Orkney Energy Storage Park application identified both a series of generic safety related considerations and also a number of technology specific instances and considerations.

4. The review of the candidate SSEG/MHI Li Ion Battery ESS concluded that this represented a technically credible product offering, for application in the UK market context, with a considerable degree of effort devoted to the design, including its safety related aspects. No fundamental barriers were identified in relation to its potential application in the UK, in terms of compliance with relevant and applicable codes and standards.

\(^{11}\) GM releases statement on Lithium Ion battery explosion, says Chevy Volt was not involved. 12\(^{\text{th}}\) April 2012. [http://www.egmcartech.com/2012/04/12/gm-releases-statement-on-lithium-ion-battery-explosion-says-chevy-volt-was-not-involved/](http://www.egmcartech.com/2012/04/12/gm-releases-statement-on-lithium-ion-battery-explosion-says-chevy-volt-was-not-involved/)
5. The phenomenon of thermal runaway and the associated possibility of the development of a series of cascading cell failures was identified as a potentially significant failure mode (hazard), for Li Ion battery storage systems, in general.

6. The incorporation of various design, manufacturing, quality control, testing and system control measures was noted to be such as to reduce the possibility for any such initiating thermal runaway event(s) occurring in the SSEG/MHI system, although they could not be guaranteed to eliminate it/them completely.

7. Further attention was therefore paid to an assessment of the efficacy of the Fire Suppression System, as proposed for the application in Orkney.

8. This work established that should, for whatever reason or reasons, a genuine battery fire occur then there was evidence, from MHI’s own in-house fire suppression testing, that such a fire could be extinguished by an inert gas Fire Suppression System, such as that proposed.

9. However, the uncertainties in relation to the unique and atypical characteristics of Li Ion battery fires and the associated underlying knowledge base did lead to a qualification of the finding here, including a recommendation in relation to the management of the residual risk.

5.4 Technical

While the project was primarily a commercial investigation, there were two technical outputs. These are the requirements developed for the ANM to ESS interface and a basic understanding of whether the tendered ESSs were fit for purpose.

5.4.1 Interface

The interface itself was based on two existing pieces of SGS work, the Shetland ANM Interface\textsuperscript{12} and the Orkney NNFG interface\textsuperscript{13}. These were integrated to allow the ANM to interface with the ESS, with the requirements governing this shown in Appendix III. The main purpose of the requirements is to govern how the ESS will be allowed to operate, how the ANM system will send it signals and how the ESS will convey availability. The portions that were relevant to the supplier were issued to them along with a list of data sets that would be populated by the ESS and the ANM.

\textsuperscript{12} NINES Project (SSEPD)
\textsuperscript{13} IFI 2005_14 Orkney RPZ Project (SSEPD)
5.4.2 Technology Assessment

As the project was a commercial investigation the approach taken for selection of technology type was a neutral one. If the technology offered met the three main requirements: a minimum electrical capacity and transfer rate; a sub two second response time to import requests; and a 20 * 20 m foot print, then it was appropriate to proceed to the next project stage. Factors like the life cycle were not important because if the unit had worn out during the project life cycle then the requirement lay with the operator to replace it. In fact the operator would also want to replace it as soon as possible as they would be losing income due to the reduced capacity available for any service.

5.5 Business analysis

During the ITT creation phase, it was quickly recognised that the project was complex and the service that was being tendered for was a first in Europe. It was essential that any potential supplier quickly understood the service requirements as this would allow them to be more innovative in accessing other market opportunities and maximum learning. Suppliers would therefore submit a more accurate and competitive bid.

To aid understanding a business analysis CASE (Computer Aided Software Design) tool was used to create material for the ITT. This was intended to clearly communicate the requirements and contract terms. The tool, Sparx Enterprise Architect\(^\text{14}\) (Sparx EA), supports Unified Modelling Language (UML\(^\text{15}\)) and Business Process Model Notation (BPMN\(^\text{16}\)) and is widely used in the software development industry. For this project Use Cases were defined, from which came Requirements, Business Process Diagrams, Component Models and State Models. The Use Cases and Component Model (shown below) were included in the ITT to aid in explaining the project and to communicate how the system should interact with the SSEPD and other external components, systems and people. The remainder of the diagrams are not presented in this report as they have been superseded by other work undertaken in the follow on project (SSET1009 Trial of Orkney Energy Storage Park) and will be disseminated via this project.

\(^\text{15}\) UML is used to specify, visualise, construct and document features of a business system.
\(^\text{16}\) BPMN diagrams articulate internal business procedures and provide a step-by-step workflow that can be readily understood and communicated to interested parties.
5.5.1 Use cases

Figure 5 Orkney Storage Park operations use cases

Each of the main actors (whether a person or a system, SSEPD staff or external individuals/organisations) are shown around the edge of the main boundary. All the functions (use cases) that each party/system performs are contained within the main boundary and are linked to the relevant actors to show who is involved in each. For example the Orkney ANM System aims to reduce the Core Zone constraint. To do this it interacts with the ESS dispatcher, which in turn imports energy from the network. All the other use cases are supporting functions of this function. This illustrates is that although there is one actor with one main function, many different supporting functions are required, involving six other actors.
5.5.2 Component model

This model shows what components are required for the project and what the potential interactions may be between the various parties.

![Component Model Diagram](image)

*Figure 6 Component Model*
6 Performance compared to original project aims, objectives and success criteria

The aim of the project was to define what commercial incentives would be necessary to encourage an ESP to locate an ESS where it would provide real benefits to a DNO. To achieve this, four objectives were set. Completion of all four objectives as detailed below (Table 8) and the creation of a contract that allowed an ESP to be taken through to a follow on project, shows the project has been a success.

Table 8 Objective Progress

<table>
<thead>
<tr>
<th>Objective</th>
<th>Purpose</th>
<th>Did the project meet this objective?</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create commercial contracts that will incentivise 3rd Party ESPs to locate on a constrained distribution network</td>
<td>Identify suitable commercial terms that will incentivise ESPs to locate at Kirkwall Power Station (KPS)</td>
<td>P</td>
<td>Commercial experts engaged to advise on terms and legal parties used to draft contract to ensure valid credible contract created. Credibility verified by submission of three full tenders from separate potential suppliers</td>
</tr>
<tr>
<td>Prepare a tender process that will ensure that the ESPs selected will fulfil the success criteria</td>
<td>Identify whether terms defined were sufficient to attract suppliers with suitable ESSs</td>
<td>P</td>
<td>Tender process run resulting in SSEG being awarded the contract. External validation of tender process as consistent and fair demonstrated through OFGEM authorisation of follow on project to make payments to SSEG as a related undertaking</td>
</tr>
<tr>
<td>Design up to 2 connection points for ESSs outside KPS</td>
<td>Give the potential ESPs confidence that SSEPD are treating this project seriously, leading to submission of well designed tenders</td>
<td>P</td>
<td>High level design completed prior to follow on project which allowed potential suppliers to be advised on specific service requirements. i.e. dispatch methods etc.</td>
</tr>
<tr>
<td>Award contracts to up to 2 ESPs</td>
<td>Ensure that submitted tenders are well designed and suitable for the task</td>
<td>P</td>
<td>Following tender evaluation SSEG submission selected as valid proposal meeting all technical and safety requirements and providing best value to the end customer</td>
</tr>
</tbody>
</table>
7 Required modifications to the planned approach during the course of the project

Although there were no deviations from the planned methodology used to deliver the project, there were two modifications to the end date of the project and an amendment to the overall budget. The initial submission had set an end date of the end of March 2012. However it became apparent it would not be possible to meet this date due to a safety case extension. The safety case extension was made because one of the parties named as a ‘preferred bidder’ did not have a sufficient level of detail to meet the original deadline for safety case submission. A three week extension was granted to all preferred bidders, which did not tie in well with the availability of EATL, resulting in a two month extension.

The project budget reforecast was also reforecast at this point. The original forecast of £300k was revised down to £175k. This was due to the reduction in ESPs to be awarded from two to one. It had been intended to install up to two ESSs however it was judged that one would be sufficient to fulfil the project objectives, thus a reduction in costs was achieved.

The second amendment changed the end date from May to August 2012. This was due to the safety case identifying the need to define the suitability of the Fire Suppression System. This resulted in a complex system of communicating questions from EATL through SSEPD to SSEG. They in turn communicated these with MHI who in turn communicated this to their packaging supplier. To further complicate this, the communications also had to cross two continents. As a result the project was extended by a further three months.

8 Significant variance in expected costs and benefits

8.1 Costs

The amount forecast to be spent during the project was £175k and was split according to the table below.

<table>
<thead>
<tr>
<th>Item</th>
<th>Forecast</th>
<th>Actual</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Management</td>
<td>£30000</td>
<td>£60500</td>
<td>+101%</td>
</tr>
<tr>
<td>Analysis</td>
<td>£40000</td>
<td>£33000</td>
<td>-17.5%</td>
</tr>
<tr>
<td>Tender Process</td>
<td>£50000</td>
<td>£53000</td>
<td>+6%</td>
</tr>
<tr>
<td>Contract Creation</td>
<td>£12500</td>
<td>£12000</td>
<td>-4%</td>
</tr>
<tr>
<td>ICT Design</td>
<td>£22500</td>
<td>£18000</td>
<td>-20%</td>
</tr>
<tr>
<td>Contingency</td>
<td>£20000</td>
<td>£0</td>
<td>-100%</td>
</tr>
<tr>
<td>Total</td>
<td>£175000</td>
<td>£176500</td>
<td>+1%</td>
</tr>
</tbody>
</table>
The project was delivered with no significant overall variance in spend, however distribution of actual expenditure across items varied considerably from original expectations. The greatest variance was the 101% increase in Project Management costs. This was due to two main factors. Firstly it was decided to add value to the project by engaging EATL to review their involvement with the project and to write a comprehensive report detailing the methodology for safety case evaluation, outcomes and learning. Secondly the original estimated allowance of 30 days of Project Manager time was found to be a significant underestimation. The eventual time required was nearly 60 work days due to the slow nature of the communications between all the relevant parties as described in Section 7. Also the level of detail required in the safety case led to a further delay due to more clarifications being sought and provided with each having to be checked.

The second significant variance in costs was the Analysis portion. The cost for network analysis performed by SGS and civil design completed by McGregor McMahon was originally estimated at £40k. The civil design portion was reduced as it was decided by the Project Manager that potential suppliers would only require the results of ground surveys to have a clear idea of their potential installation costs. SSEPD originally intended to provide sample designs of potential locations and configurations of buildings, cabling etc. This resulted in an underspend of 17.5%.

The third variance was the ICT design, which decreased by 20%. It was originally budgeted to be completed in 30 working days by an internal resource. However it was decided to perform some of the work externally due to resource constraints within SSEPD. This reduced costs as some of the work was completed by SGS who were already engaged on the project. Thus there was no period of project explanation and understanding required by a new resource and SSEPD made a saving based on economy of scales.

8.2 Benefits

When the project was registered it was envisaged that it would deliver the following learning:

1. What commercial arrangements would be necessary to incentivise third party ESPs
2. What these commercial arrangements might look like in contract form
3. What the tender process would look like that would allow the most suitable ESS to be highlighted

The first learning point was delivered through the engagement with Redpoint Energy and National Grid. From this came a working concept of the sort of commercial mechanisms which could be used to incentivise third party ESPs. These mechanisms were drawn together into a legal contract by SSE Legal (delivering the second learning point) and circulated as part of a tender process run by SSE Procurement. This delivered the third learning point and also identified a supplier to be taken forward to a follow on project. Thus all the original targeted learning was delivered as expected.
On top of this there have been two additional benefits of running this project: an appraisal of the suitability of the connection process for storage devices and a better understanding within SSEPD, and others by way of this report, of Lithium Ion Technology.

8.2.1 Connection process

During the design phase of the project a decision had to be made about how to connect any ESS chosen during the tender process. It was decided at this stage to use the existing generation connection process as this was the only existing mechanism for a third party to make a commercial connection to any DNO network. This process is highly regulated and largely standard across all GB DNOs. There are minor variances between individual DNOs but all use the same timescales and standards. Details of SSEPD’s process are laid out in the Statement of Methodology and Charges for Connection to Scottish Hydro Electric Power Distribution Plc’s Electricity Distribution System document 17.

The rationale for using this process was that a 3rd party, not SSEPD, needed to connect to SSEPD’s network for commercial gain (most closely resembling the connection characteristics of a generator). SSEPD needed to ensure the generation connection adhered to various standards so its operation would not have a negative effect on the rest of the network. However ESSs do not only display generator characteristics. Unlike a conventional generator, the ESS will import more energy than it exports. Thus it could be argued it would be more suitable for an ESS to be connected using the standard demand customer process. This process has the same principles governing it as the generation process, to ensure that the integrity of the network is maintained whilst allowing connection of new customers.

In addition to the uncertainty of which process best fits the import/export characteristics of the ESS, there is also the fact that the connected system will benefit the distribution network through constraint management. This is not a unique feature of the ESS: a large demand customer located in the same place and operating a 24 hour process could potentially provide the same network benefits to Orkney. Conversely, a generator locating in a specific place could provide benefits to other parts of the network. However, there are no commercial incentives in place to encourage these customers to apply to connect to the network in specific locations.

This project has highlighted there are potential benefits to be realised, in terms of network operation, by devising a new connection process which incentivises connection by specific customer types in specific locations. As no process currently exists it is proposed to investigate the potential for a new/modified connection process in the follow on project.

17 http://www.ssepd.co.uk/uploadedFiles/Controls/Lists/Resources/SHEPD_2012_-_2013_Charging_statements/SHEPD_CCCM_AndCS.pdf
8.2.2 Lithium Ion hazards

As the project’s main aim was commercial in nature it was not initially identified that it could generate technical learning. However following the decision to perform a safety case on the selected ESS as part of the selection process, a better understanding of ESS systems, and specifically Lithium Ion systems and their associated hazards was gained. These outcomes are listed in Section 5.3. This information has been shared with the SSE Safety, Health and Environment Team who will be better placed to perform a safety case appraisal on this type of technology on future projects. Thus DNOs will potentially be able to have lower project costs for safety appraisal of Lithium Ion technologies, which in turn will mean lower costs to DNO customers.
9 Lessons learnt for future projects
In addition to the main finding that the contract created is credible and has attracted interest from suitable potential suppliers, the project has generated learning in the areas described below.

9.1 Further trialling – follow on project
The main lesson learnt is that although a contract has been created, it is not clear what will happen when it is used to govern a service over a period of time. The number of tenders for the contract award has demonstrated the contract is credible for suppliers but further work is required to understand

1. Whether the supplier will operate under the contract
2. Whether its operation will provide the service required at the required scale and timescales
3. The extent to which the supplier will operate in other markets, if at all

The necessity for a follow on project is best illustrated by our request to Redpoint for development of a theoretical model to evaluate potential revenues and predict ESS operator behaviour, using the contract as a basis. Redpoint responded that while this would be possible, a model would not provide accurate results due to the number of variables involved crossing many different topics (energy prices, weather models, electrical network, and technology types).

A follow on project to evaluate the contract operation has been planned and registered as a new LCNF Tier 1 project SSET1009. The project started in June 2012 and will end in 1 October 2015, although LCNF funding will only be used until 31 March 2015\(^\text{18}\). The project will allow an increased amount of generation to connect through the ANM system and simultaneously allow for an increased chance of a high wind year occurring.

9.2 Technology selection process
Learning from the technology selection process includes the following lessons.

9.2.1 Designing tender process for novel service contract
When a tender is being issued for a very unique service, a longer time than standard should be allowed for answering questions prior to ITT submission. In this project three weeks were allowed for pre-tender site visits, meetings and queries, in line with SSEPD general tender processes. Although this was sufficient for potential suppliers to get up to speed on the project concept, it did not allow enough time for their contractual negotiations with third parties. Feedback from potential suppliers indicated more time was needed to hold talks with other market operators in order to set up alternative revenue streams. This could have resulted in

\(^{18}\text{http://www.ofgem.gov.uk/Networks/ElecDist/lcnf/Documents1/Low%20Carbon%20Network%20Fund%20Governance%20Document%20v5.pdf}\)
the suppliers having more revenue defined, enabling them to submit lower priced tenders. For future projects four to six weeks should be allowed for this.

9.2.2 Risk assessment of service-based contracts

The second main learning point concerned how best to ensure that a selected system was a safe proposition. Had SSEPD run the tender process, selected a party and then allowed them to install on SSEPD property outside Kirkwall Power Station without validating the system, it would have been irresponsible. Such an approach would also have contradicted SSEPD’s prioritisation of safety as the company’s primary value. Hence it was essential to run a safety case. Running a safety case for the proposed technologies in this project has enabled development of the following guidelines to be used in designing and running future safety appraisals for similar contracts.

1. Include overview of the safety appraisal process within Invitation to Tender document so suppliers are aware of the level of importance of safety case process
2. Engage expert assessor with good experience of the systems to be sought through the commercial selection process
3. Inform expert on systems proposed and ensure they research legislation/codes/standards and what hazards can arise during system design, installation, commissioning, operation and decommissioning
4. Have experts ask potential suppliers relevant questions at tender presentations
5. Once preferred bidders are named, request their design folders and pass to expert for appraisal
6. Allow engagement between expert and preferred bidders
7. Receive report from expert on safety of systems
8. Sign off residual risk identified to allow construction
9. Complete site specific risk assessment and check installation conformity with design folder
10. Sign off residual risk
11. Allow energisation

9.3 Service delivery system

The main learning outcome from this project was the finding that the new contract is a valid commercial service contract.

9.3.1 Future contract applications

The principle of using a contract to govern future applications of network services is clearly viable. Having received offers from suppliers to provide a complex service being dispatched by a complex novel system on a constrained network, there is no reason why this could not be applied to other services. The payment terms defined in the contract created through this project could form the basis of other service contracts, with only the service requiring redefinition. In principle there is no barrier to using this approach; however there is a need to define a methodology to assess whether other functions would best be met through this service
contract approach or a traditional owner-operator approach. Fig. 7 sets out possible criteria which could be used to select the approach for any energy storage need.

**Figure 7 Approach selection**

- **Function criticality**: If the function required is critical to the network it is likely a DNO cannot afford the risk of a service provider not being able to fulfil their obligations. Critical services would include substation tripping batteries.

- **Duration of service or operational life**: If it is known the function will be required for a long time then a DNO would be able to procure a novel/innovative system, develop internal organisational knowledge of its operation, performance, application etc. and operate the system at a lower cost over its lifetime than operating a service contract. However, if the nature of the function required is likely to change over time, changes could leave the DNO with an asset no longer fit for purpose. In this case the service contract approach would be advantageous. The constraint management function featured in this project is an example of this type of dynamic function.

- **Commercial revenue**: If the function is likely to deliver commercial revenues a DNO may choose not to own it for two reasons. Firstly there could be an impact in terms of a regulated income issue. Secondly, the fact there is revenue to be made indicates there could be additional associated
opportunities for a supplier to make money, leading to potentially lower tenders. In this case a service contract could be cheaper overall for the DNO than owning and operating. Examples could include voltage control management.

- **Internal experience/expertise**: if the DNO has existing organisational expertise relating to the function, ownership and operation will entail relatively low/well understood risk. Without this the DNO will be exposing itself to a higher level of risk which may not return a necessary level of value. Examples here include the operation of electrolyzers or cryogenics being a service contract function.

- **Technology Readiness Level (TRL)**: The TRL indicates the degree to which a technology is well understood generally within the industry or further afield. If a technology is not well understood it raises the risks for the DNO associated with procurement, ownership and operation, which would tend to favour the service contract model. Examples here include the operation of large boilers.

This decision tree quickly shows that all choices do not have a definite answer, i.e. either approach could work. For example the operation of a technology with a low TRL could be managed through either the owner operator or service contract models. An assessment would have to be completed prior to the decision on whether the risks outweigh the benefits that a DNO could achieve through either model. Further use of this decision tree, through other projects, will provide more clarity on which model best suits certain applications.

### 10 Planned implementation

Clearly this approach has potential as a way of improving network operation; however there are still too many unknowns to do so. These unknowns include the identity of likely service providers; the portfolio of revenues that storage systems could attract; and the appetite of DNOs to allow 3rd parties to operate network services. Through the follow on project and other R&D projects, SSEPD aims to clarify these unknowns, which will allow these services to be adopted into the business as a standard approach.

The projects that are aiming to answer these questions are:

- Trial of Orkney Energy Storage Park Tier 1 Project
- NINES DECC funded project
- PATHS Tier 2 Project

If these projects enable SSEPD to clarify the unknowns identified above, this will lead to a improved maturity in the storage market, which will give benefits to other DNOs and their customers.
11 Project replication and intellectual property

The following tables list all physical components and knowledge required to replicate the outcomes of this project, showing how the required IP can be accessed by other GB DNOs. Further detail relating to any knowledge item is available from SSEPD on request through jenny.1.rogers@sse.com

Table 10 Components required for project replication

<table>
<thead>
<tr>
<th>Component</th>
<th>Products used in project or commercially available equivalents</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANM-ESS interface</td>
<td>SGS product – contact <a href="mailto:info@smartergridsolutions.com">info@smartergridsolutions.com</a> for information on similar products</td>
</tr>
</tbody>
</table>

Table 11 – Knowledge products required for project replication

<table>
<thead>
<tr>
<th>Knowledge item</th>
<th>Application</th>
<th>IP ownership and availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Requirements</td>
<td>Specification of an ANM-ESS interface for purpose described in this close-down report</td>
<td>SSEPD Close-Down report Appendix III</td>
</tr>
<tr>
<td>Relevant codes and standards requirements for ESS review -</td>
<td>Preparation of safety case for an ESS</td>
<td>SSEPD Available to GB DNOs upon request</td>
</tr>
<tr>
<td>Literature review of operational incidents – review of operational track record of storage technology groupings</td>
<td>Preparation of safety case for an ESS</td>
<td>SSEPD Available to GB DNOs upon request</td>
</tr>
<tr>
<td>“Top Level” Operational Risk Assessment (RA) for Lithium Ion ESS</td>
<td>Preparation of safety case for a Lithium Ion ESS</td>
<td>SSEPD Sample in Close-Down Report Appendix Available to GB DNOs upon request excluding commercially sensitive 3rd Party IPR as this is not required to use this relevant foreground IPR.</td>
</tr>
<tr>
<td>Ancillary Services Agreement Template</td>
<td>Procurement of a constraint management service</td>
<td>SSEPD Close-Down report Appendix I</td>
</tr>
<tr>
<td>Interface requirements defining how ANM system is to interface with the ESS</td>
<td>Integration of an ESS with an ANM system</td>
<td>SSEPD Close-Down report Appendix III</td>
</tr>
</tbody>
</table>
Appendix I

Contract
ANCILLARY SERVICES AGREEMENT

- between -

SCOTTISH HYDRO ELECTRIC POWER DISTRIBUTION PLC

- and -

[  
   PROMPT: INSERT APPLICANT’S NAME (if an individual)  
   or COMPANY’S NAME]

- for -

[  
   PROMPT: INSERT NAME OF GENERATION FACILITY]
AGREEMENT

BETWEEN:-

(1) SCOTTISH HYDRO ELECTRIC POWER DISTRIBUTION PLC, a company incorporated in Scotland (registered no. SC213460), whose registered office is at Inveralmond House, 200 Dunkeld Road, Perth PH1 3AQ ("Scottish Hydro Electric", which expression where appropriate shall include its permitted successors and assignees);

(2) [Prompt: Insert Company Name (Note: all details must be confirmed as correct and consistent with the Company’s details published on Companies House website\(^9\)], registered no. [Prompt: Insert Co No. (Including the SC prefix if registered in Scotland)] a company having its registered office at [Prompt: Insert Registered Address] (the "Applicant" which expression where appropriate includes its permitted successors and assignees).

WHEREAS:-

(a) Scottish Hydro Electric is authorised by a licence granted under the Act to carry on the business of the distribution of electricity and the Applicant is connected to Scottish Hydro Electric’s Distribution System.

(b) Scottish Hydro Electric wishes to purchase and the Applicant wishes to provide certain Services to enable more efficient use of the Distribution System.

NOW THEREFORE the Parties HAVE AGREED AND DO HEREBY AGREE as follows:-

The Services will be provided by the Applicant in accordance with and subject to the particulars and provisions set out in this Agreement, as may be amended from time to time by agreement in writing between the Parties.

1. DEFINITIONS AND INTERPRETATION

1.1 In the Agreement except where the context otherwise requires the following expressions shall have the following meanings:-

"Act" means the Electricity Act 1989;

“Active Payment” means the payment made to the Applicant by Scottish Hydro Electric pursuant to Clause 4.2 and calculated in accordance with Part 2 of the Schedule;

\(^9\) http://wck2.companieshouse.gov.uk and link to “Company Info”
“Active Network Management” or “ANM” is the system that controls export to the Orkney distribution network;

"Affiliate" means, in relation to a Party, any holding company or subsidiary or any subsidiary of a holding company of such Party, in each case within the meaning of section 1159 of the Companies Act 2006;

"Agreement" means the agreement attached hereto and the appendices annexed and executed as relative hereto;

"Applicant's Installation" means any electrical equipment (which shall include, without limit, all ancillary equipment relating thereto), structures, electrical equipment, lines, appliances or devices owned, installed or maintained by the Applicant or leased by the Applicant from a third party or otherwise used by the Applicant to provide the Services;

“Authority” means the Gas and Electricity Markets Authority as established by section 1 of the Utilities Act 2000;

“Available” is defined as when the Applicant’s Installation is within a pre-advised period of availability, is online and is importing, exporting or idle;

“Availability Payment” means the payment made to the Applicant by Scottish Hydro Electric pursuant to Clause 4.1 and calculated in accordance with Part 2 of the Schedule;

“Availability Period or AP” means the time of day that the Applicant’s Installation is available to provide the Service;

"Commencement Date” means the date upon which the Applicant’s Installation is Energised;

"Connection Agreement" means the agreement to be entered into between the Parties which governs the connection of the Applicant’s Installation to the Distribution System;

"Distribution System" has the meaning given to that expression in the Scottish Hydro Electric Distribution Licence;

“Energisation” shall have the meaning given to that term in the Connection Agreement;
"Force Majeure" means, in relation to either Party, any event or circumstance which is beyond the reasonable control of such Party and which results in or causes the failure of that Party to perform any of its obligations under this Agreement; and, for the avoidance of doubt, lack of funds shall not be interpreted as an event or circumstances beyond the reasonable control of either Party;

"kW" means kilowatt(s);

"kWh" means kilowatt hour(s);

“Nominal Availability Payment” means the payment made to the Applicant by Scottish Hydro Electric pursuant to Clause 4.3 and calculated in accordance with Part 2 of the Schedule;

“Notional Available Capacity” means the available capacity once the higher and lower limits of the Applicants Installation charging state are taken into account

"Party" means each person for the time being and from time to time party to this Agreement and any permitted successor(s) in title to, or assignee of, such person;

"Scottish Hydro Electric Distribution Licence" means the licence granted by the Secretary of State in exercise of the powers conferred by section 6(1)(c) of the Electricity Act 1989 to Scottish Hydro Electric;

“Services” means the services to be provided by the Applicant as detailed in Part 1 of the Schedule;

"Termination Date" means the earlier of the [•] or the date upon which this Agreement terminates pursuant to Clause 6; and

"Working Day" means any day, other than a Saturday, a Sunday, Christmas Day, Good Friday, a day which is a bank holiday in Scotland within the meaning of the Banking and Financial Dealings Act 1971 or a day (a) which is a local holiday in the locality in which either Party has its head office for the time being and (b) in which the premises at which the head office of that Party is situated is not open for business.

1.2 In this Agreement:-
1.2.1 where the Applicant is an individual, this Agreement shall be binding on and enforceable against his executors and personal representatives whomsoever in their capacity as such; and

1.2.2 where the Applicant is a partnership or firm, this Agreement shall be binding upon each of the partners thereof from time to time as partners and individuals and their respective successors as partners and individuals foresaid, and the executors and personal representatives of the last such partner; and

1.2.3 where any obligation in or arising from this Agreement, is undertaken by or binding upon two or more persons, it is undertaken and binding jointly and severally on them.

1.3 Any reference herein to a numbered Clause (save where the context otherwise requires) shall be a reference to the provision of this Agreement so numbered.

1.4 Any reference in this Agreement to the singular shall (save where the context otherwise requires) include a reference to the plural (and vice-versa).

1.5 Except where stated to the contrary in this Agreement, any reference to a statute or statutory provision or a Licence or Licence Condition includes a reference to that statute, provision, Licence or Licence Condition as from time to time amended, extended or re-enacted.

1.6 The Clause headings in this Agreement have been inserted for convenience only and shall not affect its interpretation.

2. DURATION

2.1 Notwithstanding the date hereof, this Agreement shall commence on the Commencement Date and continue in full force and effect until the Termination Date.

2.2 In the event that the Commencement Date has not occurred by [•] and save where the Parties have agreed to the contrary in writing, this Agreement shall automatically terminate [and neither Party shall have any liability to the other as a result of such termination].

3. OBLIGATIONS OF APPLICANT

3.1 Subject to the terms of this Agreement the Applicant shall provide the Services to Scottish Hydro Electric.
3.2 The Applicant shall comply at all times with the terms of the Connection Agreement.

3.3 The Applicant shall ensure that the Applicant’s Installation complies at all times with the technical requirements set out in Schedule, Part 3.

3.4 The Applicant shall provide to Scottish Hydro Electric all of the information detailed in Schedule, Part 4 and acknowledges and agrees that Scottish Hydro Electric may disclose this information to any third party without restriction.

4. PAYMENT

4.1 Scottish Hydro Electric shall pay to the Applicant the Availability Payment for each Availability Period in which the Applicant makes the Services Available to Scottish Hydro Electric.

4.2 In addition to the Availability Payment Scottish Hydro Electric shall pay to the Applicant the Active Payment for each Availability Period in which the Applicant actively provides the Services in accordance with an instruction received from Scottish Hydro Electric.

4.3 Scottish Hydro Electric shall pay to the Nominal Availability Payment to the Applicant in accordance with Part 2 of the Schedule.

4.4 The Active Payment, the Availability Payment and the Nominal Availability Payment shall be paid monthly in arrears following receipt of an invoice from the Applicant along with the required supporting information to enable Scottish Hydro Electric to validate the requested payment. Scottish Hydro Electric shall make payment 30 days following receipt of the invoice and the required supporting information.

4.5 In the event that the Applicant has received a payment from Scottish Hydro Electric for and it transpires that such payment should not have been made, the Applicant shall reimburse such payment to Scottish Hydro Electric within [•] days of written demand from Scottish Hydro Electric together with interest at the rate of [•]% above the base rate of [•] Bank from the date the payment was made to the Applicant until the date upon which the payment is reimbursed to Scottish Hydro Electric.

5. LIMITATION OF LIABILITY AND INDEMNITY

5.1 Neither Party shall be liable for any breach of this Agreement directly or indirectly caused by Force Majeure or to the extent caused by a third party.
5.2 Subject to Clause 5.6 and save as further provided in Clause 5.3 hereof neither the Party (the "Party liable") nor any of its officers, employees or agents shall be liable to the other Party for loss arising from any breach of this Agreement other than for loss directly resulting from such breach and which at the date hereof was reasonably foreseeable as likely to result in the ordinary course of events from such breach and which resulted from physical damage to the property of the other Party, its officers, employees or agents.

Provided that the aggregate liability of either Party in each calendar year in respect of claims for such loss or damage shall not exceed £1,000,000 (one million pounds) sterling.

5.3 Nothing in this Agreement shall exclude or limit the liability of the Party liable for death or personal injury resulting from the negligence of the Party liable or any of its officers, employees or agents and the Party liable shall indemnify and keep indemnified the other Party, its officers, employees or agents from and against all such and any loss or liability which such other Party may suffer or incur by reason of any claim on account of death or personal injury resulting from the negligence of the Party liable or any of its officers, employees or agents.

5.4 Subject to Clause 5.6 neither Party, nor its officers, employees or agents shall in any circumstances whatsoever be liable to the other Party for:

(A) any loss of profit, loss of revenue, loss of use, loss of contract or loss of goodwill; or

(B) any indirect or consequential loss; or

(C) loss resulting from the liability of such other Party to any other person howsoever and whenssoever arising save as provided in Clause 5.3.

5.5 The rights and remedies provided by this Agreement to the Parties are exclusive and not cumulative and exclude and are in place of all substantive (but not procedural) rights or remedies express or implied and provided by common law or statute in respect of the subject matter of this Agreement, including without limitation any rights either Party may possess in delict which shall include without limitation actions brought in negligence and/or nuisance. Accordingly, each of the Parties hereby waives to the fullest extent possible all such rights and remedies provided by common law or statute, and releases the Party, its officers, employees and agents liable to the same extent from all duties, liabilities, responsibilities or obligations provided by common law or statute in respect of the matter dealt with in this
Agreement and undertakes not to enforce any of the same except as expressly provided herein.

5.6 Save as otherwise expressly provided in this Agreement, this Clause 5 insofar as it excludes or limits liability shall override any other provision of this Agreement, provided that nothing in this Clause 5 shall exclude or restrict or otherwise prejudice or affect any of:

5.6.1 the rights, powers, duties and obligations of either Party which are conferred under the Act, the Licence or otherwise howsoever; or

5.6.2 the rights, powers, duties and obligations of the Authority or the Secretary of State under the Act, the Licence or otherwise howsoever.

5.7 Each of the Sub-clauses of this Clause 5 shall:

5.7.1 be construed as a separate and severable contract term, and if one or more of such sub-clauses is held to be invalid, unlawful or otherwise unenforceable the other or others of such sub-clauses shall remain in full force and effect and shall continue to bind the Parties; and

5.7.2 survive termination of this Agreement.

5.8 Each of the Parties agrees that the other Party holds the benefit of Clause 5.2, 5.3 and 5.4 above for itself and as trustee and agent for its officers, employees and agents.

6. EVENTS OF DEFAULT AND TERMINATION

6.1 In addition to but without prejudice to the whole other rights and remedies of Scottish Hydro Electric under this Agreement in the event that:

6.1.1 the Applicant shall fail in any material respect to perform or comply with any of its obligations under this Agreement (including payment obligations pursuant to clause 4.4) and such failure is not remedied to the satisfaction of Scottish Hydro Electric within twenty eight (28) Working Days of notification to the Applicant by Scottish Hydro Electric of the occurrence thereof and requiring the same to be remedied; or
6.1.2  
(i) an order of the court is made or an effective resolution passed for the insolvent winding up or dissolution of the Applicant; or

(ii) a receiver (which expression shall include an administrative receiver within the meaning of section 29 of the Insolvency Act 1986) of the whole or any material part of the assets or undertaking of the Applicant is appointed; or

(iii) an administrative order under section 8 of the Insolvency Act 1986 is made or a voluntary arrangement is proposed under section 1 of that Act in respect of the Applicant; or

(iv) the Applicant enters into any scheme or arrangement (other than for the purpose of reconstruction or amalgamation upon terms and within such period as may previously have been approved in writing by Scottish Hydro Electric), such approval not to be unreasonably withheld or delayed; or

(v) the Applicant is unable to pay its debts (within the meaning of Section 123(1) or (2) of the Insolvency Act 1986); or

6.1.3  
the Applicant is an individual or a firm, the Applicant ceases to pay its debts as and when they fall due, or is sequestrated, or signs a trust deed for the benefit of its creditors, or makes any other composition or arrangement with or for its creditors; or

6.1.4  
the Authority has withdrawn funding for the Services; or

Scottish Hydro Electric shall be entitled at any time to serve notice on the Applicant specifying the event which has occurred and terminate this Agreement forthwith.

6.2  
This Clause shall be interpreted without prejudice to the provisions of Clause 5.

7.  
FORCE MAJEURE

7.1  
If either Party shall be unable to carry out any of its obligations hereunder due to a circumstance of Force Majeure, this Agreement shall remain in effect but save as otherwise provided herein both Parties’ obligations other than any obligation as to payment of charges pursuant to Clause 4 shall be suspended without liability for a period equal to the circumstances of Force Majeure provided that:
(a) the non-performing Party gives to the other Party as soon as reasonably practicable notice describing the circumstances of Force Majeure, including the nature of the occurrence and its expected duration, and continues where reasonably practicable to furnish regular reports with respect thereto during the period of Force Majeure;

(b) the suspension of performance is of no greater scope and of no longer duration than is required by the Force Majeure;

(c) no obligations of either Party that accrued before the Force Majeure causing the suspension of performance are excused as a result of the Force Majeure; and

(d) the non-performing Party uses all reasonable efforts to remedy its inability to perform as quickly as possible.

7.2 In the event that a Party notifies to the other Party that the first mentioned Party considers that an event of Force Majeure has occurred, that other Party shall be entitled to weekly reports with respect to its progress of remedying such event.

8. ASSIGNATION AND SUB-CONTRACTING

8.1 Subject to Clause 8.2, neither Party may assign or otherwise transfer all or any of its rights or obligations under this Agreement without the prior written consent of the other Party which consent shall not unreasonably be withheld.

8.2 Notwithstanding Clause 8.1, Scottish Hydro Electric shall be entitled without the consent of the Applicant to assign its rights and/or obligations under this Agreement, whether in whole or in part, where such assignation is to an Affiliate of Scottish Hydro Electric and such Affiliate is or will be entitled in terms of a Licence to perform the obligations of Scottish Hydro Electric under this Agreement thereby assigned.

8.3 Neither Party shall have the right to sub-contract or delegate the performance of any of its obligations or duties arising under this Agreement without the prior written consent of the other, which consent shall not be unreasonably delayed or withheld. The sub-contracting by Scottish Hydro Electric or the Applicant of the performance of any obligations or duties under this Agreement shall not relieve Scottish Hydro Electric or the Applicant (as the case may be) from liability for performance of such obligation or duty.

9. SAVINGS FOR COMPANY'S STATUTORY POWERS
Nothing in this Agreement shall prejudice or affect the rights, powers or obligations of Scottish Hydro Electric under any statute, statutory instrument, licence, regulation, direction or order for the time being in force.

10. VARIATIONS
10.1 No variations of this Agreement shall be effective unless made in writing and signed by or on behalf of both Parties. Each Party shall effect any amendment required to be made to this Agreement by the Authority or to reflect the terms of any binding decision taken by the Authority which affects this Agreement and the Applicant hereby authorises and instructs Scottish Hydro Electric to make any such amendment on its behalf and undertakes not to withdraw, qualify or revoke such authority or instruction at any time.

11. NON-WAIVER
11.1 None of the provisions of this Agreement shall be considered waived by either Party except when such waiver is given in writing and no delay or omission of either Party in exercising any right, power, privilege or remedy under this Agreement shall operate to impair such right, power, privilege or remedy or be construed as a waiver thereof.

11.2 No waiver by either Party of any default by the other in performance of any of the provisions of the Agreement shall operate or be construed as a waiver of any further or other default whether of a like or different character.

11.3 No amendment to this Agreement shall be effective unless agreed in writing by both Parties.

12. ENTIRE AGREEMENT
This Agreement constitutes the entire agreement between the Parties with respect to its subject matter and supersedes all previous agreements and understanding between the Parties with respect thereto and each of the Parties acknowledges and confirms that it does not enter into this Agreement in reliance on any representation or warranty or other undertaking not fully reflected in the terms of this Agreement.

13. GOVERNING LAW
This Agreement shall be construed in accordance with and governed by laws of Scotland and the Parties hereby prorogate the exclusive jurisdiction of the Courts of Scotland.

14. NOTICES
14.1 Any notice, demand, certificate or other communication required to be given or sent under this Agreement shall be in writing and delivered either personally or by first class recorded delivery post.

14.2 The required address and the person to whom any notice or other form of communication is to be addressed for the purposes of this Clause shall be the address and person specified below for such purposes and/or such other address and/or person as the Party concerned may notify to the other Party:

To [I Applicant]:
Address: [I ]
Attention: [I ]

To Scottish Hydro Electric Power Distribution plc:
Address:
Inveralmond House
200 Dunkeld Road
Perth
PH1 3AQ
Attention: [• ]
with a copy to: The Company Secretary, Scottish Hydro Electric Power Distribution plc, Inveralmond House, 200 Dunkeld Road, Perth, Scotland PH1 3AQ.

14.3 A notice or other form of communication shall be deemed to have been served as follows:

(a) if delivered personally, at the time when delivered;

(b) if sent by pre-paid first class recorded delivery post, at the expiration of seventy-two hours after the document was delivered into custody of the postal authorities.

In providing such service it shall be sufficient to prove that personal delivery was made or that the envelope containing the notice was properly addressed in accordance with Clause 14.2 and delivered in the custody of the postal authorities as a pre-paid first class recorded delivery letter as the case may be.
15. **SURVIVAL ON TERMINATION**

Termination of this Agreement shall not affect any rights or obligations which may have accrued prior to and including the date of such termination and shall not affect any rights and obligations of the Parties hereunder which are expressed to survive termination of this Agreement.

[Prompt: Keep Clause 15 above and following signing tables on same page in finalised document.]

Signed for Scottish Hydro Electric

[Prompt: Authorised Signatories

Signature Required]  
…………………………………… Witness :  ………………………………………

…

NAME : [Prompt: Insert Authorised Signatory’s Name in Block Capitals]  
[Prompt: Insert Date of Signing]  
…

TITLE : [Prompt: Insert Authorised Signatory’s Designation]  
[Prompt: Insert Location of signing]  
Signed at :  ………………………………………

…

[Prompt: Insert Witness Name in Block Capitals]

Witness Name:  c/o Inveralmond House

…

Witness Address :  200 Dunkeld Road

Perth PH1 3AQ
This is the Schedule referred to in the Ancillary Services Agreement between Scottish Hydro Electric Power Distribution plc and [•] dated [•]

Part 1

Description of the Service

The Service is the import of energy from the Distribution System to the Applicant’s Installation with imports being communicated via set points if the Applicant’s Installation is defined by its operator as available.

The Service will be triggered by Scottish Hydro Electric identifying: Constraints on part of the Distribution System that the Applicant’s Installation will be able to alleviate or reduce by importing from the Distribution System and that the Applicant’s Installation is Available. The set point...
communicated will be used to vary the Applicants Installation from importing at a maximum to a minimum rate. The data laid out in the table below shows what information must flow between the Applicants Information and the ANM Scheme.

<table>
<thead>
<tr>
<th>Data Point</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Real Power Set-Point</td>
<td>16 bit Signed Integer</td>
<td>Maximum permitted power export of ESS device (kW).</td>
</tr>
<tr>
<td>Curtailment Reduction Set-Point</td>
<td>16 bit Signed Integer</td>
<td>Target ESS power export/import for the purposes of reducing generator curtailment (kW).</td>
</tr>
<tr>
<td>Watchdog Signal</td>
<td>16 bit Signed Integer</td>
<td>Value increases every second. Used by ESS to establish LAC to ESS communications link status.</td>
</tr>
<tr>
<td>ESS Available Readback</td>
<td>Bool</td>
<td>Readback of the ESS Available data point (ESS to LAC), indicating that the ESS is available for reduction of generator curtailment.</td>
</tr>
<tr>
<td>Set ESS Export In Service</td>
<td>Bool</td>
<td>Permit the ESS to operate in power export mode.</td>
</tr>
<tr>
<td>Set ESS Export Out Of Service</td>
<td>Bool</td>
<td>Prohibit the ESS from operating power export mode.</td>
</tr>
<tr>
<td>Set ESS Import In Service</td>
<td>Bool</td>
<td>Permit the ESS to operate in power import mode.</td>
</tr>
<tr>
<td>Set ESS Import Out Of Service</td>
<td>Bool</td>
<td>Prohibit the ESS from operating power import mode.</td>
</tr>
<tr>
<td>Curtailment Reduction Active</td>
<td>Bool</td>
<td>Info – ESS being used for generator curtailment reduction.</td>
</tr>
<tr>
<td>ANM Service Status</td>
<td>Bool</td>
<td>Info – ANM is in service.</td>
</tr>
<tr>
<td>ANM Trim Req</td>
<td>Bool</td>
<td>Info – ANM is trimming ESS export.</td>
</tr>
<tr>
<td>ANM Trip Req</td>
<td>Bool</td>
<td>Info – ANM has Tripped ESS.</td>
</tr>
<tr>
<td>LAC ANM Comms Status</td>
<td>Bool</td>
<td>Info – LAC to ANM comms are active.</td>
</tr>
<tr>
<td>ESS Control Module In Service</td>
<td>Bool</td>
<td>Info – ESS Module is in service and online.</td>
</tr>
</tbody>
</table>

The table below shows the information that the Applicants Installation will be expected to receive from the ANM Scheme.
The Applicant will have up to 2 seconds to respond to the set point if the Applicants Installation has declared itself as available.

Upon receipt of the confirmation, the Applicant’s Installation will commence importing at the agreed rate. The Applicant’s Installation will be required to respond to import request messages from the ANM while the import is being carried out. It will be the duty of the Applicant to inform the ANM if it is going to cease importing for any other reason apart from an ANM request.
The Applicant will be required to declare the Availability of the Applicant’s Installation a week before the time period covered by the declaration and will be the Monday of each week. The declaration will follow the following format, available for all three APs for any given day (1, 2, 3, DD/MM/YY) or not available for AP2 on any given day (1, 0, 3 DD/MM/YY). This will be required for each day of the week starting on the Monday in a week’s time. This will be confirmed on the day before the relevant AP. These declarations will be communicated to Scottish Hydro Electric outside of the ANM communication set-up. The declaration will cover 3 different availability periods per day and are as listed below:

<table>
<thead>
<tr>
<th>Availability Period</th>
<th>Time Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP1</td>
<td>00:00:00 until 07:30:00</td>
</tr>
<tr>
<td>AP2</td>
<td>09:00:00 until 17:00:00</td>
</tr>
<tr>
<td>AP3</td>
<td>22:00:00 until 23:59:59</td>
</tr>
</tbody>
</table>

The Applicant will be required to commence AP2 and AP3 with Applicant’s Installation charged by no more than [•]% and save when actively providing the Service during the immediately preceding AP3 shall be required to commence AP1 with Applicant’s Installation charged by no more than [•]%.
Part 2

Payment

Availability Payment

The Availability Payment will be £[•]/kWh/h for each Availability Period in which the Applicant’s Installation is Available multiplied by the figure in the table below for the relevant month.

<table>
<thead>
<tr>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>0.7</td>
<td>0.6</td>
<td>1</td>
<td>1.1</td>
<td>1.5</td>
<td>1.4</td>
<td>1.3</td>
<td>1.2</td>
<td>0.9</td>
<td>0.6</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Active Payment

The Active Payment is £[•]/kWh actively provided by the Applicant.

Nominal Availability Payment

The ESP will receive Availability Payments during the applicable Availability Window provided it is able to meet dispatch instructions provided through the ANM. The full rules are as listed below.

- If ESS is declared as available for any availability period, non ANM requested import is not allowed. Non compliance will result in the ESS being tripped off by the ANM scheme.
- Entry requirement to APs is NAC = SC unless there was export capacity < the SC of the battery i.e. AP1 to 2 experiences export constraint meaning that NAC = 0 at start of AP2 or the ESS leaves AP3 full due to ANM requests or leaves AP3 with NAC < SC but due to import requests
- System will stop receiving availability payments, during AP1, 2 or 3, from the moment an unavailable signal is received from the ESS or the moment an SC non compliance is identified
- ESS is to be sent a minimum import of 400kW due to system characteristics
- Availability payment is £/kWh. So if the ESS only has a portion of the 500 kWh available they receive only a portion of total payment if they were fully available. This amount of availability is what’s notified to SSEPD the day before. It doesn’t mean that the availability payment reduces as the ESS fills up during the AP.
- Active payment will be equal to the amount that has been requested to be imported.
• ESS must be able to deliver stated capacity. If they are found to fill up quicker that what they have notified the day before as their SC then they will lose their availability payments

• ANM system will be separate to Availability Notification System (ANS). ANS will state what APs the ESS will be available during, also what the SC is.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS is in AP1, 2 or 3 and NAC &gt; 0 having already met entry condition of NAC=SC</td>
<td>100% availability payment of SC</td>
</tr>
<tr>
<td>ESS is in AP1, 2 or 3 and NAC = 0 (due to ANM import requests) &amp; no export capacity available</td>
<td>50% availability payment of SC</td>
</tr>
<tr>
<td>ESS is in AP1, 2 or 3 and NAC = 0 &amp; export capacity available</td>
<td>0% availability payment</td>
</tr>
<tr>
<td>ESS is in AP1, 2 or 3 and NAC = 0 &amp; no export capacity available. NAC = 0 because ESS has imported energy within AP without being asked to by ANM</td>
<td>0% availability payment</td>
</tr>
<tr>
<td>ESS is asked to import, in AP1, 2 or 3, and does so</td>
<td>100% availability payment as per normal AP payments &amp; active payment</td>
</tr>
<tr>
<td>ESS is asked to import, outside AP1, 2 or 3, and does so</td>
<td>100% availability payment &amp; active payment but only for the period of time ESS is importing</td>
</tr>
<tr>
<td>ESS is asked to reduce export during AP (ESS having declared that they are available) but not to the level of starting importing</td>
<td>No payment made for reducing export</td>
</tr>
<tr>
<td>ESS will not be asked to reduce exports outside AP apart from normal ANM operation</td>
<td>No payment made</td>
</tr>
</tbody>
</table>

The ESP will not receive Availability Payments if the ESS is technically unavailable or unable to receive charge as a result of being fully charged, with the exceptions set out below.

When the Applicant’s Installation has become fully charged as a result of continuous charging instructions received via the ANM, and has been unable to discharge subsequently due to export constraints the Applicant will be entitled to receive a proportion of the relevant Availability Payment calculated as follows:

When the device is fully discharged the NAC would be set to the storage capacity of the Applicant’s Installation (in effect the difference between the maximum recommended charge, ~[ ]%, and the minimum recommended charge, ~[ ]%, of the device). When the NAC > 0, the Applicant will not receive any Availability Payment if it is unable to meet an instruction to charge via the ANM.

When the NAC = 0 (ie the device is notionally fully charged), the Applicant receives 50% of the Availability Payment if it is unable to meet an injection instruction, or 100% if it is able to meet a injection instruction having discharged the system following the Applicants decision to do so.

The NAC is calculated as follows:

\[ NAC = SC - \text{Import} + \text{Export} \]
where

\[-\text{Import} + \text{Export} \geq 0\]

Where:

- \(SC\) = Capacity of the Applicant’s Installation
- \(\text{Import and Export}\) = All Imports/Exports of units of electricity to the ESS as registered at the 11kV metering circuit breaker

The concept is illustrated in the figure below. The NAC is shown as the green line. At the start of the period, in this example, the Applicant’s Installation is discharged. It receives a charging instruction until the device is full. It receives its full Availability Payment during this period and is also paid the Active Payment for the volume of electricity injected. Once the NAC = 0, but the Applicant's Installation is unable to discharge due to a Distribution System constraint, the Applicant's Installation receives [50%] of the Availability Payment. Once the constraint disappears, the Applicant's Installation receives the full Availability Payment and the NAC increases at the Minimum Discharge Rate until it is equal to the SC.

The concept is further illustrated in the figure below. Using the same concept as the figure above, in this illustration the Applicant's Installation is not discharged after the constraint on the export is link is removed. For the period until the NAC > 0 of the Application’s Installation, Availability Payment Adjustment is set to 100% implying a zero Availability Payment for that period.
Physical capacity

Charging instruction
Export link constrained

NAC = SC

100% Availability Payment + [50%] Availability Payment [0] Availability Payment

NAC = 0

Availability Payment

Utilisation Fee [50%] Availability Payment

NAC = SC

NAC = SC

NA C = 0

NA C = SC

10% 90%

SC

T

CT

© Scottish Hydro Electric Power Distribution 2012
Part 3

Applicant’s Installation

The Applicants ESS will meet the following requirements:

- Minimum charging rate of [•] kW
- Maximum charging rate of [•] kW
- Minimum discharging rate of [•] kW
- Maximum discharging rate of [•] kW
- Minimum storage capacity of 500 kWh
- Minimum response time of 2 seconds

[These will be defined once the tenders have been submitted]
Part 4

Information to be provided by the Applicant

Applicant is to provide the following information:

• What energy markets the ESS has been active in.
• What percentage of income they gained from each active market.
• Details of contracts that the ESS is operating to.
• Whether the Applicant was able to gain access to any markets through the relaxation of access criteria.
• Would the Applicant repeat a similar project based on the economic knowledge gained from this project?
Appendix II

Sample risk assessment developed during safety case
<table>
<thead>
<tr>
<th>Hazard Type</th>
<th>Hazard</th>
<th>Risk Rating Before Countermeasure</th>
<th>Countermeasure(s)</th>
<th>Risk Rating After Countermeasure</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical</td>
<td>DC Electric Shock</td>
<td>Severity</td>
<td>Likelihood</td>
<td>Risk Factor</td>
<td>Severity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P=4</td>
<td>E=1</td>
<td>A=3</td>
<td>R=5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Placarding of battery containers, racks and modules to warn of electric shock hazards; Access to battery containers to be restricted to authorised persons; Lockable personnel access doors, with controlled access to keys, to be limited to authorised persons only; Training of selected personnel for work in battery containers, such that they shall be competent to carry out such work; 

*Incorporation of multiple design measures, to limit access to live terminals (detail tbc)*; 

Compliance with Low Voltage Directive and CE marking in relation to same; Adoption of protective measures for access/maintenance (eg to follow those described in para 7.2 of BS EN 50272-2; Isolation of battery circuits for purposes of module/rack connection or disconnection; Removal of metallic personal objects & jewellery, prior to commencing work; Wearing of insulated protective clothing and application of local insulated coverings.

1. Further work will be required to determine the details of the various electrical connections employed between the modules, racks and the interconnection of the racks, in a battery container.
<table>
<thead>
<tr>
<th>Electrical shorting, due to water ingress</th>
<th>P=2</th>
<th>E=2</th>
<th>A=3</th>
<th>R=2</th>
<th>B</th>
<th>L</th>
<th>Basic integrity and water tightness of containers; Adequacy and appropriateness of access doors and associated sealing mechanisms; Integrity of sealing at cable and other penetrations; Mounting of equipment on (200mm) raised false floor, to safeguard against flood risk.</th>
<th>P=2</th>
<th>E=2</th>
<th>A=3</th>
<th>R=2</th>
<th>A</th>
<th>L</th>
<th>2. The adequacy of the proposed raised false floor will require further consideration, relative to the actual flood risk at the Kirkwall site, in any subsequent site specific Risk Assessment(s)</th>
</tr>
</thead>
</table>

© Scottish Hydro Electric Power Distribution 2012
Appendix III

ANM / ESS Interface requirements
<table>
<thead>
<tr>
<th>Requirement Number</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Each ESS will have a dedicated interface with the Orkney ANM scheme</td>
</tr>
<tr>
<td>2</td>
<td>An LAC will be supplied for each ESS included within the Orkney ANM scheme and a direct communication link will be installed between the LAC and the control system of the ESS.</td>
</tr>
</tbody>
</table>
| 3                  | The LAC-ESS communication link will use one of the following open standard communication protocols:  
|                    | • DNP 3.0 Over IP (Slave only)  
|                    | • DNP 3.0 RS-232/485  
|                    | • Modbus TCP/IP  
|                    | • Modbus RS-232/485 |
| 4                  | When exporting power the ESS will be subjected to the conventional rules of the Orkney ANM scheme as applied to all new power exporting devices connecting to the network as part of the ANM scheme. |
| 5                  | The ESS will be assigned a position within the Orkney ANM priority stack. |
| 6                  | The ANM scheme will issue a real power set-point instruction to the ESS to indicate the limit above which its power export must not exceed. |
| 7                  | The ANM scheme will, when required, issue “trip” instructions to the interface circuit breaker of the ESS to disconnect it from the network in accordance with the escalating control actions taken by the ANM scheme to ensure network security is maintained. |
| 8                  | Upon the breach of a thermal constraint the ANM scheme will attempt to allocate as much of the required curtailment as possible to the ESS in the form of a reduction in power export or an increase in power import. |
| 9                  | The ANM scheme will issue a real power set-point instruction to the ESS to indicate its required point of operation if it is to participate in the reallocation of curtailment away from generators. This will be in addition to the real power set-point instruction associated with Req. 6. |
| 10                 | The ANM scheme will allow an ANM operator to manually override the existing value of the real power set-point described in Req. 9. The operator will be able to manually input a new value for this real power set-point via the ANM scheme. This will be required for testing of the ESS and the ANM interface. |
| 11                 | The ANM scheme will be capable of receiving an availability signal from the ESS. This signal will have two states: “Available” and “Unavailable”. Only when this signal is in the “Available” state will the ANM scheme attempt to reallocate curtailment from generators to the ESS. |
| 12                 | The real power set-point signal indicating the limit above which ESS power export must not exceed will be ‘released’ in the conventional manner of the ANM scheme akin to the real power-setpoint issued to generators within the ANM scheme. |
| 13                 | The real power set-point indicating the ANM’s requested operating position for the ESS will be ‘released’ back to a pre-determined default position that can be updated by the ESS. |
| 14                 | The ANM scheme will be capable of receiving a real power value from the ESS that indicates the default operating position of the ESS upon the ‘release’ from ANM control. |
| 15                 | The ANM scheme will receive values from the ESS indicating if any |
limits are presently imposed on its power import or export capability. The ANM scheme will then account for these limits and will not issue real power set-point instructions outside of these limits.

### 16
The ANM scheme will monitor the response of the ESS to critical ANM scheme instructions. Failure by the ESS to respond to a critical ANM instruction will result in the ESS being disconnected from the network. This will be initiated by the issuing of “trip” instruction to the interface circuit breaker of the ESS.

### 17
The ANM scheme will monitor the integrity of the communication link between it and the ESS as well as the quality of the input data received from the ESS. If either of these is degraded the ANM scheme will issue a real power set-point instruction to the ESS that is predetermined and operator configurable.

### 18
The ANM scheme will monitor the state of the Orkney to UK Mainland Interconnectors and prohibit the use of the ESS as an importer of power if either of these interconnectors is out of service.

### 19
The ANM scheme will continuously monitor and record the state of charge of the ESS throughout each availability period.

### 20
The ANM scheme will record the total energy imported by the ESS upon instruction from the ANM both inside and outside of the availability periods. This will include determining energy import undertaken by the ESS but not requested by the ANM scheme.

### 21
The ANM scheme will store configurable limits on the operation of the ESS such as a MWh limit on ESS import instructions issued by the ANM scheme. These will be configurable over different time periods such as per hour/month.