## E6 – Innovative Solutions

**Allocation and estimation methodologies:** detail any estimations, allocations or apportionments to calculate the numbers submitted.

**General E6 Assumptions for All Technologies**

1) Costs represent the cost of the technology only i.e. it doesn't include associated costs in the CBA such as reinforcement costs
2) MVA released represents the MVA released by the technology only i.e. it doesn't include associated MVA released by reinforcement as shown in the CBA
3) Estimated gross avoided costs are the gross costs avoided by the technology plus the actual cost of implementing the technology. It doesn't include NPV costs e.g. for ANM

**Hybrid Generator**

This is a generator that runs on both diesel and battery power.

CO2e calculation = Number of litres used x 2.67614. This figure has been taken from DECC carbon calculation factors for 100% mineral oil.
It is assumed that the maintenance costs of the hybrid generator are half that of the diesel generator. Obtained by internal stakeholder engagement.
Standard generator diesel use per hour is estimated at 6 litres for a 30kva generator running at 75% load.

2016/17 Update
Hybrid generator fuel savings now calculated through battery usage i.e. 2.5 kWhrs per litre of fuel used. Figure has been taken from hybrid generator close down report. Only 2 Hybrid Generators in use. 2 of 4 hybrid generators have been removed due to reliability issues.

2017/18 Update
Benefits are no longer being reported due to minimal usage on SSEN mobile offices only and reliability issues.

**Live Line Tree Harvesting**
This is where tree felling occurs by a specialised machine working adjacent to a live line.

Conventional Harvesting under outage with generation
CIs & CML's: halved in value as it is a planned outage. This means both CI's and CML's are halved in value when calculating CI CML costs.
Two disconnections occur: As customers must be disconnected from main supply onto generator supply and then disconnected from generator supply to go back onto main supply. This means CI's are doubled when calculating cost of CI's.
Staff costs: These include staff, senior authorised personnel and standby staff. They are calculated by using estimated daily costs multiplied by the number of days they are required for.

Generation costs: Estimated generator equipment costs based on size/type of generator and number of days used for.
CI CML Generator trip costs: generators estimated to trip at least once in 55 days for a period of 4 hours before supply is restored. This leads to additional likely CI/CML's that are preventable if live line harvesting was to occur. As this counts as an unplanned outage, full CI CML costs occur. These CI CML costs are calculated by assuming the generator will trip for a 4 hour period before power is restored. The 4 hour figure was obtained by internal stakeholder engagement. CI/CML's are then multiplied by 4 hours to find a total number and then multiplied by the percentage likelihood of the generator tripping. Generators trip percentages are found by dividing the number of days the outage occurred by 55 (the number of days before a generator is likely to trip).
Staff generator trip costs are incurred as staff are required to attend faulty generators. This is calculated by multiplying £500 (average staff costs to attend and fix faulty generators) by the percentage likelihood that the

generator will trip.

Live Line Harvester Costs: Based on costs incurred by SSEPD and costs to rent the harvester from the contractor.

Potential system security
CI's and CML's that could occur if a fault developed on a nearby circuit that usually has the ability to be back-fed. However, without a live line harvester, the circuit that usually has the ability to back-feed has manual tree cutting taking place and can't be used to supply power. Manual tree felling work must be done during a planned shutdown over several weeks. This puts other customers at risk if a fault develops as supply can't be back-fed. Calculated by finding total CI's and CML's if a fault were to occur on affected circuit and multiplying it by 5%. 5% is used as a conservative estimate. As in some cases faults will not develop at all and will therefore not incur any costs. Whereas in other cases faults will develop incurring full costs.

All calculations are presented in the CBA workings tabs.

2016/17 Update: Change to how CO2e from diesel usage has been calculated as 2015/16 method was incorrect. Both years now showing correct CO2 emissions for diesel usage.

2017/18 Update: No changes to calculation methodology.

2018/19 Update: No changes to calculation methodology.

**Pole Pinning**
This is where poles reaching end of life are pinned to extend their lives

Cost of replacing one pole: This is taken from the RIIO-ED1 2016 unit cost sheet. The values vary slightly for the north and south networks and so have been separated in the CBA.

PP Tractor/Beaver Cost per month: This is the cost involved in hiring the pole pinning beaver tail machine. The annual hire cost of the machine has been split up into 12 separate months to come up with a monthly figure

Pole pinning cost per pole: This is the cost involved for pinning a single pole i.e. labour costs, pole pinning material costs.

# of poles pinned: The number of poles that were pinned in any given month
Total pole pinning cost: Total costs of pinning poles for any given month. This is also the method investment used in the asset deferment table (see CBA).

Replacement cost avoided: This is the cost that would have been spent had the poles been replaced rather than pinned. This is also the base investment figure that is used in the asset deferment table.
Method NPV: The NPV costs involved in pole pinning based on the assumption that one pole, once pinned, does not need to be replaced for 14 years. This is calculated using the asset deferment benefits table.

NPV Saving: The actual saving of replacing a pole based on a poles life being extended 14 years before it needs to be replaced. It is the base investment minus the method NPV.

All calculations are demonstrated in the CBA

2016/17 Update
Pole pinning has been stopped. However, costs were incurred as it took time to take the machine off hire.

2017/18 Update
Benefits no longer recorded as technology is not in use.

**Forestry Mulcher**
A specialised machine that is designed to clear small trees and shrubs underneath OHL.

Hand felling assumptions: Assumptions must be made in order to calculate how much the forestry mulcher costs vs the traditional hand felling methods.
Hand felling labour costs are estimated at an average of £225 per day.
Hand felling costs also include the hiring of a chipper machine at £225 per week and vehicle hire estimated at £1,171 per month.
Chainsaw fuel costs are estimated at £15 per day.
Chipper fuel costs are estimated at £22.80 per day.
Number of days work estimated by tree cutting manager.
Forestry mulcher assumptions: Labour & vehicle hire costs are the same as hand felling costs.
Cost of the Mulchers has been incurred via NIA project. 10% of project costs have been included here to reflect costs.
Mulcher fuel costs are estimated to be £103 per day (higher cost estimate).
All costs have been obtained from consulting the tree cutting manager who has access to costs.

2017/18 Update: No changes to calculation methodology. One machine no longer in use due to reliability issues.

2018/19 Update: No changes to calculation methodology.

**Western Isles (WI) Active Network Management (ANM)**
ANM frees up additional capacity on the network by constraining generation under specific conditions

CBA Narration

Option Baseline: This is the do nothing scenario. It is unlikely that this scenario would ever occur as it would mean generators would be constrained beyond acceptable levels. It also shows a lack of commitment to customers for developing the network and prevents new connections from occurring. For these reasons, this option was not chosen and has been removed from the CBA as it has no value.

In this scenario the network capacity is at its maximum and so there is no benefit in terms of constrained volume avoided.

Option 2: There is strong demand for generators to connect renewable generation on the island. Previously this has not been an issue as we had sufficient network capacity to connect new generators. However, as we are at the limits of our network's capacity on the Island, the cost to connect and time to connect has steeply increased.
For example, a generator requesting a new connection would be quoted approximately 20m in 2016. This is because a sub-sea cable reinforcement would be necessary in order to increase capacity, taking approximately 3 years to complete.

In this scenario generators can't operate until 2020, once the subsea cable reinforcement is complete. The £20m reinforcement releases an additional 9MVA of capacity, once works have completed (approximately 3 years).
MWhrs of renewable generation have been calculated by using actual generation export values from WI ANM generators & accounts for the fact that this generator was constrained 0.09% over the one year period it was operational.

Option 3: Instead of going ahead with the traditional reinforcement proposed above, we have implemented single generator ANM on the WI. ANM allows us to offer generators requesting a connection to be given a constrained connection instead. ANM has freed up an additional 9MVA of constrained capacity on the WI network without the need for expensive reinforcement. This capacity has already been filled by a single generator. It is forecast that more generators will want to connect to the WI network throughout the RIIO-ED1 period. A full ANM scheme will be implemented when the next request for generation occurs. This is forecast to occur in 2019. However, this will only release an additional 9MVA of capacity. Any more generators requesting connections after this point will then trigger the £20m reinforcement to be implemented. This has been forecast to be triggered in 2022 and not be completed until RIIO-ED2.

In this scenario ANM is in place, which allows increased capacity on the network of 18MVA over RIIO-ED1. Around 9MVA of capacity has already been filled and another 9MVA of capacity if forecast to be filled in 2019 alongside the completion of a full ANM scheme. The £20m reinforcement will then be triggered by demand for new connections in 2022. This will be completed during RIIO-ED2 and release an additional 9MVA of capacity.
At some point within the next 16 years the subsea cables connecting WI to mainland Scotland are forecast to be replaced. It is assumed that the new cables will be higher capacity to allow more firm connections of generation to connect to the network. Once this occurs the benefits of ANM will have to be reassessed as it may not be necessary if enough capacity is made available via subsea cables.

Orkney ANM
ANM frees up additional capacity on the network by constraining generation under specific conditions

CBA Narration

Orkney ANM: Only one scenario has been inserted into the CBA as it has been operational pre RIIO-ED1. Costs have been recorded against each year where they were incurred. Reinforcement avoided occurred pre RIIO-ED1 and so benefits have not been counted again here. The main benefit here is from reduced emissions as a result of renewable generation being connected via ANM.

No new capacity has been freed up due to ANM in RIIO-ED1 on Orkney

E6 Template: Orkney ANM
Costs: Only costs for the ANM solution have been inserted here
Only the MVA released by ANM has been included. Total MVA released is 0MVA.
Estimated Gross Avoided costs: No avoided costs as traditional reinforcement would have occurred pre RIIO-ED1. Small burden of costs incurred by SSEN to run the scheme as not all operational costs are covered in contracts with generators.

**3rd Party ANM**
Generators connect earlier and therefore create carbon benefits by increasing the amount of renewables.
Carbon benefits are calculating by taking total MWhrs of operation over the regulatory year and using the Ofgem conversion methodology within the CBA.

Costs are Generator connection costs.

**General**
For each of the solutions please explain:

- In detail what the solution is, linking to external documents where necessary.
- How this is being used, and how it is delivering benefits.
- What the volume unit is and what you have counted as a single unit.
- How each of the impacts have been calculated, including what assumptions have been relied upon.

**Hybrid Generator**

**Benefits for this technology are no longer being recorded due to minimal usage on SSEN mobile work sites only and reliability issues making it unfit to use for customer power restoration**

1) The hybrid generator (HG) technology is offered as a solution for off-grid power supply requirements in remote locations and can be used to provide power for residential, construction, telecom towers and disaster relief applications. It is a temporary mobile generator and not utilised full time.

The HG is a combination of a diesel generator (DG) and a power-electronic converter with integrated battery storage. In conventional generator-only applications, the diesel generator must "load follow" and therefore operates at off-optimal conditions for the vast majority of time – the battery system alleviates this requirement.

Other benefits include low/no noise through noise insulation and operation in battery-only mode, less carbon emissions through operation of the DG at optimal conditions and use of battery, generally more efficient operation of the DG and reduced cost of ownership since the engine has to run less often.

Close down report located here:
ED_SSE - RRP - 2016-16 RRP\2011_14 Hybrid Generator LTI Close down report

2) Two hybrid generators are currently in use on SSEN mobile work sites. The main benefit of the hybrid generator is that it reduces the amount of money spent on diesel by running in battery mode. This also reduces CO2 output. Maintenance costs are also less than diesel generators.

3) The volume unit is the number of hybrid generators. One generator equates to one unit.

4) Litres of fuel saved by the hybrid generator was calculated through battery usage i.e. kWhrs converted into litres of fuel used. Figure has been taken from hybrid generator close down report.
CO2e was calculated by using DCF carbon calculation figures for 100% diesel mineral oil.

**Live Line Tree Harvester**

1) Tree harvesting adjacent to our overhead network presents increasing challenges to SSEPD, particularly in our SHEPD licence area. Volumes of timber available to be harvested by third parties will continue to rise over the next 20 years and we have increased ESQCR obligations to gain enhanced (falling distance) clearances over the next 25 years.

Current guidance and practice on tree felling within falling distance of the network is to either provide an outage or to fell or dismantle the trees using manual techniques.

Providing outages has obvious disadvantages:

- significant CI/CML consequences
- hazards associated with switching and provision of generation
- reduction in network security
- time constraints on shutdowns could result in failure to complete works
- machinery breakdown might result in further outages being required

The use of manual methods adjacent to a live line for large numbers of trees also has significant drawbacks:

- unacceptable exposure to hazard to operatives over long periods from working at height, chainsaws, falling trees and electricity
- drain on highly trained resources needed to carry out programmed maintenance work

The objective of the project was to fully investigate the scope of the issue, evaluate potential methods and machinery that could be employed and to develop safe systems of work to carry out mechanised harvesting adjacent to a live network.

The close down report is located here:
ED_SSE - RRP - 2016-16 RRP Returns\Live Line Harvesting Closedown Report

2) Currently two live line harvesters are in operation, which is under contract. Harvesters have only been used in the SHEPD and SHET regions (SHET use not reported here). The harvester works by felling trees

adjacent to live lines. It produces benefits as it is a far less costly method of harvesting vs conventional hand felling harvesting methods. It is also far more efficient. Benefits come from reduced CI CML's, improved security of supply (also CI CML benefits) and lower generation costs. Unquantifiable safety benefits also exist, as hand felling of trees for long periods of time are risky.

3) The voluime of units are the number of live line harvesters owned by SSEN.

4) Assumptions and how they have been calculated are mentioned in the first box

2016/17 update: new live line harvester was purchased in July, costing £440,000. This is why costs are so much higher this year.

2017/18 update: Both harvesters are now operational, but due to driver recruitment issues related to the new purchased harvester it has meant utilisation hasn't been as high as possible.

**Pole Pinning**

**This technology is no longer in use and so benefits are no longer recorded**

1) Poles reaching their end of life or those that are significantly deteriorating to the point where they need to be replaced, can instead be pinned. Pole pinning involves using a specialised pole pinning machine that drives a pin through the base of a deteriorating pole. The pin provides the pole with additional strength. It is estimated that pinned poles will have their lifetime extended by 14 years, providing significant financial benefits.

2) Unfortunately pole pinning failed to deliver positive financial benefits and the technology has been stopped by SSEPD. This is because not enough poles were being pinned to cover the cost of the equipment hire. Field staff reported problems such as poles being too rotten to pin. It has also been discovered that pole pinning has a negative effect on asset health indices, so it was decided to stop pursuing use of this technology.

3) The volume unit is the number of poles pinning machines owned by SSEN.

4) Assumptions and how they have been calculated are mentioned in the first box.

**Forestry Mulcher**

1) The forestry mulcher is a machine designed to remove small shrubs and woody species underneath OHL. More details can be found in the close down report:
   Forestry Mulcher closedown report location

2) The mulcher is currently being used in the northern SHEPD network where there is a higher proportion of vegetation where use of the mulcher is applicable. The mulcher can't cut vegetation too large or mature and so its prime purpose is for controlling new growth. It is estimated to be 3.8 to 3.4 times more productive than hand felling. This means more spans can be cut per £ spent, improving unit costs.

3) Units are the number of Bushfighter machines that are in use i.e. 2. These 2 machines were moved into BaU in 16/17 after successfully proving their benefit as part of an NIA project.

4) Assumptions have been detailed in the first box.

2017/18 update: One of the Mulchers is no longer operational due to mechanical issue associated with manufacturer defect. Work is being carried out to remedy the situation.

**ANM**

1) The solution deployed is Active Network Management (ANM), where generators that may otherwise have been unable to connect to the distribution network due to excessive reinforcement costs or timescales, can connect through a flexible connection. The system constitutes Information Communication Technology (ICT) architecture that monitors, in real time, the pre-identified network constraint points and ensures that no generators connected through it can breach the networks operational limits. If those limits are threatened then the system sends control signals to the most appropriate generator to reduce their export until the network limits are no longer threatened, then the generators are released back to a safe operating state. The key governing principles are described in the ENA produced ANM Good Practice Guide, which can be found at the following link.
http://www.energynetworks.org/assets/files/news/publications/1500205_ENA_ANM_report_AW_online.pdf
The report was created by the ENA ANM Working Group where the relevant subject matter experts meet to share learning and to tackle industry wide issues affecting the wider roll out of ANM.

SSEPD have been working on ANM for a number of years, as can be seen through the work completed and charted for the Orkney ANM at the following link https://www.ssepd.co.uk/OrkneySmartGrid/ . Through this work SSEPD has built up an in-depth understanding of ANM that has allowed us to roll out ANM into Business as Usual so that more of our customers can experience the benefits that ANM can bring.

SSEPD have also recognised the need to support the rollout of this kind of innovation and have implemented business structural change to setup a team, the Active Solutions Team, whose sole responsibility is the rollout out of the more involved proven innovations, like ANM. Through setting up this team SSEPD aim to better rollout innovations quicker so that our customers can start realising the benefits sooner.

The main document detailing the reinforcement costs for the Western Isles over the RIIO-ED1 period is located here:
Western Isles ANM paper.pdf

2) Customer's benefit from ANM as they are able to connect much sooner and at a far cheaper cost compared to traditional reinforcement. ANM defers this reinforcement cost creating NPV benefits, while allowing more generators to connect.

3) The volume unit on this is 1 ANM scheme.

4) Reinforcement costs has been calculated by system planners based on the size of the subsea cable that is necessary for the Isle of Wight network to ensure additional capacity is available for new connections as soon as possible.

The amount of time reinforcement is deferred for is calculated by system planners and is based upon how much additional capacity ANM can free up and predicted generator connection demand.

Currently, ANM has connected 9MVA to WI. Another 9MVA can be connected through ANM. After this an expensive reinforcement scheme will be necessary to free up additional capacity. Orkney ANM is already at full capacity.

**3rd Party ANM**
1) There are two types of 3rd party ANM connections for the customer to consider - shared capacity and demand management. Both of which are installed and managed by the customer.

Shared capacity example: An existing generator may have a contracted capacity of 10MW but only have

6MW of connected generation. Therefore, there is the potential for a customer to approach this generator and make use of the spare capacity. The customers will install a system that will ensure the combined export of both generators does not exceed the contracted capacity.

Demand Management example: A new 250kW generator wishes to connect to the distribution network. However due to transmission constraint upstream the generator has a limited export of 50kW. The generator develops a proposal to increase the minimum demand by changing gas boilers to electric boilers on the same circuit as the constrained asset. The generator has calculated this will increase the minimum demand by 200kW. The generator must then ensure that when the 50kW limit is breached that suitable demand is brought onto the network.

2) 3rd Party ANM allows renewables to connect cheaper and faster. It also allows generators to benefits from government subsidies that are time bound.

3) 1 ANM generator counts as 1 scheme.

4) Calculations are explained in the first section of this report

**Use of the RIIO-ED1 CBA Tool**
DNOs should use the latest version of the RIIO-ED1 CBA Tool for each solution reported in the Regulatory Year under report. Where the RIIO-ED1 CBA Tool cannot be used to justify a solution, DNOs should explain why and provide evidence for how they have derived the equivalent figures for the worksheet. The most up-to-date CBA for each solution reported in the Regulatory Year under report which are used to complete the worksheet must be submitted.

RIIO-ED1 CBA tool used for all technologies

**Changes to CBAs**
If, following an update to the CBA used to originally justify the activity in column C, the updated CBA shows a negative net benefit for an activity, but the DNO decides it is in the best interests of consumers to continue the activity, the DNO should include an explanation of what has changed and why the DNO is continuing the activity.

Live Line Tree Cutting: CI and CML monetary savings now taken from Ofgem fixed costs tab instead of those costs charged directly to SSEN for incurring IIS fines.
Reason: IIS costs vary each year for DNOs and between DNOs. Using Ofgem's fixed cost figures allows for more accurate cost saving comparisons between DNOs.

**Calculation of benefits**
Explain how the benefits have been calculated, including all assumptions used and details of the counterfactual scenario against which the benefits are calculated.

**Hybrid Generator**

Option 1 (Baseline):
Total Running time that hybrid generator was used for was used to compare figures against.
Amount of Diesel used by a similar standard diesel generator was used. This was estimated to be 6 litres an hour for a generator of the same size (30kVA) running at 75% load. These figures were used by consulting internal company experts and well known web sites.
$CO_2$ used: Multiply litres used by 2.67614 (taken from DCF carbon calculation spreadsheet for 100% diesel mineral oil)
Maintenance Cost: This was assumed to be twice that of the hybrid generator (confirmed by internal company experts who use the generator).

Option 2
Total running time was estimated from use of the hybrid generator on specific jobs over a one month

period
Diesel used: The amount of diesel that the hybrid generator used over a one month period
$CO_2$ used: Multiply litres used by 2.67614 (taken from DCF carbon calculation spreadsheet for 100% diesel mineral oil)
Maintenance costs: Costs spent on maintaining the hybrid generator

**Live Line Tree Cutter**

Refer to first box

**Pole Pinning**

Refer to first box

**Forestry Mulcher**

This is simply the traditional cost of hand felling vs the cost of mulching per span. Assumptions are detailed in the first box.

**WI ANM**

Benefit of ANM is an NPV cost reduction that must be viewed in the CBA. Traditional reinforcement (Option 2) will have an NPV cost of -£11.53m over 16 years vs ANM forecast scenario (Option 3), which has an NPV cost of -£0.77m over 16 years. This represents and NPV cost saving of £10.67m over 16 years. 16 years is chosen as it is expected that one or more of the subsea cables will be replaced within this time period. Once replacement has occurred and assuming the replacement cable has higher capacity the benefits of ANM will reduce as more firm connections can be made. NPV calculations are demonstrated in the CBA and assumptions explained in previous boxes.

**Orkney ANM**

Benefit of ANM is shown as a positive NPV value over time (16-45 years). Costs of operating the ANM scheme each year to SSEN are included. Ideally costs should be £0 as generators should cover all operation costs. However, SSEN tends to incur minor additional costs, which is why a small negative number is shown. NPV is positive due to environmental benefits associated with reduction in $CO_2e$ emissions.

**3rd Party ANM**

Refer to first box

**Cost benefit analysis additional information**
Please include a reference to the file name and location of any additional relevant evidence submitted to support the costs and benefits inputted into this worksheet. This should include the most recent CBA for each solution reported in the Regulatory Year under report.

**Hybrid Generator**

Link to reporting document where hybrid generator benefits are calculated:
ED_SSE - RRP - 2016-16 RRP Returns\Hybrid generator close down report

CBA Location:
ED_SSE - RRP - 2016-16 RRP Returns\SSEH CBA RIIO ED1_v4 - Bi Directional Hybrid Generator v2

**Live Line Tree Cutter**

CBA Location:
ED_SSE - RRP - 2016-16 RRP Returns\SSEH CBA RIIO ED1_v4 - Live Line Tree Cutting V3

**Pole Pinning**

CBA Location:
ED_SSE - RRP - 2016-16 RRP Returns\SSES CBA RIIO ED1_v4 - Pole Pinning V2

**Forestry Mulcher**

Link to original benefits tracker
Xxxxx

CBA Location:
Xxxxx

**ANM Orkney**

CBA Location:
Xxxxx

ANM Western Isles

CBA Location:
xxxxx

System planning reinforcement document:
Xxxx

**3rd Party ANM**

CBA Location: