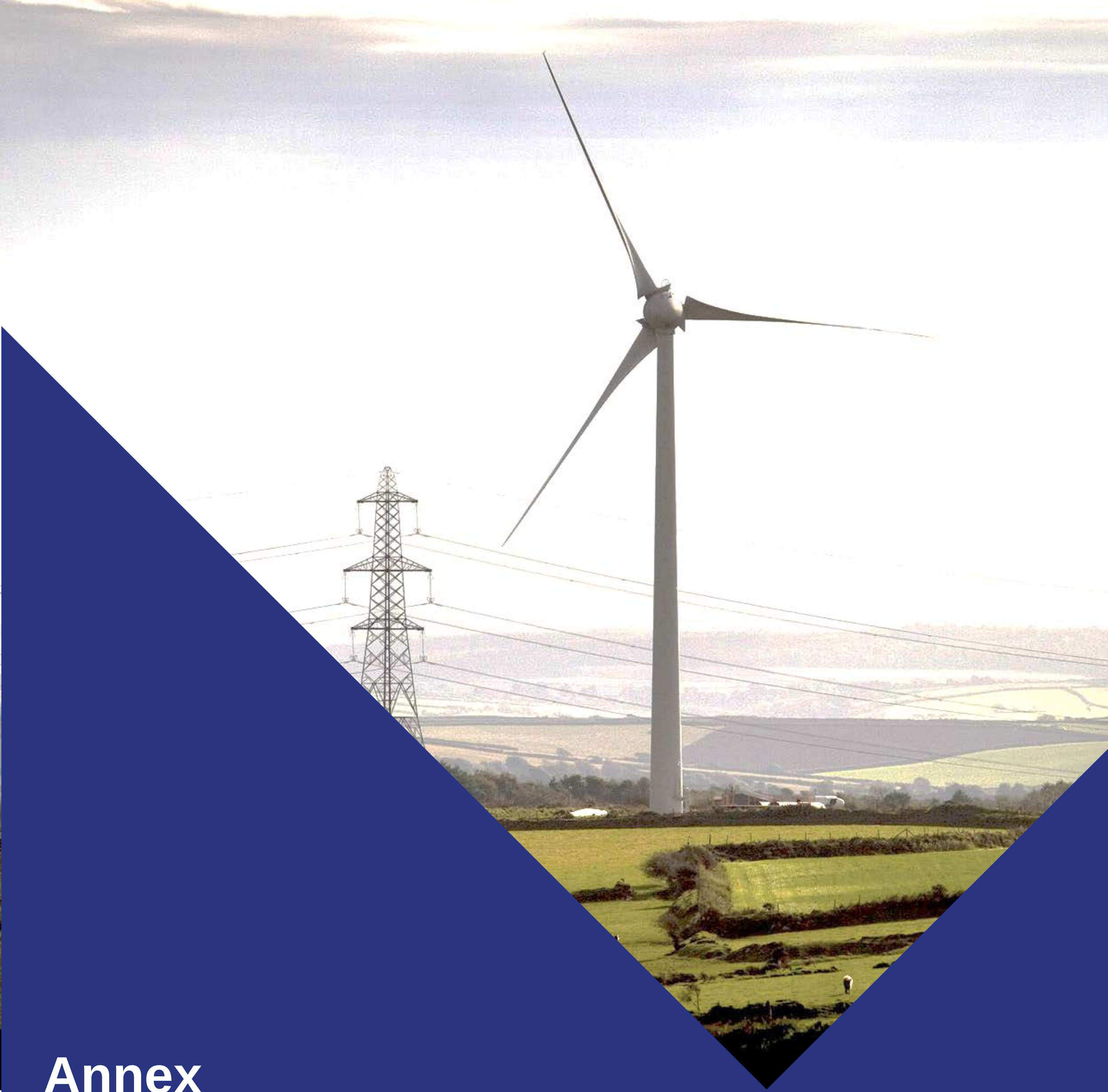


Annex

NGET_A9.11 ENS Incentive

December 2019

As a part of the NGET Business Plan Submission

nationalgrid

RIIO-T2

nationalgrid
Electricity Transmission

NGET_A9.11 ENS Incentive

Safe and Reliable
(December 2019)

Submission annex 2019

Contents

Executive Summary

Energy Not Supplied (ENS) is the incentive to minimise the loss of supply events and to encourage behaviours to achieve the reliability plans that our stakeholders want. The existence of an ENS incentive with an upside and downside performance element most efficiently manages the trade-off between reliability and affordability. Our performance during T1, where the baseline was set at 316MWh, has been positive, as a result of an extensive list of activities that we have performed to mitigate network risk.

For RIIO-T2, Ofgem has determined the need for a new baseline that will give more weight to recent performance, the need for an appropriate Value of Lost Load (VoLL) value and the need to account for embedded generation.

Therefore, we have explored a list of options: using the same methodology used in T1, giving more weight to recent performance and using different weighting assumptions, considering the effect of embedded generation and finally doing a sensitivity analysis of VoLL to determine which will be the most appropriate value. We have tested our analysis with stakeholders who support our proposal for a 50/30/20 weighted methodology. This would give a target of 175MWh if performance against the target remained at current levels.

1. Background

Reliability is the likelihood that the system will perform as planned under stated conditions, these being the "normal" operating parameters for all the assets that make up NGET's network.

Energy Not Supplied (ENS) is the primary output for electricity transmission reliability and one of the ways TOs use to measure performance. We assess ENS by taking the data from our equipment and calculating the volumes of energy (MWh) that are not supplied to consumers as a result of faults or failures.

The ENS incentive is intended to drive behaviours contributing to a reliable network. Events shorter than 3 minutes (to allow protection to operate and return a circuit automatically), and events that are out of NGETs control (for example in the case of extreme weather or the other "force majeure" conditions) are excluded from the determination of ENS.

The incentive is designed to reward network companies for good performance and penalise them for poor performance. Loss of supply events are rare; however, the consequences are often of national importance. The downside measure is such that a single incident has the potential to offset several years of accumulated incentive reward.

The incentive uses the Value of Lost Load (VoLL) for consumers to calculate this reward and penalty.

2. T1 Performance

The methodology used for RIIO-T1 set the baseline at 316 MWh. This was calculated using a numerical simulation of the number of potential events and their magnitude based upon historical performance.

The total ENS recorded for the period April 1990 - April 2013 was 8035MWh; covering 111 events. A simple average of loss per year total ENS would return a value of 349 MWh/year. The simulated target is, therefore, more onerous a target.

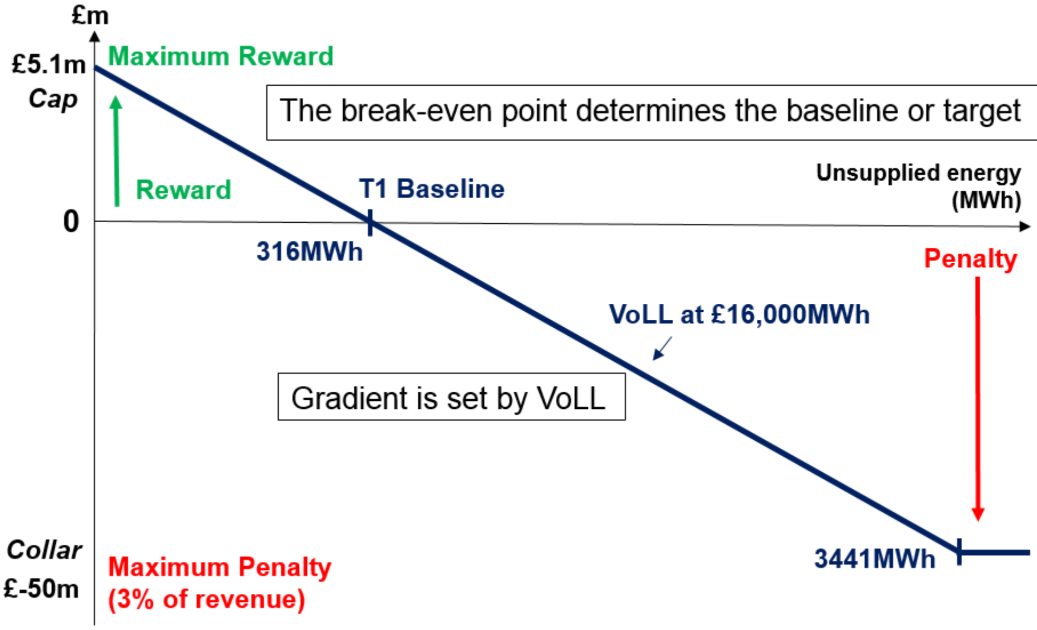


Figure 1. Energy Not Supplied Incentive.

During the first 5 years of T1, NGETs ENS performance has been good. Figure 2 shows the ENS long-term performance, where a trend can be seen, showing how the incentive improves performance. But as history shows us, with events like the ones in 2003 and 2007, a high impact event, although of low probability could put the incentive into penalty regardless of remaining annual performance.

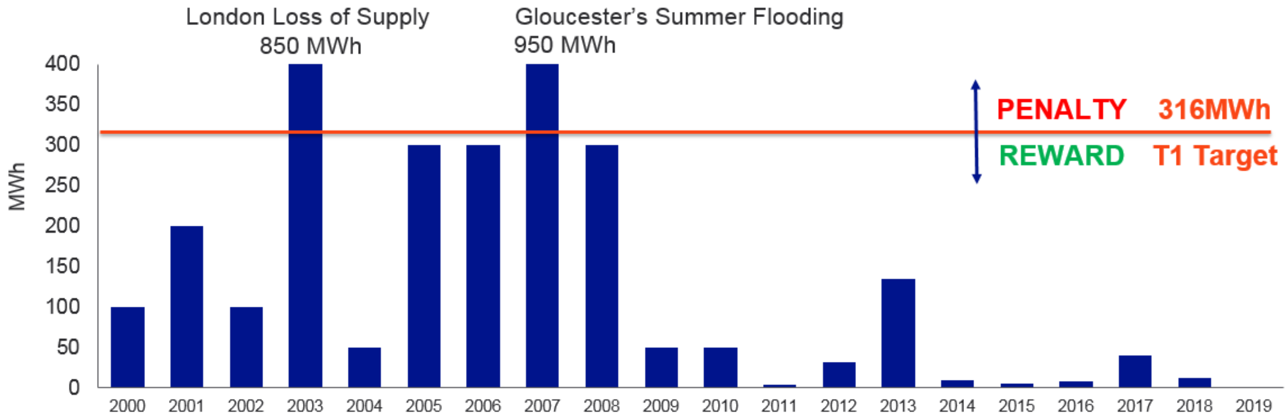


Figure 2. Long-term performance of volume of incentivised unsupplied energy.

The incentive promotes and encourages behaviour which reflects the importance that ENS has for stakeholders. The incentive has gained even more importance post TO and ESO separation. Note that while the incentive resides within the TO, both TO and ESO activities have a bearing on ENS. The TO does not schedule standby generation, rolling standby and the use of market interventions to manage system consequences, therefore the retention of a positive incentive for ENS is important.

3. T1 Mitigation and Behaviour

The primary TO activities that have a bearing on incentive performance are those activities that mitigate network risk. Maintenance, refurbishment and replacement activities have direct implications for the risks and costs being managed by the ESO. These are some of the ways we manage ENS:

a) A procedure that sets out the process for managing outages that place demand at risk.
With this process, the aim is to reduce as much as reasonable the risk of loss of supplies by raising awareness of these outages, understanding the risks and where reasonable undertaking mitigating actions to manage them. This procedure consists of a collaboration between the planning team in the ESO, which identifies the outages that place demand at risk. The Electricity Transmission planning team is responsible for reviewing the outages and design and undertake the actions needed to mitigate the risk. For example, site health checks or overhead line patrols. By doing this, the likelihood of ENS is reduced over and above NETS SQSS security standards.

b) Examples of self-funded work to minimise ENS

i. Replacement of a damaged tower on the Bradford – Leeds OHL route. The process of removing a tower and replacing it in-situ with a new one, in normal conditions, would mean a total of at least 6 weeks with demand at risk. But for the replacement of the tower in this route, a specialised reduced height piling rig was used to install new foundations under the existing live circuits, and a short double circuit outage was used for the final transfer from the old tower to the new one.

This solution successfully reduced demand at risk from 6 weeks or more to only 4 days. Due to the work being planned over a low demand period (which minimised ENS further), this resulted in additional costs being incurred.

ii. Standard emergency return to service (ERTS) time for protection replacement takes, under normal conditions, a total of 10 days, meaning a long time with demand at risk and an increased risk of energy not supplied.

We considered this a potential area of improvement for reducing demand at risk and therefore invested in new equipment to reduce this risk, with the use of temporary protection units (DALEKS).

This was put into use on the Amersham – Iver – East Claydon outage in 2018. The standard emergency return to service (ERTS) time would have put demand at risk for 10 days, but DALEKS were used and the ERTS was reduced to 24 hours.

iii. Substations containing Gas Insulated Switchgear (GIS) are high voltage equipment in which most structures are contained in a sealed environment with SF6.

In these substations, the main gas zone and the adjacent zones need to be depressurised to work on a single piece of equipment. A gas zone is a part of the GIS that contains one or more gas chambers that have a common gas monitoring system and whose gas density fluctuates in unison. The standard practice is to take adjacent zones out of service when working on a piece of equipment, but this means a high danger of putting demand at risk.
Analysing this problem, we innovated to design and build "barrier cones". This unique design was tested at Elstree (London), which includes the crucial Elstree – St Johns Wood circuit in Central London. A shunt reactor fault at this substation in December 2016, could have put demand at risk during the Winter period. But the installation of "barrier cones", removed the crucial circuit from the adjacent zone, allowing the circuit to be returned to service, reducing the risk of ENS, whilst the repair on the shunt reactor was carried.

iv. The event with the highest ENS to date is Gloucester's Summer flooding in 2007. The effects of those weather conditions impacted on National Grid's operations and assets, leading to parts of the substation becoming flooded by water. Although our engineers reconfigured the electricity system to ensure continued supply to Gloucester and South Wales, a total of 968.5MWh were lost. Due to the repercussions of these events, we have minimised the future risk of this reoccurring by investing in portable and permanent flood defences. The value of these devices was proven on 1st August 2019 at Bredbury Substation in response to the deterioration of the Whaley Bridge Dam (full and detailed analysis on Appendix 3). Had the dam to deteriorated further, the defences would have served to avert the potential catastrophic flooding of the Bredbury substation which supplies power to Manchester.

Figure 3. Deterioration of the Whaley Bridge Dam - https://www.bbc.co.uk/news/uk-england-derbyshire-49566517

NGET also undertakes visual assessment using a new process of helicopter and drone data capture, in addition to more traditional foot patrols, to mitigate operational risk associated with vegetation management and 3rd party interference. This information is used by our engineers to proactively identify future issues and put in place plans to resolve them before they become ENS events.

4. T2 Framework Discussions and Options

OFGEM has determined that there should be an ENS incentive in the T2 period with a positive upside. We have had a total of seven consultations and workshops with Ofgem to determine the new package of ODIs (Output Delivery Incentives). We have also engaged with our stakeholders, through workshops and webinars, to determine what they want in terms of reliability, and we have a specific ENS engagement session scheduled in October to ask our stakeholders their views. We have heard what they need and expect from us, which has influenced the options we have considered. Our stakeholders support the decision to retain an upside ENS incentive for the T2 period.

4.1 T2 Option 1

For the T2 period, an additional 5 years of data are available that were collected during T1, resulting in a new total of 128 events and 8230MWh of ENS. By a simple average calculation, the new baseline could be set at 293.3 MWh/year. When repeating the same methodology used to determine the target for T1, we establish a revised target of 254MWh. The method used is unlikely to be affected by random variations as the simulation was subject to 50,000 iterations.

4.2 T2 Option 2

As recent performance has been generally positive, we investigated if a weighting mechanism could be considered for setting the baseline, giving more importance to the most recent period. A trial was conducted using a weighted distribution of 50% - 5 most recent years (0-5), 30% - last 10 years (0-10) and 20% - for remaining years. This method puts undue emphasis on recent performance and could be considered statistically flawed, as the 0-5 years' period is being evaluated 3 times. This produces a baseline target of 82MWh.

For the T1 period, 111 events were recorded up to 2013, 8 of these events exceeded 316MWh. For a reduced baseline of 82MWh, 22 individual events would exceed that threshold; i.e. the probability of an incentive loss being prompted by a single event would be significantly higher. For a collection of smaller events, which are much more common, the probability of exceeding particular thresholds depends upon the number and size of events encountered. Using the same Monte-Carlo simulation as used to forecast ENS for T1; we find that for just 3 ENS events; the median forecast energy not supplied would exceed the 82MWh threshold; whereas 7 events would be required for the median to exceed 316MWh.

The incentive is also significantly reduced compared to the T1 potential. The investment of that revenue into mitigating activities would therefore potentially also be compromised. Setting a low baseline in the short term risks the incentive being counterproductive to network reliability in the long term, particularly concerning opportunities to access the network where incentive risks are higher. The ESO costs associated with such an outage will also be increased, for example having to secure additional reserve and standby generation beyond current levels to mitigate the risk.

To avoid the triple counting problem, a second evaluation was carried out using three groups considering the 5 most recent years (0-5), a second one grouping the next 10 years (5-15) and a third one from the 15th year until the last year that data is available. The results found to give a more realistic baseline of 149 MWh. Where the number of historical events exceeding this level is reduced to 14 out of 128 events. Using the full historical dataset and avoiding triple-counting ensures the method uses all available experience in a statistically valid way. More recent performance is still being given importance, but the target still reflects the rarity and potentially significant impact of an event.

Alternative weightings were also trialled. A 40%, 40%, 20% split produces a baseline of 175MWh. At this level, 12 of 128 historical events still exceed this value. But since we believe that justifying the choice of any particular weighting configuration is problematic and open for interpretation, we have tested ENS proposals with our stakeholders which informed our proposals (see section 7 for more detail)

For a weighted forecast, where we consider 0-5 years history with 50% weighting, 5-15 years with 30% weighting, and 15-End with 20% weighting, the weighted forecast expected ENS is the forecast expected ENS for each of those time periods multiplied by the weighting.

For example:

Years End	0-5	5-15	15+	SUM
Forecast expected (P50)	21.081	84.136	69.58	**174.797**
P90	527.923	47.629	300.158	**180.136**
Weighting Assumption	50%	30%	20%	**100%**
Weighted Forecast Expected (P50)	10.54	25.24	13.916	**49.6873**
Weighted P90 Case	23.8145	90.0474	36.0272	**149.8861**

for comparison, 14 out of 128 single historical events exceeded 149.8

The P90 case is the 90th Percentile of the output of the Monte-Carlo simulation of a number of events versus the scale of the event (where the mean is the 50th). The extreme improbability of a large number of large events is such that 90th percentile remains well within the range of out-turn ENS that we have historically seen.

4.3 T2 Final Proposal

Recent performance has been positive, and we suggest that the 40%/40%/20% weighting demonstrated could represent a sensible lower bound for the incentive upside performance (175MWh), whereas the unweighted forecast of 254MWh would represent a realistic upper bound. This would be a more onerous target than that set in T1, reducing the potential upside revenue, while increasing exposure to downside risk. This will fulfil the dual objectives of incentivising the right behaviour without unduly penalising or increasing costs to actually operate or maintain the network. This follows the principle and purpose behind the incentive of encouraging TOs to efficiently improve network reliability by managing short-term operational risk and mitigation actions.

Full and detailed analysis of how the different baselines have been calculated can be found in Appendix 2.

For clarity, in all diagrams the collar has been set at -£50m to be able to compare T1 to T2. We are proposing that the collar is set at 3% of revenue in the T2 period.

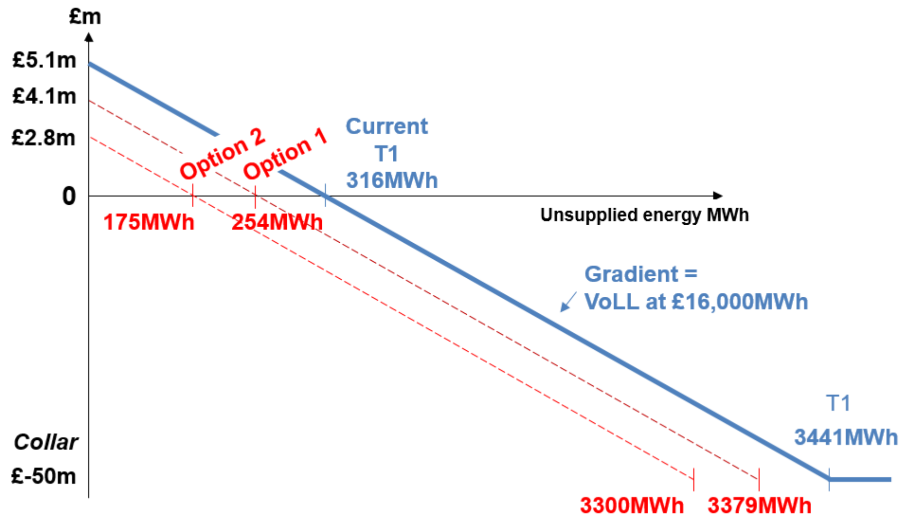


Figure 4. ENS T1 baseline & recommended range for T2

A zero-target incentive was not considered reflecting the decision made by OFGEM that the incentive would have an upside.

5. Embedded Generation

The growth of embedded generation is significant to out-turn ENS performance. For a transmission network, the presence of embedded generators is generally good due to reduced transmission demand, and therefore thermal stress on assets are also reduced. The presence of large quantities of embedded generation under most circumstances will reduce the consequences of many events provided frequency is still maintained. Certain combinations of events can prompt the loss of embedded generation, as demonstrated on the 9th August 2019 and the estimated loss of 350 MW linked to Rates of Change of Frequency (RoCoF). National Grid in general, expects fewer incentive-impacting ENS events to occur, however, where they do occur, the potential scale of loss is arguably greater and harder to predict than before, Reductions of numbers of events per year is observable in the recent ENS history.

The data required to evaluate embedded generation on a per-GSP (Grid Supply Point) basis does not exist. A GSP is an interface between the electricity transmission system and distribution networks. This means the TO does not have the detailed knowledge of how particular embedded generators may interface with one or more GSP's, only DNOs have access to this information. In the absence of data or examples specific to a UK-style network, it is not possible for the TO to plan a useful method of handling embedded generators with respect to ENS.

Note that at the DNO level, radial and single circuit design are relatively common. Hence the impact on ENS for the TO would be unfairly related to the design of the individual DNO system, and not a reflection on how well the TO can manage their network.

It is also important to consider that the penalty of the incentive, capped at 3% of revenue (approximate £1.6 billion per year) is a significant threat regardless of where the break-even point for the incentive is set. And it should be noted, that a long run of good performance can become a net negative for a single event.

We recognise that there is more work to do across the industry, to improve the sharing of data, particularly around the embedded generation. We are committed to working together with our stakeholders to find a proportionate and appropriate methodology for taking into account the effect of embedded generation on energy not supplied events.

6. Value of Lost Load

6.1 Consumer Value

Our Willingness to Pay (WTP) studies has told us that consumers are willing to pay for a more reliable system. And also, that they would be willing to pay more for a bigger decrease in this probability (from 4 hours compared with 2 hours). Although it is not possible to derive any sort of VoLL from this, it is accurate to conclude that there is a positive willingness to pay for a more reliable system.

A sensitivity analysis has been carried out considering different VoLL since this would have a material effect on the penalty. The report carried out by London Economics for Ofgem on the study on VoLL[1], based on the willingness-to-accept of consumers, concluded a peak winter workday VoLL of £10,289/MWh for domestic users and £35,488 for SME users, therefore different values in this range were taken to carry out the study. The current VoLL used at the moment for ENS is the one obtained by this study which calculations yielded a headline weighted-average VoLL figure of £16,940/MWh for peak winter workdays in GB.

The graph in Figure 4 shows the effect that a different VoLL value has on the reward and penalty for the incentive. The baseline derived in Option 1 of 254MWh is used as an example to show these effects. A higher VoLL (£20,000MWh for example) will give a greater upside and downside, while a lower one will reduce the impact of the incentive. With the collar fixed at 3% of the company's revenue, a higher VoLL will hit this amount at a much lower ENS with the risk this implies, while having a higher upside limit. The risk at the collar will be mitigated when considering a smaller VoLL (£12,000MWh for example), which will give a higher ENS permitted before being penalised, but the revenue obtained will be considerably less.

Full and detailed analysis of how the different VoLL values affect the penalty and reward of the incentive can be found in Appendix 3.

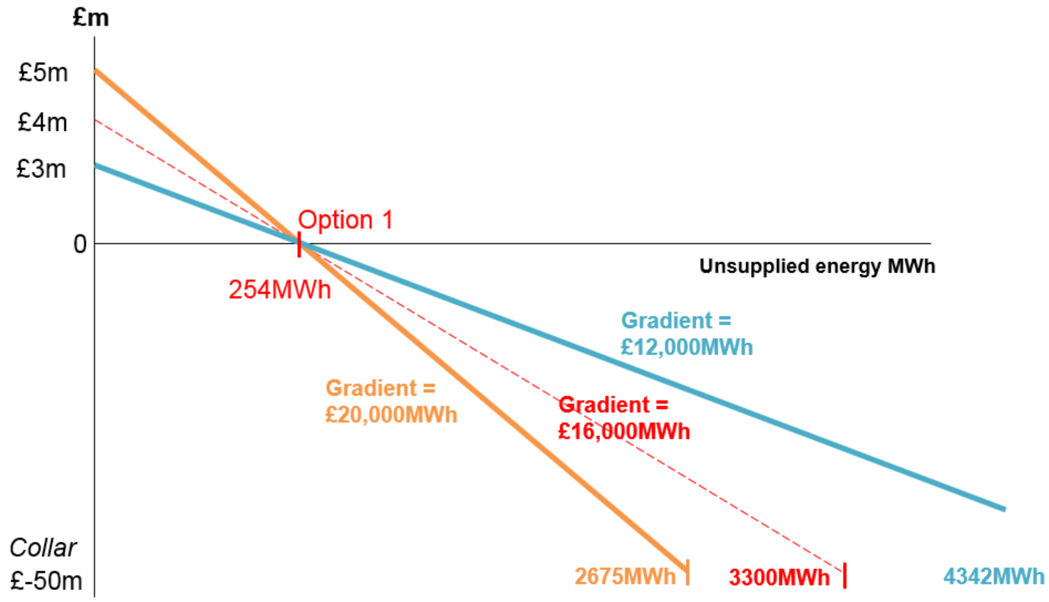


Figure 5. VoLL Sensitivity study.

[1] https://www.ofgem.gov.uk/ofgem-publications/40961/london-economics-estimating-value-lost-load-final-report-ofgempdf

6.2 Directly Connected Customers

We have a number of directly connected customers to our network:

- Generators
- DNOs
- Network Rail
- Interconnectors
- Steelworks
- Future customers (battery storage, EV charging)

When determining our stakeholder engagement strategy (see NGET A9.01 Engagement Log) we identified our key stakeholders, including directly connected customers to ensure we had a balanced representation of stakeholders in our engagement activities.

The level of reliability on the network applies to the entire network, not to a regional or local area. However, there are some instances where directly connected customers have higher or lower reliability connections as they manage the trade-off between affordability and reliability. For any directly connected party, there are design options available (customer choice connections) which will more directly affect the reliability of their connection.

Due to the loss of supply events of August 9th, and the ongoing investigation, it was not appropriate to engage directly connected customers as part of this process.

6.3 Future Value of ENS

The majority of stakeholders informed us that they would like a more reliable network in the future, as the reliance on electricity increased. However some stakeholders questioned whether this should be provided by the transmission system, hence there was a trade-off to be made. Our Engagement Log NGET A9.01 and section 3 of our 'Safe and Reliable' chapter provide more detail on how we have managed this trade-off. This is also included in the stakeholder engagement section below.

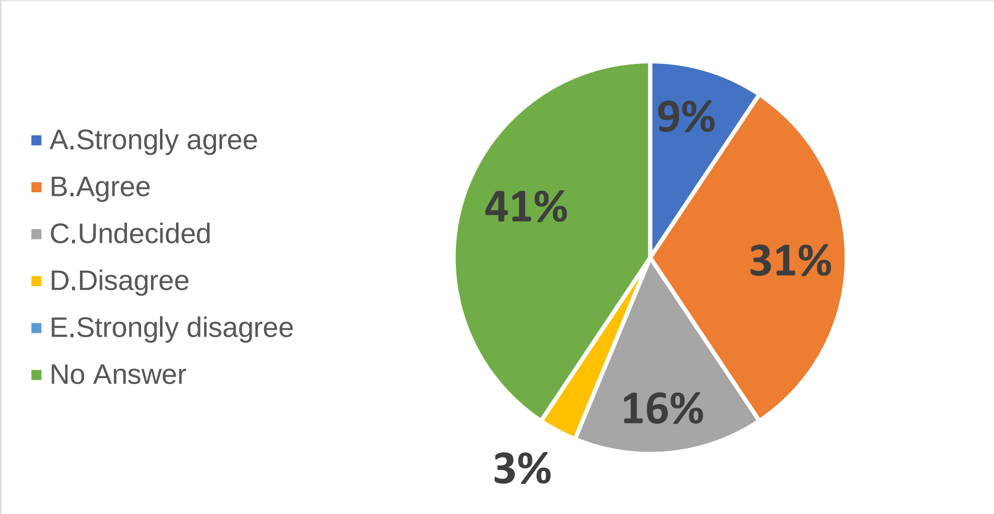
7. Stakeholder Engagement

Stakeholders have told us that reliability is a key topic, and consumers are willing to pay for improved reliability. At face value this indicates that the incentive to retain reliability should be strong, reflecting the views of stakeholders and consumers. However, we recognise that there is a trade-off with affordability. Our track record has been good, therefore our proposals to stakeholders highlight that we commit to meeting their requirements for reliability, but with a tougher target for ENS.

On Wednesday the 23rd October 2019, we held a Reliability Webinar to test our ENS proposals (amongst other areas) with stakeholders. 30 stakeholders participated in covering all our major stakeholders (See reliability engagement log for further detail).

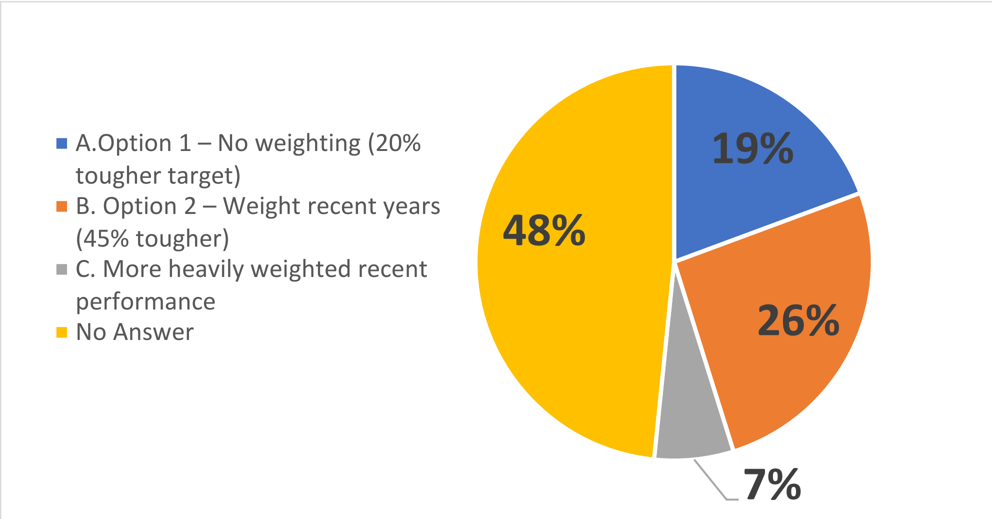
We asked stakeholders;

'To what extent do you agree that we should be taking into account recent performance when determining the ENS target for T2?'



Of the people that answered (some were unavailable to answer as they were representative of National Grid or OFGEM), the majority supported the proposals to take into account more recent performance.

'Which option best reflects your views'



Of the people that answered, the majority preferred option 2, resulting in a 175MWh target, with a high proportion of the remainder preferring the 254MWh target.

8. Innovation in ENS

Our innovation chapter (Chapter 12 – We will be innovative) details some areas of the business as usual innovation (delivering benefits in T2) and NIA projects (delivering benefits in T3 & beyond) which will help improve reliability and reduce ENS in the future. In summary, these are:

- **New Assets to connect generation quicker**. Being more agile in connecting generation increases the amount of generation on the network in the short-term, providing reliability benefits.

- **Digitisation**. A common digital platform across all networks and connected parties improves communication and allows more informed, and quicker decisions to be made.
- **Whole Systems / Deeside Centre for Innovation**. Our Deeside centre is open for business for all networks and will allow the offline testing of new innovative solutions in a safe environment, reducing the likelihood of faults occurring on the 'live' network.
- **Improving Collaboration**. We have made a commitment to improving our collaboration as part of our business as usual activities in T2. Improvements in collaboration and communication reduce the likelihood of an ENS event which could be prevented through network collaboration.

More information can be found in our Safe & Reliable Chapter (12) in section 4.

9. Conclusion

Based upon our engagement with stakeholders, internal analysis and OFGEM engagement we propose:

1. A weighted methodology of 50/30/20% for years 0-5/5-15/15+ respectively.
2. Extrapolating current performance, this would set a target of 175MWh for T2. This is a tougher target than the T1 period; with the downside threat also greater. This also reflects the views of stakeholders and effectively manages the trade-off between reliability and affordability.
3. The target should be set using final T1 data, taking into account performance in all years of RIIO-T1.
4. In all the scenarios considered in our sensitivity analysis, the maximum reward per annum will be smaller, and the maximum penalty will remain the same (3% of revenue) but would be reached sooner.
5. The proposals reflect Ofgem's decisions and guidelines.

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APPENDIX 1 - FLOOD BARRIER DEPLOYMENT

At approx' 20.00 on Thursday 1st August, as a result of the worsening situation regarding the potential collapse of the Dam at Toddbrook Reservoir near Whaley Bridge, Derbyshire, the decision was made to mobilise National Grids in-house Flood Defence system to protect Bredbury Substation; Bredbury Substation sits alongside the river Goyt and is approximately 5 miles from Toddbrook Reservoir. Concerns were twofold, the Dam collapsing and the rising river levels as the emergency services attempted to drop the water level of the Reservoir, depositing the water into the River Goyt.

On receipt of the instruction our team based at Thorpe Marsh, Doncaster began to prepare the Flood Defence System for despatch. The full system is located at our Oil Management facility and is permanently loaded on 5 articulated trailers, ready for despatch as and when required. Closely liaising with the on-duty National Grid Standby Engineer, a sufficient amount of barrier equipment to surround the substation was despatched. Operatives trained to unload and supervise the deployment of the barrier accompanied the shipment.

The trucks departed Doncaster at 23.00, arriving on-site at 01.00, Friday 2nd August.

Communication lines were established with the duty Standby Engineer, the local Team Leader (Colin Simcock) and Nathan Farrell-Jones who was enacting the role of Regional Operations Manager. Once in receipt of the instruction to deploy, Colin and Nathan began making calls to mobilise Engineers to support the deployment of the Barrier; by 12.00 in excess on 20 Engineers had responded to the call.

Whilst awaiting the arrival of the Flood Barrier the local staff reviewed the local flood plans and underwent video refresher training in how to deploy the barrier. All activities were co-ordinated alongside the local Fire and Rescue services.

On arrival at the site, the Flood Defence System was unloaded and, after reviewing Risk Assessments and Working Method Statements, the team set to work. The Engineers on-site worked through the night, being replaced in the morning by Engineers from our Substation teams, Overhead Lines, Oil Management Unit and our Capital Delivery Contracting partners.

By 20.00, Friday 2nd August, 24 hours after the initial notification to deploy, the system was fully installed providing a 900-metre-long perimeter flood defence for the Substation; the Barrier will remain in place until the risk has been removed.

APPENDIX 2 – T2 Baseline Calculations

To determine the new T2 baseline, a series of calculations were done.

Table 1 shows the calculations done to obtain the baseline when considering the 50%/30%/20% weighting and the triple counting effect is ignored.

Table 1. Calculations for 82MWh baseline.

Years	0-5	0-10	0-20	**SUM**
Forecast expected	21.081	29.867	72.054	123.002
P90	47.629	63.467	197.447	308.543
Weighting assumption	50%	30%	20%	100%
Weighted Forecast expected	10.5405	8.9601	14.4108	**33.9114**
Weighted P90 case	23.8145	19.0401	39.4894	**82.344**

Table 2 shows the baseline when considering the 50%/30%/20% weighting and the triple counting effect is been acknowledge, with the solution of taking different groups for the study.

Table 2. Calculations for 150MWh baseline.

Years	0-5	5-15	15-End	**SUM**
Forecast expected	21.081	84.136	69.58	174.797
P90	47.629	300.158	180.136	527.923
Weighting assumption	50%	30%	20%	100%
Weighted Forecast expected	10.5405	25.2408	13.916	**49.6973**
Weighted P90 case (MWh)	23.8145	90.0474	36.0272	**149.8891**

Table 3 shows the baseline when considering the 40%/40%/20% weighting and the triple counting effect is been acknowledge, with the solution of taking different groups for the study.

Table 3. Calculations for 175MWh baseline.

Weighting assumption	40%	40%	20%	100%
Weighted Forecast expected	8.4324	33.6544	13.916	**56.0028**
Weighted P90 case (MWh)	19.0516	120.063	54.0408	**175.142**

The graph shown in Figure 5 shows the different baselines and how these affects to the reward/penalty of the incentive as it is summarised in Table 4.

Table 4. Baseline effects on penalty/reward.

Baseline		CAP	COLLAR (set at 3% of revenue ~ £50m)
316 MWh (T1)	£4m	4253MWh	
254 MWh (the top limit for T2)	£3.23m	4191MWh	
175 MWh (the bottom limit for T2)	£2.22m	4112MWh	

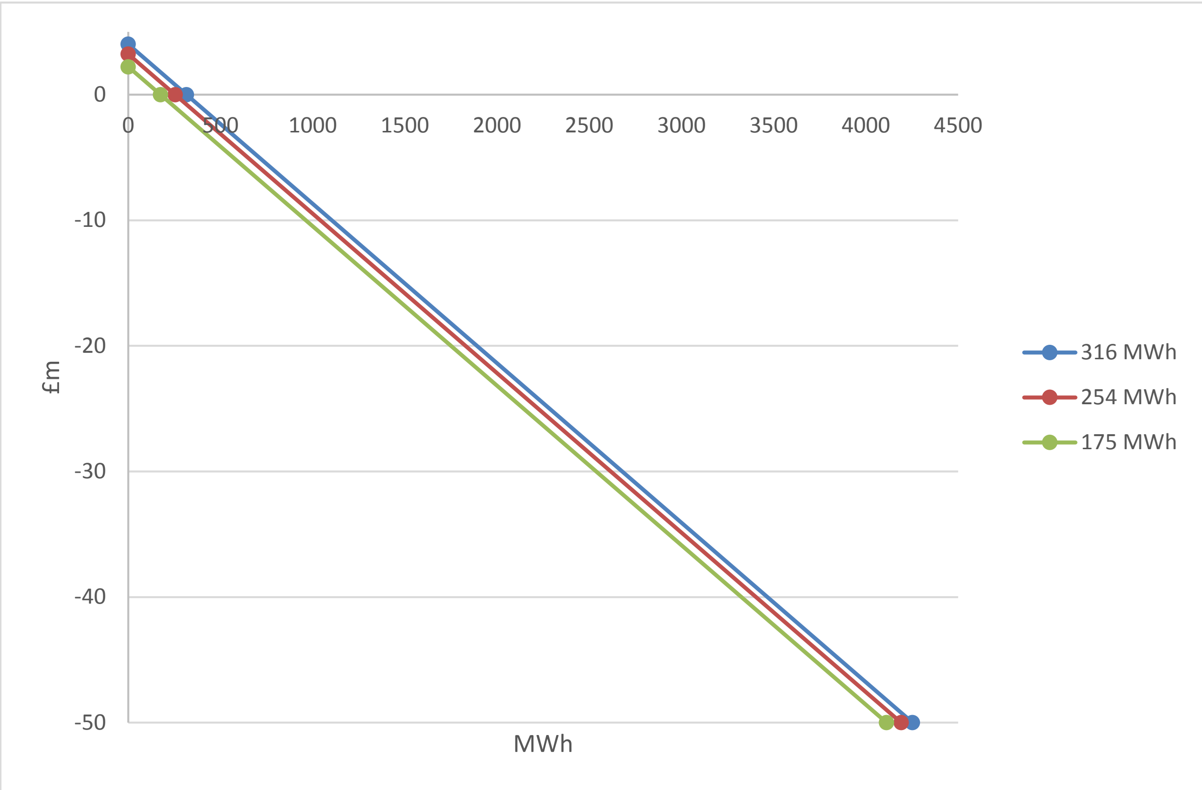

Figure 6. Effects of baselines on penalty/reward

APPENDIX 3 – VoLL SENSITIVITY STUDY

Both Figures 6 and 7 show the effect of the different VoLL on the gradient of the ENS incentive calculation, giving different reward and hitting the penalty at a different MWh depending on the VoLL value. A summary of the most relevant values is collected in Table 5.

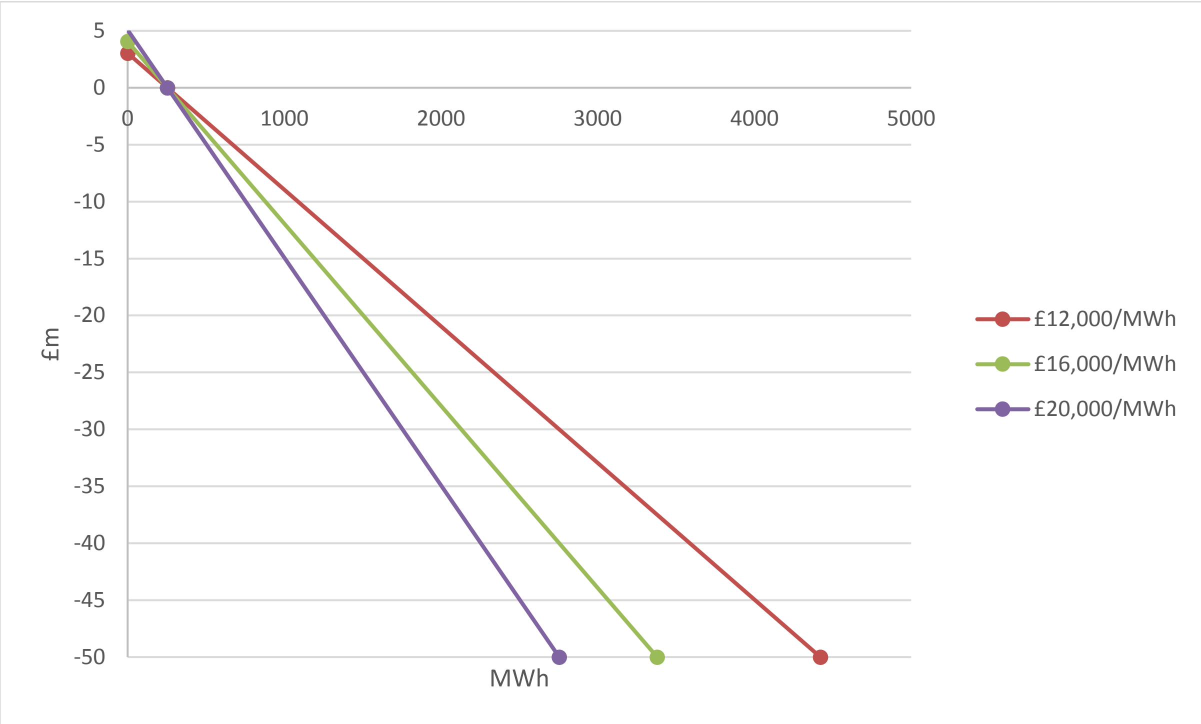

Figure 7. Effect of VoLL for 254MWh baseline.

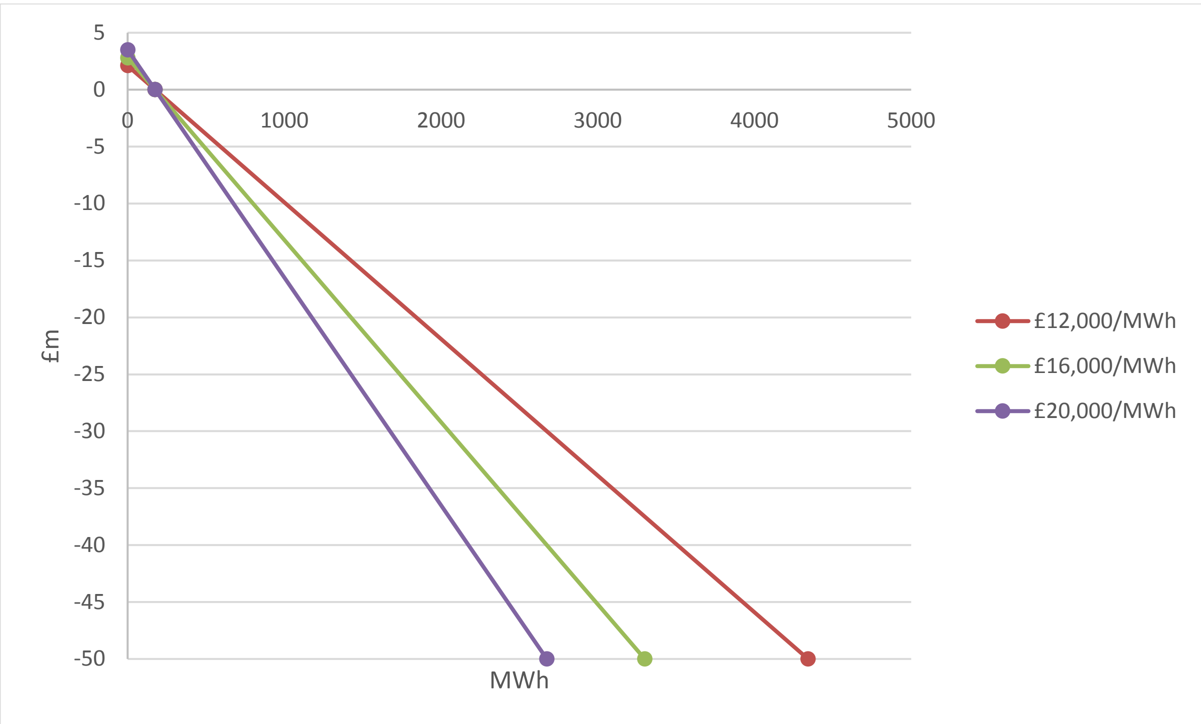

Figure 8. Effect of VoLL for 175MWh baseline.

Table 5. Effects of VoLL values on penalty and reward of the incentive.

VoLL	Baseline	CAP	COLLAR (set at 3% of revenue ~ £50m)
	316MWh	£3.8m	4483MWh
£12,000/MWh	254MWh	£3.05m	4421MWh
	175MWh	£2.1m	4342MWh
	316MWh	£5.06m	3441MWh
£16,000MWh	254MWh	£4.06m	3379MWh
	175MWh	£2.8m	3300MWh
	316MWh	£6.32m	2816MWh
£20,000MWh	254MWh	£5.08m	2754MWh
	175MWh	£3.5m	2675MWh

APPENDIX 4 – ENS HISTORY

Fault Date	Fault Time	Location	Mins	MWh Lost	Incentivised
22/07/2018	17:55	Rugeley 132kV Substation	25	12.06	Yes
28/11/2018	16:46	Tremorfa 33kV Substation	37	25.16	No
30/03/2019	15:22	Culham Jet 400kV Substation	158	0	No
21/08/2017	12:22	Chickerell 400kV Substation	69	39.7	Yes
10/01/2018	15:00	Hutton 400kV Substation	89	0	Yes
27/06/2017	12:35	Elstree 400kV Substation	1.9	0.1	No
01/08/2017	15:36	Poppleton 400kV Substation	0.7	0.06	No
29/10/2017	07:33	Wincobank 400kV Substation	0.43	0.07	No
07/06/2016	17:04	Leighton Buzzard 25kV Substation	3.3	0	Yes
15/09/2016	11:55	Rassau 132kV Substation	5	5.17	Yes
16/09/2016	04:58	Tynemouth 11kV Substation	33.3	1.6	Yes
20/11/2016	09:36	Frodsham 400kV Substation	122.1	0	Yes
23/02/2017	10:13	Frodsham 400kV Substation	39	0	Yes
23/06/2016	01:48	Redbridge 33kV Substation	0.7	0.58	No
23/02/2017	10:13	Frodsham 400kV Substation	240.8	81.26	No
15/09/2016	11:55	Rassau 132kV Substation		0.65	No
11/09/2015	09:16	Imperial Park 400kV Substation	4	0.31	Yes
20/10/2015	15:14	Killingholme 400kV Substation	621	4.14	Yes
04/07/2015	01:16	Leighton Buzzard 25kV Substation	2	0	No
31/07/2015	05:25	Penhros 132kV Substation	0	0	No
20/10/2015	15:14	Killingholme 400kV Substation	0	0	No
18/11/2014	09:05	Poppleton 275kV Substation	37	8.7	Yes
18/07/2014	02:31	Culham Jet 400kV Substation	155	0	No
09/10/2014	06:27	Penrhos 132kV Substation	0	0	No
22/12/2014	19:10	Tremorfa 33kV Substation	1	0	No
26/12/2014	23:59	Axminster 132kV Substation	1	1.1	No
30/06/2013	16:57	Silverlink 11kV Substation	10	0.5	Yes
05/07/2013	19:47	Rugeley 400kV Substation	8	17.2	Yes
09/07/2013	11:00	Hartmoor 275kV Substation	12	14	Yes

Fault Date	Fault Time	Location	Mins	MWh Lost	Incentivised
28/10/2013	07:05	Dungeness 275kV Substation	525	52.5	Yes
05/11/2013	14:41	Barking 400kV Substation	6	2	Yes
05/11/2013	14:49	Barking 400kV Substation	12	0	Yes
06/12/2013	16:22	West Burton 400kV Substation	41	48.8	Yes
18/12/2013	19:49	Frodsham 275kV Substation	3	0.9	No
14/02/2014	02:28	Penrhos 132kV Substation	0	0	No
06/10/2012	11:16	Fourstones 275kV Substation	10	1	Yes
11/12/2012	07:00	Willenhall 275kV Substation	19	21.5	Yes
13/02/2013	19:24	Poppleton 33kV Substation	12	9	Yes
13/02/2013	19:24	Poppleton 33kV Substation	29	1.5	No
07/09/2011	11:37	St. Johns Wood 275kV Substation	0	0.5	Yes
13/12/2011	13:38	Pyle 275kV Substation	1	2	Yes
08/04/2011	12:52	Penhros 132kV Substation	10	0.5	No
20/04/2011	08:40	Penhros 132kV Substation	4	0.5	No
28/05/2011	10:16	Elstree 400kV Substation	0	0.5	No
16/10/2011	11:48	Wymondley 400kV Substation	4	0.5	No
17/11/2011	01:05	Tremorfa 275kV Substation	163	9	No
17/11/2011	15:49	Tremorfa 275kV Substation	554	3.5	No
30/11/2011	07:11	Aldwarke 275kV Substation	573	774	No
20/07/2010	17:05	Lackenby 275kV Substation	59	34.5	Yes
17/09/2010	11:33	Elstree 275kV Substation	0	0.5	Yes
30/11/2010	09:43	Hartmoor 275kV Substation	45	24.5	Yes
20/09/2010	08:08	Wymondley 400kV Substation	4	0.5	No
31/10/2010	12:05	Aberthaw 132kV Substation	2	0.5	No
12/11/2010	18:13	Hutton 400kV Substation	29	1.5	No
26/11/2010	18:14	Kemsley 400kV Substation	98	0	No
13/02/2011	17:57	Patford Bridge 400kV Substation	3	0.5	No
01/07/2009	15:27	South Shields 275kV Substation	5	3	Yes
01/07/2009	15:52	South Shields 275kV Substation	71	15	Yes
02/07/2009	15:03	Kingsnorth 132kV Substation	11	28.5	Yes
04/08/2009	18:51	Sheffield City 275kV Substation	33	14.5	Yes

Fault Date	Fault Time	Location	Mins	MWh Lost	Incentivised
03/02/2010	10:12	Aberthaw 132kV Substation	0.87	0	Yes
15/05/2009	20:19	Poppleton 275kV Substation	2	0.5	No
12/07/2009	18:18	Wymondley 400kV Substation	2	0.5	No
28/01/2010	03:53	Aldwarke 275kV Substation	411	424	No
31/03/2010	11:51	Uskmouth 275kV Substation	150	1	No
27/05/2008	11:34	Various DNO Locations	58	278	Yes
14/09/2008	12:18	Thurcroft 275kV Substation	61	51.5	Yes
07/06/2008	05:21	Wymondley 400kV Substation	1	0.5	No
06/10/2008	06:40	Aldwarke 275kV Substation	1	0.5	No
09/10/2008	22:55	Aldwarke 275kV Substation	1	0	No
11/10/2008	14:59	Aldwarke 275kV Substation	1	0.5	No
14/10/2008	21:53	Aldwarke 275kV Substation	1	0	No
03/11/2008	15:52	Tod Point 275kV Substation	5	4.5	No
25/06/2007	15:23	Neepsend 275kV Substation	4335	968.5	Yes
01/07/2007	14:54	Poppleton 275kV Substation	12	5.5	Yes
01/02/2008	12:56	Fourstones 275kV Substation	3	0.5	Yes
03/07/2007	17:54	Kemsley 400kV Substation	3	0	No
25/08/2007	08:37	Aldwarke 275kV Substation	38	40	No
29/08/2007	12:51	Tremorfa 275kV Substation	19	19	No
28/09/2007	22:06	Wymondley 400kV Substation	1	0.5	No
19/10/2007	05:40	Kemsley 400kV Substation	39	3	No
13/12/2007	00:43	Barking 275kV Substation	92	4.5	No
14/12/2007	15:32	Wymondley 400kV Substation	1	0.5	No
06/02/2008	08:46	Aldwarke 275kV Substation	31	34	No
15/03/2008	04:50	Kemsley 400kV Substation	364	424.5	No
22/03/2008	18:00	Kemsley 400kV Substation	13	12.5	No
28/06/2006	08:49	Kearsley 132kV Substation	0.02	0.05	Yes
04/07/2006	17:06	Grendon 132kV Substation	81	309.65	Yes
25/08/2006	14:53	Gloucester 132kV Substation	6	0.55	Yes
07/12/2006	11:46	Upper Boat 132kV Substation	1	2.54	Yes
09/11/2006	14:58	Patford Bridge 25kV Substation	3	0.73	No

Fault Date	Fault Time	Location	Mins	MWh Lost	Incentivised
06/05/2005	14:52	Margam 66kV Substation	85	53.69	Yes
19/06/2005	14:34	Kitwell 132kV Substation	2	1.45	Yes
25/08/2005	15:07	Barking West 33kV Substation	5	3.64	Yes
31/08/2005	16:27	Stalybridge 132kV Substation	50	148.27	Yes
11/10/2005	17:21	Tynemouth 132kV Substation	163	96.8	Yes
19/04/2005	19:58	Tremorfa 33kV Substation	17	17.57	No
19/04/2005	19:58	Uskmouth 33kV Substation	122	40.67	No
25/06/2005	10:20	Uskmouth 33kV Substation	133	13.3	No
07/07/2005	08:53	Uskmouth 33kV Substation	73	37.84	No
17/10/2005	14:01	Sellindge 132kV Substation	1	0.25	No
24/10/2005	11:20	Tinsley Park 33kV Substation	3	1.98	No
14/11/2005	12:05	Tremorfa 33kV Substation	6	0	No
18/11/2005	10:23	Tinsley Park 33kV Substation	7	1.98	No
15/04/2004	09:06	Oldbury 400kV Substation	23	34.5	Yes
04/07/2004	18:13	Hams Hall 132kV Substation	5	0.67	Yes
17/08/2004	08:44	Pyle 132kV Substation	4	3.73	Yes
18/08/2004	19:35	South Shields 275/33kV Substation	11	4.58	Yes
29/11/2004	14:45	Fourstones 275/20.5kV Substation	6	0.8	Yes
13/02/2005	12:41	Poppleton 275/33kV Substation	4	3	Yes
			18	10.5	Yes
26/04/2004	08:36	Kemsley (Ridham Dock/Sheemess)	663	817.7	No
14/05/2004	23:40	Kemsley (Ridham Dock/Sheemess)	4	3.33	No
22/06/2004	16:33	Alpha Steel 33kV	14	0	No
05/08/2004	17:55	Patford Bridge	3	0.08	No
14/02/2005	14:24	Tremorfa 275/33kV	34	9.07	No
26/04/2003	01:21	Fourstones 275/20.5kV Substation	17	1.13	Yes
30/04/2003	15:01	Elstree 275/25kV Substation	3	0.5	Yes
03/06/2003	05:48	Uskmouth 132kV Substation	60	70	Yes
28/08/2003	18:20	Hurst, New Cross and Wimbledon 275kV Substations	37	433.5	Yes
05/09/2003	10:10	Hams Hall 400/132kV Substation	11	83.72	Yes
22/10/2003	08:05	Gloucester 132kV Substation	89	237.33	Yes

Fault Date	Fault Time	Location	Mins	MWh Lost	Incentivised
22/10/2003	22:43	South Shields 275kV Substation	55	23.47	Yes
29/03/2004	14:11	Fourstones 275/20.5kV Substation	32	3.2	Yes
11/10/2003	18:14	Tremorfa 275/33kV Substation	56	47.6	No
21/12/2003	16:25	Kemsley (Ridham Dock/Sheemess)	398	0	No
09/04/2002	07:45	Amersham 132kV Substation	18	24	Non-Anomalous Losses
02/06/2002	22:32	Tynemouth 275/11kV Substation	89	8.9	Non-Anomalous Losses
11/08/2002	15:25	Lackenby 66kV Substation	10	4.83	Non-Anomalous Losses
			52	14.73	Non-Anomalous Losses
			24	1.6	Non-Anomalous Losses
29/10/2002	02:48	Imperial Park 400kV Substation	1	0.18	Non-Anomalous Losses
07/03/2003	16:41	Margam 275/66kV Substation	12	18.8	Non-Anomalous Losses
17/04/2002	21:23	Rock Savage 400/132kV Substation	31	109.02	Anomalous Losses
03/05/2002	17:52	Kemsley 132kV Substation	1	0.75	Anomalous Losses
29/07/2002	15:07	Tinsley Park 132/33kV Substation	6	5.7	Anomalous Losses
04/08/2002	14:57	Earlham/Sall 33kV Substation	20	20	Anomalous Losses
			10	6	Anomalous Losses
01/01/2003	03:53	Fourstones 275/20.5kV Substation	3	0.15	Anomalous Losses
05/01/2003	12:45	Patford Bridge 400/25kV Substation	1	0.16	Anomalous Losses
05/02/2003	15:13	Elstree 275/132kV Substation	<1	0.15	Anomalous Losses
27/04/2001	14:37	Wincobank 275kV Substation	58	7.7	Non-Anomalous Losses
10/05/2001	21:19	Axminster 400kV Substation	81	117.7	Non-Anomalous Losses
15/06/2001	15:41	Rassau 400kV Substation	1.5	3.7	Non-Anomalous Losses
04/07/2001	02:21	Chickerell 400kV Substation	10	5.2	Non-Anomalous Losses
04/07/2001	06:11	Chickerell 400kV Substation	0.5	0.2	Non-Anomalous Losses
04/07/2001	06:17	Chickerell 400kV Substation	0.5	0.2	Non-Anomalous Losses
04/07/2001	04:30	Tremorfa 275kV Substation	144	256.8	Non-Anomalous Losses
26/02/2002	10:50	Templeborough 275/33kV Substation	173	59.8	Non-Anomalous Losses
28/02/2002	11:50	Templeborough 275/33kV Substation	120	6	Non-Anomalous Losses
26/03/2002	10:31	Hawthorn Pit 275/66kV Substation	10	13.8	Non-Anomalous Losses
17/05/2001	06:09	Tinsley Park 275/33kV Substation	1	0.1	Anomalous Losses
27/01/2002	08:32	Tinsley Park 275/33kV Substation	1	1.1	Anomalous Losses

Fault Date	Fault Time	Location	Mins	MWh Lost	Incentivised
11/02/2002	14:51	Alpha Steel 275/33kV Substation	13	0.2	Anomalous Losses
03/08/2000	12:28	Northfleet West 275kV	33	101	Non-Anomalous Losses
03/06/2000	00:42	Frodsham 400kV Substation	103	422	Anomalous Losses
13/12/2000	01:47	Alpha Steel 275kV Substation	5	2.75	Anomalous Losses

Prior to the RIIO T1 period, ENS events were classified as events "Excluding 3 or less customer's sites" (which have been documented as incentivised) and "Affecting 3 or fewer customer sites" (which have been documented as non-incentivised). In the 2002-2003 report, and the reports issued earlier than this, some of the events are classified as "Anomalous", as opposed to using the categories "Incentivised" or "Affecting 3 or more customers", we have documented these events as "Anomalous" and "Non-Anomalous".

We have highlighted with a border around some of the events which have multiple rows. These are due to the fact in the Transmission System Performance Reports, some events have one description but have multiple lines ENS data.

The Electricity performance reports can be found here:

https://www.nationalgrideso.com/insights/transmission-performance-reports