QUALITY OF SUPPLY PERFORMANCE BENCHMARKING: IMPROVEMENTS TO METHODOLOGY

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ABSTRACT

The current OFGEM performance comparison and benchmark approach has, together with the IIS, delivered tangible improvements to the quality of supply experienced by customers. This approach was developed through collaboration between OFGEM and Distribution Network Operators (DNOs) and has stood the test of time. However, through analysis it has been shown that the approach contains a conceptual flaw, which can be corrected relatively simply. This can only add value to the process and bring further confidence to the output of the benchmarking process.

1. INTRODUCTION

In the UK, Quality of Supply (QoS) performance benchmarks have been adopted by the electricity regulator, OFGEM, to facilitate the comparison of CI\(^1\) and CML\(^2\) performances between Distribution Network Operators (DNOs) and consequently to promote the enhancement of the QoS received by customers [1]. This is being done under the Information and Incentives Scheme (IIS) which reinforces the so-called performance-based regulation in the UK. However, in order to enable an effective and consistent comparison between the relative performance of different DNOs, the ability to relate differences in key network parameters with the corresponding QoS performance is required. In order to achieve the latter, OFGEM has developed a “Comparison and Benchmarking Quality of Supply Performance” four-stage process [2], as illustrated in the figure 1. QoS performance benchmarks have been adopted by OFGEM with the purpose of helping to measure efficiency and to help identifying areas for improvement.

![Flowchart for performance comparison model](image)

The rationale behind data disaggregation is that similar distribution feeders/circuits should have a similar performance across all DNOs and therefore network differences (inherited\(^3\) and inherent\(^4\)) should be considered when comparing the QoS of several DNOs. The first step of this stage is to disaggregate the distribution network into four different voltages (132 kV, EHV, HV and LV). With this, OFGEM acknowledges the different network construction, operation and maintenance practices across different voltage levels. This paper deals with the HV voltage level only. For each DNO all its HV circuits are disaggregated into a number of different bands based on its total length, number of connected customers and percentage of overhead line. These characteristics have been identified by OFGEM as key performance drivers. There are 23 HV bands and their description can be found in reference [3].

2. CALCULATION OF BENCHMARKS

CI Benchmark

The CI performance of a HV circuit is expected to be proportional to the product of the number of customers per circuit, circuit length, fault rate and proportion of customers on the circuit interrupted. Customers per circuit and circuit length are considered to be inherent and inherited factors, respectively and the disaggregation process is intended to normalise these out of the benchmark setting process. OFGEM recognises that there is little that can be done with regards to the length per circuit and therefore DNO specific values are used in calculating the benchmarks. Fault rate and proportion of customers on the circuit interrupted are considered by OFGEM to be incurred factors\(^5\) and therefore are not normalised out. The CI benchmark calculation is shown below:

\[
CI_{\text{benchmark}} = \frac{C}{C_{\text{DNO}}} \times \frac{L}{L_{\text{DNO}}} \times \frac{N_{\text{DNO}}}{N_{\text{benchmark}}} \times CI_{\text{DNO}}
\]

where:

- \(CI_{\text{benchmark}}\) : Customer interruptions benchmark
- \(C_{\text{DNO}}\) : DNO’s own number of connected customers in the band
- \(C_{\text{benchmark}}\) : total number of customers in the band
- \(L_{\text{DNO}}\) : DNO’s own total circuit length in the band
- \(L_{\text{band}}\) : total circuit length in the band
- \(N_{\text{DNO}}\) : DNO’s own number of circuits in the band
- \(N_{\text{band}}\) : total number of circuits in the band
- \(CI_{\text{DNO}}\) : Total customer interruptions in the band

1 Number of customer interruptions per 100 connected customers.
2 Number of customer minutes lost per connected customer.
3 Differences in the business inherited at privatisation such as network design and configuration.
4 Differences in the area in which the DNO operates which may include topographic factors such as length of network, customers’ location and customer density.
5 Differences which are the direct result of management action since privatisation.
\( \frac{L_{\text{DNO}}}{N_{\text{DNO}}} \) and \( \frac{L_{\text{band}}}{N_{\text{band}}} \) are length corrections, which were found necessary as significant differences in DNO average circuit lengths were found within each of the groups and the number of faults is normally expected to be directly related to the length of the circuit.

**CML Benchmark**

The CML performance of a HV circuit is generally expected to be proportional to the product of customers per circuit, circuit length, fault rate, proportion of customers on the circuit interrupted and customer minutes lost per interruption. The latter is considered to be an incurred factor and therefore is not normalised out.

CML benchmark is calculated, for each DNO in each group, from the product of the CI benchmark multiplied by a restoration time. Restoration time is considered to be very much under the control of a DNO. Consequently, the benchmark is based on the lower quartile restoration performance of DNOs in each group, i.e. the average restoration performance (CML per CI) of each DNO in the group is calculated and the lower quartile of these performances is then taken as the benchmark restoration performance. The CML benchmark is given by the following:

\[
\text{CML}_{\text{bm}} = \text{CI}_{\text{bm}} \times CML_{CI} \times \text{Upper Quartile} \]

(2)

where:

\( \text{Upper Quartile} \): upper quartile of the ratio \( \frac{CML}{CI} \) calculated for each of the 14 DNOs in the band

**Aggregation and QoS comparison**

The benchmarks at each voltage level are summed to give an aggregate benchmark for each DNO. Under the methodology, actual DNO performance can then be compared with their average benchmark on a more robust basis given that similar groups of circuits take into account DNOs’ own customer numbers per circuit and average circuit length. The HV benchmark for each DNO is the sum of all 23 HV band benchmarks. Similarly, the total benchmark is the sum of the HV benchmarks.

### 3. WORKED EXAMPLE

This section sets out a worked example of the performance comparison model described above. For simplicity it considers two hypothetical DNOs and uses a limited degree of disaggregation. However, the same steps apply using actual performance data for all 14 DNOs to a greater level of disaggregation. Figure 2 depicts two sets of five simple feeders operated by two hypothetical DNOs: DNO A and DNO B. The average network failure rate is considered to be the same for both DNOs (\( \lambda = 1 \text{ fault/km.year} \)).

![Fig.2– Hypothetical DNOs A and B](image)

**Disaggregation of network data and calculation of benchmarks**

According to the current HV disaggregation bands [3], feeders from both DNO A and DNO B are part of the UG1A band (\( \% \text{OHL} = 0; 0<\text{length} \leq 4 \text{km}; 0<\text{no.customers} \leq 1000 \)). From Equation (1) Customer Interruptions benchmarks for DNOs A & B can be calculated as follows:

\[
\text{CML}_{\text{OFGEM A}} = \frac{(5 \times 1000)}{(5 \times 1000 + 5 \times 100)} \times \frac{5 + 4}{5 + 5} \times 20200 = 33388
\]

(3)

\[
\text{CML}_{\text{OFGEM B}} = \frac{(5 \times 100)}{(5 \times 1000 + 5 \times 100)} \times \frac{5 + 4}{5 + 5} \times 20200 = 333.88
\]

(4)

where:

\[
\text{CI}_{\text{band}} = \text{CI}_{\text{DNO A}} + \text{CI}_{\text{DNO B}} = (5 \times \lambda \times 4 \times 1000) + (5 \times \lambda \times 0.4 \times 100)
\]

(5)

\[
= 20000 + 200 = 20200
\]

**Aggregation and QoS comparison**

Customer Interruptions benchmarks have been calculated for both DNOs by setting the CI benchmark to the average industry performance which is intended to be corrected (purpose of the present methodology) to take into account each DNO’s own average length. However, the purpose of benchmarking is to highlight best practice amongst DNOs and to help in the setting of appropriate targets to encourage all DNOs to achieve the desired level of performance. A closer look at Equations (3)-(5) shows that the CI benchmarks, upon which performance targets are to be set for the hypothetical networks, are significantly above the actual average performance of both DNOs as illustrated by the following equations:

\[
\%\text{CI}_{\text{OFGEM A,bm}} = \frac{33388}{20000} = 167\%
\]

(6)

\[
\%\text{CI}_{\text{OFGEM B,bm}} = \frac{333.88}{200} = 167\%
\]

(7)

It should be noted that if both networks were identical in every aspect apart from their average length, as is the case, their benchmarks should actually match their expected average performances. The purpose of the benchmark formula is to establish a benchmark that is based on the average industry CI performance, taking into account the...
DNO’s own average length. It can be seen from the results shown above that the current approach does not achieve that aim. This is because the calculation of the Customer Interruptions benchmark is based on the national average performance but is not adequately accounting for the correction of the length of the network. Basically, the method does not correct for customer density on each feeder. The current approach assumes that the density of customers on each circuit is accounted for by considering the number of connected customers to each circuit. The issue is that the limited number of disaggregation bands utilised in the current benchmark setting formula does not adequately correct for these customer density issues. There are two possible approaches to improve the robustness of the CI and CML benchmarking. They are:

1. OFGEM could either substantially increase the number of disaggregation bands to minimize the effects of the present approach; or
2. change the benchmark formula to accommodate customer density whilst maintaining the limited number of bands.

The latter is more realistic and consequently this paper proposes an amendment to the benchmark formula to correct OFGEM’s current approach.

**Proposed formula alteration to correct OFGEM’s present model**

Research has shown that a simple modification to the current formula for computing CI and CML benchmarks [4] which deals with the inconsistencies described in the previous sections may be proposed which reinforces the merits of the present overall methodology.

Essentially, the calculation of average network length should not be weighted by the number of feeders solely as proposed by OFGEM at present (see equation (1)). Instead, it should be weighted by the number of connected customers to each feeder. Therefore, a consistent Customer Interruptions benchmark formulation is given by equations (8) and (9):

\[
C_{I_b}^{\text{Proposed}} = C_{I_n} \times \frac{\sum_{i=1}^{\text{No. feeders}} t_{\text{DNOfeeder}_{i}} \times C_{\text{DNOfeeder}_{i}}}{\sum_{i=1}^{\text{No. feeders}} C_{\text{DNOfeeder}_{i}}} 
\]

and

\[
(9)
\]

\[
C_{I_b}^{\text{Proposed}} = C_{I_n} \times \frac{\sum_{i=1}^{\text{No. feeders}} L_{\text{Bandfeeder}_{i}} \times C_{\text{Bandfeeder}_{i}}}{\sum_{i=1}^{\text{No. feeders}} C_{\text{Bandfeeder}_{i}}} 
\]

The latter equation can be used to compute the Customer Interruptions benchmark for the two hypothetical DNOs described in Fig. 1:

\[
C_{I_b}^{\text{Proposed}} = \frac{20200 \times 5 \times (0.4 \times 100)}{5 \times (4 \times 1000) + 5 \times (0.4 \times 100)} = 200
\]

and therefore,

\[
\%C_{I_b}^{\text{Proposed}} = \frac{20000}{20000} = 100\% 
\]

\[
\%C_{I_b}^{\text{Proposed}} = \frac{200}{200} = 100\% 
\]

The above results set appropriate CI Benchmarks for both DNOs. Their benchmarks should match their average performance since both networks are essentially identical in terms of their operation and only differ in their average length.

This simple alteration to OFGEM’s current benchmark formula takes into account the different number of customers on each feeder within each band and therefore it can adequately accommodate the limited number of disaggregation bands.

4. **IMPACT ON DNOs QOS PERFORMANCE BENCHMARKS**

The current OFGEM performance comparison approach has served its purposes well in recent years. Together with the IIS, it has yielded tangible improvements in the number and duration of interruptions, delivering measurable benefits for customers. However, the previous sections have highlighted the need to adjust the current performance benchmark formula to be in line with the conceptual framework which is intended to be place. This is important to ensure cross-DNO performance comparisons are carried out in a transparent and consistent manner. A formula alteration has been outlined together with the theoretical rationale behind that change which allows the regulator to adequately compare and benchmark DNOs performance. The measurable impact of the proposed formula alteration on the HV performance benchmark for all DNOs is depicted in figure 3, 2005/06 disaggregation data has been used.
In the figure above, the primary Y-axis illustrates the difference between CI benchmarks using the proposed formula and the current OFGEM’s formula. In addition, the secondary Y-axis shows the percentage of that difference relative to the current CI benchmark. A negative value indicates that the CI benchmark should be lower than it is at the moment, whereas a positive value demonstrates that the CI benchmark should actually be higher than what has been set by OFGEM. It can be seen from Fig. 3 that 11 out of 14 DNOs should have their CI benchmarks reduced. Conversely, 3 DNOs should have their CI benchmarks increased. The largest movements are observed for DNO I and DNO C. The latter should have its CI benchmark 2.6% (1.0 CIs) lower than it is at the moment, whereas the former has a CI benchmark 4.3% higher than it should, which corresponds to 2.1 CIs. The impact of these errors is that incorrect incentive messages are being sent to DNOs. The proposed HV CI benchmark absolute values are depicted in Fig. 4.

The figure above shows the correct CI benchmarks for all DNOs using 2005/06 disaggregation data. These benchmarks have been calculated using the proposed formula alteration, equation (9), and also taking into account that CI benchmarks are set to be the average industry performance, corrected to allow for each DNO average length, as currently envisaged by OFGEM.

CML benchmarks would be similarly affected by the proposed formula alteration, as their calculation is based on CI benchmarks.

5. CONCLUSIONS

This paper has shown that a simple change to OFGEM’s current CI benchmark formula can improve the overall existing QoS performance comparison and benchmark methodology. A benchmark setting formula alteration has been proposed. Essentially, it outlines that the calculation of the average network length should be weighted by the number of connected customers to each feeder and not solely by the number of feeders as implied in the current benchmark formula. The proposed formula modification has proven to eliminate the inconsistencies in setting performance benchmarks for different DNOs. Moreover, analysis on the 2005/06 disaggregation data has shown that 11 out of 14 DNOs should have their CI benchmarks reduced. On the contrary, 3 DNOs should have their CI benchmarks increased. The largest movements were observed for DNO I and DNO C. The latter should have its CI benchmark 2.6% lower than it is at the moment, whereas the former has a CI benchmark 4.3% higher than it should. The implementation of the suggested formula alteration is simple and ultimately enhances the existing QoS performance comparison and benchmark methodology, which in recent years has significantly improved the QoS experienced by customers.

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REFERENCES

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