Shrinkage and Leakage Model Review 2021-22 – Final Report

Joint Gas Distribution Network Publication

Northern Gas Networks

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Contents

1 Background

Gas Distribution Networks (GDN's) have committed through the Licence to reduce fugitive emissions and Shrinkage gas from our network distribution system and through our operational activities. GDN's also strive to ensure that the calculation and reporting of Shrinkage and Leakage is continuously reviewed and areas of potential improvement identified with a particular focus on accuracy.

As in RIIO-GD1, the GDN's publish an annual joint report for consultation with stakeholders and the wider UK Gas Industry, highlighting the development of the Shrinkage and Leakage Model (SLM), and the commitments to explore potential improvements to the SLM over the coming year. On the 23rd February 2022, the GDN's published a joint report for consultation, and we are pleased to have received responses from Ovo Energy Ltd and Centrica PLC.

Once again, the GDN's would like to take this opportunity to assure any stakeholders that, whilst the annual SLM Review process provides a positive outlet for review and comment from the wider industry, we also wish to continue our commitment to understanding views and concerns raised via the regular Shrinkage Forums facilitated by the Joint Office of Gas Transporters. To that end, the GDN's will invite Centrica to provide greater clarity on the importance of daily shrinkage profiling to the Shipper community, at a future Shrinkage Forum, if this can be arranged, to better understand the concerns that have been raised within their response.

These forums offer a valuable opportunity for interested parties to further understand elements of the Shrinkage and Leakage assessment and reporting mechanisms of most interest to them, and to allow stakeholders to directly address these points to the GDN's.

As always, through responses to this annual consultation, actions emanating from the Shrinkage Forum, and also representations via the Authority, the GDN's will make appropriate effort to accommodate the views and requirements of our stakeholders when possible and proportionate. The GDN's have always, and will continue to, engage with the wider industry when requested, to make the Shrinkage process as a whole and specifically the methodologies within the SLM, understandable, relevant, and accurate.

As stated in the Consultation document (Section 7: 'Areas of Focus'; Page 24), the GDN's are currently in the process of reviewing the Own Use Gas (OUG) calculation following representations from an external stakeholder. The GDN's have consistently engaged with all parties on this matter over the last 12 months and will continue to do so in the coming formula year. This engagement led to a request from the Authority to consider further validation options for OUG in December 2021. As a result, in early 2022, the GDN's, in conjunction with DNV, have identified a series of potential options to validate the existing OUG calculation and are currently assessing which presents the best value for the customer.

We remain committed to improving all aspects of Shrinkage measurement and reporting. We review and consider all feedback to help develop our future work's programme relating to Shrinkage and Shrinkage modelling. We consider the cost to consumer and potential benefits to consumer and society when prioritising future programmes of work.

Finally, the GDN's would like to, once again, thank all respondents to this consultation. Your feedback on this process is valued and very much welcomed.

2 Responses to Consultation

Response 1 – Ovo Energy:

Ovo Energy Ltd submitted a response to the consultation via email to the Joint Office of Gas Transporters on 3rd March 2022, specifically in relation to the MP Leakage Report commissioned by the GDN's and authored by Newcastle University. The request for information can be seen below:

"Within the SLM Consultation (p.3) it notes that there's a Newcastle Uni study into improvements that could be made to the SLM. Please can you share this with me?"

Joint GDN Response:

Thank you for your response to the 2021/22 Shrinkage and Leakage Model Review (SLMR) consultation. The study you refer to was specific to Medium Pressure leakage modelling, rather than the Shrinkage and Leakage Model (SLM). Below, the GDN's have provided some further information relating to the project and summarising the scope, findings, and overall outcome:

Scope.

- The Gas Distribution Networks report annual leakage estimates of the leakage across their medium pressure networks. This project was undertaken to review the approach used to produce these estimates with a particular focus on the assumptions made, the relationship between pressure and leakage, and the estimation of the quantities/parameters required to produce the leakage estimates.
- The project aimed to identify the strengths in the current approach and the opportunities for further improvement, and to make recommendations based on these findings.

Identified Strengths.

- The leakage estimates are based on an extensive national leakage testing programme conducted in 2002/03. These leakage tests were conducted in a representative manner and the methods used to infer the LP leakage rates from the test data were appropriate.
- The standard spreadsheet model used by all of the GDNs ensures consistency in the approach to medium pressure leakage estimation. The GDNs meet regularly to discuss their use of the model and ensure their understanding is consistent.
- The general structure of the model to estimate medium pressure leakage is similar to the spreadsheet model used to estimate low pressure leakage, ensuring a level of consistency between the two leakage estimates.
- The pipe lengths in each LDZ of different materials are central to the spreadsheet model. The lengths of the PE pipes in each medium pressure network are accurately recorded and hence known with accuracy.

Options for Improvement & GDN Comments.

- A GDN accessible unifying document summarising the modelling approach might prove to be a useful resource, providing a reference point in the initiation of further reviews
  GDNs already document their modelling approaches in their respective procedures and the model itself is industry approved, any modification to approach requires consultation and approval. That said, the GDN's also agree that this could be beneficial and are now in the process of developing a unifying document to share best practice.

- From the perspective of reporting year-on-year improvements in Shrinkage & Leakage Reviews there is potential to incorporate statistical measures within the model that reflect degrees of variation around the cited averages values and other elements.
  Deemed unnecessary when overall year on year shrinkage and leakage is already reported and would add additional complexities to the process considering the revised RIIO-2 reporting

methodologies. As GDN's, we are mandated to calculate an annual volume for both Shrinkage and Leakage, and statistical variations of this type would not be helpful in this respect.

- To carry out a further national leakage testing programme to provide up-to-date estimates of leakage rates. Recognising the cost of this, there may be scope for smaller-scale, non-invasive atmospheric tests on MP lines. These tests could inform possible changes to (or the validity of) the current approach for defining MP leakage rates.
  The cost involved in smaller scale testing is still significant and a large sample size would be needed to be reflective of all types of system operation. The GDN's would also point to the response to the Energy UK Gas Retail Group study in 2016[1], whereby other international leakage tests, put forward by the study as being superior to the UK NLTs, were found to be less robust and lacking in the volume and detail of the 2002 tests.

- To consider modification of the model to include the distribution of operating pressures in MP lines, allowing weighted average leakage rates to be calculated.
  Current MP Leakage rates are estimated based on LP leakage rates from the National Leakage Tests (NLT) and observations in the field. Given the operating pressures of MP networks, it would not be appropriate to assume the same linear relationship between pressure and leakage. Through RIIO-2, the GDN's are focussing on improvements in facilitation of Bio-Methane injection into the MP system, improving the balance between green gas and leakage.

- To extend the approach to include the effect of lead yarn jointing on leakage.
  Lead yarn jointing is not used as extensively in medium pressure pipes as it is in low pressure pipes, therefore the value in doing this is deemed negligible. It should also be noted that any amendments to the model in respect of this would likely lead to a reduction in leakage volumes.

- To extend the approach to include services in addition to mains in the leakage estimates.
  As above, there are fewer services in the MP network, therefore the value in carrying out this change is again deemed to be negligible, especially when considering that there is not the same linear relationship between pressures and leakage, as found in LP systems. That said, this may be a low cost amendment to the methodology and the GDN's will investigate further in 2022/23 and report on any findings through the Shrinkage Forum

Response 2 – Centrica PLC:

Centrica PLC submitted a response to the consultation via email on 22nd March 2022, comprising of a number of queries related to the methodologies and parameters applied by the SLM, and also requests for additional information on the GDN's areas of focus for 2022/23. Each response will be addressed in turn.

"We continue to encourage the gas distribution network operators (GDNs) to place focus on improving the shrinkage arrangements to reduce potential misallocation of gas volumes between shrinkage and unidentified gas (UIG). We remain concerned that UIG volumes are higher than necessary as a result of shrinkage being under-estimated during certain periods and across the year. Reducing the potential misallocation of gas volumes could also reduce the risk of wider market distortions in the energy market caused by that misallocation, which now assumes even greater significance given current concerns such as supplier failures, high commodity prices, etc. We recommend the following commitments should be prioritised:"

[1] Joint GDN Response to Energy UK Gas Retail Group Study

Point 1:

"A methodology for profiling shrinkage volumes across the year that better reflects the timing of losses should be developed."

"We are aware licensees currently assume a 'flat' shrinkage profile i.e. it is assumed an equal amount of gas is lost through shrinkage in each day across the regulatory year. Given shrinkage volumes are influenced by factors that vary across the year (such as system pressures and demand), a 'flat' shrinkage profile is unlikely to reasonably represent the profile of actual losses. This may lead to the misallocation of gas volumes between shrinkage and UIG over shorter time periods, which gives rise to the risk of market distortions. Licensees should endeavour to reduce to the risk of market distortions, so as to fulfil their legal obligation to establish transportation arrangements that secure effective competition between relevant shippers and between relevant suppliers. We recommend that a methodology for profiling shrinkage volumes to reasonably represent actual losses be developed. Profiling already occurs in other areas of the energy sector so profiling shrinkage should not present unique challenges."

Joint GDN Response:

As stated in the response, GDN's have a UNC obligation to estimate the quantity of shrinkage gas prior to the start of each formula year. Initial volume proposals are published by 31st December each year and interested parties are requested to provide feedback on these estimates. Following this, a final forecast of shrinkage volumes are published at the end of February, which informs the amount of gas that is procured daily to replenish the gas lost from our distribution systems through shrinkage and leakage. It should be noted that these forecasts are historically exceptionally accurate. Current year, and historical data can be found here: https://www.gasgovernance.co.uk/Shrinkage/Shrinkage-Quantity-Proposals`

At the end of the formula year, the GDN's estimate the quantity of shrinkage gas lost through our distribution systems and report this through the regulatory reporting process. This volume is then compared against the procured gas, and through reconciliation will either leave the individual GDN's in credit or debt with the shippers.

The determination of final volumes of gas lost is calculated using full year asset data, and for components such as system pressure on the low-pressure network, an average value for the year is used. In calculations such as this, any extreme spikes due to operational issues or weather-related influences will be captured in a weighted manner within the final determination.

To calculate a daily gas loss volume would be extremely intensive and would require daily updates for mains replacement activities, in-day pressure performance, gas conditioning readings and assessment of zonal spread, along with up-to-date asset and disruption information for all above ground installations and 3rd party damages. The resulting procurement of gas would then either require post day purchasing (of exact calculated volumes), or a further post event reconciliation process. Whilst it is true that the daily rate of procurement would differ depending on season and environmental conditions, the end of year total gas losses would be the same.

The method of forward forecasting the volumes based on average performance and expected end of year asset profiles allows Distribution Networks to procure the same amount of gas daily to meet the total year emissions volume. From a customer perspective, this means that they are paying the actual in-day price for the gas.

Once again, it should be noted that shrinkage gas for each LDZ is purchased by the responsible GDN on a flat profile, and this is because, due to fluctuations in the price of gas throughout the year, procuring shrinkage gas in this manner prevents any windfall gains and losses due to factors out-with the GDN's control.

The GDN's have always acknowledged that the purchase of gas on such a flat profile, reflecting an average daily quantity, does not accurately reflect the actual gas lost on a daily basis throughout the year. As stated in the response, during the winter heating period, when our network pressures are typically highest, we would

expect to see an increase in gas lost through leakage, greater than the average daily quantity from the flat profile, whereas in summer we would expect to see the opposite.

Within previous RIIO-GD1 consultations and through the regular Shrinkage Forums, the GDN's have on many occasions detailed the difficulties in adopting a variable profile gas purchasing strategy, particularly highlighting the potential risks to customer money.

Shrinkage gas accounts for approx. 0.4% of overall throughput, so we assume any benefits from daily calculations would be immaterial. That said, if open to it, we would like to invite Centrica to attend a Shrinkage Forum in 2022, specifically to describe the benefits of moving from the current profile, so we can better understand the issues from a Shipper perspective and explore any other potential ways forward.

Point 2:

"The materiality of the potential errors associated with the use of outdated parameters in the Shrinkage and Leakage Model should be assessed."

Joint GDN Response:

In relation to low-pressure mains and service leakage (by far the most influential factor within total leakage – circa 78%), the National Leakage Tests (NLT), the results of which formed the basis of the mains leakage rates applied within the SLM, have been widely acknowledged as the most comprehensive study of its kind worldwide. The NLT's comprised of over 800 samples from across the UK, capturing precise leakage rates from mains of all materials and diameters and accounting for varied soil types, to allow the GDN's to accurately estimate fugitive emissions.

The accuracy and continued relevance of the NLT leakage rates have been discussed at length throughout RIIO-GD1 in previous consultations and within the Shrinkage Forum. The Shipper community, as part of the UK Gas Retail Group Shrinkage Study, have also independently reviewed the NLT's and resulting leakage rates. In response, the GDN's have always maintained that the cost prohibitive nature of repeating these invasive leakage tests, when assessed in conjunction with the diminishing metallic mains population within the distribution networks, would represent a poor use of customers money at this time.

The UK distribution network currently consists of 75% Poly-Ethylene (PE) mains. Through modern jointing techniques and the material properties of PE, fugitive emissions from these mains are marginal in comparison to the decreasing metallic population. Through the risk based mains replacement processes in place through RIIO-GD1, the at-risk, leakiest metallic mains have already been replaced with PE, and this process continues. The GDN's replace approximately 3,000 km of metallic mains per year.

In March 2021, the Independent Gas Transporters (IGT's), presented the findings of a study[2] looking at the leakage rates from their PE asset bases, to the Shrinkage Forum. This study maintained that fugitive emissions from PE mains were minimal and calculated a lower leakage rate than that used within the SLM. In line with this, GDN's would indeed expect any revised leakage rates from a refreshed NLT to be lower than those used within the SLM, following the improving trend seen in the differences between the 1992 and 2002 leakage tests.

The GDN's are looking into the viability of other areas of the SLM in 22/23 and beyond, including potential reviews into the Own Use Gas calculation methodology and AGI leakage. Results and potential amendments to these and other areas of focus will be communicated in due course through this medium and the regular Shrinkage Forums. Also, recognising the recommendations made by Centrica within this report, the GDN's will engage with 3rd party industry experts to better understand the potential cost of reviewing the NLTs at the same scale or reduced, at today's prices, and report back through the Shrinkage Forum

Point 3:

[2] https://www.gasgovernance.co.uk/sites/default/files/ggf/2021-03/PE%20leakage%20estimate%20for%20INA%20%28final%29.pdf

"Additional information should be provided:"

"As explained above, the information in the consultation does not allow us to independently assess whether the proposed commitments are focussed on those areas which should be treated with priority. Additionally, the information presented does not allow us to provide feedback on each individual area of focus. We explain below."

Joint GDN Response:

In section 4 of the consultation document, each individual element of shrinkage and leakage is given a weighting relating to its % influence on overall shrinkage volumes.

"Medium Pressure Leakage:"

"It appears the second phase of this project has been ruled out because of cost considerations. It has not been made clear whether the project has been closed or additional steps will be taken and will remain as an area of focus. We are also unable to comment on whether closing or continuing the investigation is appropriate because cost information has not been included in the consultation. These clarifications should be provided at the earliest opportunity."

Joint GDN Response:

The second phase of the project has not been initiated as the GDN's felt that the actions under consideration would either not provide value for customers money or were deemed to be of minimal value (see responses to Ovo Energy above).

As stated above, the GDN's focus for RIIO-2 has shifted somewhat, to concentrate on better facilitating the efficient injection of bio-methane into the MP system. As we prioritise gas entry and exit connections, this would make incorporating pressures into the MP leakage calculation a particularly challenging exercise. Operating pressures are increasingly impacted by sudden demand changes on the MP distribution system, which could cause network pressures to rise and fall in an unpredictable manner as electricity peaking plants are brought online to balance electricity demand. There is a current innovation project called Optinet, led by Cadent in collaboration with WWU, which looks to create capacity in the network to allow additional bio-methane plants or other distributed gas generation to inject into the system. This will maximise the opportunities to increase decarbonisation of the gas network and support future energy system transition.

"Capture of Remediated Mains:"

"SGN will again engage with the other GDNs to seek approval before submission to the Authority and wider industry. We suggest that engaging with the wider industry ahead of submission would be better, so as to keep stakeholders abreast of developments and, potentially, to improve the submission. We recommend SGN's engagement with other GDNs ahead of seeking approval be widened to include other stakeholders."

Joint GDN Response:

The process for any proposed modification to the SLM remains the same as in RIIO-1. Once the proposer is confident in the revised methodology, they will submit the proposal for consideration with the Authority, Stakeholders, and the wider industry (SpC 4.4.17). As the proposer in this respect is SGN, it is felt that the responsible course of action would be to first engage with the other Gas Distribution Networks, as this modification could potentially impact on the mains leakage rate calculation used by all GDN's. That said, SGN have no objections to sharing the proposal with the wider industry for comment and feedback prior to any formal consultation and will progress this accordingly once the 3rd party review is complete.

"Other:"

"Project costs should be included in future consultations, especially in those instances in which actions will not be progressed because costs are considered to be prohibitive (as explained above)."

Joint GDN Response:

The GDN's recognise the potential validity of this recommendation and will duly discuss these requirements and report back to Stakeholders through the Shrinkage Forum.

3 Summary of Consultation

The GDN's have reviewed these representations and we can conclude that the amended commitments documented below accurately reflect the areas of focus for the formula year 2022/23.

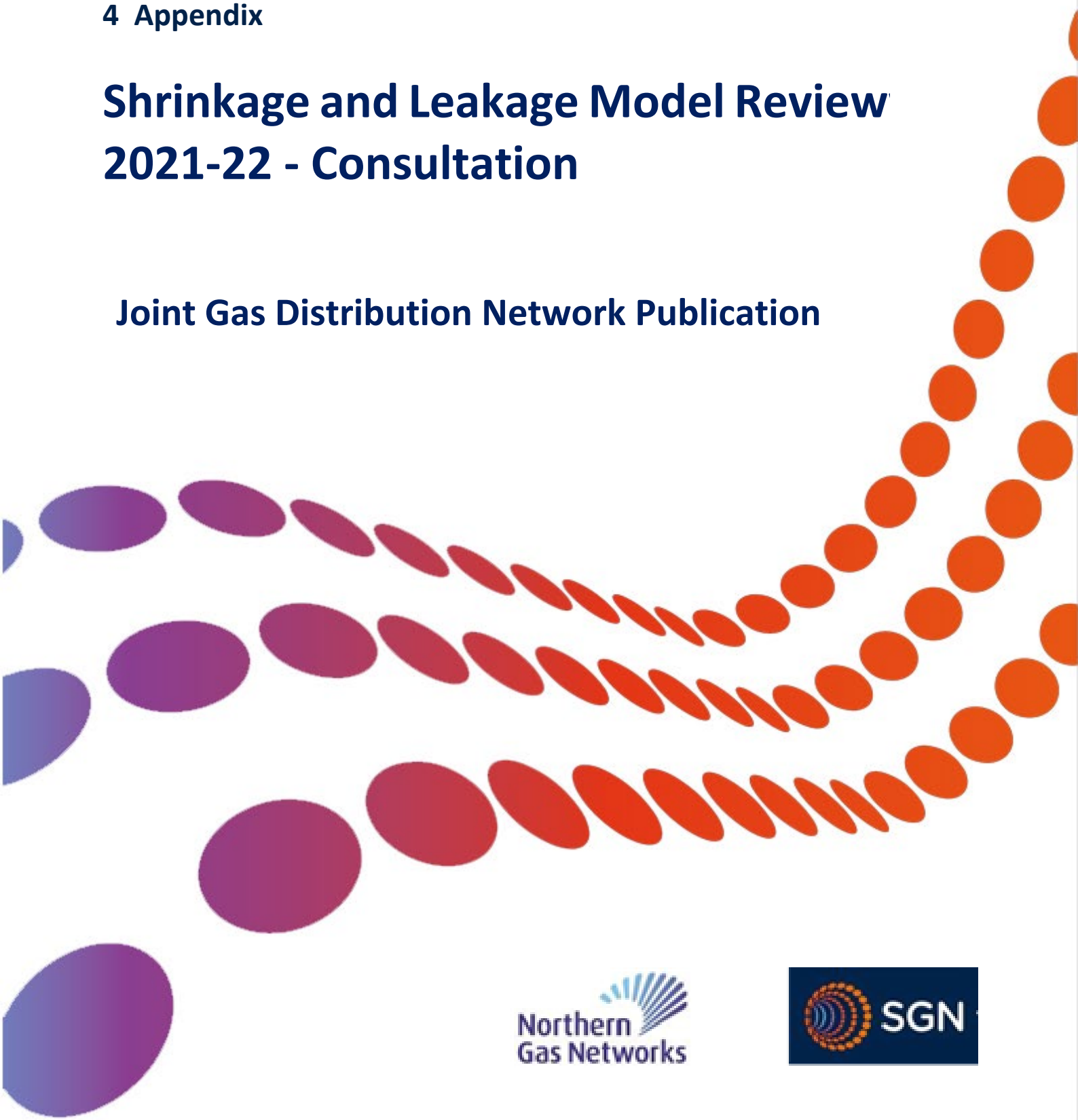
Table 1: Summary of Commitments

Priority Area	Approach/Description	Potential Impact on SLM
Priority 1: Methodology Review ***Medium Pressure leakage does not include a pressure correction factor***	An independent review was commissioned with Newcastle University. The 7 options were considered by the GDNs to potentially improve medium pressure leakage estimation and these ideas were explored in 2021. **Recognising the appetite for further engagement with stakeholders in relation to project costs, the GDN's will discuss the potential to report on future estimates through this forum. We will also investigate the possibility and likely impacts of considering service populations within the MP Leakage calculation.**	Report produced by GDNs to outline approach to MP modelling. 2nd phase of the project discounted due to cost of further leakage testing
Priority 2 Accuracy Improvement ***Internal pipe remediation is used with no method of reflecting the associated leakage reduction within the SLM***	SGN have developed a joint GDN consultation document and had intended to bring this to the Authority and stakeholders prior to the end of GD1. This has now rolled over into GD2, with SGN seeking a 3rd party expert review before submission of the proposed modification of the SLM. **Following this review and prior to the formal consultation, SGN will engage with Stakeholders to request comment and feedback on the proposed modification.**	Remediation allows maintenance of pipe assets to be undertaken with reduced disruption to our customers. SLM calculations should reflect any difference in assessed leakage from using this method, with no mechanism allowing this to be captured currently. SGN intend to submit this proposed modification with any associated leakage reductions backdated to the beginning of the CISBOT remediation programme.
Priority 3 Validation of Calculation ***Own Use Gas is calculated as a percentage of throughput***	Following representations from the Authority and interested parties, the GDN's have begun the process of developing a proposal to be put to the Authority, related to a potential review of the Own Use Gas (OUG) calculation methodology, with the objective of determining whether the current model remains an appropriate and accurate means of assessing the associated volumes. This 3rd party expert led review will look to implement efficient and cost-effective measures to validate the key variables that form an integral part of the current methodology and revise where appropriate. **Any and all progress will be reported through the Shrinkage Forum.**	This process is in the very early stages of development, and the initial scoping of the overarching framework is ongoing. If the variables and assumptions that feed into the current model are subsequently found to be out-dated or in need of revision, this may lead to an amendment to the current correction factor used to calculate OUG and have an associated impact on future reported Shrinkage volumes.

4 Appendix

Shrinkage and Leakage Model Review 2021-22 - Consultation

Joint Gas Distribution Network Publication



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1 Executive Summary

The Shrinkage & Leakage Model Review process is an opportunity for Gas Distribution Networks (GDNs) and interested stakeholders to consult and review (on an annual basis) the components and assumptions used within the Shrinkage and Leakage Model (SLM), by way of a 28 day consultation period.

The outcome of this consultation will be submitted to the authority by 31 March 2022.

The purpose of this review is to assess how the SLM can better achieve the objective set out in Special Condition 4.4. Part D of the Licence. This requires the SLM to be designed to facilitate the accurate calculation and reporting of gas shrinkage and gas leakage in each GDN operated by a Licensee. As a result of the joint GDN review, it is proposed a continuation of focus in the following keys areas, with a new commitment to investigate the possibility of a review into the Own Use Gas methodology:

Table 1: Summary of Commitments

Priority Area	Approach/Description	Potential Impact on SLM
Priority 1: Methodology Review *Medium Pressure leakage does not include a pressure correction factor*	An independent review was commissioned with Newcastle University. The 7 options were considered by the GDNs to potentially improve medium pressure leakage estimation and these ideas were explored in 2021.	Report produced by GDNs to outline approach to MP modelling. 2nd phase of the project discounted due to cost of further leakage testing
Priority 2 Accuracy Improvement *Internal pipe remediation is used with no method of reflecting the associated leakage reduction within the SLM*	SGN have developed a joint GDN consultation document and had intended to bring this to the Authority and stakeholders prior to the end of GD1. This has now rolled over into GD2, with SGN seeking a 3rd party expert review before submission of the proposed modification of the SLM	Remediation allows maintenance of pipe assets to be undertaken with reduced disruption to our customers. SLM calculations should reflect any difference in assessed leakage from using this method, with no mechanism allowing this to be captured currently. SGN intend to submit this proposed modification with any associated leakage reductions backdated to the beginning of the CISBOT remediation programme.
Priority 3 Validation of Calculation *Own Use Gas is calculated as a percentage of throughput*	Following representations from the Authority and interested parties, the GDN's have begun the process of developing a proposal to be put to the Authority, related to a potential review of the Own Use Gas (OUG) calculation methodology, with the objective of determining whether the current model remains an appropriate and accurate means of assessing the associated volumes. This 3rd party expert led review will look to implement efficient and cost-effective measures to validate the key variables that form an integral part of the current methodology and revise where appropriate.	This process is in the very early stages of development, and the initial scoping of the overarching framework is ongoing. If the variables and assumptions that feed into the current model are subsequently found to be out-dated or in need of revision, this may lead to an amendment to the current correction factor used to calculate OUG and have an associated impact on future reported Shrinkage volumes.

2 Background

GDNs have a requirement under Special Condition 4.4 Part D of the Licence to review the SLM on an annual basis and to consult on the outcome of that review with other GDN operators, gas shippers and other interested parties.

The outcome of this consultation will be submitted to the authority by 31st March 2022.

The purpose of the SLM Review is to assess how the SLM can better achieve the objective set out in Special Condition 4.4. Part D of the Licence. This requires the SLM to be designed to facilitate the accurate calculation and reporting of gas shrinkage and gas leakage from each GDN operated by a Licensee.

We value all feedback and representations; responses to this document are encouraged and should be received no later than **22nd March 2022**. Communication should be directed to Colin Wainwright or via the Joint Office (contact details below).

Colin Wainwright, Network Support Officer

SGN

Email: colin.wainwright@sgn.co.uk

Write to:

Colin Wainwright

5 Lonehead Drive,

Newbridge,

Edinburgh.

EH28 8TG

Alternatively

Joint Office: enquiries@gasgovernance.co.uk

3 Overview of Shrinkage

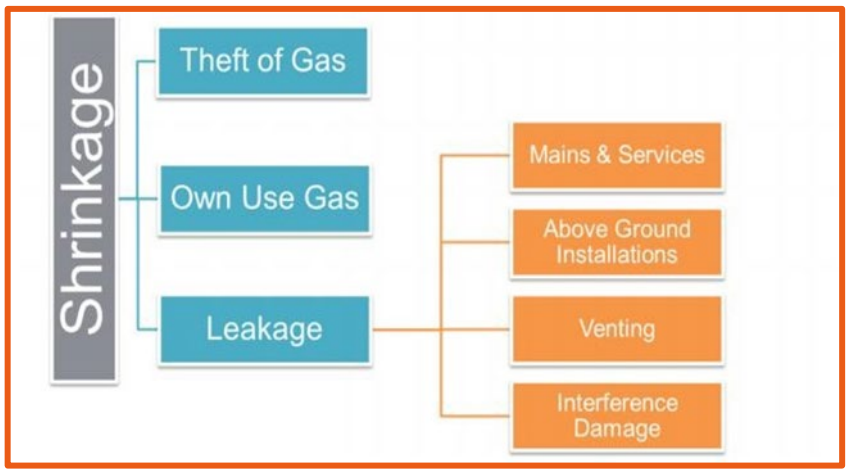
Shrinkage refers to the gas which is emitted from the transportation network.

Under the Uniform Network Code (UNC), GDNs are responsible for purchasing gas to replace the gas lost through Shrinkage.

GDNs estimate Shrinkage using an industry developed, and Ofgem approved, methodology and engineering model. The model applies predetermined leakage rates and is updated annually for a number of activity-based factors. The methodology used to determine Shrinkage quantities continues to evolve; this document details the GDN's collective thoughts of how we can continue to improve the methodology and accuracy of the calculations. As part of this consultation, and throughout the annual lifecycle of the Shrinkage process, GDNs request feedback from shippers and other interested parties on how we can continuously improve elements of the SLM.

Shrinkage is comprised of three elements (leakage, theft of gas and own use gas), of which leakage contributes around 95% of the total quantity. Detail of how each element is calculated is found later in this document.

Figure 1 – Elements of Shrinkage



The Joint Office of Gas Transporters regularly host Shrinkage Forums throughout the year, the forum is open to all interested parties and attendance is strongly encouraged for those persons with an interest in gas distribution shrinkage. The Shrinkage Forum is an opportunity to connect with colleagues from the gas distribution and shipper community. This Forum facilitates discussions relating to the measurement of Shrinkage gas and allows for opinions and ideas to be shared.

Further information relating to the Shrinkage Forum can be found at: https://www.gasgovernance.co.uk/SF

4 Overview of the SLM

This section details each of the components of shrinkage which includes leakage assumptions, % influence of each component on the total volume, the calculation methods, and our commitments to increasing accuracy in each area, improving the SLM.

Table 2: Summary of the key data used to calculate Shrinkage (from 2020/21 Leakage Calculations)

No. of Networks	Length of Mains (Low and Medium Pressure	No. of Above Ground Installations (AGI's)	No. of Services
2318	**255,963 km**	**108,963**	**22,774,653**

Table 2 demonstrates the large volume of data GDNs update, review, and process annually in order to provide an accurate Shrinkage assessment. As well as processing large volumes of data, GDNs adhere to rigorous Data Assurance Guidelines (DAG) procedures which require strict internal approval processes. The procurement, processing, and validation of this large volume of data results in lead times of approximately 4 months each year (April-July) to produce the final Leakage and Shrinkage figures. These are subject to detailed internal scrutiny and formal approval processes prior to being sent to Ofgem as part of the GDN's Regulatory Reporting Pack (RRP) and is used to compile the annual Assessment and Adjustment Report3 published at the end of July

Low Pressure Mains and Service Leakage

Weighting: circa 78% of leakage

Background: Leakage from low pressure mains is estimated by applying the leakage rates determined from the National Leakage Tests (NLT) programme to the mains asset records. Leakage from low pressure services is estimated by applying the leakage rates determined from the NLT, which provided an average leakage rate for each service classification.

LP Mains Calculation method: Asset length (km) X annual leakage rate X average system pressure correction[4] X Mono-ethylene Glycol[5] correction (where applicable)

LP Mains Rates: 11 rates from 25 categories based on materials and diameters

LP Service Calculation method: No. of services by category x annual leakage rate x average system pressure correction

LP Service Rates: 4 rates/categories (steel and PE service connections to PE or metallic mains)

The NLT, commissioned by the UK GDNs, remains world leading in both scale and accuracy. The tests involved sampling 849 Low Pressure pipes and 6,054 services. There is no evidence to suggest that the resulting leakage rates have materially changed since these tests. GDNs continue to invest in replacing metallic mains, which targets pipes most susceptible to degradation, progressively reducing the overall population of the highest leakage pipes year on year. As such, the significant additional investment and disruption required to repeat the NLT would, in our view, represent poor value for money for the customer. This was discussed in Ofgem working groups in preparation for RIIO-GD2, with little support from GDN's and Ofgem to include a repeat of these tests and associated spend in the RIIO-GD2 plans.

[3] https://www.gasgovernance.co.uk/Shrinkage/Assessment-and-Adjustment

[4] Leakage rates were determined at 30mbarg pressure so require correction if pressures are greater or lower than this amount. The lower the average system pressure the less an asset will leak.

[5] Lead yarn joints leak less if Mono-ethylene Glycol is saturated in the gas, MEG treatment only impacts spun cast and pit cast assets. The higher the MEG saturation the greater the leakage reduction.

Medium Pressure Mains Leakage

Weighting: circa 8% of leakage.

Background: Medium pressure (MP) leakage is estimated by applying the LP leakage rates at 30mbarg to the MP mains asset profile. The rationale for this is that the number of public reported escapes per km of MP main is of a similar order to that of the LP system. Therefore, it is inferred that the mains must be leaking at a similar rate. Systems operating at higher pressures are constructed and tested to an appropriately higher level of integrity.

Unlike Low Pressure mains the calculation method for Medium Pressure mains takes no cognisance of the actual average operating pressures of the respective grids. To review the accuracy of the calculation, we will investigate the value of a pressure related factor. This could facilitate a mechanism for achieving and reflecting leakage reduction through intelligent pressure management. To achieve this, it would be necessary to establish MP specific leakage rates; however, isolating sections of the MP system to undertake pressure decay tests is difficult due to the strategic importance of these mains to security or supply, even under low demand periods. Cadent Gas raised a NIA project which confirmed a correlation between MP leakage and system pressures.

We have engaged with industry experts at Newcastle University ISRU to understand if there was a better and more concise methodology to report Medium Pressure leakage. The scope of this project was to assess the suitability of the MP leakage rates currently used and determine whether the implementation of a pressure correction factor will increase the accuracy of the calculation.

Preliminary investigatory work has now been completed with specialist support from Newcastle University ISRU. The options for improvement outlined by Newcastle University ISRU were explored by the GDNs in 2021.

Calculation method: Asset length (km) x annual leakage rate

Rates: 6 rates from 25 categories based on materials and diameters

Above Ground Installation Leakage

Weighting: circa 8% of leakage

Background: Leakage for AGIs is estimated by multiplying the number of AGI assets by the pre-determined leakage rate calculated for the asset type. The five types of AGIs are listed below:

- Holder Station (Largely phased out)
- NTS Offtake (Reduce pressure from above 70 bar to Local Transmission)
- Local Transmission (Reduce pressures from up to 69 bar to lower pressure tiers)
- District Governor (Supply gas to lower pressure tiers. Outlet pressure 25-75 mbar)
- Service Governor (Commonly feed individual premises)

The leakage rates for AGIs were determined by Advantica in 2003 and are documented in the Above Ground Installation Shrinkage report. The programme established average leakage rates for the five types of AGI's. **Table 3** below provides a summary of findings.

Table 3: AGI Leakage Rates and Sites Surveyed

Asset Type	Leakage (m^3/year/site)	Number Surveyed
Holder Station	7,692	24
NTS Offtake	31,075	67
Local Transmission	6,485	145
District Governor	407	246
Service Governor	8	54

The AGI sample plan included a total of 536 sites across the UK and utilised 2 leakage measurements techniques, Fugitive Measurement Device (FMD) and Area Survey Vehicle (ASV), the latter was only used for holder stations.

To ensure that the AGI Shrinkage report 2003 was valid (a similar test had not been previously carried out), the University of Nottingham were engaged to carry out an independent validation of the technique involved and concluded that the FMD is a valid, practical method for making measures of fugitive emissions from the Gas Distribution System. The University of Newcastle were also engaged to validate the statistical analysis carried out within the report and concluded there is no evidence of any bias and the data had been correctly analysed.

The cost of completing the extensive study into AGI Shrinkage was in the region of £1m[6]. The conclusions which were drawn are still considered valid due to similar network operating procedures that are still in use today. The AGIs which are in service today are of similar nature compared to what was in use in 2003.

Calculation method: Asset quantity x annual leakage rate.

Rates: 5 leakage rates (Holder Stations, NTS offtakes, Local Transmission Stations, District Governors, Service Governors)

Above Ground Installation Venting

Weighting: circa 5.5% of leakage

Background: AGI Venting rates were determined as part of a 1994 Watt Committee Report, the derivation of this value is unknown and is a single fixed value for each LDZ

Calculation method: Fixed annual leakage volume per LDZ

Rates: Fixed annual leakage volume per LDZ

Interference Damage

Weighting: circa 0.5% of leakage

Background: Interference damage is the gas escaping into the atmosphere as part of an unplanned incident usually caused by third party damage. Interference damage is split into two categories, above and below 500kg of gas released and is calculated using assumed leakage rates per incident together with an average response and repair time (for below 500kg incidents).

GDNs have a licence obligation to attend at least 97% of uncontrolled gas escapes within 1 hour and 97% of controlled gas escape within 2 hours (where the risk to the customer is deemed lower). These targets have been consistently outperformed in recent years and include incidents of interference damage. For interference damage, the source of the leak is generally more obvious due to the nature of the incidents and so can be made safe more quickly.

[6] https://www.gasgovernance.co.uk/sites/default/files/ggf/Shrinkage%20and%20Leakage%20Model%20Review%20No%201%20WWU.pdf

Calculation method: Multiple scenarios

>500kg interference damages: An assessment is made of each >500kg incident and included in the model.

<500kg interference damages (Mains): Number of incidents split 95:5 between low pressure and medium pressure incidents. Different leakage rate and response time for low pressure and medium pressure.

<500kg interference damages (Services): Number of incidents split 50:50 between severed and punctured services. Different leakage rate and response time for severed and punctured services.

Number of incidents x leakage rate x predetermined response/fix time

Theft of Gas

Weighting: circa 4% of shrinkage

Background: Shrinkage includes the element of Theft of Gas (ToG) deemed 'transporter responsible'. This is currently estimated by applying a fixed 0.02% factor to throughput. However, the absolute level of theft, by its nature, is impossible to establish and the current assumption can be considered conservative and likely to overestimate the total quantity of transporter responsible gas. GDN data from 2010 on detected ToG cases, provided to the Shrinkage Forums in August 7 and September 8 2011, indicated that levels were several times lower than the current throughput factor suggests. However, GDNs have no statistically robust basis to suggest that the current assumed level of transporter responsible theft is any higher or lower than the current assumption as a percentage of throughput.

Furthermore, during 2016/17, a specific LDZ experienced an uncontrolled increase in demand as a result of a large industrial connection which inflated the value of the ToG. Our current view is that this component would be useful to investigate, as detailed within our commitments, to determine if a better methodology for estimating theft exists, however, by its nature it is difficult to quantify an unknown.

Calculation method: 0.02% of throughput

Own Use Gas

Weighting: circa 2% of shrinkage

Background: Own Use Gas (OUG) refers to gas used by the transporter for operational purposes, primarily pre-heating, but which does not pass through a meter. This is currently estimated by applying a fixed 0.0113% factor to throughput.

In our commitments for the coming year, we describe our intention to develop a proposal to be submitted to the Authority, for a potential 3rd party expert review into the assumptions and variables that fed into the original modelling used to calculate the fixed correction factor. If this is approved and subject to the availability of funding, any required or appropriate amendments will be actioned.

Calculation method: 0.0113% of throughput

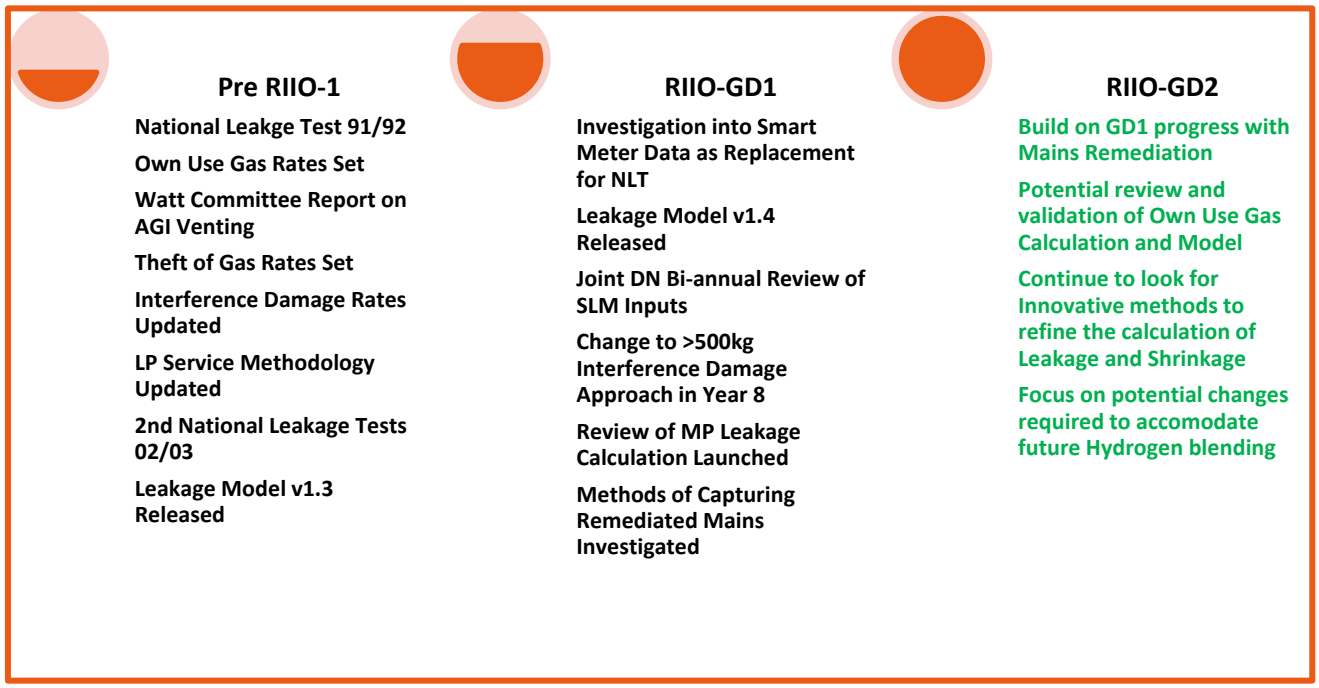
[7] https://www.gasgovernance.co.uk/sf/100811

[8] https://www.gasgovernance.co.uk/SF/280911

5 Shrinkage Development Timeline

The graphic below demonstrates the continued evolution of shrinkage methodology and our commitments to address each of the elements

Figure 2 – Shrinkage Component Timeline



6 Shrinkage Reduction Success

Shrinkage forms the majority of a gas distribution network companies' business carbon footprint and accounts for around 1% of Great Britain's total greenhouse gas emissions. As such, reducing losses aligns with achieving the UK government's emissions target and contributes to reducing customer bills.

Each GDN continues to see incremental improvements in shrinkage reduction; we have made progress in several areas which have seen a positive impact in reducing Shrinkage:

- **We continue to see the biggest reduction in our year on year emissions coming from the delivery of the mains replacement programme which replaces ageing metallic pipes with polyethylene. Since the start of RIIO GD1, GDNs have abandoned over 28,020 km of metallic mains.**
- **Behind our mains replacement programme, the second greatest influence on Shrinkage is system pressure. We are continuing to work to enhance the capabilities of our pressure management systems, however there is a limit to which such improvements can be made because customers must receive gas at an appropriate pressure to operate their appliances. We have implemented pressure profiling systems that automatically manage low pressure governor settings in line with customer requirements. This ensures networks run at the optimum levels to minimise lost gas, while at the same time achieving security of supply.**
- **A continuous review of established profiling systems is carried out to ensure they remain relevant to other changes taking place on the LP network. This is demonstrated by network length covered by self-learn profiling. Approximately 70% of the GDNs network length is on profile control.**
- **Installation of new, and the replacement of any obsolete clocking systems to allow differential within day pressure settings on those networks where it may not be economically justified to install profile control.**
- **Pro-active management of network pressures through adjusting district governor settings seasonally.**
- **Reinforced governance around the management of temporary modifications to pressure settings for operational works.**
- **Within each of our networks we still have a significant amount of low pressure iron mains that have lead yarn joints. These joints can be treated using MEG which in turn can reduce the rate at which gas leaks from them. A proportion of lead yarn jointed pipe is replaced annually with polyethylene pipe as part of our Mains Replacement programme.**
- **Introduction of more sophisticated management information to help support the management of networks, allow early identification of underperforming areas and actions to resolve any issues.**
- **Ongoing replacement of low-efficiency water bath heaters with more efficient condensing boiler plant to reduce Own Use Gas volumes.**
- **Lead yarn joint remediation on Cast and Spun Iron mains using robotics to reduce joint leakage.**
- **Decommissioning of Gas Holder sites with associated reductions in AGI leakage.**

7 Areas of Focus

The outcome of the Joint GDNs SLM review is detailed below (this expands on Table 1 contained in the Executive Summary).

Project Name: Medium Pressure Leakage

Project Lead: Northern Gas Networks Ltd

Shrinkage Component: Medium Pressure Calculation

Potential Shrinkage Impact Assessment Checklist:

- **Expected Calculation Change**
- **Expected Shrinkage Baseline Impact (ODI-R – Reputational Incentive)**
- **Expected Rate Alteration/Addition**

Brief Overview: Medium pressure (MP) leakage is estimated by applying the LP leakage rates at 30mbarg to the MP mains asset profile. The rationale for this is that the number of public reported escapes per km of MP main is of a similar order to that of the LP system. Therefore, it is inferred that the mains must be leaking at a similar rate. Systems operating at higher pressures are constructed and tested to an appropriately higher level of integrity.

Reason for Review: Unlike Low Pressure mains, the calculation of leakage from Medium Pressure mains does not include an average system pressure correction. To improve the calculation a pressure related calculation of leakage may be more appropriate, which would also facilitate a mechanism for achieving and reflecting leakage reduction through effective pressure management.

GDNs engaged with Newcastle University to review and understand if there is a better and more concise methodology to report Medium Pressure leakage. The project aimed to identify the strengths in the current approach and the opportunities for further improvement, and to make recommendations based on these findings. 7 options were recommended for GDN consideration to potentially improve medium pressure leakage estimation, and these ideas were explored in 2021.

Anticipated Baseline Impacts: Unknown at this time

Expected Completion: Preliminary investigatory work has now been completed with specialist support from Newcastle University ISRU. The options for improvement outlined by ISRU were explored by the GDNs in 2021. The first recommendation of creating a unifying document by the GDNs to summarise the modelling approach used, which is to allow independent third parties to understand the approach taken and ensure consistency and transparency in the approaches taken by the GDNs. Consideration was then given to whether a 2nd phase should progress, but as this would incur significant costs associated with MP leakage testing it was not deemed to be a viable option.

Project Name: Capture of Remediated Mains

Project Lead: SGN

Shrinkage Component: Low Pressure Mains

Potential Shrinkage Impact Assessment Checklist:

- **Expected Calculation Change**
- **Expected Shrinkage Baseline Impact (ODI-R – Reputational Incentive)**
- **Expected Rate Alteration/Addition**

Brief Overview: Leakage from low pressure mains is estimated by applying the leakage rates determined from the NLT programme to the mains asset records. Currently mains leakage is calculated as:

Asset length (km) x annual leakage rate x average system pressure correction x Mono-ethylene Glycol correction (where applicable)

Reason for Review: Currently, the above mains leakage rate formula does not account for the reduction in leakage attributable to large diameter iron mains remediated through robotic (CISBOT) joint repair. The overwhelming majority of leakage from iron mains is through the lead yarn joint, and this form of remediation is proven to eliminate this risk. The proposed submission will consult to incorporate a change to this formula within the model to rectify this.

The initial consultation document was prepared in 2021 and it was SGN's intention to submit prior to the end of the RIIO-1 price control period, but in recognition of the ongoing workload to determine the RIIO-2 Licences and Incentive Mechanisms and the associated uncertainty, the decision was taken to withhold any consultation until the new regulatory period.

Following internal discussions over recent months, the revised methodology and consultation paper will now be subject to a review by 3rd party industry experts prior to submission, to validate the proposed changes and to confirm the forecast impacts. Once this review has taken place, SGN will once again engage with the other GDN's to seek joint approval before submission to the Authority and wider industry.

SGN will strive to update on progress through this medium and also the regular Joint Office Shrinkage Forums.

Anticipated Baseline Impacts: No impact on ODI-F

Expected Completion: 2023/24

Project Name: Own Use Gas

Project Lead: Joint GDN

Shrinkage Component: Own Use Gas Calculation

Potential Shrinkage Impact Assessment Checklist:

- **Potential Calculation Change**
- **Potential Shrinkage Baseline Impact (ODI-R – Reputational Incentive)**
- **Potential Rate Alteration/Addition**

Brief Overview: Own Use Gas makes up approximately 2% of all Distribution Network Shrinkage and is calculated as a factor (0.0113%) of LDZ throughput. Own Use Gas is gas that is used as part of the operational requirements of the distribution networks at pressure reduction stations i.e., pre-heating.

Reason for Review: Own Use Gas (OUG) is driven by consumer gas demand, and by being a factor of throughput cannot be targeted for reduction by gas distribution networks. The correction factor for LDZ throughput applied by the GDN's, was formulated following extensive data gathering and modelling exercises by 3rd party industry experts in 2002 and re-validated in 2006.

In 2021, following representations from interested parties and subsequently the Authority, the GDN's, in conjunction with 3rd party industry experts, have begun the process of developing a proposal to review the OUG calculation methodology, with the primary objective of determining whether the current model remains an appropriate and accurate means of assessing the OUG shrinkage volumes. Following approval by the Authority, and subject to any required funding, this 3rd party expert led review will look to implement efficient and cost-effective measures to validate the key variables that form an integral part of the current methodology, and revise where required/appropriate.

This process is in the very early stages of development, and the initial scoping of the overarching framework is ongoing. If the variables and assumptions that feed into the current model are subsequently found to be out-dated or in need of revision, this may lead to an amendment to the current correction factor used to calculate OUG and have an associated impact on future reported Shrinkage volumes.

Anticipated Baseline Impacts: Depending on the findings of this independent review into the current OUG model inputs and calculation, reported OUG volumes may change. If this change is felt to be of significance, there may be a requirement to re-submit RIIO-2 leakage reduction baseline volumes for the ODI-R (Reputational Incentive). ODI-F (Financial Incentive) baselines will remain unaffected.

Expected Completion: Unknown at this stage, will depend on any agreed project scope, but regular progress updates will be provided through the Joint Office Shrinkage Forum.

Project Name: Gas Venting Research

Project Lead: Northern Gas Networks Ltd and Wales and West Utilities

Shrinkage Component: AGI venting

Potential Shrinkage Impact Assessment Checklist:

- **Potential Calculation Change**
- **Potential Rate Alteration/Addition**
- **Potentially Linked to Innovation Project**

Brief Overview: For UK gas distribution networks, gas venting remains a necessary part of normal operations for maintenance and safety purposes which can be either manual or automatic. Gas venting results in unburned natural gas being released into atmosphere. Depending on the source of venting, various quantities of gas will be released and there is limited understanding of the environmental impact this causes. Additionally, vented gas results in shrinkage.

Reason for Review: Currently there are varying methods to different degrees of sophistication, to quantify and forecast the extent and impact of venting. The objectives are: Stage 1: Identify and detail current venting processes and equipment which release gas. Include literature review of previous projects and identify the lessons learned. Provide an assessment of the frequency at which gas is released (considering variation through periods of high and low demand). Provide a detailed understanding of the volume of gas being vented annually from equipment and operations. Provide an assessment of the environmental impact of current venting processes.

Stage 2: Identify safe, environmentally friendly, alternative processes and technologies that could be adopted by the networks.

Stage 3: Quantify the benefits associated with the options identified and highlight the most appropriate.

Anticipated Baseline Impacts: None

Expected Completion: Unknown at present

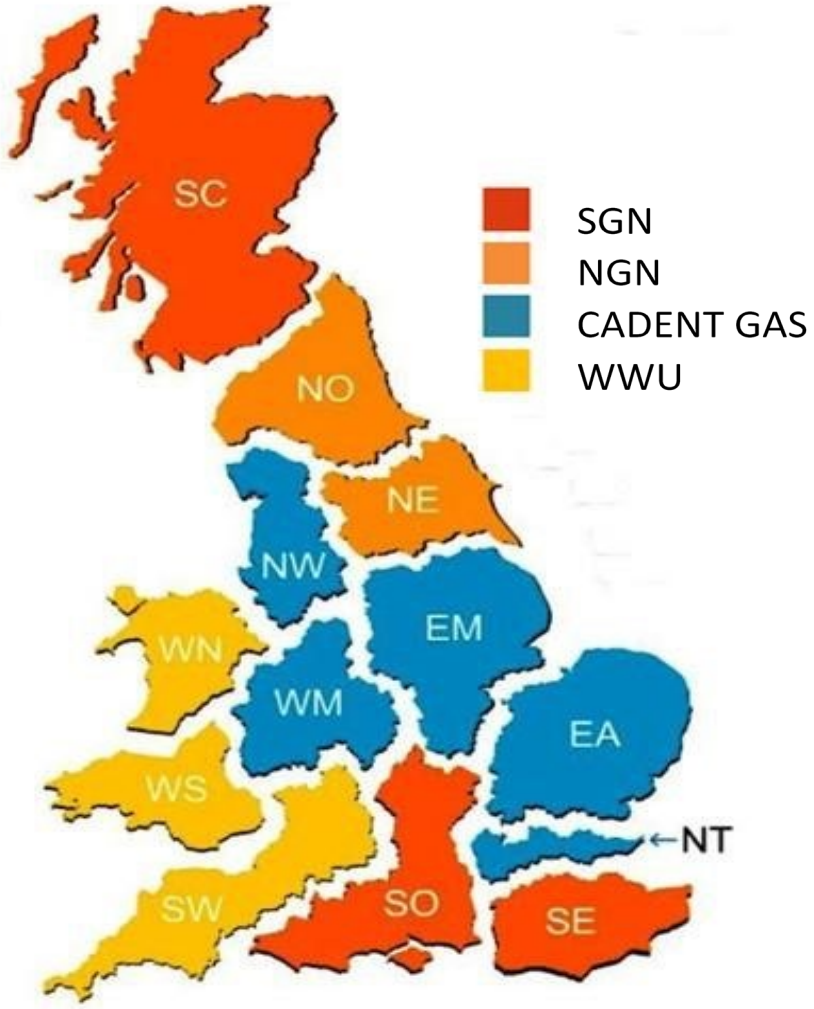
To date, the review has highlighted that the primary source of emissions from this element is from automatic venting controllers. WWU will now focus on exploring alternatives to these controllers and will update through future iterations of this review and the usual forums.

Although this does not constitute a priority area for the GDN's in the coming year, WWU are looking to trial Zero Emissions Operation (ZEO) LGT Pump Systems as a potential future replacement of the existing odorant pumps. WWU are also investigating potential replacements for the current Bristol 624 automatic venting controllers. Updates on progress once any trial commences will be made through this medium, as well as the regular Joint Office Shrinkage Forums.

8 LDZ Performance

The performance breakdown contained within the following pages demonstrates the main components of Shrinkage for each Local Distribution Zone (LDZ). The introduction of these performance measures is an outcome of the feedback received during a previous SLM Review stakeholder consultation and August 2018 Shrinkage Forum.

The network map below shows the geographic location of each LDZ, colour coded by network owner.

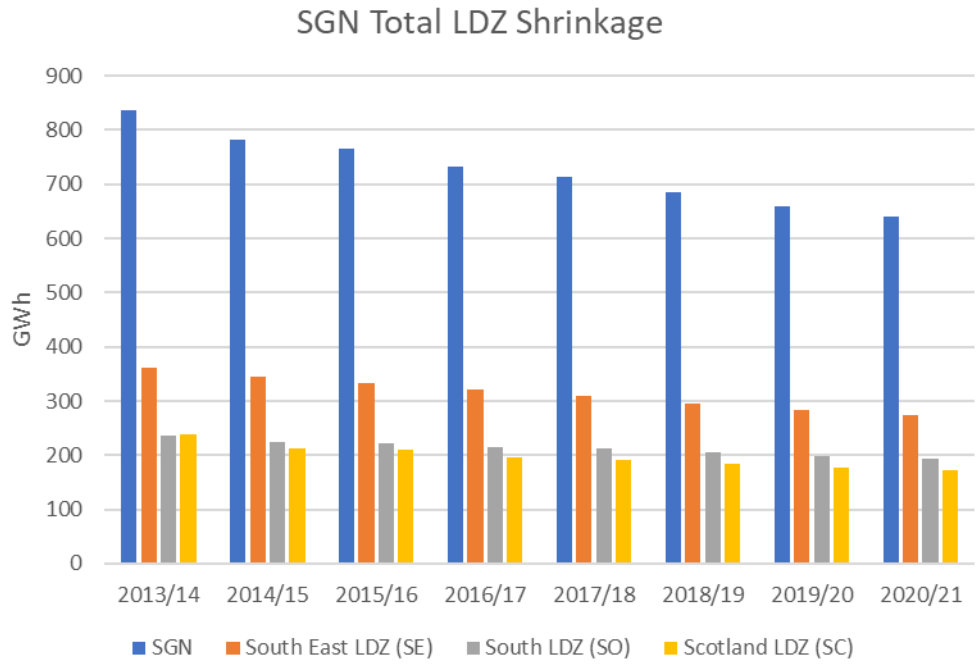


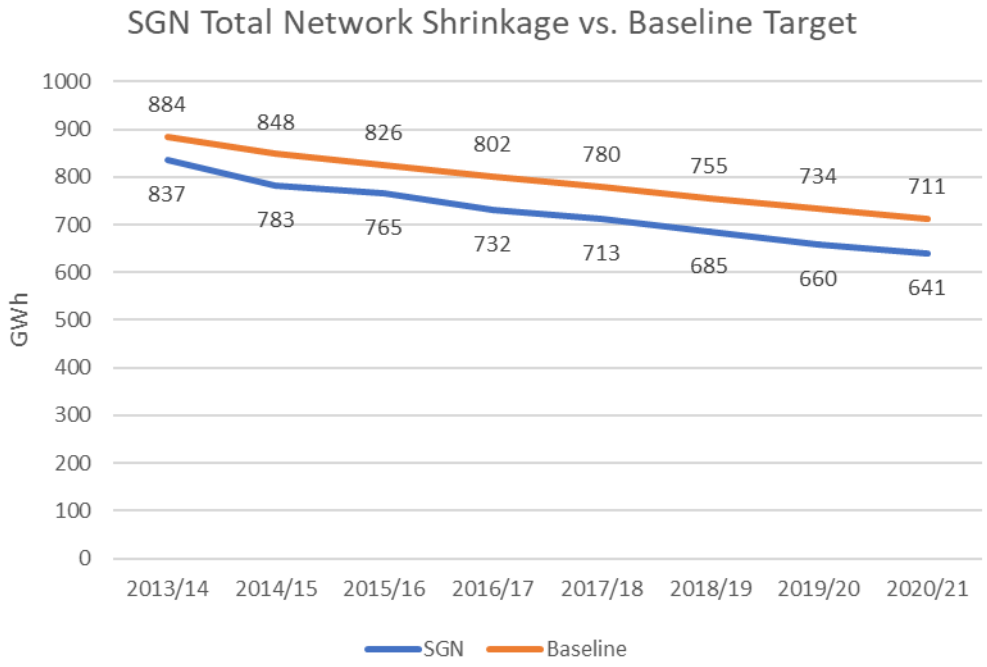
SGN Network Performance

Total Network Shrinkage was reduced by 18.9GWh in 2020/21 from 2019/20.

Average System Pressure decreased by 0.22mbar, metallic pipe length reduced by 525km.

Total Shrinkage in 2020/21 has reduced by approximately 2.9% compared to 2019/20.





SGN Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	462.6 GWh 70%	525km of metallic low pressure mains removed. ASP decreased by 0.2mb, MEG saturation increased by 6.1%. Demand decreased by 1% which means OUG and TOG decreased by the same margin compared to 2019/20.	443.2 GWh 69%	-19.4 GWh -4.2%
MP Leakage	56.3 GWh 9%		55.7 GWh 9%	-0.6 GWh -1.0%
Other (AGI's, OUG, Theft & Interference)	140.8 GWh 21%		141.9 GWh 22%	1.1 GWh 0.7%
Total	659.7 GWh 100%		640.8 GWh 100%	-18.94 GWh -2.9%

South East LDZ (SE) Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	222.1 GWh 78%	242km of metallic low pressure mains removed. ASP decreased by 0.4mb, MEG saturation increased by 6.8%. Demand increased by 2.2% which means OUG and TOG increased by the same margin compared to 2019/20.	211.1 GWh 77%	-11 GWh -4.9%
MP Leakage	14 GWh 5%		13.9 GWh 5%	-0.1 GWh -0.9%
Other (AGI's, OUG, Theft & Interference)	48.4 GWh 17%		48.5 GWh 18%	0.2 GWh 0.4%
Total	284.4 GWh 100%		273.5 GWh 100%	-10.9 GWh -3.8%

South LDZ (SO) Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	128.3 GWh 65%	130km of metallic low pressure mains removed. ASP decreased by 1.9mb, MEG saturation remained the same by 0%. Demand increased by 3.6% which means OUG and TOG increased by the same margin compared to 2019/20.	123.9 GWh 64%	-4.4 GWh -3.4%
MP Leakage	26.9 GWh 14%		26.7 GWh 14%	-0.3 GWh -1.0%
Other (AGI's, OUG, Theft & Interference)	42.5 GWh 21%		43.3 GWh 22%	0.8 GWh 2.0%
Total	197.7 GWh 100%		193.9 GWh 100%	-3.8 GWh -1.9%

Scotland LDZ (SC) Network Performance

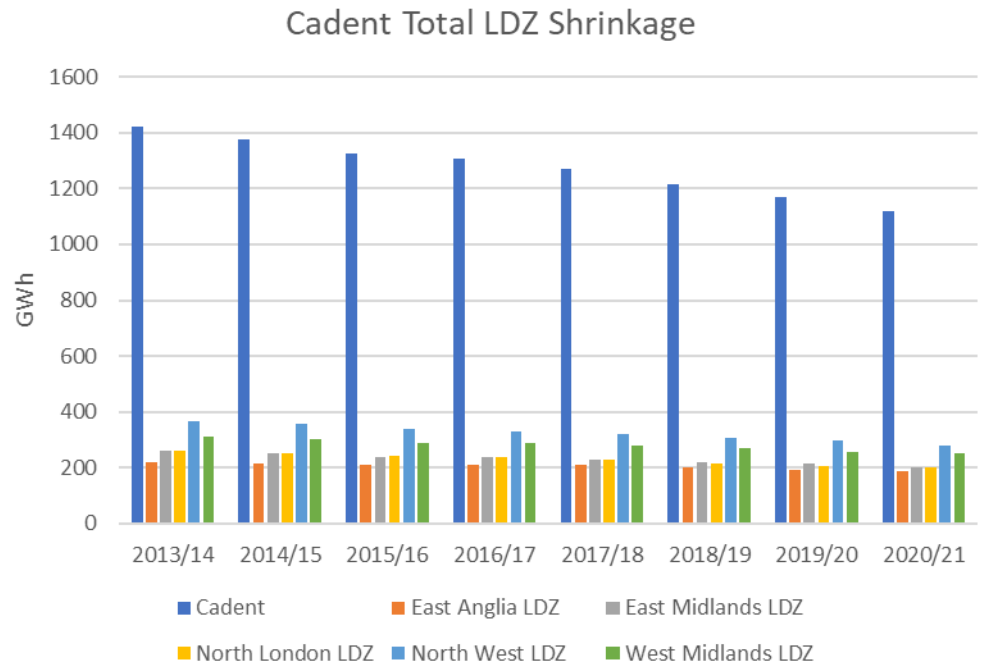
Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	112.3 GWh 63%	153km of metallic low pressure mains removed. ASP increased by 0.1mb, MEG saturation increased by 6.8%. Demand decreased by 8.1% which means OUG and TOG decreased by the same margin compared to 2019/20.	108.2 GWh 62%	-4 GWh -3.6%
MP Leakage	15.3 GWh 9%		15.2 GWh 9%	-0.2 GWh -1.0%
Other (AGI's, OUG, Theft & Interference)	50 GWh 28%		50 GWh 29%	0 GWh 0.0%
Total	177.6 GWh 100%		173.4 GWh 100%	-4.2 GWh -2.4%

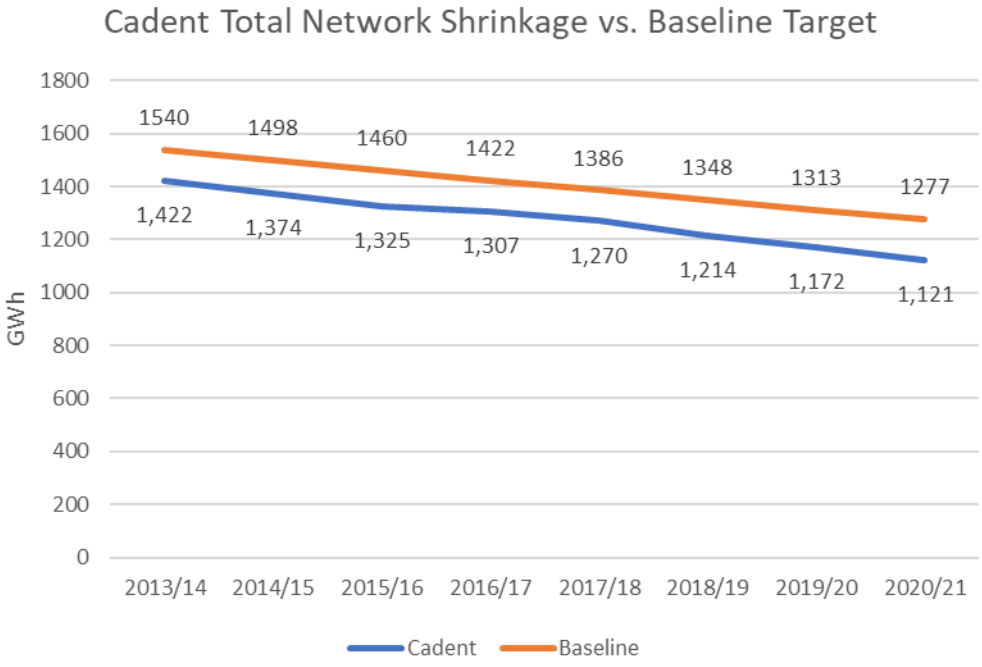
Cadent Performance

Total Network Shrinkage was reduced by 50.7GWh in 2020/21 from 2019/20.

Average System Pressure increased/decreased by 0.36mbar, metallic pipe length reduced by 1746km.

Total Shrinkage in 2020/21 has reduced by approximately 4.3% compared to 2019/20.





East Anglia LDZ Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	126.9 GWh 65%	225.2km of metallic low pressure mains removed. ASP decreased by 0.3mb. Demand decreased by 1.9% which means OUG and TOG decreased by the same margin compared to 2019/20.	120.9 GWh 64%	-6 GWh -4.7%
MP Leakage	14.8 GWh 8%		14.6 GWh 8%	-0.2 GWh -1.4%
Other (AGI's, OUG, Theft & Interference)	52.5 GWh 27%		53.2 GWh 28%	0.7 GWh 1.3%
Total	194.2 GWh 100%		188.7 GWh 100%	-5.5 GWh -2.8%

East Midlands LDZ Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	117.5 GWh 55%	425.4km of metallic low pressure mains removed. ASP decreased by 0.2mb, MEG saturation increased by 10.1%. Demand decreased by 0.8% which means OUG and TOG decreased by the same margin compared to 2019/20.	106.4 GWh 52%	-11.1 GWh -9.4%
MP Leakage	39.9 GWh 19%		39.3 GWh 19%	-0.6 GWh -1.5%
Other (AGI's, OUG, Theft & Interference)	58.1 GWh 27%		57.8 GWh 28%	-0.3 GWh -0.5%
Total	215.5 GWh 100%		203.5 GWh 100%	-12 GWh -5.6%

North London LDZ Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	140.3 GWh 68%	230.5km of metallic low pressure mains removed. ASP decreased by 0.2mb, MEG saturation increased by 0.6%. Demand decreased by 0.8% which means OUG and TOG decreased by the same margin compared to 2019/20.	135.3 GWh 68%	-5 GWh -3.6%
MP Leakage	19.4 GWh 9%		19 GWh 10%	-0.4 GWh -2.1%
Other (AGI's, OUG, Theft & Interference)	46.4 GWh 23%		45.4 GWh 23%	-1 GWh -2.2%
Total	206.1 GWh 100%		199.7 GWh 100%	-6.4 GWh -3.1%

North West LDZ Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	215.8 GWh 73%	469.9km of metallic low pressure mains removed. ASP decreased by 0.7mb, MEG saturation increased by 4.2%. Demand increased by 1.5% which means OUG and TOG increased by the same margin compared to 2019/20.	196.9 GWh 71%	-18.9 GWh -8.8%
MP Leakage	14.5 GWh 5%		14.4 GWh 5%	-0.1 GWh -0.7%
Other (AGI's, OUG, Theft & Interference)	67 GWh 23%		67.1 GWh 24%	0.1 GWh 0.1%
Total	297.3 GWh 100%		278.4 GWh 100%	-18.9 GWh -6.4%

West Midlands LDZ Network Performance

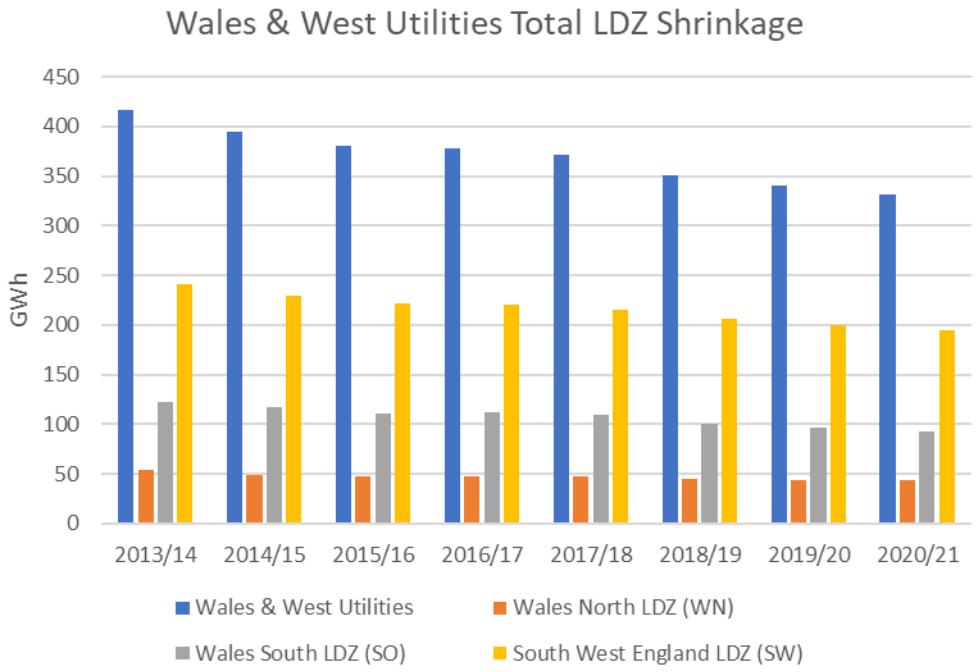
Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	185.9 GWh 72%	395.3km of metallic low pressure mains removed. ASP decreased by 0.2mb, MEG saturation decreased by 5.2%. Demand decreased by 1.1% which means OUG and TOG decreased by the same margin compared to 2019/20.	178.1 GWh 71%	-7.8 GWh -4.2%
MP Leakage	19.7 GWh 8%		19.6 GWh 8%	-0.1 GWh -0.5%
Other (AGI's, OUG, Theft & Interference)	53 GWh 20%		53 GWh 21%	0 GWh 0.0%
Total	258.6 GWh 100%		250.7 GWh 100%	-7.9 GWh -3.1%

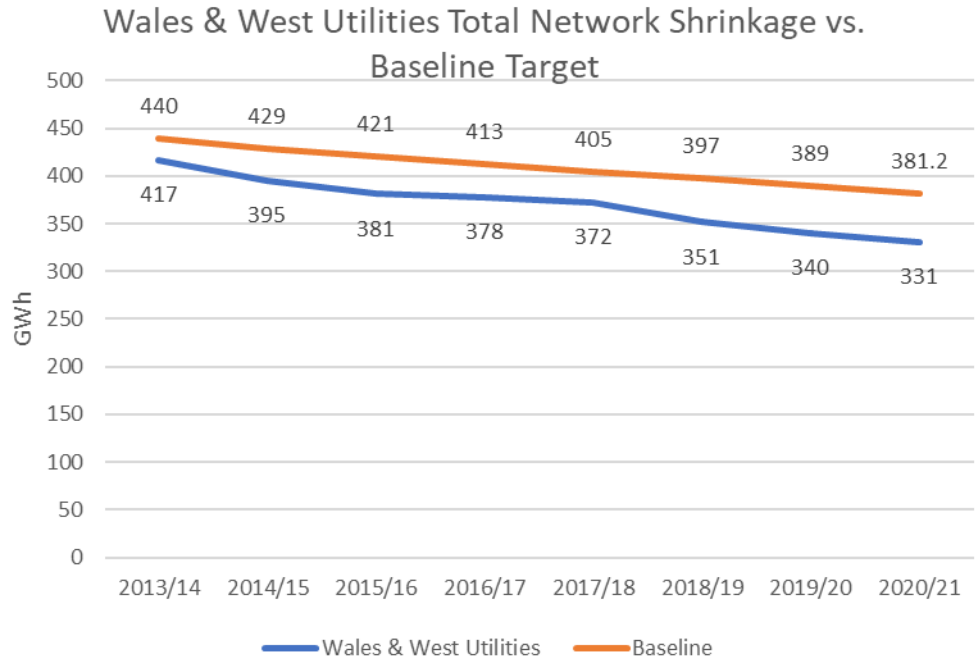
Wales & West Utilities Network Performance

Total Network Shrinkage was reduced by 9.1GWh in 2020/21 from 2019/20.

Average System Pressure increased/decreased by 0.07mbar and metallic pipe length reduced by 327km.

Total Shrinkage in 2020/21 reduced by approximately 2.7% compared to 2019/20.





Wales & West Utilities Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	215 GWh 63%	327km of metallic low pressure mains removed. ASP increased by 0.1mb. Demand decreased by 4.6% which means OUG and TOG decreased by the same margin compared to 2019/20.	207 GWh 62%	-8.2 GWh -3.8%
MP Leakage	32 GWh 9%		32 GWh 10%	0.1 GWh 0.3%
Other (AGI's, OUG, Theft & Interference)	94 GWh 28%		93 GWh 28%	-1 GWh -1.1%
Total	340 GWh 100%		331 GWh 100%	-9.1 GWh -2.7%

Wales North LDZ (WN) Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	17.4 GWh 40%	28km of metallic low pressure mains removed. ASP decreased by 0.3mb. Demand decreased by 2.2% which means OUG and TOG decreased by the same margin compared to 2019/20.	16.8 GWh 39%	-0.6 GWh -3.4%
MP Leakage	3.4 GWh 8%		3.5 GWh 8%	0.1 GWh 2.9%
Other (AGI's, OUG, Theft & Interference)	22.8 GWh 52%		22.8 GWh 53%	0 GWh 0.0%
Total	43.6 GWh 100%		43.1 GWh 100%	-0.5 GWh -1.1%

Wales South LDZ (SO) Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	55.7 GWh 58%	85km of metallic low pressure mains removed. ASP increased by 0.5mb. Demand decreased by 12% which means OUG and TOG decreased by the same margin compared to 2019/20.	53.7 GWh 58%	-2 GWh -3.6%
MP Leakage	9.5 GWh 10%		9.4 GWh 10%	-0.1 GWh -1.1%
Other (AGI's, OUG, Theft & Interference)	30.9 GWh 32%		29.9 GWh 32%	-1 GWh -3.2%
Total	96.1 GWh 100%		93 GWh 100%	-3.1 GWh -3.2%

South West England LDZ (SW) Network Performance

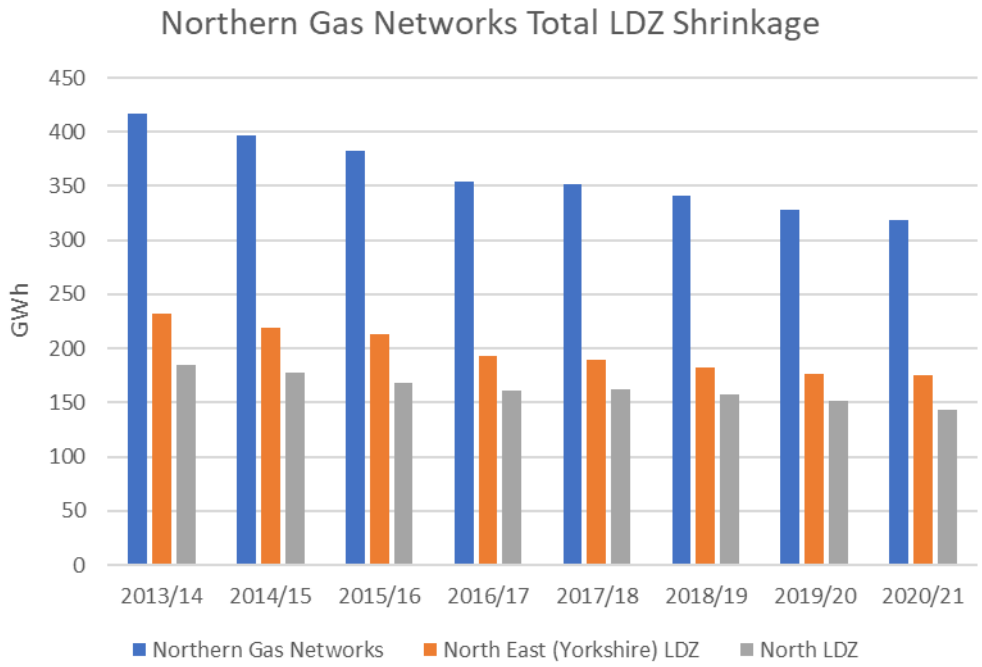
Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	141.7 GWh 71%	213km of metallic low pressure mains removed. ASP decreased by 0.1mb. Demand increased by 0.5% which means OUG and TOG increased by the same margin compared to 2019/20.	136.1 GWh 70%	-5.6 GWh -4.0%
MP Leakage	18.6 GWh 9%		18.7 GWh 10%	0.1 GWh 0.5%
Other (AGI's, OUG, Theft & Interference)	40.1 GWh 20%		40 GWh 21%	-0.1 GWh -0.2%
Total	200.4 GWh 100%		194.8 GWh 100%	-5.6 GWh -2.8%

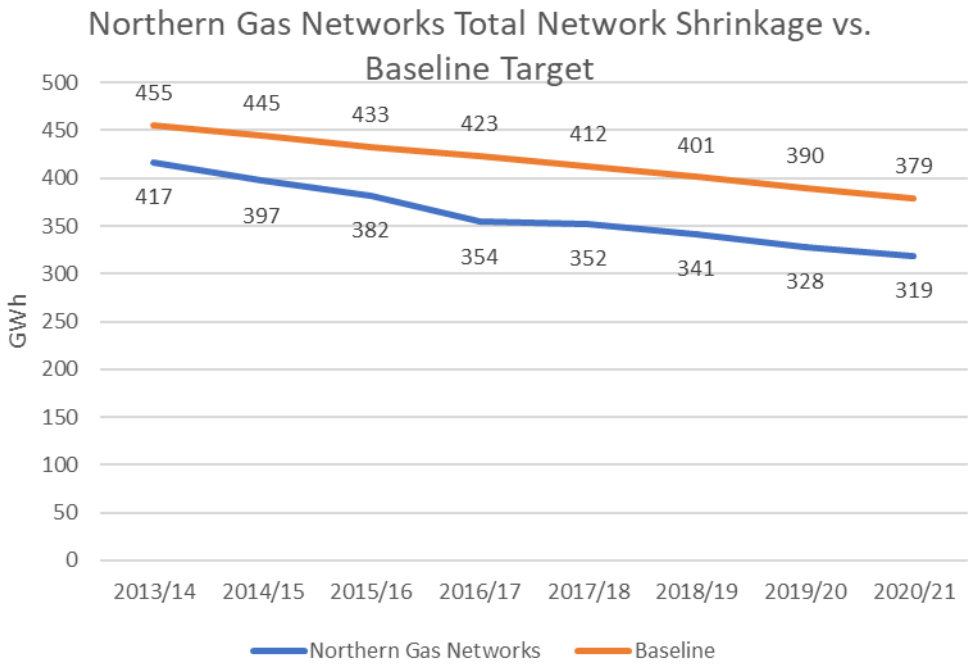
Northern Gas Network Performance

Total Network Shrinkage was reduced by 9.4GWh in 2020/21 from 2019/20.

Average System Pressure increased/decreased by 0.05mbar, metallic pipe length reduced by 405km.

Total Shrinkage in 2020/21 has reduced by approximately 2.8% compared to 2019/20.





Northern Gas Networks Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	220.9 GWh 70%	405.2km of metallic low pressure mains removed. ASP decreased by 0.1mb, MEG saturation decreased by 7%. Demand increased by 1.3% which means OUG and TOG increased by the same margin compared to 2019/20.	212.1 GWh 66%	-8.8 GWh -4.0%
MP Leakage	25.4 GWh 8%		25.1 GWh 8%	-0.3 GWh -1.2%
Other (AGI's, OUG, Theft & Interference)	70.5 GWh 22%		81.9 GWh 26%	11.4 GWh 16.2%
Total	316.8 GWh 100%		319.1 GWh 100%	2.3 GWh 0.7%

North East (Yorkshire) LDZ Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	119.5 GWh 69%	238.2km of metallic low pressure mains removed. ASP decreased by 0.1mb, MEG saturation decreased by 6.7%. Demand increased by 0.8% which means OUG and TOG increased by the same margin compared to 2019/20.	114.7 GWh 65%	-4.8 GWh -4.0%
MP Leakage	16.1 GWh 9%		16 GWh 9%	-0.1 GWh -0.6%
Other (AGI's, OUG, Theft & Interference)	38.7 GWh 22%		45 GWh 26%	6.3 GWh 16.3%
Total	174.3 GWh 100%		175.7 GWh 100%	1.4 GWh 0.8%

North LDZ Network Performance

Component	2019/20	Drivers of Change	2020/21	Difference
LP Leakage	101.4 GWh 71%	167km of metallic low pressure mains removed. ASP increased by 0mb, MEG saturation decreased by 0.3%. Demand increased by 1.9% which means OUG and TOG increased by the same margin compared to 2019/20.	97.4 GWh 68%	-4 GWh -3.9%
MP Leakage	9.3 GWh 7%		9.1 GWh 6%	-0.2 GWh -2.2%
Other (AGI's, OUG, Theft & Interference)	31.8 GWh 22%		36.9 GWh 26%	5.1 GWh 16.0%
Total	142.5 GWh 100%		143.4 GWh 100%	0.9 GWh 0.6%