Shrinkage and Leakage Model Review

Joint Distribution Network Publication

February 2023

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Shrinkage Leakage Model Review
Consultation Document
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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 2023.

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 to focus on the following areas, which are a combination of new and existing commitments.

Table 1 Summary of Commitments

	New or Existing Project	Description
Digital Platform for Leakage Analytics	**New**	Innovation programme reviewing all controllable elements of fugitive emissions.
Shrinkage Profiling	**New**	Reflecting seasonality and a daily Shrinkage profile in each year's emissions assessment.
Independent Shrinkage Expert	**New**	Support the development of MOD0828R.
Own Use Gas review	Existing	Continued investigation into the refreshment of the Own Use Gas methodology assumptions.
Pipe Remediation review	Existing	Modification to incorporate robotic mains remediation in the current Shrinkage Leakage Model methodology.
AGI Venting	Existing	Reviewing varying methods to quantify and forecast the extent and impact of AGI venting.

We value all feedback and representations; responses to this document are encouraged and should be received no later than 17th March 2023. Communication should be directed to Matt Marshall or via the Joint Office (contact details below).

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Shrinkage Leakage Model Review
Overview of Shrinkage Environmental Impact

GDNs estimate Shrinkage using an industry approved methodology and engineering model. The model applies predetermined leakage rates and is updated annually for a number of activity-based factors. All Distribution Networks use a single regulated methodology to ensure a consistent approach to determining emissions.

Elements of Shrinkage

Shrinkage is a combination of fugitive emissions (leakage), own use gas (OUG) and theft of gas (TOG). Leakage accounts for 98.9% of the environmental impact of shrinkage within the Gas Distribution Networks footprint. Details of how each element is calculated is found later in this document.

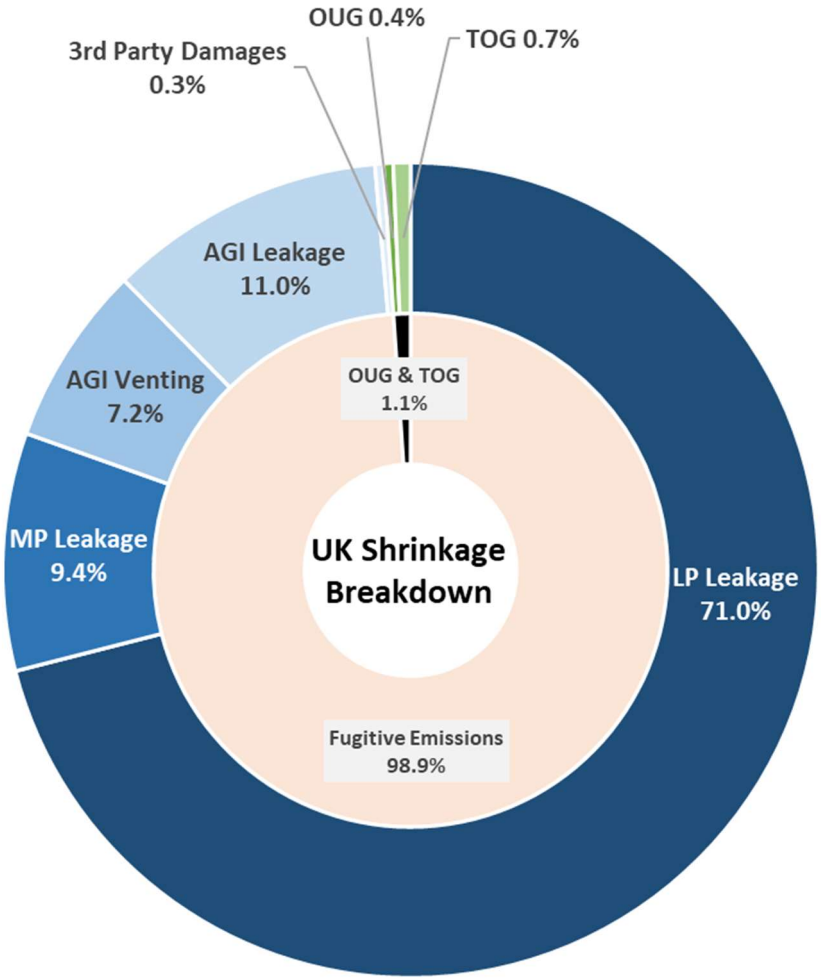
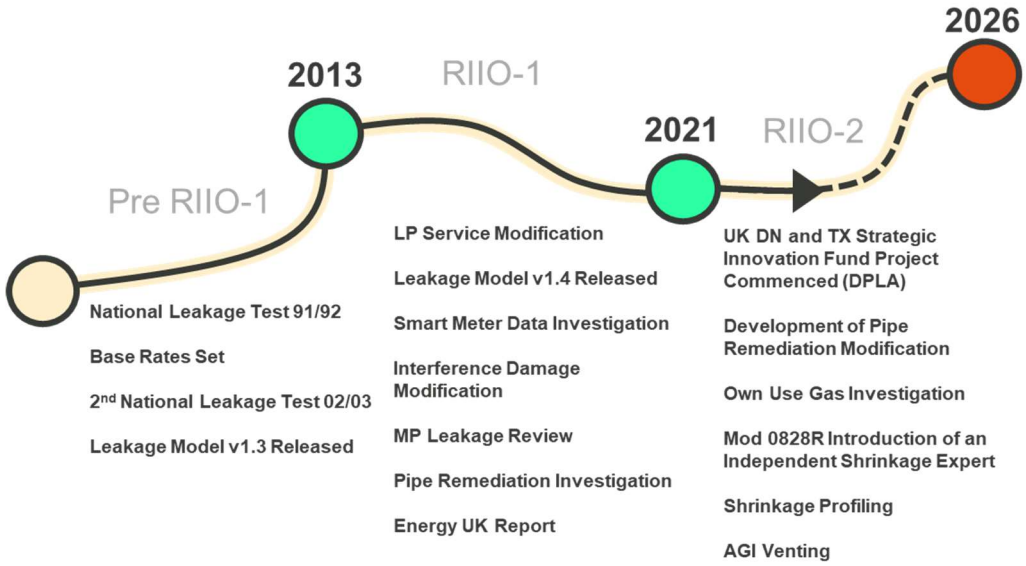


Figure 1 Breakdown of Shrinkage

Shrinkage Leakage Model Review
Overview of Shrinkage
Shrinkage Development Timeline

The methodology applied within the SLM has continued to develop over time, the graphic below demonstrates the continued evolution of shrinkage methodology and our commitments to address each of the elements.

Figure 2 Shrinkage Development Timeline



RIIO-2 Focus
The Digital Platform for Leakage Analytics (DPLA) SIF project is reviewing new technological methods to revolutionise the reporting methodology for each of the fugitive emissions elements of shrinkage. This is a collaborative project and the primary focus of all Distribution Networks.

Pipe remediation is the review of the impact of robotics on the pipe network and reflecting remediated mains leakage within the Shrinkage Leakage Model.

All DNs will continue to investigate the Own Use Gas stakeholder representation with a view to making any required alterations to the reporting methodology.

Modification 0828R, Introduction of an Independent Shrinkage Expert, was released in the final quarter of 2022. The Distribution Networks are committed to supporting the workgroup sessions.

Shrinkage profiling would see the introduction of daily and seasonal variations in shrinkage apportionment.

AGI venting is the review of the varying methods to quantify and forecast the extent and impact of venting.

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Shrinkage Leakage Model Review
Overview of Shrinkage
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.

Shrinkage emissions

The chart below demonstrates the overall reduction in emissions since 2012/13 with a total reduction in emissions of 870GWh to date. The largest contributing factor to further reduction is the continuation of the mains replacement programme, all DNs have optimised system pressure performance and gas conditioning (where used) and although we can expect some potential incremental improvements, we are targeting maintaining historic performance into the future. Capacity loss through pipe insertion and exogenous factors (periods of cold weather) could impact this.

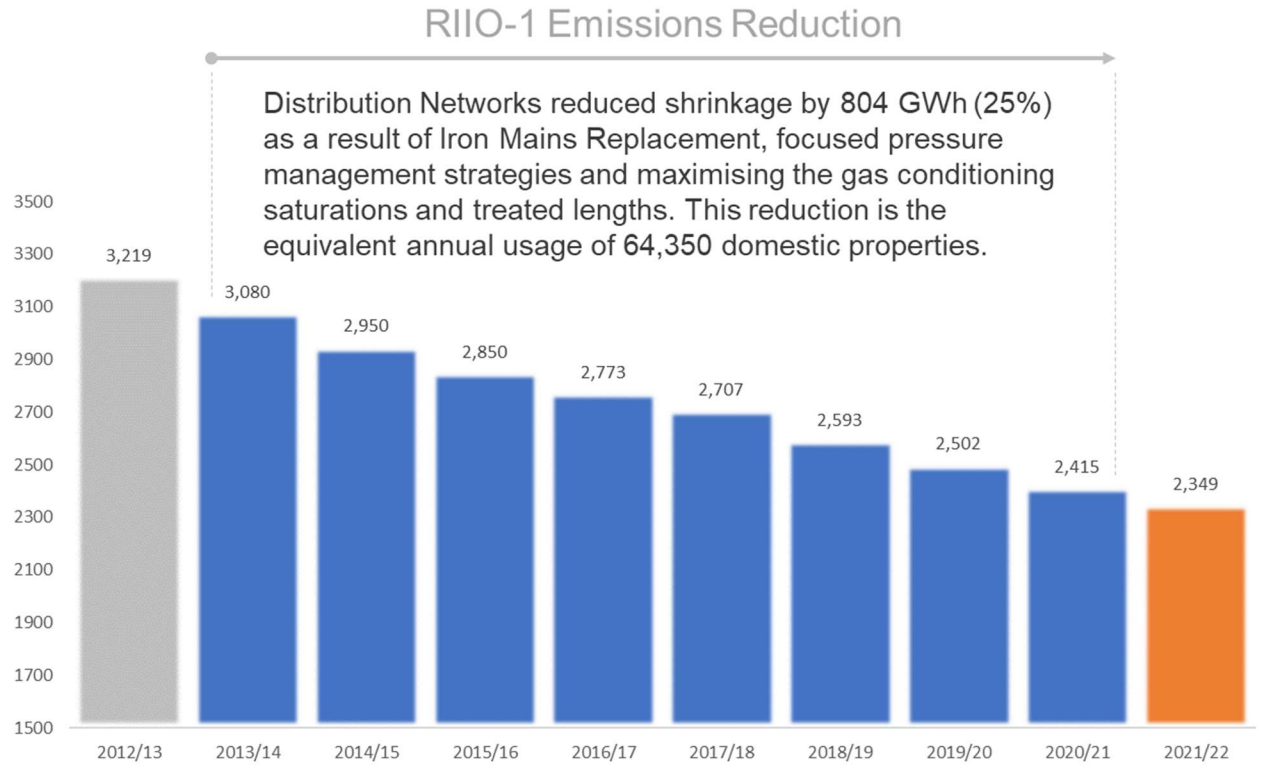

Figure 3 Shrinkage Emissions Pathway

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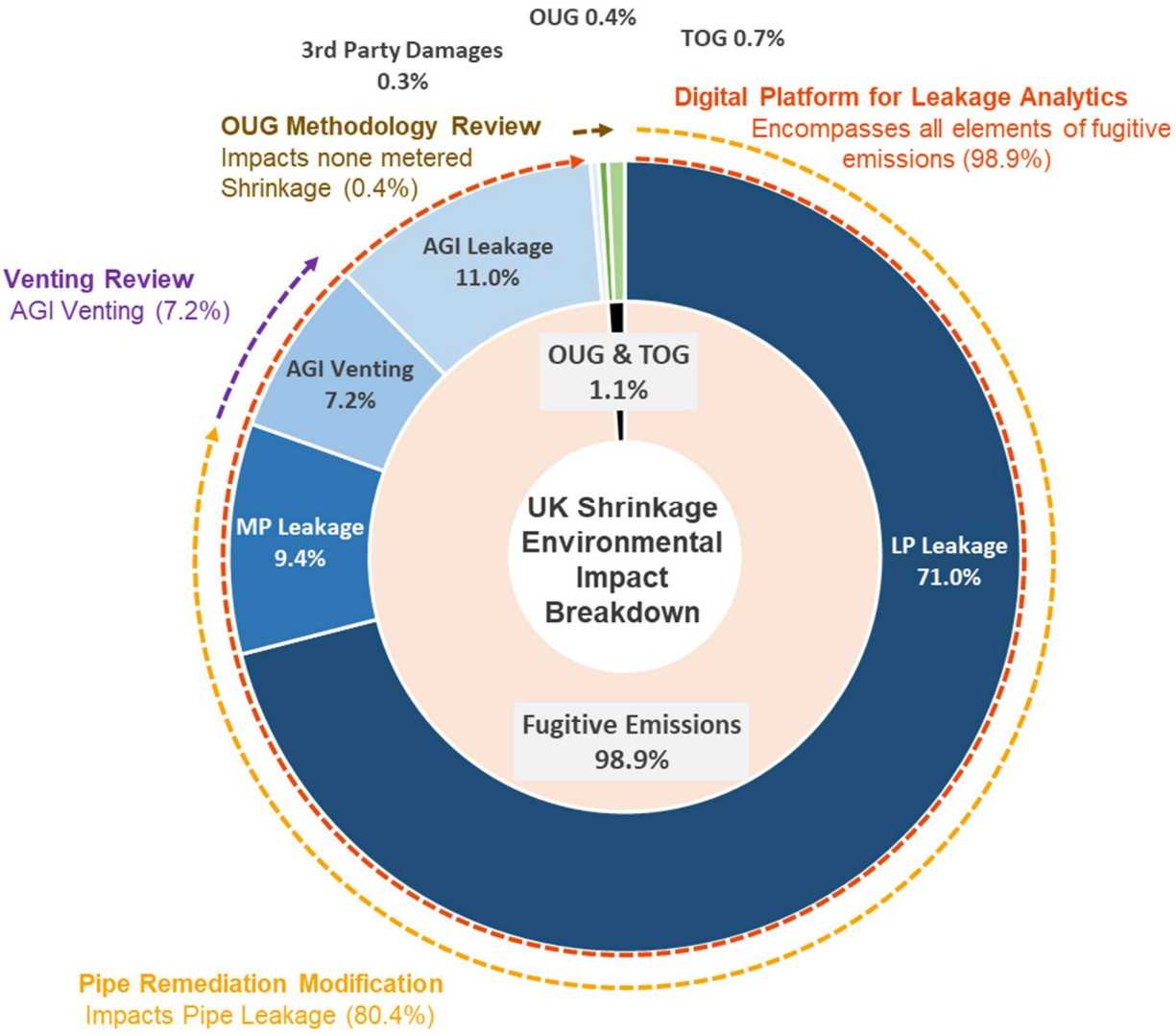
Shrinkage Leakage Model Review
RIIO-2 Commitments
Areas of Focus

The outcome of the Joint GDNs SLM review is a combination of DN initiated projects and stakeholder representations. Details of each of these projects are below, this information expands on the data contained in the executive summary.

Figure 4 Areas of Focus



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Shrinkage Leakage Model Review
RIIO-2 Commitments
Digital Platform for Leakage Analytics

Project Name: Digital Platform for Leakage Analytics (SIF Project)

Project Team: Cadent, SGN, WWU, NGN, NGG, Guidehouse

Shrinkage Components: Pipe Leakage, AGI Leakage (98.9%)

Potential Impact Assessment:

Replacement of SLM and methodologies for fugitive emissions

Granular understanding of real time asset emissions

Regulatory and procurement reporting and processes

Strategic Innovation Fund (SIF): The Strategic Innovation Fund (SIF) supports network innovation that contributes to the achievement of Net Zero, while delivering net benefits to energy consumers.

Ofgem operate the SIF in partnership with Innovate UK, which is part of UK Research & Innovation (UKRI). Ofgem is the decision maker in relation to Project Funding and its decisions on which Projects to fund are informed by the recommendations of Expert Assessors.

Strategic Innovation Fund projects are split into three funding parts, an initial Discovery phase that lasts for two months, the Alpha stage that lasts for six months, and then the final Beta stage that we'd expect to last in the region of two years for this project.

The Discovery phase is an accelerated review of the problem and understanding potential solutions, the Alpha stage of the project focuses on preparing and testing the different solutions to the problem identified during the Discovery phase, and the Beta phase focuses on the deployment of the solution to the problem.

Project Overview: Technological advances since the inception of the current Shrinkage and Leakage Model opened up opportunities for reform. The Digital Platform for Leakage Analytics (DPLA) Project aims to develop a new approach to quantifying and locating leaks from GDNs using a combination of cutting-edge technology, hydraulic modelling and advanced algorithms. This is a big change from the current SLM, which uses a static, theoretical approach, and would make it one of the most advanced methods in Europe. The new approach will also improve operational decision making, maintenance and asset replacement strategies, customer safety, and deliver better value for customers by decreasing the socialised costs of gas leakage.

Shrinkage Leakage Model Review
RIIO-2 Commitments
Digital Platform for Leakage Analytics

The project is at the end of the Alpha Phase which focussed on the following areas:

- Testing, research and feasibility studies of leak detection technologies: including methane sensors, mobile ground labs, drone-based sensing and helicopter-based LiDAR technology
- Testing, research and vendor assessment for digital leakage analytics platform development
- Impact assessment of leakage methodology change: including IT systems integration, operational protocols, Health and Safety Executive considerations, workforce management
- Regulatory considerations: regulatory changes, arrangements and incentives
- Business considerations: cost benefit analysis business case, commercial design options

The next steps of the project would be to apply for Beta Phase approval. A successful Beta Phase would set the framework for the deployment of a DPLA, enabling the aggregation of leakage information for the first time.

Baseline Impacts: New Baselines Required.

Expected Completion: January 2023, Beta – Application Process Ongoing.

Figure 5 Example of DPLA Output Reports

Shrinkage Leakage Model Review
RIIO-2 Commitments
Own Use Gas Methodology Review

Project Name: Own Use Gas methodology review

Project Team: NGN, SGN, WWU, Cadent

Shrinkage Components: Own Use Gas (0.4%)

Potential Impact Assessment:

Update of Own Use Gas methodology

Accuracy of reporting

Project Overview:

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 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.

At the time of print, all Distribution Networks have supplied the required supporting information to DNV (industry expert organisation), and a programme of works to utilise this information and ratify the current approach to Own Use Gas calculations is underway, supplemented by regular communication and progress updates with the Authority.

This item remains a standard agenda item at the Joint Office Shrinkage Forum.

Baseline Impacts: New Baselines Required.

Expected Completion: Anticipated Completion 2023.

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Shrinkage Leakage Model Review
RIIO-2 Commitments
Pipe Remediation Review

Project Name: Pipe Remediation

Project Team: SGN

Shrinkage Components: Pipe Leakage (80.4%)

Potential Impact Assessment:

Update of pipe leakage rates

Accuracy of reporting

Project Overview: The 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.

SGN continue to review and are close to releasing a modification consultation relating to the use of robotics on the pipe network, which would better reflect remediated mains leakage within the Shrinkage Leakage Model. 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.

The introduction of this modification would have a short term impact on accuracy of reporting and in the event of a successful deployment of the DPLA project would be superseded by new methods of reporting, for example, the use of above ground methane detection sensors would report real time emissions and capture the benefits of robotics as part of that assessment.

Baseline Impacts: None expected.

Expected Completion: 2023/24.

Shrinkage Leakage Model Review
RIIO-2 Commitments
Independent Shrinkage Expert

Project Name: Modification 0828R – Introduction of an Independent Shrinkage Expert

Modification Owner: OVO Energy

Shrinkage Components: All

Potential Impact Assessment:

Unknown

Project Overview: Modification 0828R, Introduction of an Independent Shrinkage Expert, was released in the final quarter of 2022. This modification is proposing an alternate method of shrinkage management and the appointment of a new role to the UNC. The workgroup panel is requested to investigate the introduction of the new role and what activities the ISE should be responsible for, this could include the production of the Shrinkage Leakage Model and refreshment of modelled emissions rates through innovation. The Distribution Networks are committed to supporting the workgroup sessions.

Baseline Impacts: Unknown.

Expected Completion: Unknown.

Further Information: https://www.gasgovernance.co.uk/0828

Shrinkage Leakage Model Review
RIIO-2 Commitments
Shrinkage Profiling

Project Name: Shrinkage Profiling

Project Team: SGN, NGN, Cadent, WWU

Shrinkage Components: Annual Profiling

Potential Impact Assessment:

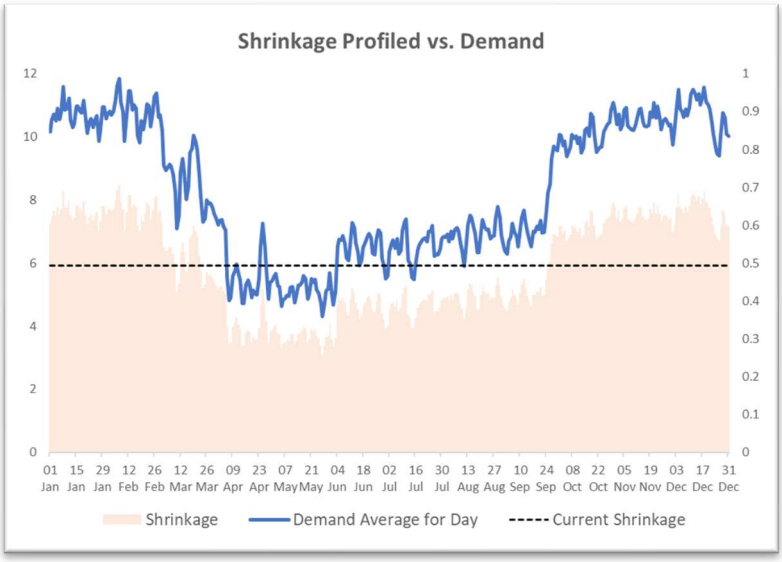
Shrinkage Gas Procurement

Accuracy of Reporting

Project Overview: Shrinkage volumes are calculated on an annual basis using a combination of actual asset data and average performance measures over the year (for example average system pressures in different localities across the network). These shrinkage volumes are currently assumed as flat across a year, in other words it is assumed an equal amount of gas is lost through shrinkage in each day across the regulatory year. This project will look at methods to align shrinkage to applicable annual profiles (an example below is shown linking shrinkage to a typical daily demand profile) which would help to mitigate misallocation of gas volumes between shrinkage and unidentified gas over shorter time periods.

Baseline Impacts: None expected.

Expected Completion: Unknown.



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Shrinkage Leakage Model Review
RIIO-2 Commitments
AGI Venting

Project Name: AGI Venting

Project Team: NGN, WWU

Shrinkage Components: AGI Venting (7.2%)

Potential Impact Assessment:

Potential Calculation Change

Accuracy of Reporting

Project 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.

Currently there are varying methods to different degrees of sophistication, to quantify and forecast the extent and impact of venting.

The Gas Venting Research project was a desktop study which reviewed the available literature and procedures to identify current venting processes and equipment from the gas distribution networks. This also included the quantification of manual and automatic venting volumes based on 2014-2019 data. The technical experts estimated a total venting volume for 2019 which was 32.2% and 21.9% of what was reported by WWU and NGN respectively for the AGI venting component of shrinkage. As the AGI venting component was sourced from a 1994 Watt Committee Report where derivations are unknown, a direct comparison cannot be made.

The recommendations from the AGI Venting project to reduce emissions continue to be explored including the trial of alternatives to venting devices and conducting a review of operating procedures to minimise gas losses as far as possible.

Baseline Impacts: Unknown.

Expected Completion: Unknown.

Shrinkage Leakage Model Review
Calculating Shrinkage
Components of Shrinkage

This section details each of the components of shrinkage which includes assumptions, % influence of each component on the total volume and the current calculation methods.

Shrinkage is comprised of three elements (fugitive emissions, theft of gas and own use gas), of which fugitive emissions contributes around 98.9% of the total environmental impact. Detail of how each element is calculated is found within this section.

Figure 6 Seven Components 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

Shrinkage Leakage Model Review
Calculating Shrinkage
Components of Shrinkage

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 assurance processes to ensure the data reported is timely, accurate and complete.

Table 2 Summary of the key data used to calculate Shrinkage

Number of Networks	Length of Mains (Low and Medium Pressure)	Above Ground Installations (AGIs)	No. of Services
2,318	256,000 km	109,000	23,000,000

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. The data is subject to a detailed internal review and approvals process in alignment with Ofgem's DAG as part of the annual Regulatory Reporting Pack (RRP) submission. Also used to compile the annual assessment.

The image below shows an example of a simplistic network composition and examples of the sources of shrinkage.

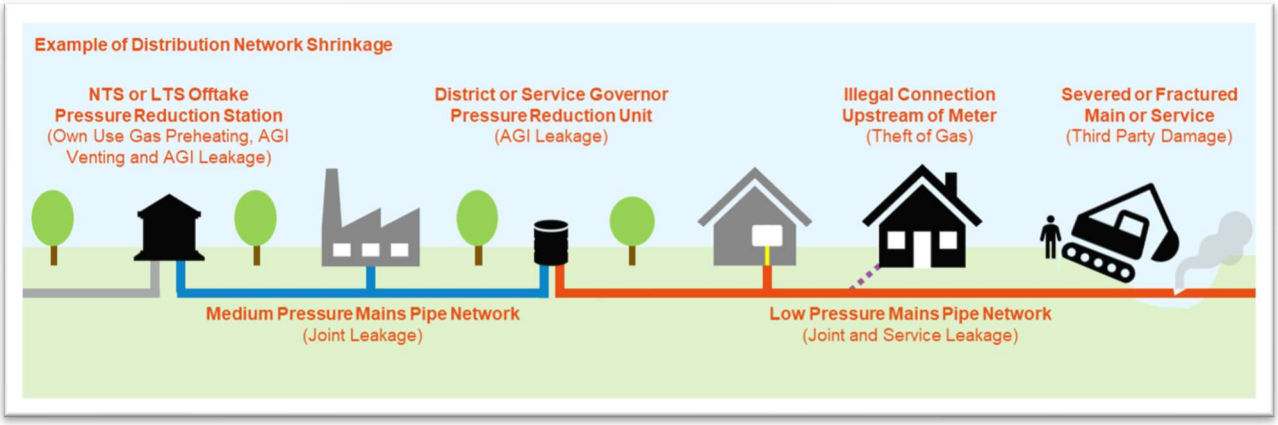


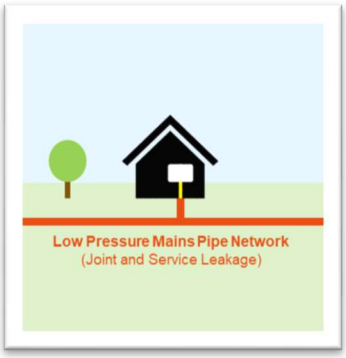
Figure 7 Example of Simplistic Network Composition with Shrinkage Points

The methodology for each component is detailed in the following pages.

Shrinkage Leakage Model Review
Calculating Shrinkage
Low Pressure Mains and Service Leakage

Component: Low Pressure Mains and Service Leakage

Component Type: Fugitive Emission



Weighting: Circa 71.0% of Shrinkage

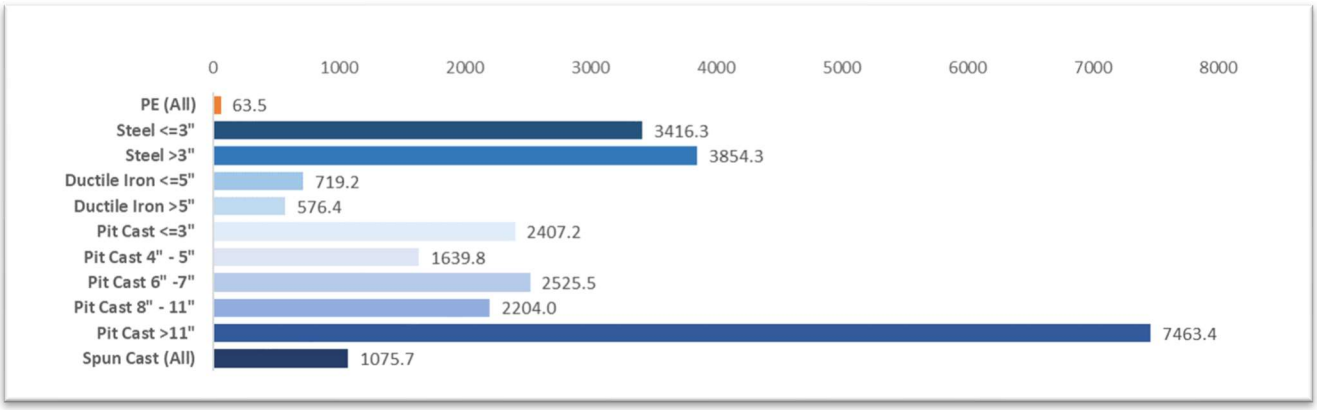
LP Mains Calculation: Asset length (km) X annual leakage rate X average system pressure correction X Mono-ethylene Glycol correction (where applicable)

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

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

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

Figure 8 Low Pressure Leakage Rates in cu.m/Annum/K at 30mb Pressure



Background: The National Leakage Test (NLT), commissioned by the UK GDNs, remains world leading in both scale and accuracy for this type of testing methodology. The tests involved sampling 849 Low Pressure pipes and 6,054 services and determined the annual leakage rates per asset type.

Link to Commitments:

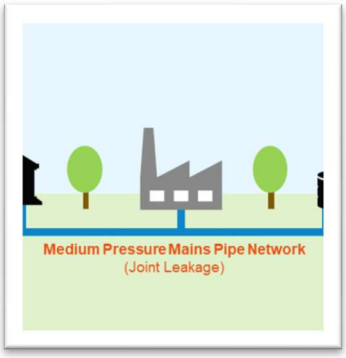
Short Term: Pipe remediation modification to reflect the benefits of robotics on leakage.

Medium Term: DPLA project is reviewing methods to supersede the current calculation methodology.

Shrinkage Leakage Model Review
Calculating Shrinkage
Medium Pressure Leakage

Component: Medium Pressure Mains Leakage

Component Type: Fugitive Emission



Weighting: Circa 9.4% of Shrinkage

Medium Pressure Mains Calculation: Asset length (km) X annual leakage rate

Medium Pressure Mains Rates: LP Leakages rates at 30mbarg

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.

Link to Commitments:

Short Term: Pipe remediation modification to reflect the benefits of robotics on leakage.

Medium Term: DPLA project is reviewing methods to supersede the current calculation methodology.

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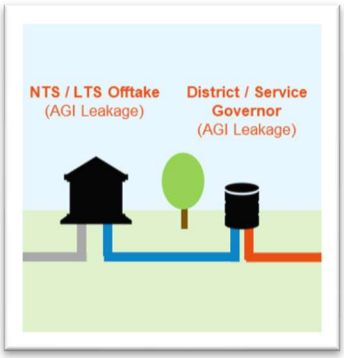
Shrinkage Leakage Model Review
Calculating Shrinkage Above Ground Installation Leakage

Component: Above Ground Installation Leakage

Component Type: Fugitive Emission



Weighting: Circa 11.0% of Shrinkage

AGI Leakage Calculation: Asset type (number) x annual leakage rate

AGI Leakage Asset Types: Holder Station, NTS Offtakes, LTS Offtakes, District and Service Governors

AGI Leakage Rates: Ranges from 8 to 31,075 m3/year/site

Background: The AGI sample plan included a total of 536 sites across the UK and utilised two leakage measurements techniques, Fugitive Measurement Device (FMD) and Area Survey Vehicle (ASV). The University of Nottingham were engaged to carry out an independent validation of the techniques involved. 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 AGIs which are in service today are of similar nature compared to what was in use in 2003.

Table 3 AGI leakage components and associated leakage rates

Asset Type	Leakage (m3/year/site)	Number Surveyed
Holder Station	7,692	24
NTS Offtake	31,075	67
Local Transmission Offtake	6,485	145
District Governor	407	246
Service Governor	8	54

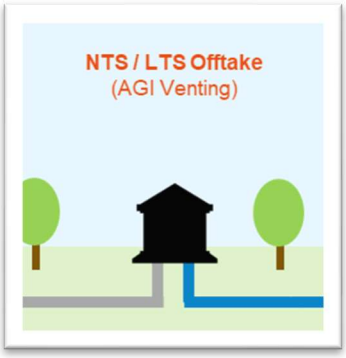
Link to Commitments:

Medium Term: DPLA project is reviewing methods to supersede the current calculation methodology.

Shrinkage Leakage Model Review
Calculating Shrinkage Above Ground Installation Venting

Component: Above Ground Installation Venting

Component Type: Fugitive Emission



Weighting: Circa 7.2% of Shrinkage

AGI Venting Calculation: Fixed annual leakage volume for each LDZ

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.

Link to Commitments:

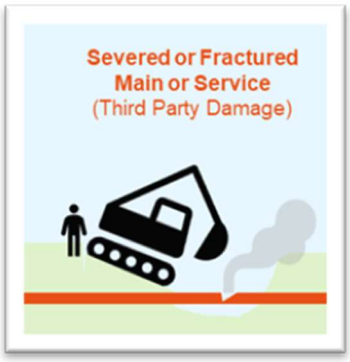
Short Term: AGI Venting investigation would improve short term confidence.

Medium Term: DPLA project is reviewing methods to supersede the current calculation methodology.

Shrinkage Leakage Model Review
Calculating Shrinkage
Third Party Damages

Component: 3rd Party Damage (Interference Damage)

Component Type: Fugitive Emission



Weighting: Circa 0.3% of Shrinkage

>500kg Calculation: An assessment is made of each incident and included in the SLM

<500kg Mains Calculation: Number of incidents split between low and medium pressure with different leakage rates applied

<500kg Service Calculation: Number of incidents split between severed and punctured services with different leakage rates applied to each

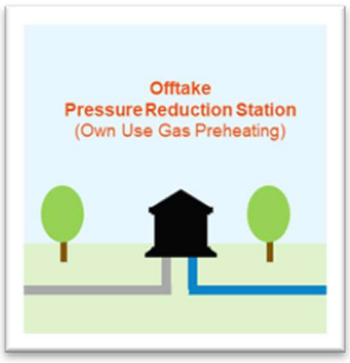
Background: Interference damage is the gas escaping into the atmosphere as part of an unplanned incident usually caused by third party damage. Interference damage is split into two categories, above and below 500kg of gas released and is calculated using assumed leakage rates per incident together with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

Shrinkage Leakage Model Review
Calculating Shrinkage Own Use Gas

Component: Own Use Gas

Component Type: Gas Used for Operational Purposes



Weighting: Circa 0.4% of Shrinkage

OUG Calculation: 0.0113% of LDZ Throughput

Background: Own Use Gas (OUG) refers to gas used by the transporter for operational purposes, primarily preheating, 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 RIIO-2, we describe our intention to develop a proposal to be submitted to the Authority, for a 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.

Link to Commitments:

Short Term: Own Use Gas review in conjunction with DNV.

Medium Term: Short term refreshment of rates or assumptions would be incorporated into any future DPLA platform.

Long Term: Replacing Natural Gas with Hydrogen would result in the removal of the requirement for preheating equipment and the associated fuel usage.

Shrinkage Leakage Model Review
Calculating Shrinkage
Theft of Gas

Component: Theft of Gas

Component Type: Gas Stolen by a Third Party

Weighting: Circa 0.7% of Shrinkage

TOG Calculation: 0.02% of LDZ Throughput

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 5 and September 6 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.

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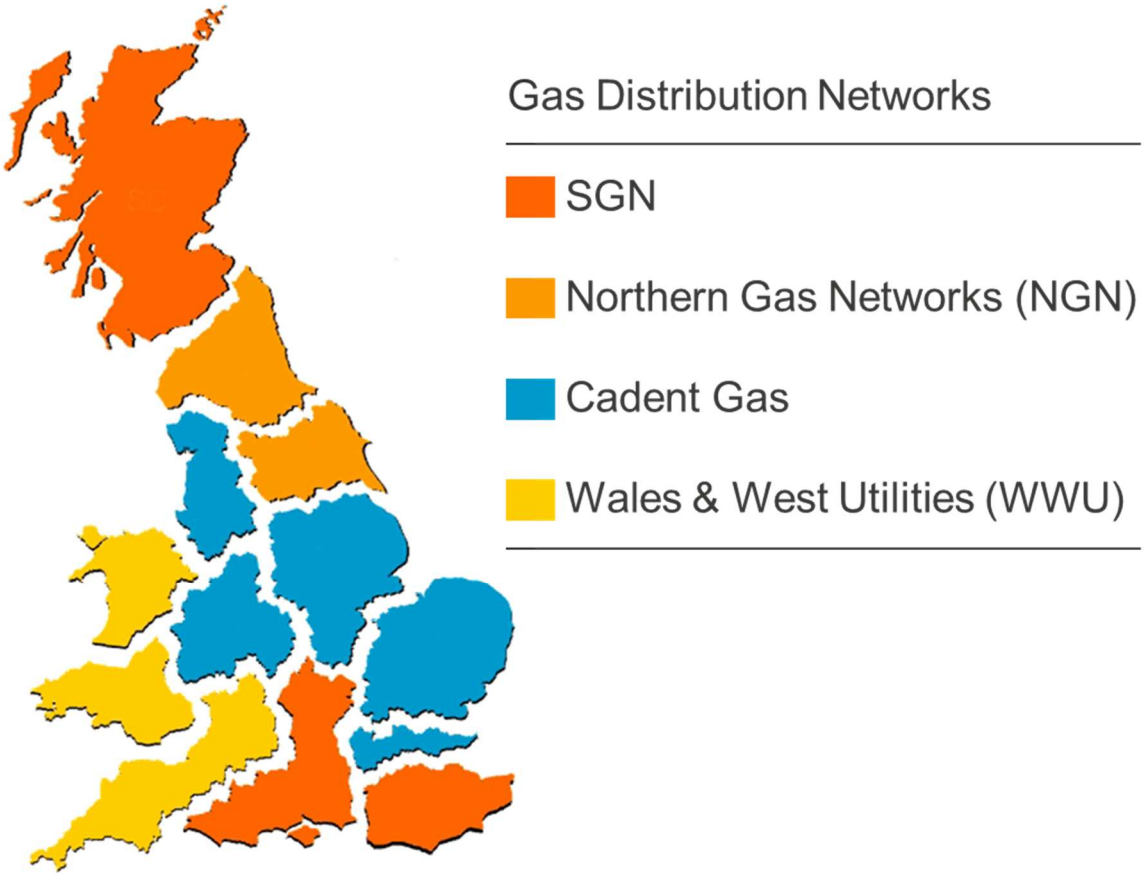
Shrinkage Leakage Model Review
Shrinkage Performance Network Breakdown

The performance breakdown contained within the following pages demonstrates the main components of shrinkage for each Distribution Network.

The network map below shows the geographic location of each network operator.



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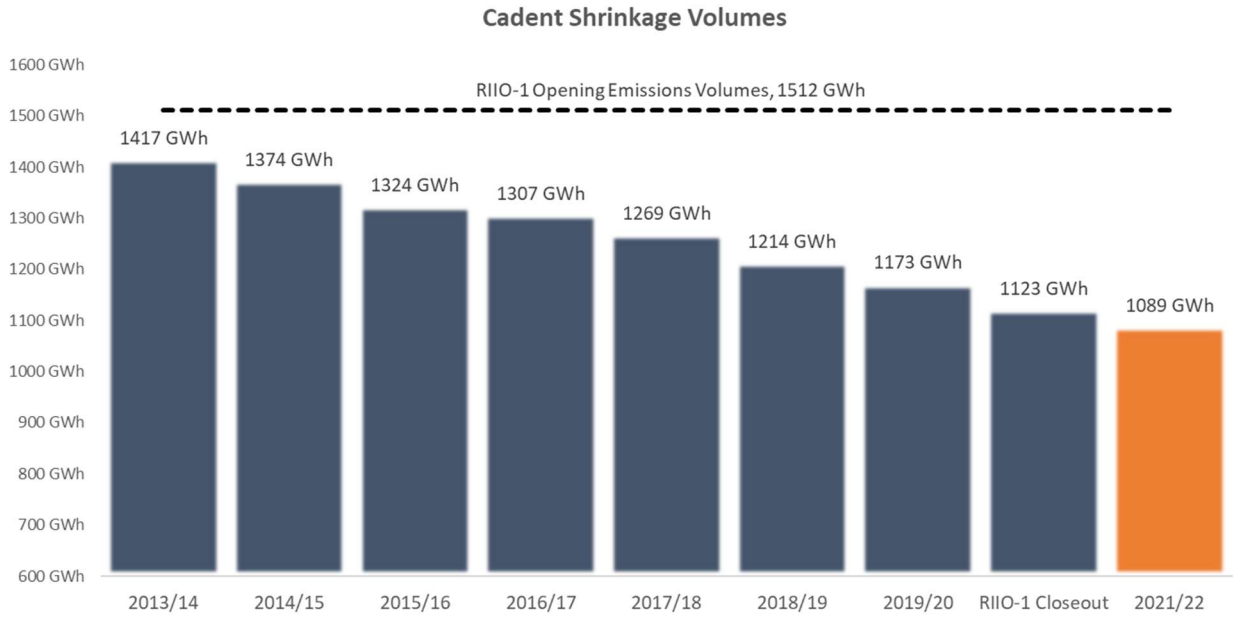
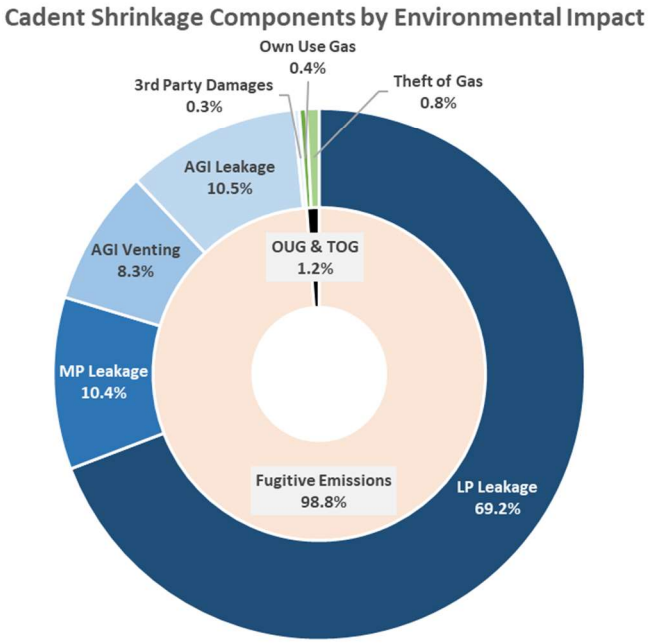
Shrinkage Leakage Model Review
Shrinkage Performance
Cadent

Total Cadent shrinkage reduced by 34GWh in 2021/22 compared to 2020/21, and by 423GWh from the start of RIIO-1.





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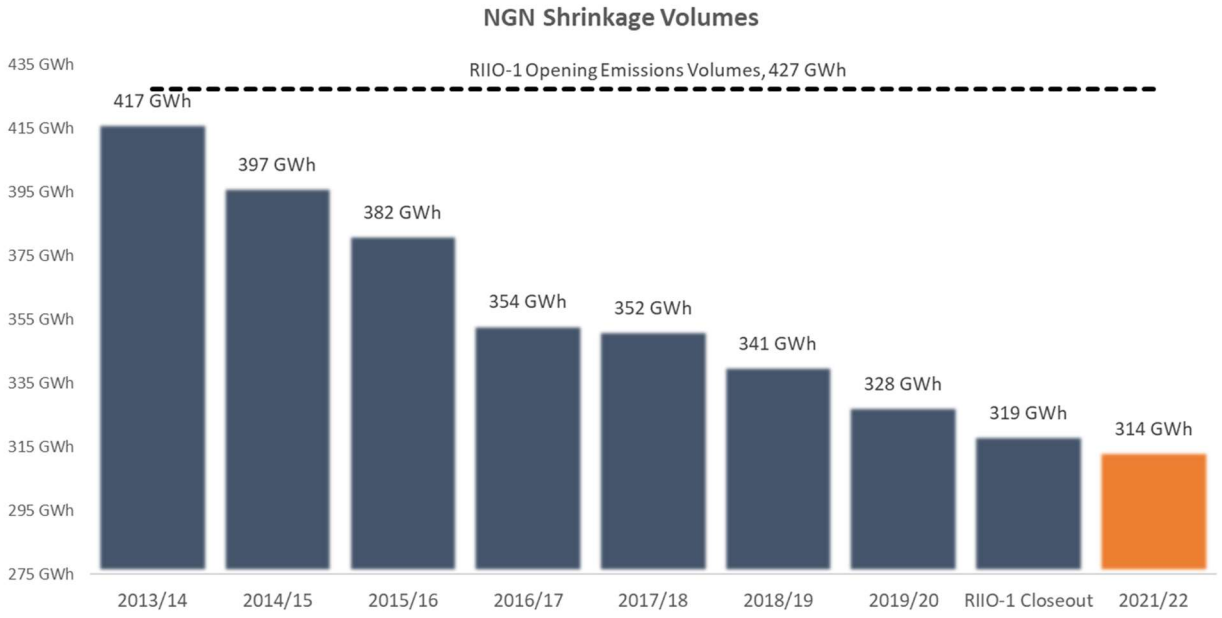
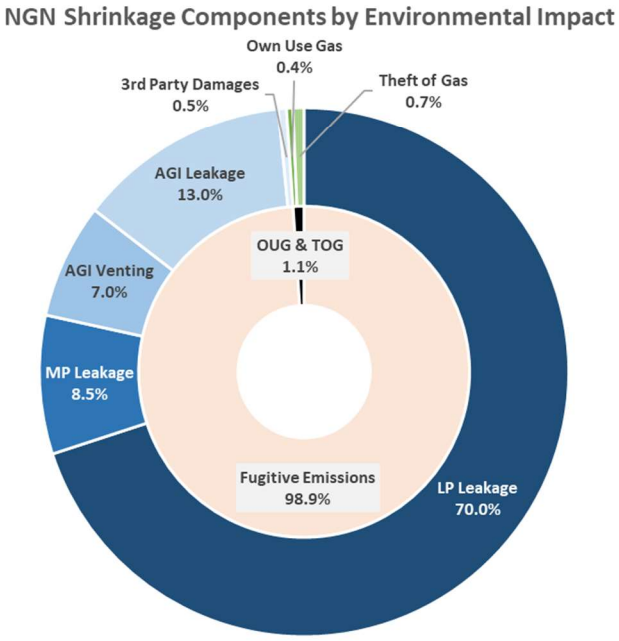
Shrinkage Leakage Model Review
Shrinkage Performance
Northern Gas Network

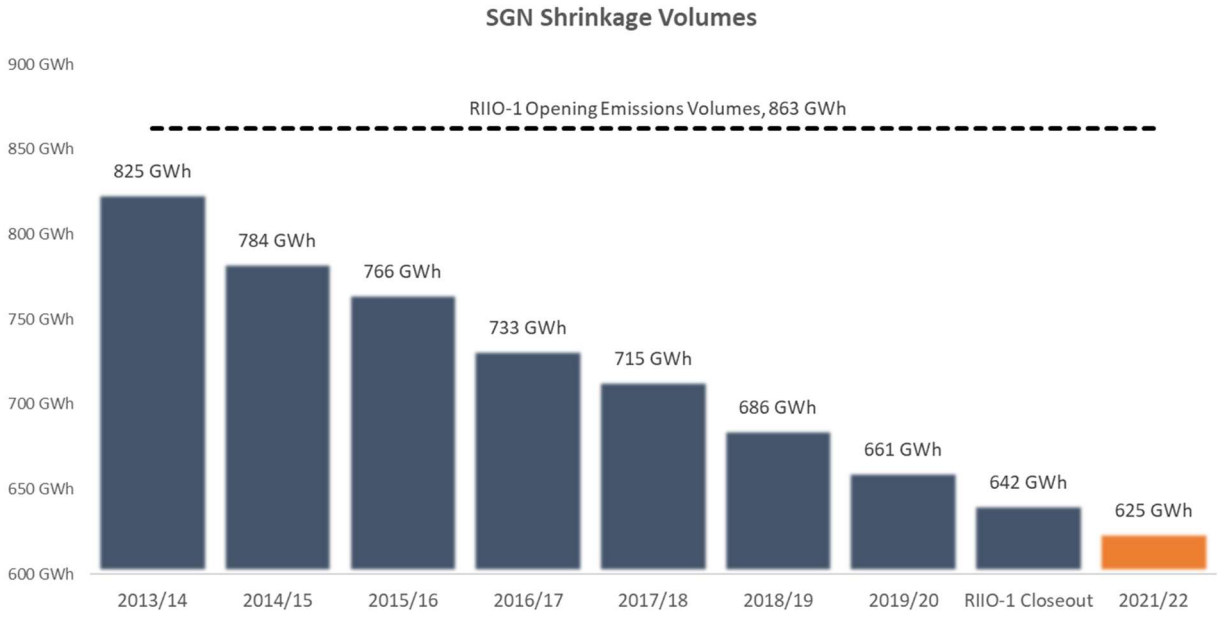
Total Northern Gas Network shrinkage reduced by 5GWh in 2021/22 compared to 2020/21, and by 113GWh from the start of RIIO-1.

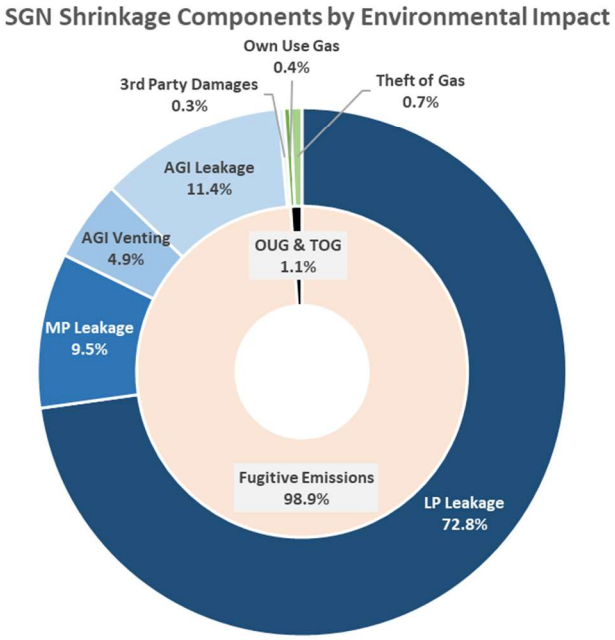




Shrinkage Leakage Model Review
Shrinkage Performance
SGN

Total SGN shrinkage reduced by 16GWh in 2021/22 compared to 2020/21, and by 237GWh from the start of RIIO-1.





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Shrinkage Leakage Model Review
Shrinkage Performance
Wales & West Utilities

Total Wales & West Utilities shrinkage reduced by 11GWh in 2021/22 compared to 2020/21, and by 97GWh from the start of RIIO-1.