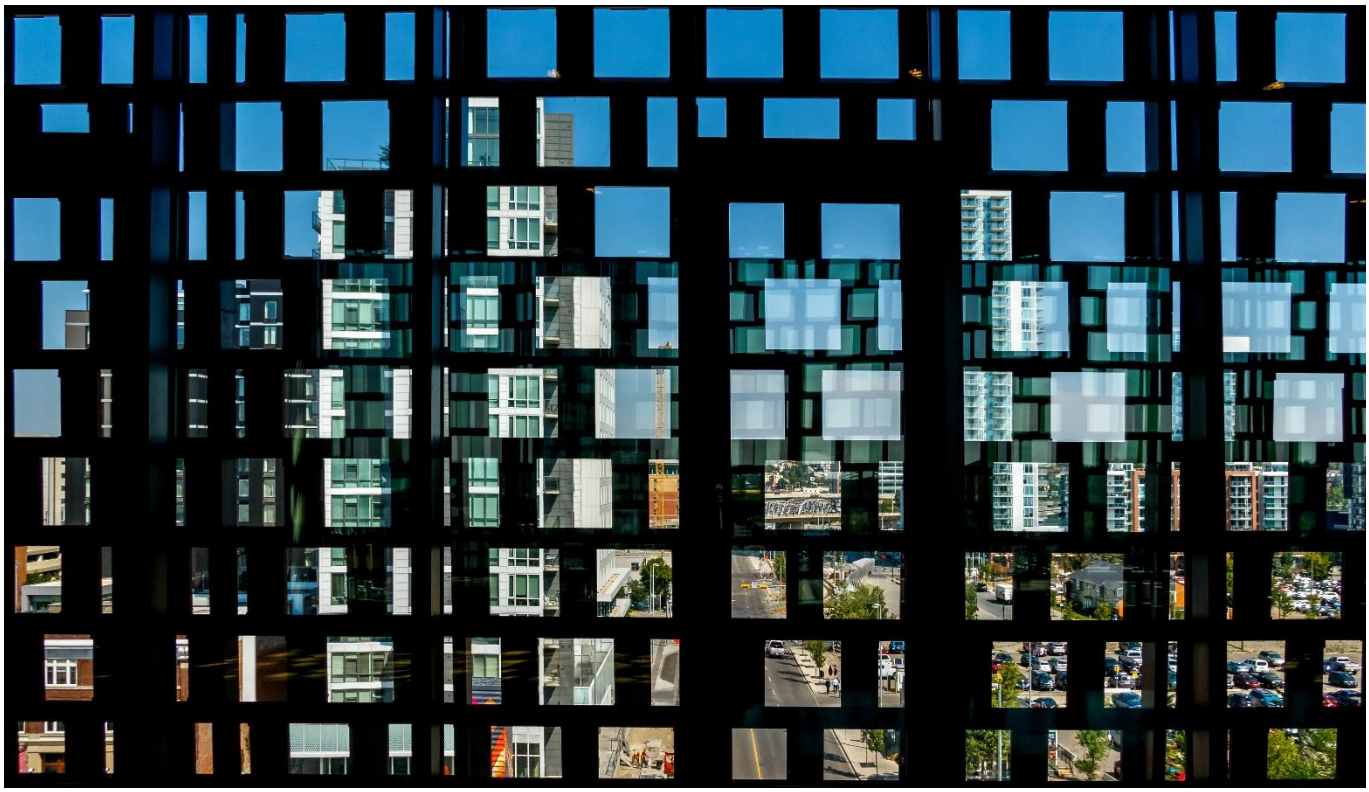
Report
March 2020

Investigating the methods used to set committed Levels of Service (LoS)



National Infrastructure Commission (NIC)
Our ref: 23708101
Client ref: CCZZ19A37

steer

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Investigating the methods used to set committed Levels of Service (LoS)

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Abbreviations

AMP Asset Management Period

BEIS Department for Business, Energy and Industrial Strategy

BCMR Business Connectivity Market Review

CBA Cost Benefit Analysis

CML Customer Minutes Lost

CP Control Period

CRI Compliance Risk Index

DCC Data Communications Company

DCMS Department for Digital, Culture, Media and Sport

DECC Department of Energy & Climate Change

Defra Department for Environment, Food and Rural Affairs

DfT Department for Transport

DNO Distribution Network Operators

DWI Drinking Water Inspectorate

DYAA Dry Year Annual Average

ENS Energy Not Supplied

ERI Event Risk Index

FTTP fibre-to-the-premises

HE Highways England

LoS Level of Service

NIC National Infrastructure Commission

NR Network Rail

Ofcom Office of Communications

Ofgem Office of Gas and Electricity Markets

Ofwat	**Water Services Regulation Authority**
ORR	**Office of Rail and Road**
QoS	**Quality of Service**
RDG	**Rail Delivery Group**
RIS	**Road Investment Strategy**
RP	**Revealed Preference**
SP	**Stated Preference**
TOC	**Train Operating Company**
TSO	**Transmission System Operator**
UK	**United Kingdom**
USO	**Universal Service Obligation**
VoLL	**Value of Lost Load**
LoLE	**Loss of Load Expectation**
WTA	**Willingness To Accept**
WTP	**Willingness To Pay**

Appendices

Executive Summary

Overview

In August 2019, to support the analysis undertaken as part of its resilience study[1], the National Infrastructure Commission (NIC) commissioned Steer to investigate the methodologies used to set committed Levels of Service across four infrastructure sectors. The views expressed and recommendations set out in this report are the authors' own and do not necessarily reflect the position of the NIC.

This project focuses on the methodologies (divided between benchmarking and appraisal techniques) used to set committed LoS thresholds, rather than the value of the thresholds themselves. It focussed on four key infrastructure sectors: Energy, Water, Transport (strategic roads and national rail) and Digital.

The methodologies were categorised into various typologies and then assessed against specific criteria, with the conclusions of the analysis being used to develop "best practice" suggestions.

As part of this project, a panel of experts – one for each sector – was established to help identify, explore and reflect on the information available in the public domain. Stakeholder interviews and a workshop helped validate the findings of the desk-based research and, when necessary, provided additional documents not available in the public domain.

The work undertaken was based on a list of 19 Level-of-Service (LoS) metrics that were selected from across the four key infrastructure sectors and which included international examples.

Methodology evaluation summary

Benchmarking

To determine the committed LoS, the methodology of **benchmarking across companies compares** LoS performance across companies in a specific sector while **benchmarking from previous performance** uses previous performance data from the same (or similar) infrastructure. Whilst we assessed benchmarking methodologies as a group, we recognise that the context of its use can be quite different across companies, sectors and especially countries.

The methodology of **benchmarking across companies** has the following attributes:

- If used appropriately as part of a wider incentive framework, it can be useful for driving competition and, therefore, encouraging better service for users.
- International benchmarking is only used to provide "basic" values, meaning values which can be defined precisely and simply, and which are comparable across countries. These values are mainly used as inputs to the methodology (for example, quantifying the usage of a service per person, such as water or electricity consumption).

The methodology of **benchmarking from previous performance** is widely used, often to triangulate other methodologies. It has the following attributes:

- It is most appropriate for setting short-term LoS thresholds as it provides a comparison of performance across the board at a specific moment in time (it is less appropriate for

[1] https://www.nic.org.uk/our-work/resilience/

setting longer term thresholds as it cannot capture externalities and structural change in each company).
- It is often used to validate results of Cost-Benefit Analysis.
- It requires a relatively large amount of performance data from previous years and is, therefore, not suitable for recently established metrics.

Appraisal techniques

In general, **Cost-Benefit Analysis (CBA)** methodologies are appraisal techniques used to compare the monetised value of benefits against the cost of investments for a specific project. The outcome, labelled the cost-benefit ratio, represents the “value for money” of a business or project investment. The **cost driven methodology** focuses primarily on the cost side of the CBA, while the **benefit driven methodology** focuses on the benefit side of the CBA.

CBA is a popular methodology and has the following advantages:

- It can be used to establish thresholds for the medium to long term.
- It is mostly used for everyday events.
- It is better than the other methodologies at taking account of local and sector-specific considerations (especially if benefits are calculated by user segment).
- It is also used for "non-standard" performance metrics and for metrics that have a very specific context.
- However, it is not used extensively as it could, because it is costly in terms of resources (time, money and data).

The **cost driven methodology** can be employed:

- When resources available to carry out the assessment are limited.
- For extreme events: to determine expected outcomes (event probability multiplied by costs associated with the event).

The **benefit driven methodology** is rarely used:

- As costs are usually taken into account in setting LoS thresholds.
- It is a complex methodology which can require the use of demanding appraisal techniques and significant user engagement.

1 Introduction

1.1 This section provides an introduction to the Levels of Service (LoS) Methodology project[2], defines concepts related to infrastructure reliability, sets out the background to and the wider context of the project, and explains the structure of this report.

This project

1.2 In August 2019, to support the analysis undertaken as part of its resilience study [3], the National Infrastructure Commission (NIC) commissioned Steer to investigate the methodologies used to set committed Levels of Service across four infrastructure sectors.

1.3 Building and preserving the resilience of infrastructure is essential for maintaining society's safety and security. Infrastructure is the basis of modern life, providing a range of services from an individual to a societal level: necessities such as water and electricity, which are often take for granted, and on a larger scale, infrastructure such as transport and digital, enable nations to increase their productivity and grow their economies.

1.4 It is imperative that policymakers understand how resilient the UK infrastructure is and are able to commit infrastructure providers to targeted levels of performance. The resilience of infrastructure is defined here as its capacity to maintain specific LoS for its users, despite the various stresses it can undergo due to everyday use and external factors, or due to major disruption. It is therefore also important for policymakers to understand the analytical approaches of how to determine committed LoS for different infrastructure systems in different scenarios.

Aim and deliverables of the project

1.5 The **aim of this project** is to identify and evaluate how costs, benefits and consumer expectations are balanced (or "methodologies") to set committed Levels of Service for infrastructure performance.

1.6 The focus of this project is on the type of methodologies used to set committed LoS thresholds (e.g. Cost-Benefit Analysis (CBA), benchmarking, past performance, etc.), rather than the value of the thresholds themselves. For example, if the target threshold for train reliability is set at "92.5% of trains arrive on time", this project examines how the 92.5% was determined and the pros and cons of the methodology used, but it passes no judgment on whether or not 92.5% is an appropriate value.

1.7 In addition, although not a direct aim of the project, the NIC is keen to understand if and how it would be possible (or not) to standardise a methodology to systematically set committed LoS across sectors.

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[2] Contract Reference: CCZZ19A37 - Resilience Study: Levels of Service methods study

[3] https://www.nic.org.uk/our-work/resilience/

1.8 The deliverables of this project are to present the results of an evaluation of the methodologies against specific criteria, examining the costs, benefits, customer expectations and other – less typical – aspects of those methodologies.

1.9 This project looks at methodologies used to set committed LoS across four key infrastructure sectors: Energy, Water, Transport[4] and Digital.

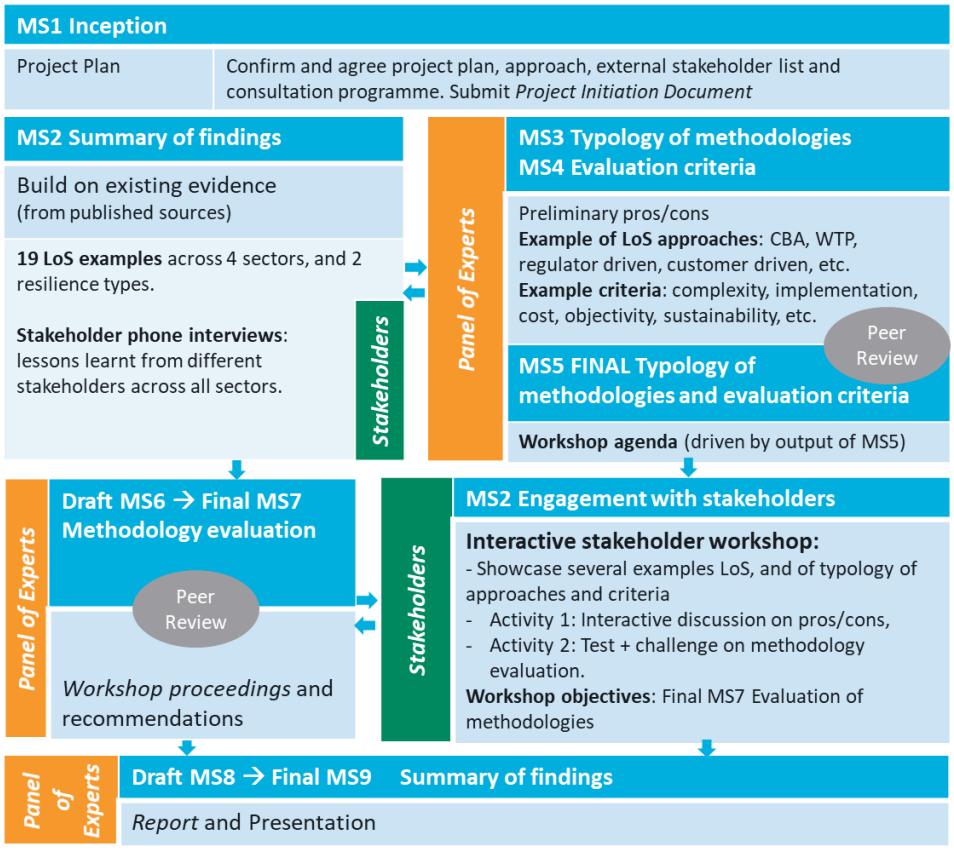
Our approach

1.10 Our approach has been divided into five tasks:

- Selection of LoS metrics and methodologies;
- Establishing the typology of each methodology;
- Identifying and agreeing evaluation criteria;
- Evaluating each methodology, identifying its strengths and weaknesses; and
- Assessing the transferability of the various approaches across sectors.

1.11 Figure 1.1 below sets out the overall approach to the project, identifying the steps and milestones (MS) in its execution.

Figure 1.1: LoS Methodology project approach



Source: Steer

1.12 As part of this project, a panel of experts – one for each sector – was established to help identify and explore information available in the public domain. The panel was involved

[4] Strategic roads and rail only. Aviation, shipping, cycling, local roads were excluded from this scope.

throughout the project and used their expertise to guide the methodology and to reflect on the preliminary and final findings. The panel reviewed this report and provided advice and amendments where needed on their corresponding sector of expertise. Stakeholder interviews and a workshop helped provide valuable insights, validate the findings of the desk-based research and, when necessary, provided additional documents not available in the public domain. The NIC has guided the work throughout, reviewing and approving each milestone and deliverable.

1.13 The type of event for which LoS thresholds are set was specified, distinguishing between everyday and extreme events. It should be noted that exceptional events related to extreme flood risk, terrorist attack, and cyber-attack fall outside the scope of this project. These are not included in the terms of reference for the NIC's resilience study.[5]

1.14 This report was produced to inform the NIC study on resilience. The views expressed and recommendations set out in this report are the authors' own and do not necessarily reflect the position of the NIC.

Definitions

1.15 This subsection outlines the infrastructure sectors covered by this project, explains concepts around Levels of Service and Reliability Standards, specifying a terminology defined by the NIC that is used consistently across all of its work on resilience.[6]

Infrastructure sectors covered

- **Water and Wastewater** – Potable water distributed through taps; and used water from domestic, industrial and commercial activities, or surface runoff;
- **Energy** – Available supply of electricity/gas to homes and businesses;
- **Transport** – Travel (by strategic road network or rail) from A to B;
- **Digital** – Supply of digital communications services.

Minimum Level of Service

1.16 Used to express the minimum standard of quality or availability that an infrastructure provider should provide.

Example: the 98% minimum availability for the DCC's self-service interface.

Committed Level of Service

1.17 A standard or threshold used to express the quality and/or availability of an infrastructure service that an infrastructure provider should aim for. This is distinct from customer service or customer satisfaction levels (e.g. the number of complaints received by a supplier).

1.18 A committed Level of Service is usually more challenging than a minimum Level of Service.

[5] **https://www.nic.org.uk/wp-content/uploads/CX_letter_resillience_study_and_terms_or_reference_29102018-002_final-digi.pdf**

[6] Terminology used in expert reviews by Arup, UCL and Atkins in 2019, commissioned by the NIC (see **https://www.nic.org.uk/our-work/resilience/**)

1.19 Generally, there is no single measure for this – levels of service are measured, monitored and represented through a mixture of reliability measures, performance measures and the ability to cope with a defined severe event.

> *Examples: the 99.5% target availability for the DCC's self-service interface;[7] Loss of Load Expectation[8]; resilience against a 1-in-200-year flood event.[9]*

1.20 While the LoS standards are measures of the service quality (or availability), the coverage is a measure of the reach of the service to the general population of users. These are different measures, but they interact when considering the overall performance of the infrastructure. Therefore, they both need to be set to fixed values in order to define a threshold for Minimum or for Committed LoS. In this report, we consider the coverage (by metonymy) to be the LoS metric.

> *Example: The NZ Ultra-Fast Broadband coverage target for fibre-to-the-premises (FTTP) is set to be 87% coverage by 2022. The LoS threshold is availability of FTTP (available or not) for a coverage of 87% of the NZ homes.*

Delivered Level of Service

1.21 The quality or availability of an infrastructure service that is actually delivered.

> *Example: By December 2017, O2 had delivered 98% indoor coverage of UK residential premises for mobile data services (of at least 2Mbps download speed), in compliance with its 800MHz licence obligation.*

Background

NIC Resilience Study

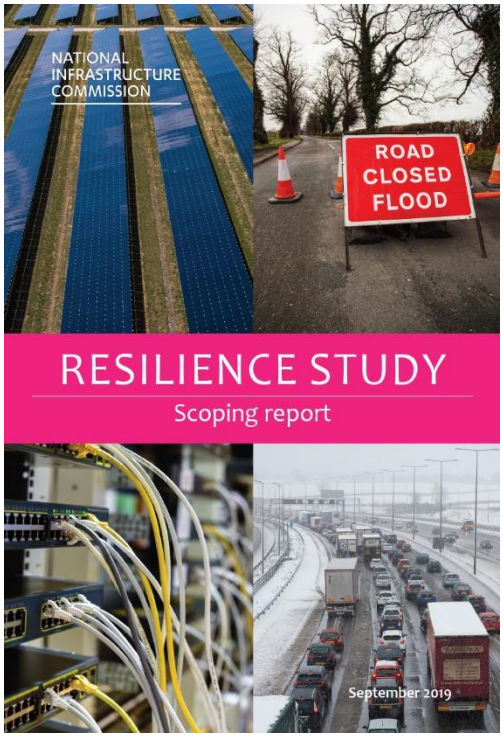
1.22 This LoS Methodology project will be used as evidence to inform the NIC's resilience study.[10]

[7] DCC Performance Measurement Methodology: https://www.smartdcc.co.uk/media/1950/dcc_performance_measurement_methodology_v22june2018.pdf

[8] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/267613/Annex_C_-_reliability_standard_methodology.pdf

[9] Ofwat drought resilience metric: https://www.ofwat.gov.uk/wp-content/uploads/2018/03/Drought-resilience-metric-March-18.pdf

[10] https://www.nic.org.uk/publications/resilience-study-scoping-report/



Source: NIC

1.23 The key outputs from the NIC's Resilience study are expected to include:

- A framework to consider resilience across economic infrastructure, primarily for application during future National Infrastructure Assessments, but which can also evolve over time as knowledge improves.
- The terms of reference[11] for this study are to:
  - Review UK and international knowledge and approaches relating to the resilience of current and future economic infrastructure systems, including how this can be best understood, definitions, ways of assessing resilience, treatment of interdependencies and the management of the risk from different threats and hazards.
  - Develop an understanding of public expectations and response to the potential loss of infrastructure services and review alternative options and contingency planning, for example, in the light of technological advances such as cyber threats, and behavioural changes.
  - Develop an analytical approach that can be used to better understand the resilience of economic infrastructure systems, and the costs and benefits of measures to improve this.
  - Undertake pilot analysis of infrastructure systems (for example through 'stress tests' of sectors, geographical areas or companies) to identify actions to improve the resilience of national infrastructure systems and inform investment decisions.
  - Make recommendations to government on the resilience of economic infrastructure, how best to assess resilience, sharing of good practice, actions needed and data collection or analysis to inform the next National Infrastructure Assessment.

[11] https://www.nic.org.uk/wp-content/uploads/CX_letter_resillience_study_and_terms_or_reference_29102018-002_final-digi.pdf

UK levels of infrastructure service project

1.24 This project builds upon previous work undertaken by the NIC as part of its wider resilience study (which was commissioned by the Chancellor of the Exchequer in October 2018). In particular, the "UK Levels of Infrastructure Service" study[12] in 2019 looked at the assessment of the current LoS expected from or required by the sectors. An Annex to that project contained a large set of Levels of Service (LoS) metrics – these provided a starting point for this project.

Report structure

1.25 This report has been structured as follows:

- **Section 2, Existing LoS methodologies**, identifies a number of LoS metrics and the methodologies used to set LoS thresholds, proposes a typology for those methodologies and explains each type of methodology. It defines the process for setting LoS by sector and the relationship between stakeholders, and summarises the insights gained from the stakeholder interviews.
- **Section 3, Methodology evaluation**, sets out the criteria against which the methodologies have been evaluated, describe our approach to evaluating the methodologies and present the results of that evaluation.
- **Section 4, Conclusions**, contains the conclusions to the project, summarising the findings of the work and including observations on the approach to the project.

[12] https://www.nic.org.uk/wp-content/uploads/Review-of-UK-levels-of-infrastructure-service.pdf

2 Existing LoS methodologies

2.1 This section outlines the chosen LoS metrics and the methodologies used to set committed LoS thresholds, proposes a typology for those methodologies and explains each type of methodology. It defines the process for setting LoS by sector, describes the relationship between stakeholders and summarises the insights gained from the stakeholder interviews.

2.2 The content of this section is based on a combination of background research and stakeholder engagement, including phone interviews for which insights are summarised from paragraph 2.42 and details are provided in Appendix B.

Selected committed LoS metrics

2.3 Nineteen Level-of-Service (LoS) metrics were selected from across the four key infrastructure sectors: Energy, Water, Transport and Digital. These include nine metrics that were prescribed by the NIC as well as additional metrics chosen by our panel of experts for each sector. The nine metrics were selected by the NIC because they represented a good mix of sectors and methodologies and had publicly available data supporting those assessments. The additional metrics were selected in order to gather the widest variety of methodologies utilised to set LoS thresholds, with a fairly even spread across the sectors.

2.4 Our list of 19 LoS metric examples is set out in Table 2.1 below. One of the examples (number 5) is not a metric per se but a reference to guidance on methodologies to set LoS standards.

2.5 More details about the selected LoS metrics and the methodologies used to set committed thresholds are provided in Appendix A.

Table 2.1: List of selected LoS metrics and corresponding methodologies and processes

No.	Infrastructure sector	Infrastructure subsector	LoS metric	Coverage	Methodology (M) and Process (P) used to determine LoS
1	Energy	Electricity Generation	**Loss of Load Expectation (LoLE)** Average number of hours per year in which supply is expected to be lower than demand under normal operation of the system. Supply is not expected to match demand: on average, 3 hours per year, in a typical year	GB	**M**: LoS is set by comparing the marginal cost of providing additional generating capacity with Value of Lost Load (VoLL). VoLL research based on a variety of methods, but major work element involved estimation of VoLL using stated preference choice experiments. **P**: Government-led with proposals set out in a consultation document.
2	Energy	Electricity Distribution	**Customer Minutes Lost (CML)** Average number of minutes that a customer has their supply interrupted. Supply loss of > 3 minutes duration for each year. Applies to everyday stress events but excludes exceptional events.	GB	**M**: Committed LoS determined by benchmarking across Distribution Network Operators (DNOs) and each DNO's historic performance. VoLL used as an input to determine incentive structure for CML. VoLL based on a combination of qualitative and quantitative Willingness To Pay (WTP), Willingness To Accept (WTA) and cost of interruptions research. **P**: Regulator-led with extensive input from operators. Operators and third parties can appeal regulator's decision.
3	Energy	Electricity Transmission	**Energy Not Supplied (ENS)** Volume of energy to customers that is lost as a result of faults or failures on the network. Each Transmission System Operator (TSO) sets a target for each year. Applies to everyday stress events but excludes exceptional events.	GB	**M**: Committed LoS determined by benchmarking each Transmission System Operator's (TSO's) historic performance. VoLL used as an input to determine incentive structure for Energy Not Supplied (ENS). VoLL is determined by Ofgem, based on previous estimates applied previously in GB and other jurisdictions (e.g. Ireland and Victoria (Australia)). **P**: Regulator-led with extensive input from operators. Operators and third parties can appeal regulator's decision.
4	Energy	Gas Distribution	**Loss of Supply** Minimum levels of network reliability performance for customers, covering number and duration of interruptions. Each DNO sets targets for each year. Applies to everyday stress events but excludes large events.	GB	**M**: Committed LoS determined by benchmarking each DNO's historic performance. **P**: Regulator-led with extensive input from operators. Operators and third parties can appeal regulator's decision.

No.	Infrastructure sector	Infrastructure subsector	LoS metric	Coverage	Methodology (M) and Process (P) used to determine LoS
5	Energy	Electricity	**Council of European Energy Regulators Guidelines on Methodologies** This document does not refer to a metric, but it recommends good practice on estimating costs due to electricity interruptions and voltage disturbances.	EU	**M**: The guidelines cover various cost-estimation methods: Direct Worth; Contingent Valuation; Conjoint Analysis; Preparatory Action Method; Preventative Cost Method; and Direct Worth in Case Study.
6	Water	Water supply	**Supply/Demand Balance** Supply must exceed demand plus target headroom; target headroom is established taking account of the range of uncertainty around each component of supply and demand.	England	**M**: The LoS setting methodology is CBA based on modelling network performance which takes account of risk. Costs are calculated as financial and/or environmental costs of providing supply-demand solutions, and benefits are calculated as customers' willingness (or not) to accept a higher risk on the future achievement of the target level of service. **P**: The methodology used to determine the balance between supply and demand is established by UK Water Industry Research (UKWIR)/Environment Agency (EA). Individual companies determine the values of the parameters used in the assessment but will use sensitivity analyses and customer preferences (among other factors) to determine the robustness of their projections.
7	Water	Water supply	**Supply restrictions** The percentage of the customer population at risk of experiencing severe restrictions in a 1-in-200-year drought, on average, over 25 years – calculated for each water resource zone (as used in each company's Water Resource Management Plan) and summed for the company as a whole. For example: • Severn Trent: target that, by 2030, 0% of customers will be at risk.	England and Wales	**M**: This could have included cost-benefit analysis (CBA), which is the default approach where companies set the level of service where marginal cost equals marginal willingness to pay (the latter determined though stated preference WTP and other approaches). Companies' PR19 submissions suggest that this approach has not been followed and that additional modelling work is required before Performance Commitments levels can be set. The LoS setting methodology has been based on modelling network performance and benchmarking from previous performance. **P**: The regulator, Ofwat, examines companies' submissions to ensure consistency with their Water Resource Management Plans and approves final LoS standards.

No.	Infrastructure sector	Infrastructure subsector	LoS metric	Coverage	Methodology (M) and Process (P) used to determine LoS
8	Water	Water Quality	**Compliance Risk Index (CRI)** The Compliance Risk Index (CRI) has been adopted by Ofwat as a new measure of drinking water quality. It is defined and calculated by the Drinking Water Inspectorate (DWI) and reflects the DWI's adoption of a risk-based methodology for assessing compliance failures. Ofwat sets a target of zero for CRI, although it allows a deadband before financial penalties are imposed for non-compliance.	England and Wales	**M**: The CRI score is developed for water supply zones, supply points, treatment works and service reservoirs. It is calculated by using a "weighted scores" methodology which takes account of the severity of a failure, its cause and its location. Deadbands, which allow for some fluctuations in performance, but which still provide a strong incentive to minimise compliance failures, are permitted. In PR19, the deadband was set on the basis of the industry median performance over four previous years (i.e. a combination of benchmarking across companies and on the basis of past performance). **P**: In its PR19 methodology, Ofwat initially proposed a deadband based on a combination of past and forecast upper quartile performance. In their subsequent submissions, the water companies developed and proposed their own deadbands, which were then reviewed and modified / approved by Ofwat.
9	Water	Wastewater	**Risk of sewer flooding in a 1-in-50-year storm** This is a new, forward-looking measure of resilience which was introduced for PR19. This measure requires companies to determine the percentage of the population in their area that is at risk of being flooded in a 1-in-50-year storm event. The use of this metric has been justified on the basis that the potential for sewer flooding in a storm "is important to customers".	England and Wales	**M**: Suggested methodology is based on using the most recent year's performance which may or may not improve over time, i.e. benchmarking using previous experience or performance. **P**: As a new metric, cross-company comparative data and company-specific historic data is not yet available for many years. The metric (and methodology) is currently a proposal, but Ofwat has stated it should be used by water companies wherever possible.
10	Transport	Rail	**% of trains on time** Percentage of trains that arrive at their terminating station within a lateness threshold (10 minutes for Long-distance services, 5 minutes for others) compared to number of trains planned Public Performance Measure (PPM) combines figures for punctuality and reliability into a single performance measure expressed as a % - the Control Period CP5 (2014-2019) target was 92.5%.	England, Wales and Scotland	**M**: This metric threshold is set to reflect the experience/impact on customers and to benchmark the performance of Network Rail in asset stewardship, operational control decisions and management of incidents to mitigate delays. **P**: The Office of Rail and Road (ORR) specifies the performance measure to be set, and the DfT approves the LoS levels proposed by Network Rail.

No.	Infrastructure sector	Infrastructure subsector	LoS metric	Coverage	Methodology (M) and Process (P) used to determine LoS
11	Transport	Road	**Percentage of motorway incidents cleared within one hour** On the Strategic Road Network (SRN), in any one rolling year, maintain performance of at least 85% of all motorway lane impact closures between 0600 and 2200 being cleared within one hour.	England	**M**: Highways England (HE) seeks to minimise the impact of traffic related delays. Target are based from previous performance and on looking at optimising costs (limited funds) allocated to the different roads. **P**: HE develops and calculate thresholds for this metric (as part of the Road Investment Strategy) for which the ORR monitors and provide quality assurance and DfT approves methodology and values.
12	Transport	Rail	**Operational warning (Taiwan High Speed Rail)** Graded response to level of danger detected by Disaster Warning System (DWS) (includes earthquake detector, weather detector, and intrusion detector). Trains have speed limit (and therefore reduced LoS targets) based on weather severity forecast (e.g. expected rainfall and wind speed in 24 hours/1-hour period)	Taiwan	**M**: While no evidence was found in the public domain, it is often the case that the LoS thresholds for extreme events are calculated by prioritising safety and therefore reducing expected incidents and costs of failure/breakdown.
13	Transport	Road	**Pavement condition maintenance costs** The Highway Performance Monitoring System (HPMS) is a national level highway information system that includes data on the extent, condition, performance, use and operating characteristics of federally sponsored road network. Interstate pavements: <5% of mileage in poor condition. National Highway System bridges: <10% in poor condition.	United States	**M**: The HPMS is underpinned by a cost driven methodology. The minimum pavement condition needs to be set so that enough funds (minimising repair costs) can be allocated to improve the set of roads in poor condition and prioritise the repair of these roads in a cost-efficient manner (cost minimising). **P**: The Federal Highway Administration (FHWA) develops a methodology for the HPMS
14	Transport	Rail	**Freight train delays** Delay minutes per 100 freight train-kms. Cancellation payment (above/below thresholds); late notice cancellation sum; prolonged disruption sum; planned disruption sum.	England, Wales, Scotland	**M**: A CBA methodology is used to appraise costs of minimising delays versus benefits (that includes incentive payments for cancellations). **P**: Freight operator benchmarks determined by the Office of Rail and Road (ORR, the Regulator) which sets the level of performance at which freight operators will neither pay nor receive Schedule 8 payments in relation to delays that they cause.

No.	Infrastructure sector	Infrastructure subsector	LoS metric	Coverage	Methodology (M) and Process (P) used to determine LoS
15	Digital	Broadband	**Broadband Universal Service Obligation (USO)** UK-wide measure to deliver broadband connections to the hardest to reach premises in the UK Minimum download speed 10 Mbps; Minimum upload speed of 1 Mbps; Additional quality parameters: latency sufficiently low for real-time voice calls, a minimum data cap of 100GB per month, and a maximum contention rate of 50:1.	UK	**M**: LoS was underpinned by consumer research by Ofcom, information on monthly data usage by access speed, technical advice from Ofcom on the costs of various service levels and of the maximum connection cost thresholds, public consultations on USO principles and service levels, and the Impact Assessment which assessed the economic costs and benefits of four potential options (i.e. CBA methodology). **P**: The regulator, Ofcom, developed and proposed a LoS threshold for this metric.
16	Digital	Mobile Communications	**Mobile communications data service coverage/speed** Providing, with 90% confidence, a mobile telecommunications service with a sustained downlink speed of not less than 2 Mbps when that network is lightly loaded By 31 December 2017: (i) in an area which at least: a) 98% population of UK lives; b) 95% population of each England, Wales, Scotland and Northern Ireland lives (ii) indoor locations	UK	**M**: LoS was determined using a cost driven methodology underpinned by mobile 'notspot' analysis (PA Consulting), network coverage modelling by Ofcom, and cost modelling for extending coverage for specific example areas (Real Wireless). There is no evidence whether any quantification of monetised benefits was undertaken for this LoS. **P**: The original Ofcom consultation proposed 95% UK population coverage, but this received many calls for a higher level to be set - including from politicians (e.g. Culture Media and Sport [CMS] Select committee); this resulted in Ofcom consulting on a higher level of coverage (98%), followed by its implementation in the 4G licence auction.
17	Digital	Smart metering data communications	**Smart metering** Percentage of time that services do not have unscheduled downtime. Other than the self-service interface availability measure, the specific service level percentages are redacted in the public domain versions of the Data and Communications Company's (DCC's) contracts with Communications Service Providers.	England, Wales, Scotland	**M**: Specific minimum and target service levels have been negotiated with Communications Service Providers (CSPs), using benchmarking of their previous experience or performance and fed into the regulator or operator estimation process for determining the LoS. **P**: This was one of a set of service levels included in Ofgem's Operational Performance Regime (OPR) for DCC. Ofgem consulted on the principles and then the more detailed types of service measures. The specific minimum and target service level percentages were previously negotiated by Department of Energy and Climate Change (DECC, dissolved in July 2016) and the service providers, and these were inherited by DCC.

No.	Infrastructure sector	Infrastructure subsector	LoS metric	Coverage	Methodology (M) and Process (P) used to determine LoS
18	Digital	Telecommunications	**Openreach's ethernet circuit provisions** Openreach's proportion of ethernet circuit provisions taking longer than an upper threshold time, in non-competitive areas of UK. No more than 3% delivered in more than 138 working days (year 1), or 135 working days (year 2).	UK	**M**: The Quality of Service (QoS) threshold for broadband was set based on CBA and readjusted based from previous performance. **P**: Ofcom's 2016 Business Connectivity Market Review (BCMR) found that Openreach's performance in delivering ethernet circuits had significantly deteriorated over previous years. Ofcom consulted on - and then implemented - a set of QoS remedies in areas of the UK where Openreach had significant market power. In the light of experience, the original target of 3% within 118 working days was relaxed to 3% within 138 working days in the 2019 Business Connectivity Market Review (BCMR).
19	Digital	Broadband	**NZ Ultra-Fast Broadband coverage** New Zealand's target for fibre-to-the-premises (FTTP) coverage (Ultra-Fast Broadband). 87% coverage by 2022	New Zealand	**M**: The threshold was originally set in 2008 mainly based on deriving user benefits, citing potential economic benefits from the New Zealand Institute, without mentioning costs. **P**: In 2008 New Zealand's National Party promised that 75% of New Zealand homes would have access to FTTP, citing the potential economic benefits that would be derived from that access. Upon its election, the government set up the Ultra-Fast Broadband Initiative to deliver this. The target has since been raised and is now set at 87% coverage by 2022.

Source: Steer

Typology of methodologies

2.6 After reviewing the methodologies used to set LoS thresholds for the 19 metrics, they were grouped into broad categories and a typology of the methodologies was derived. The methodologies can be split into two broad categories:

- Benchmarking; and
- Appraisal techniques.

2.7 Each category is made up of three sub-categories. These are shown in Table 2.2 below.

Table 2.2: Typologies of methodologies used to set committed LoS thresholds

Typology		Examples of LoS metrics
Bench-marking	Across companies	Compliance Risk Index (CRI) Customer Minutes Lost (CML)
	Using previous experience or performance	Compliance Risk Index (CRI) Supply restrictions Risk of sewer flooding in a storm Openreach's ethernet circuit provisions Percentage of motorway incidents cleared within one hour % of trains on time (PPM) Customer Minutes Lost (CML) (historic VoLL also considered for incentive) Energy Not Supplied (ENS) (historic VoLL also considered for incentive) Loss of Supply
	Internationally	Energy Not Supplied (ENS): VoLL benchmarked for input
Appraisal techniques	Cost-Benefit Analysis (CBA): Stated Preference; Revealed Preference; Macroeconomic	Supply/Demand Balance Loss of Load Expectation (LoLE) Broadband USO
	Cost driven	Mobile communications data service coverage/speed Operational warning (e.g. Taiwan rainfall) Pavement condition maintenance
	Benefit driven	NZ Ultra-Fast Broadband coverage

Legend: Energy Water Transport Digital

Source: Steer

2.8 In most cases, the LoS was not set using just one methodology but rather a combination of several methodologies. For example, if CBA was used, the results were validated using another method such as benchmarking from previous performance and/or across companies. International benchmarking tended to be used as an input into methodologies rather than for comparing actual LoS thresholds.

Example methodologies

Benchmarking across companies

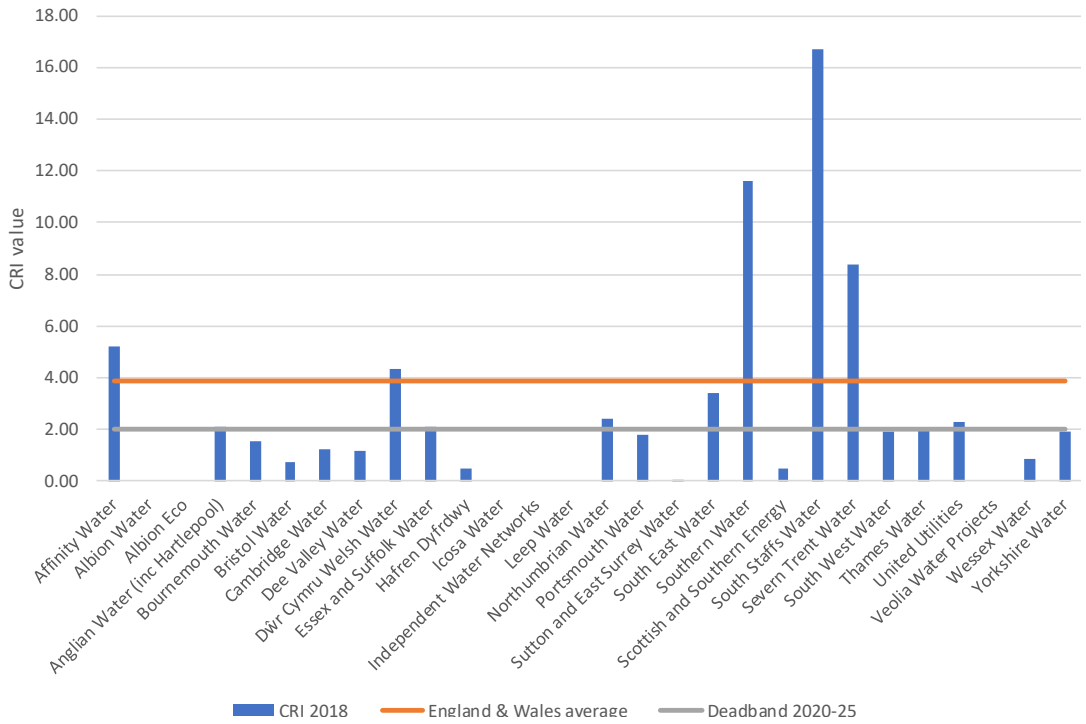
2.9 This methodology compares LoS performance across companies in a sector to determine the committed LoS.

2.10 In the water sector, the Compliance Risk Index (CRI) is used to measure water quality compliance across a company's asset base with three subcategories: supply points, service reservoirs and water supply zones. The CRI aligns with the risk-based approach of the Drinking Water Inspectorate (DWI) in regulating water supplies.

2.11 As a statutory obligation, Ofwat requires the performance commitment level to be set at zero.[13] However, deadbands are permitted to allow for some fluctuation in performance. Deadbands are defined by Ofwat as "zones of performance close to the performance commitment level, for which no financial outcome delivery incentive (ODI) applies". These recognise that small variances in performance could occur due to external factors outside of a company's control. The deadband for 2020-25 was set using Ofwat's analysis of industry median CRI data for 2016-18, which was comparable with median industry performance in 2018-19.

2.12 The CRI values for England and Wales and for various companies are published by the DWI. The CRI for various companies and for England & Wales in 2018, as well as the deadband for 2010-25, are shown in Figure 2.1.

Figure 2.1: Compliance Risk Indices (CRI) for England and Wales



Source: Drinking water 2018: Compliance Risk Index and Events Risk Index figures, 11 July 2019, DWI.

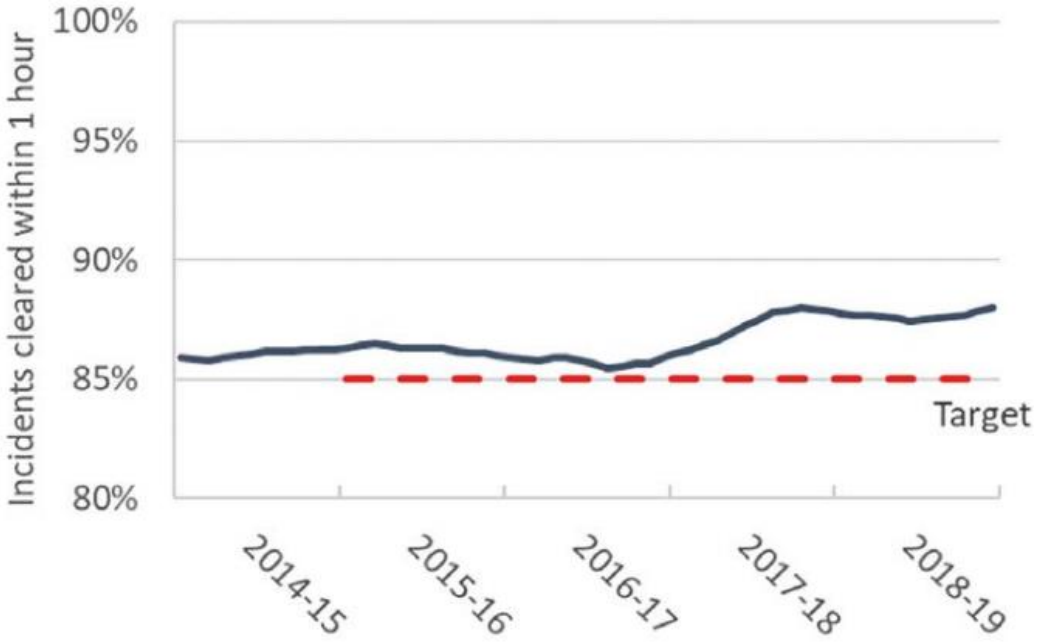
[13] Ofwat: Delivering Water 2020, Appendix 2: Delivering outcomes for customers: https://www.ofwat.gov.uk/wp-content/uploads/2017/12/Appendix-2-Outcomes-FM-final.pdf

Benchmarking from previous performance

2.13 This methodology uses previous performance to determine the committed LoS. An example from the transport sector is the percentage of motorway incidents cleared within one hour. The committed LoS target of 85% was set on the basis of observations in 2013 and 2014 of how much time highway officers spent out in the field when managing incidents.

2.14 Performance over the last five years against the 85% target, as well as other performance targets, are shown in Figure 2.2 below.

Figure 2.2: Percentage of motorway incidents cleared within one hour



Source: Office of Rail and Road (Annual Assessment April 2018-March 2019)

2.15 This methodology is often used to validate or benchmark results from Cost Benefit Analyses.

International Benchmarking

2.16 International benchmarking (comparing LoS thresholds in the same sector in other countries) can be used to determine the level of the local committed LoS. None of the 19 LoS metrics considered in this project relied upon international benchmarking, although it was noted that most CBA methodologies included inputs that had been benchmarked internationally (for example, per capita water consumption or the VoLL value for CML and ENS).

Cost-Benefit Analysis (CBA)

2.17 In general, CBA methodologies are appraisal techniques used to compare the monetarised value of benefits against the cost of investments for a specific project (such as improved or additional service or increase in capacity). The outcome, labelled the cost-benefit ratio, represents the "value for money" of a business or project investment.

2.18 CBA techniques are used in the Energy sector to determine the Loss of Load Expectation (LoLE) reliability standard, comparing the marginal cost of providing additional generating capacity against the VoLL.

2.19 There are a number of different ways of calculating benefits, and often a combination of these are used to validate estimates:

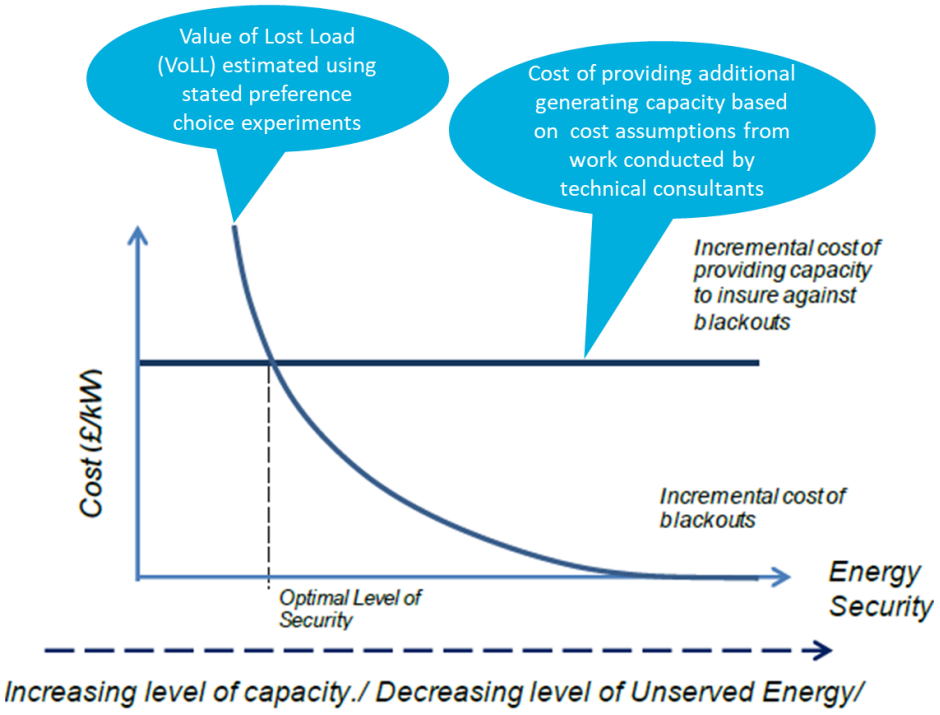
- Benefits can be calculated using **qualitative engagement** (through various types of consultations), such as:
  - Customer/Consumer research;
  - Customer focus groups; and
  - Customer interviews.
- Benefits can be calculated using **quantitative approaches**, such as
  - Stated Preference;
  - Revealed Preference; and
  - Macroeconomic techniques.

Stated Preference (SP)

2.20 Stated Preference methods use surveys to elicit estimates of customer's willingness to pay (or accept) a particular LoS.

2.21 Estimates of the VoLL are often derived using SP techniques – these include surveys of domestic and SME electricity users on Willingness To Accept (WTA) payment for an outage and Willingness To Pay (WTP) to avoid an outage. The graph in Figure 2.3 below illustrates, for LoLE, how the incremental additional generating capacity varies against the incremental level of energy security (as measured by VoLL).

Figure 2.3: Optimal Level of Security (for LoLE)



Source: Department of Energy and Climate Change

Revealed Preference (RP)

2.22 Revealed Preference techniques rely upon observations of customers' actual behaviour in related markets to determine the willingness to pay for (or accept) a particular LoS.

2.23 While SP methods offer a virtual context for an individual's choices, the RP method observes an individual's actual behaviour to determine benefits. However, under both approaches, there may be many other factors which can influencing an individual's choice or preference, and it can be difficult to identify the most significant.

Macroeconomic techniques

2.24 Macroeconomic techniques use macroeconomic data and sector-wide consumption to estimate the value of benefits. For example, a value may be calculated based on a "forecastable variable" and then extrapolated. For example, the VoLL (used as an input to determine incentive structures in CML and ENS) can be estimated using macroeconomic assumptions, for example, by dividing gross domestic product by energy consumed.

Cost driven

2.25 The cost driven methodology focuses primarily on the cost side of the CBA. In general, the aim is to set a LoS threshold which minimises costs, or optimise the LoS levels with the limited costs (or resources) available.

2.26 This approach (of minimising costs) has been used in Taiwan's transport sector, for the country's High Speed Rail (HSR). Running an HSR under poor weather conditions such as strong winds and rainfall may disrupt the service and/or damage the infrastructure (including incidents such as derailments). The Taiwan HSR has set thresholds for both wind and rain and has adopted an operational warning system based on weather forecasts that indicates whether meteorological hazards will affect operations.

2.27 The LoS standards are set as follows: level 1 with rain under 35mm/h, level 2 with rain over or equal to 35mm/h and under 45mm/h, level 3 with rain over or equal to 45mm/h and under 50mm/h, and level 4 over or equal to 50mm/h. The HSR is monitored closely for level 2, reduces its speed for level 3, and suspends some services for level 4, with a different LoS set for each weather condition level. These LoS standards are set to minimise the expected costs.

2.28 For each level of poor weather condition, the corresponding risk probability (i.e. likelihood of poor weather condition happening) and risk outcome (i.e. the cost incurred would an incident occur) can be estimated. In turn, the total expected cost is the probability of an accident happening at a certain level multiplied by the estimated cost outcomes of that accident. The difference between the highest LoS and the reduced one can be interpreted as costs of safety measures taken to prevent it. Although they are probably negligible with regards to the expect costs of incidents, it is possible to add to these the savings in operating costs for using an incrementally lower LoS, although they would be balanced by revenue loss due to service reduction.

2.29 As a conclusion, this approach is a trade-off between an increase in LoS standard or a decrease in expected costs due to potential incidents.

Benefit driven

2.30 The benefit driven methodology focuses on the benefit side of the CBA. It is therefore driven by improving the user benefits for a specific service, which can be measured using simple satisfaction scale survey, or using the more complex benefit appraisal techniques described in the previous CBA subsection (e.g. WTP/WTA using SP or RP). This approach is not always necessarily to maximise user benefits but to consider them as the main decision driver without balancing against costs.

2.31 This approach is sometimes taken by political leaders to set stretching policy objectives for improvements. Driven by what is gauged to be beneficial for users, these policy commitments may be informed by past performance and/or high-level satisfaction user feedback. Once announced, they would usually be subject to more formal quantification of benefits and/or costs in advance of implementation.

2.32 An example of this approach from the digital sector is the New Zealand National Party's manifesto commitment in 2008 to extend fibre-to-the-premises to 75% of the population (this target has since been raised to 87%). This LoS was promised (and later set) by citing potential economic benefits from the New Zealand Institute, although it is not entirely clear how these were estimated.

Processes

Process interactions by sector

2.33 Different patterns were observed in the decision-making processes and the interaction with stakeholders across the four infrastructure sectors. It appears that the ways in which processes have evolved have been influenced by the type of market, the role of the regulator, and the extent to which customer feedback is taken on board.

2.34 We describe our high-level understanding of the key relationships between stakeholders in the process of setting LoS methodologies by sector with two examples:

- For the energy monopoly networks, Ofgem first publishes its strategy decision on key elements of the price control framework which includes the outputs the network companies (Operators) need to deliver to deliver wider policy objectives (which will include amongst other things Ofgem's proposals for LoS targets). On the basis of this, network companies develop their business plans to deliver these outputs (and LoS), which should reflect comprehensive stakeholder engagement. LoS targets are set in advance by Ofgem, with annual monitoring. Prior to each price control, Ofgem may also commission research into the value customers place on interruptions to energy.
- For the transport sector, there is a dynamic that is particular to sector in the sense that the infrastructure managers (e.g. Network Rail, Highways England) propose methodologies and associated LoS thresholds which are approved by DfT in the final stage, and for which the process is continuously monitored by the ORR. Separately in the rail sector, each TOC develops and proposes its own LoS as part of their bid franchise per route, which is adopted by NR, the infrastructure manager.

2.35 These are a "simple" reflection of the overarching processes rather than a complex description of what actually takes place in practice. As mentioned above, differences in methodologies are often linked to the processes in which they were established.

2.36 The energy sector's processes for setting LoS metrics have been developed and used over many years. Energy has more or less standardised an approach of using benchmarking and, in some cases, CBA alongside SP as a methodology to set committed LoS thresholds. While the Digital sector has been around for some time, the processes that are in place are not as developed although very similar methodologies are being used. One of the latest Metrics in place is for Smart Metering (DCC) at the intersection of the Digital and Energy sectors, where there is almost no data from previous performance and there is a current effort to put a process in place to set up the required LoS.

2.37 In contrast to the more standardised processes in the Energy Sector, in the Digital sector, different stakeholders are more likely to have to continually adapt to a very fast-changing industry, which is underpinned by rapid technology developments. Due to the fast pace of change, its methodologies need to adapt to customers' constantly changing expectations and changes in costs. For example, the USO for broadband metric may be reviewed earlier than dictated by the regular update frequency of the Business Connectivity Review. The Digital Economy Act 2017 gives the Secretary of State discretionary powers to review the USO for broadband from time to time, but also *requires* that the USO is reviewed when the uptake of superfast broadband (30 Mbps or more) reaches 75% of UK premises. To capture the continual changes in customer benefits, methodologies used in the digital sector are heavily influenced by new political commitments (e.g. as mentioned in the metric on broadband coverage in the New Zealand manifesto in 2008), data on the user experience, and analyses of the costs associated with a LoS. Benefits are sometimes, but not always, quantified in financial terms, for inclusion in a CBA.

2.38 Another important interaction to consider is cross-sector influences and impacts. One good illustration of this is trends in lifestyles such as working from home/remotely. Such trends have impacted travel, where services provided by the transport sector have been substituted by digital solutions (e.g. laptops utilising broadband for remote working, virtual meetings, etc.). However, this is not downplaying the importance of reliability of the road networks particularly in terms of freight. Moreover, there may be other technological developments in the future that will need to be considered when setting LoS.

2.39 It should also be noted that **methodologies and processes are closely linked.** As a result, it is difficult to assess the methodologies without considering the impact of a related process, and vice versa.

2.40 For example, there are sometimes external inputs into setting LoS, where decisions may be influenced by perceptions of user satisfaction or previous experience, then later quantified based on evidence. Interactions like these could include policy announcements which sets a headline LoS.

2.41 Furthermore, there can often be negotiations between the regulator and operator (which may be monitored by government) resulting in a LoS threshold which is not a direct output of one of the methodologies mentioned above (e.g. this was the case for several metrics such as the Energy Not Supplied (ENS), supply/demand balance in the Water sector, and the USO for Openreach metric) . In addition, some LoS-related work done by stakeholders is mandated by a statutory process and has some influence on the final LoS set for the industry.

Insights on methodologies and processes

2.42 During phone interviews, as well as in the workshop, stakeholders in the Transport and Water sectors brought up the difficulty of making direct comparisons across different geographies. These differences would more likely be on costs, geographical and meteorological constraints, and cultural for different regions. There were concerns that methodologies such as benchmarking did not accurately capture regional differences, and that this could result in unrealistically high expectations or unnecessarily high costs for both the operator and the customer.

2.43 However, stakeholders from the Transport and Water sectors conceded that company cross-comparison has driven improvement; another benefit of benchmarking was that it provided a

good incentive by promoting competition between regional monopoly companies to improve their performance.

2.44 The difficulty of obtaining sufficient data to set a LoS also kept resurfacing as a challenge for all sectors, especially Digital which has fast-changing customer expectations that may be difficult to draw out from limited data. More details on the stakeholder interviews are provided in Appendix B.

2.45 Most representatives from Water wanted to see greater emphasis placed on costs in the decision-making process, rather than having the target set in what could be perceived as an arbitrary manner.

2.46 Very little formal work has been carried out into international benchmarking, although some general international comparisons were observed (for example, with Value of Time in transport and per capita water consumption in water).

Operators

2.47 Several operators in Water had used surveys and other techniques to engage with their customers, incorporating this feedback into their business plans. However, they believed that Ofwat needs to pay more attention to the results of this engagement, as it was unclear to the operators how much the customer input was taken into account when finalising LoS thresholds.

2.48 In Water there were concerns that short-term plans (as associated with, for example, a five-year price control period) do not take account of a company's longer-term investments, the management of its assets (over a 30-year asset life) and its need to consider sustainability and risks to assets.

2.49 Some operators in Water stressed the need for better alignment of cost and LoS. They strongly advocated comparing costs and benefits rather than using cross-company comparisons to establish common targets. As was pointed out several times, companies operate in very different circumstances.

2.50 In some cases (for example in Rail and Energy) it was found that the LoS had been set several years previously; the people involved had moved on, and there was little or no documentation available (in the public domain or to our consultees) as to how the LoS had been determined. In at least one case, a set of LoS standards had been inherited (after being negotiated elsewhere) and no longer reflected customer needs.

2.51 Some operators said that there was a need for a systems approach to resilience. They thought there was a potential for more synergy between assets and across sectors, where all aspects of resilience need to come together to provide a better service.

Regulators and infrastructure managers

2.52 Some regulators wanted the government to be more explicit in setting policies about the approval of LoS standards in specific conditions (e.g. force majeure) or specific events (such as winter resilience).

2.53 In several sectors, especially Transport, it was suggested that a separate set of winter-resilient service requirements should be established for atypical conditions, such as adverse or extreme weather conditions. Transport suggested that having different targets for extreme conditions

could help stakeholders to better plan how to invest in infrastructure and better manage customer expectations.

2.54 The potential for confusion due to different definitions of LoS was also highlighted – for example, between a minimum LoS threshold (below which there would be a system failure), a committed LoS threshold, or a Customer LoS threshold (e.g. Retail Service Level for the digital sector).

2.55 Regulators' public consultation processes were a key mechanism to inform the choice of LoS in several cases. For example, in Digital, following consultation feedback, the mobile data service coverage obligation was increased from 95% to 98% in the 4G spectrum licence auction and Ofcom's subsequent decision paper clearly set out the rationale for the choice of LoS.

2.56 Technology is providing new resources for regulators to inform future LoS setting. For example, Ofcom has used crowdsourced data from an Android smartphone app to obtain insights into the performance of mobile services. There have been cases, e.g. in Digital, where a threshold is clearly unachievable, perhaps due to the LoS being set in the past and not updated for the current market or state of infrastructure. This sometimes results in the regulator and operator reaching a mutual agreement that a specific threshold is unachievable.

3 Methodology evaluation

3.1 This section lists the criteria against which the methodologies have been evaluated; describes the approach used to evaluate the methodologies; and summarises the results of that evaluation.

Evaluation criteria

3.2 The advantages and disadvantages of the various methodologies (as identified by the panel of experts and as discussed in stakeholder interviews) were used to develop the evaluation criteria: the eight criteria used in the evaluation are listed in Table 3.1 below (the criteria were chosen specifically in order to avoid overlap among the criteria and, at the same time, to ensure that all aspects of the methodologies were covered):

Table 3.1: Evaluation criteria and definitions

	Criteria	Criteria description (in the case of a positive assessment of the methodology)
1	**Adaptability (time)**	The methodology's approach remains valid over time (i.e. when hazards or threats change or when customer expectations of reliability change) and/or it is straightforward to update any critical values/data
2	**Level of user/consumer engagement**	The methodology engages users / takes into account views of consumers
3	**Equitability/Distributional**	The methodology responds to inequity issues or distributes services / measures performance in a fair manner
4	**Driving improvement**	The methodology is proven to be successful in improving performance
5	**Simplicity**	The methodology does not involve multiple or difficult calculations
6	**No reliance on historic data**	The methodology does not rely on records of past performance
7	**Adaptability (type of event)**	The methodology is applicable or can be adapted to both everyday and extreme events
8	**Transferability**	The methodology is transferable and can easily be used across metrics and sectors

Source: Steer

3.3 In developing this list of criteria, it has been important to ensure not only that there is no overlap between the coverage of each criterion, but also that all aspects of the methodologies are covered. The level of effort and cost required to establish key data, develop key assumptions and create models in order to implement the methodology are considered additional inconveniences and are incorporated in the *Simplicity* criterion.

3.4 During the stakeholder workshop, it was mentioned that external factors influenced the setting of LoS thresholds. While this may be the case for some LoS metrics, it is not part of the methodologies as defined in this project – it falls within the process of engagement between stakeholders and is reflected in, for example, the negotiations between regulators and operators.

Evaluation of methodologies

Approach and validation

3.5 The methodologies were evaluated against the eight criteria. The methodology categories from the typology were evaluated within the wider infrastructure context rather than in the specific context of selected LoS metrics. The results of the evaluation were validated during stakeholder engagements.

Draft evaluation of methodology

3.6 An initial (draft) evaluation of the methodologies was carried out, the results of which were discussed with the NIC.

Evaluation validation: Stakeholder workshop

3.7 A wide range of stakeholders (regulators, operators, trade associations and infrastructure managers) from all four infrastructure sectors were invited to a workshop on 28th November 2019 – nine representatives attended the workshop.

3.8 Stakeholders were engaged to validate the pros and cons of each methodology and the initial (draft) evaluation of the methodologies.

3.9 The workshop was considered to have been very productive in that it confirmed most of the work that had been carried out, provided additional insights on the pros and cons of the alternative methodologies and the evaluation criteria, and helped validate the results of the evaluation of the methodologies.

3.10 The attendance at and the agenda for the stakeholder workshop can be found in Appendix C.

Evaluation of methodologies against eight criteria

3.11 The results of the evaluation of the methodologies against each of the eight criteria is summarised in Table 3.2 below; a more detailed description of the evaluation is contained in the rest of this section.

3.12 The evaluation was conducted in a qualitative (as opposed to a quantitative) manner, with the relative assessment based on publicly available documents, stakeholder interviews and the workshop, and the panel of experts' experience of each industry.

3.13 It should be noted that, although the evaluation may provide a guideline for a large proportion of the metrics across the four infrastructure sectors, there may be exceptions that have not been captured in the typology.

3.14 It should also be noted that the methodologies used to set LoS are based on publicly available information and stakeholder interviews.

Table 3.2: Evaluation of methodologies used to set committed LoS

	Criteria	Benchmarking: across companies	Benchmarking: from previous performance	Appraisal techniques: CBA	Appraisal techniques: Cost driven	Appraisal techniques: Benefit driven
1	**Adaptability (time)**	**Easily adaptable** in the short-term, but excluding major changes	**Easily adaptable** in the short-term, but excluding major changes	**Needs (costly) updating** in the long term (but takes account of major changes)	**Needs updating** in the long term (but takes account of major changes)	**Needs updating** in the long term (but takes account of major changes)
2	**User/Consumer engagement**	**Limited**	**Limited**	**High** (feeds into benefits)	**Low**	**High** (feeds into benefits)
3	**Equitability/Distributional**	**Less equitable** if considered without performance context	**Potentially less equitable** if considered without performance context	**More equitable** if benefits calculated on a representative sample of users	**Not equitable** if cost is considered solely on its own	**More equitable** if benefits calculated on a representative sample of users
4	**Driving improvement**	**Drives improvement** because of direct cross-company comparison	**Drives improvement** with continuous improvement	**Drives some improvement** as CBA more adaptable to each context	**Drives limited improvement** as only costs are taken into account	**Drives some improvement** as user satisfaction is taken into account
5	**Simplicity**	**Simple**	**Simple**	**Complex:** benefits calculations may be resource demanding	**Moderate:** dependent on costs types	**Complex:** benefits calculations may be resource demanding
6	**No reliance on historic data**	No reliance on historic data	**Reliance on historic data** (several years)	Limited reliance on historic data	No reliance on historic data	Limited reliance on historic data
7	**Adaptability (type of event)**	**Fairly adaptable**, for overview but needs specifics	**Adaptable**, with everyday/extreme events records	**Less adaptable** (everyday events)	**Adaptable**	**Less adaptable** (everyday events)
8	**Transferability**	**Transferable,** for certain market types	**Transferable**	**Transferable,** for most LoS	**Transferable**, but not appropriate for many sectors	**Transferable,** for most LoS

Source: Steer

Evaluation details

Adaptability (time)

3.15 The **benchmarking methodologies, across companies** and **from previous performance,** are easy to adapt over time because of the simplicity of their application. However, they cannot be adapted easily when moderate to major changes occur either to the infrastructure or to the specific context of an individual performance metric. This is because it is difficult to disentangle and identify the impact of such changes from "normal" change over time. For example, in the Transport (Rail) sector, a change in the way the arrival times of trains are recorded (for instance, from manual to automatic) would have an impact on the way performance is measured. As a result, it may not be appropriate to establish a new LoS threshold based on past performance without any adjustment for past changes. These methodologies could be more adaptable using regression analysis on past performance to derive the impact of significant changes as exploratory variables (such as changes in service and price, changes in infrastructure, weather, economic growth). This additional analysis brings a layer of added complexity in terms of costs/efforts and requires historical data to be available.

3.16 While both costs and benefits, calculated separately for the **CBA**, **cost driven** and **benefit driven** methodologies, remain valid in the short term (if derived from current or recent years' data), they need to be updated in the medium to longer term to capture any changes in the infrastructure context or the provision of the service. For example, the WTA a power cut is estimated in the benefit calculations of the LoLE LoS metrics. The value of this WTA estimate may change over the longer term – for example, as consumers become accustomed to more reliable power supplies, their WTA a power cut would decrease and, therefore, the value they place on maintaining reliable supplies would increase. These methodologies (in particular, WTA/WTP methods) can be conducted on a more frequent basis to ensure up-to-date estimates, but they are expensive and time consuming.

User/Consumer engagement

3.17 The results of user/consumer engagement feed directly into the calculation of benefits within the **CBA** and **benefit driven** methodologies. User/consumer engagement is a key element of these methodologies—for example, customer surveys are used to derive the value of WTP that is used in the CBA to determine the LoLE metric in the energy sector. In general, benefits estimated as part of a CBA can be derived from complex methods (such as SP, RP or macroeconomic analyses) or more directly from the level of satisfaction perceived by the user. The **cost driven** methodology focuses on costs and does not take account of user benefits.

3.18 The **benchmarking** methodologies (**across companies** or **from previous performance**) do not explicitly take account of user benefits. However, the methodologies may implicitly take account of user/consumer benefits – for example, when a metric is developed to measure the provision of a service to users and an improvement to the LoS threshold is based on previous performance. For certain metrics (e.g. Energy Not Supplied per user or per user group – impacted by a power cut or not), it is possible to calculate LoS standards per user or by segment. This is different from using the CBA methodology because it does not calculate the disbenefits of these reductions in supply but would bring the LoS metric closer to the user/consumer level. However, implementing this type of calculation would require additional resources and more disaggregated data.

Equitability/Distributional

3.19 Both **CBA** and **benefits driven** methodologies are considered to be the most equitable in that they more fully account for user benefits, in particular if they estimate benefits using sophisticated methods (such as SP and RP, which aim to determine local and context-relevant values) and using a representative sample of users. For example, stakeholder engagement has stimulated discussion on whether survey results will be affected by the proportion of users that have (or have not) been affected by a flood. To determine a "fair" value, the values from those affected/not affected would have to be reweighted to a represent the population as a whole in the area covered by the operator.

3.20 **Benchmarking from previous performance** may be less equitable if the context within which the performance is measured changes over time. The LoS threshold that was considered to have been equitable in the past may no longer be so. To achieve equitability, the background to the setting of the LoS threshold (such as the weather, economic conditions and other externalities) should be considered explicitly and interpreted carefully alongside past performance.

3.21 **Benchmarking across companies** is considered less equitable as it does not take account of external factors. For example, in the Water sector, adverse weather conditions (including storms) will be more frequent in certain regions of the country and may, therefore, have a greater impact on the standard set for the "Risk of sewer flooding in a storm" metric compared to other parts of the country. A comparison at the disaggregated level using a simple segmentation by type (and levels) of external factors influencing the LoS could help make this methodology more equitable.

3.22 Although rarely used, the **cost driven** methodology is the least equitable as it does not include any user benefits. Costs are usually estimated at an aggregate level for large infrastructure investments and/or system operations. Splitting these estimated costs by users would not take into account their usage/consumption of a specific infrastructure service. If, however, the user's usage/consumption is estimated (which is assumed to be a proxy for user benefits) and usage weights used to allocate costs to different user segments, then the approach follows a more equitable cost allocation and is closer to the CBA methodology.

Driving improvement

3.23 The methodology that best drives improvement is **benchmarking across companies** as it provides a direct comparison across companies for a specific metric. Known as "comparative competition", and often used within a regulatory framework, knowledge about the relative performance of different companies aims to provide the incentive for individual companies to improve their performance. However, the perceived competitive "pressure" which drives improvements is valuable only as long as it is considered "fair". In the Water sector, benchmarking across companies is often used to triangulate other methodologies to set LoS thresholds. For example, although Ofwat encouraged companies to consult users in setting leakage reduction targets, individual company targets were refined by reference to other companies' performance. However, some companies might feel that this approach is not fair, for example if their infrastructure is older or ground conditions make their network more susceptible to leaks. This methodology is not possible for markets where the infrastructure company has a national monopoly (e.g. the data communications infrastructure company for energy smart metering) but can be used for those where monopolies occur at a regional level

(e.g. electricity distribution, water and wastewater, and rail), allowing for comparisons across regions.

3.24 **Benchmarking from previous performance, CBA** and **appraisal of user benefits** are methodologies which, when combined with an appropriate incentive structure, can drive improvement. Indeed, knowing what has been achieved in the past can (as part of an appropriate incentive structure) drive the will to improve and over-perform, while understanding user benefits can help ensure that adequate enhancements are made to maximise those benefits. For example, in the Digital sector, user benefits take an important place in the methodology for setting LoS thresholds. In some competitive markets (e.g. mobile phone coverage), user benefits (especially if estimated using perceived user satisfaction) strongly drive the direction and speed of technological improvements. In monopoly markets, the methodology to set LoS thresholds may be applied during the Price Control Review process, where the role of the Regulator is important in driving improvements to ensure efficient prices and high-quality services for users for which the **benchmarking from previous performance**, **CBA** and **appraisal of user benefits** methodologies are more appropriate.

3.25 The methodology which provides the least incentive to improve performance is the **cost driven** methodology as it does not provide any cross-company comparators or set an objective that needs to be achieved. Comparing costs at a more disaggregate level (e.g. by weather conditions for LoS under extreme events) may be used to provide a more appropriate (and sometimes more credible) comparison, although it involves more resources. It is noted that the segmentation should be carefully thought out (e.g. comparing the costs for high speed rail across countries would require many adjustments and understanding of exogenous factors). It could provide, if these adjustments are credible, a more objective comparison, which may in that case drive improvements.

Simplicity

3.26 Both **benchmarking** methodologies (**across companies** or **from previous performance**) are simple in that they do not require much effort to implement, gather information or set LoS thresholds. It is possible to use trends in past performance to understand potential future improvements, but the use of such trends in setting the threshold is limited.

3.27 The **cost driven methodology** is usually relatively straightforward, based on accounting and financial rules. However, it can become more complex to implement if, for example, it is used to estimate expected costs (the probability of an event multiplied by the costs associated with that event). Extreme events are, by their nature, rare, as a result of which the costs associated with them are much harder to quantify.

3.28 The **CBA** and **benefit driven** methodologies are the most complex, not only in terms of the resources and data required to implement but also in terms of the need to establish a sound theoretical base for the identification and valuation of benefits. In particular, methodologies that include an SP or RP survey and analysis are time-, money- and data-consuming. For example, estimating a value for the WTP for train punctuality (i.e. the benefit of improving the rail LoS punctuality metric) would require the use of a large survey to ensure that all users' views were captured (across, for example, different routes and times of travel), complex analyses to determine the resulting values, and additional work to apply those values to a representative population of rail users. The benefits calculation methods are more complex than other methodologies, but if they start to become more popular, frequently used across the different sectors and peer reviewed and published, they may provide more results both

within and across sectors. In cases where this occurs, estimates for input into CBA could be extrapolated from industry standards and peer reviewed publications.

No reliance on historic data

3.29 This criterion evaluates the dependence of a methodology on data from previous performance and is meant to mitigate the potential for (non-)recency bias in simple methodologies (such as **benchmarking from previous performance**). This methodology relies on having at least several years of historic data. For example, the risk of sewer flooding in a storm metric is a new metric for which there is no historic data, while only a few years data is available for the Smart Metering metric.

3.30 The **CBA** and **benefit driven** methodologies are less dependent on data from previous performance, although such data can usefully be employed, for example, to validate the results of SP or RP surveys.

3.31 The **benchmarking across companies** and **cost driven** methodologies do not specifically rely on historic data. These methodologies are more frequently deployed to determine LoS performance thresholds when historic data is rarely or not at all available (for example, in an extreme event).

Adaptability (type of event)

3.32 Most methodologies are currently used to set LoS performance thresholds for everyday events. Adaptability evaluates their suitability for determining both everyday and extreme events.

3.33 **Benchmarking from previous performance** and **cost driven** methodologies are considered to be the most adaptable. As long as there is sufficient data on the LoS performance in extreme events, the benchmarking **from previous performance** methodology can easily be adapted. The **cost driven** methodology can likewise be adapted to the type of event. For everyday events, the committed LoS metric can be set on the basis of actual costs; for extreme events, the committed LoS metric can be set on the basis of expected costs (event probability times the expected cost associated with the event).

3.34 **Benchmarking across companies** could be adaptable for extreme events, but its adaptability is dependent on sufficient data on the performance of other companies in similar extreme events being available (a condition which maty be difficult to satisfy). For example, for the supply restriction metric, a drought would rarely occur and when it does, it would only be for a few specific regions.

3.35 The benefits calculations included in the **CBA** and **benefits driven** methodologies are more appropriate for everyday rather than extreme events because of the difficulty in quantifying user benefits (or disbenefits) in extreme events. This is due to the lack of experience of extreme events (if RP or a macroeconomic approach is used to estimate benefits) and the difficulty in setting the context for a SP survey. Despite these barriers, it is still possible to use in the context of extreme events, the benefits calculation methods (such as SP surveys) used for everyday events. However, the need for input data from extreme events remains. This can be achieved by putting more effort towards data collection for extreme events, or eventually, by combining datasets across companies/regions/countries, and adjusting them for comparison (the latter option might be less successful in obtaining credible results).

Transferability

3.36 Most methodologies are transferable, albeit only for specific metrics and in different conditions.

3.37 **Benchmarking from previous performance** is the most transferrable methodology, provided that the metric has not been introduced only recently and that data is available for several years.

3.38 While the **CBA** and the **benefit driven** methodologies are generally transferable across sectors, this transferability may depend on the LoS metric.

3.39 The **cost driven** methodology would be transferable, but it is rarely used because many metrics either require benchmark performance or take into account user benefits.

3.40 **Benchmarking across companies** is transferable across sectors, but not across all markets as some are competitive and others are monopolistic. In the former, data from very different companies should be interpreted carefully, understanding and taking account of the performance context. In the latter, there needs to be a sufficient number of peers for comparisons. For example, in the electricity distribution sector there are sufficient number of regional monopoly distribution companies, whereas for electricity transmission the number of peers is limited.

Everyday/Extreme events

3.41 The suitability and applicability of alternative methodologies in setting LoS thresholds for everyday and extreme events was much debated during stakeholder engagement activities. It was noted that the energy and water sectors allow exemptions to everyday thresholds – for example, LoS thresholds for restrictions in a 1-in-a-200 year drought, for Customer Minutes Lost in electricity distribution and for Loss of Supply in gas distribution apply to everyday events and explicitly exclude extraordinary events. Stakeholders from the transport sector (rail) have questioned whether different targets could be set for everyday and extreme events, because passenger expectations on performance differ for extreme events compare to everyday conditions.

3.42 In conclusion, all methodologies are suitable for everyday events.

3.43 However, for extreme events:

- The most suitable methodologies are:
  - Cost driven; and
  - Benchmarking from previous performance (provided historic data is available).
- The least suitable methodologies are:
  - CBA; and
  - Benefit driven.

The discussion at the CBA Roundtable organised by the NIC on 18th November 2019 corroborated these conclusions.

Key data requirements

3.44 The key data requirements vary considerably across the methodologies:

- For benchmarking across companies/countries:
  - Information on metric thresholds for other companies is required (and it may be confidential).
- For benchmarking from previous performance:
  - Comparable and relevant data should have been collected for several years (particularly important if previous performance is going to be used to set future LoS).
- For cost appraisal, the type of data required includes:
  - physical infrastructure costs;
  - resourcing costs;
  - management and monitoring costs;
  - other costs;
  - event probabilities (if LoS metrics includes the risk of extreme events – this data may be difficult to obtain and quantify).
- For benefit appraisal, the type of data required include:
  - service usage (frequency/duration/availability/take-up);
  - service quality;
  - service reliability;
  - an *a priori* range of value estimates (if benefits are calculated using SP techniques);
  - market segmentation by characteristics of the users or of the service usage (if SP outputs are estimated at a disaggregate level);
  - projections of the impacts of service availability/quality/reliability on economic parameters such as productivity, employment and value-of-time savings (if wider economic benefits are estimated).

4 Conclusions

4.1 This section contains the conclusions of this project, summarising the findings of the evaluation of the alternative methodologies.

Methodology evaluation summary

4.2 In the LoS metrics examined for this study, many approaches to setting LoS involved some element of benchmarking (in combination with or separately from other methodologies). We looked at the benchmarking methodologies and how they may be applied across different infrastructure sectors.

4.3 Two types of benchmarking approaches were identified and examined: **benchmarking across companies** and **benchmarking from previous performance.** Both are simple methodologies providing useful insights and incentives that can drive competition and improve performance. It is also important to consider the context in which the benchmarking is done, as it could be less equitable than other methodologies, if this is not taken into account. There are nuances in how benchmarking across companies and from previous performance use data, and how they are used in combination with other methodologies. Below, we summarise the key points.

4.4 **Benchmarking across companies** has the following attributes:

- There is no reliance on historical data and there may be limited user engagement.
- It is considered easily adaptable over time (excluding major changes/externalities) and is adaptable from everyday to extreme events.
- If used correctly in monopoly markets (e.g. for electricity distribution networks), it can be useful, when combined with an appropriate incentive structure, for driving competition and, therefore, provide a better service for users.
- International benchmarking is only used for “basic” values, i.e. those which can be defined precisely, and which are comparable across countries. These values are mainly used as inputs to methodologies.

4.5 **Benchmarking from previous performance** is widely used, often to triangulate other methodologies. Some of the key points about this methodology are:

- It has a heavy reliance on historical data, with several years of data needed for a more insightful analysis.
- It requires sufficient records of performance data, so is not suitable for recently established metrics (such as Risk of sewer flooding in a storm).
- It also generally involves limited user engagement.
- It is considered to be easily adaptable over time (excluding major changes/externalities) and adaptable from everyday to extreme events (assuming that historical data on extreme events is available).
- When combined with an appropriate incentive structure, it provides some incentive to improve performance.
- It is very frequently used to validate CBA or benefit driven LoS threshold results.

4.6 During our research and also during discussions with stakeholders from the different sectors, we recognised that benchmarking can, if combined with an appropriate incentive structure, drive competition which results in an improvement of services provided to users.

4.7 Stakeholders also agreed that they considered **CBA** to be the most objective methodology. In comparison to benchmarking, it involves significant user engagement and considers context to some extent due to the way the methodology works. Some of its key features are:

- It is complex, as the calculations of benefits may involve demanding appraisal techniques such as Stated Preference and Revealed Preference (which require considerable user engagement).
- There is limited reliance on historical data, although such data may be used as an initial input to the benefit calculations.
- It is more equitable, in that the calculation of benefits takes greater account of local conditions and the context of the evaluation.
- However, the methodology needs to be adapted over time.
- It is mostly used for everyday events and is less adaptable to extreme events.
- It is also used for "non-standard" performance metrics and for metrics that have a very specific context.
- However, although often recommended, it is not used extensively as it is costly in terms of resources (time, money and data).

4.8 Some methodologies are used for more particular circumstances. For example, the **cost driven methodology** is often used when there is going to be a trade-off between an increase in LoS standards or an increase in expected costs due to potential incidents. It can be a simple methodology but grows more complex when expected costs are calculated. As with benchmarking, it is not considered equitable, as cost is considered apart from the context and there is limited user engagement. Other attributes of the cost driven methodology include:

- It does not rely on historical data, except when establishing event probability.
- It has a limited impact on driving improvement.
- It is considered to be adaptable over time even though it may need to be updated, and it is considered to be adaptable across everyday and extreme events.
- It is usually employed:
    - When costs or funds are limited;
    - For extreme events: to determine expected outcomes (event probability multiplied by costs associated with the event).

4.9 The cost driven methodology appears to have a limited impact on driving improvement. In contrast, if one adds context and user engagement back into the equation – for example, in the case of the **benefit driven methodology** – this is considered to have more of an effect on increasing user benefits.

4.10 The **benefit driven methodology** is rarely used as costs are usually taken into account in setting LoS thresholds. It is a complex methodology, which may include demanding appraisal techniques such as the ones used in CBA. Attributes include:

- Benefit calculations could use demanding appraisal techniques such as SP and RP. For the same reason, it also involves significant user engagement.
- It has limited reliance on historical data, although such data may be used as initial input for benefit calculations.

- It is more equitable, as the benefits estimations reflect local conditions and are context-dependent.
- As a result, the methodology needs to be adapted over time, with updated estimates required in the long term, and it is less adaptable to extreme events.
- It is considered to drive improvement as it sets an objective of maximising user benefits.

Project approach findings

4.11 We made two main observations related to how the project was carried out and how it evolved during the study period, especially due to inputs from experts in their respective industries and extensive engagement with stakeholders.

4.12 We found that there was a fairly limited number of methodology categories used across sectors. Initially there appeared to be very different approaches taken in the four sectors considered, and/or in the different geographies from which the examples were chose. However, there were similarities that allowed approaches to fall into a smaller number of categories, so that the typology was simpler than initially expected. That said, the way specific metrics are calculated does often vary from one to the other. The actual methodologies to determine the threshold eventually fit into one of the six methodology categories we developed.

4.13 We also found that stakeholders showed lots of interest in the topic. During the interviews and workshop, there was a genuine enthusiasm about the topic and a willingness to debate the minutiae of the methodologies.

4.14 Following an exploration of current and historical industry practices, we made key observations related to the setting of LoS thresholds. LoS thresholds describing infrastructure resilience were historically based on capacity (base level), while current thresholds now seem to be customer-oriented (satisfaction level). The operator or infrastructure management may have to strain the infrastructure physical assets, which are designed for the base level, when aiming to provide customer-oriented service. In most cases, the LoS was not set using just one methodology but rather a combination of several methodologies. For example, if CBA was used, the results were validated using another method such as benchmarking from previous performance and/or across companies.

Transferability across sectors

4.15 While the aim of the project was not to find a standardised methodology to set committed LoS thresholds for all sectors, the importance of comparing methodologies across sectors was emphasised in all stakeholder consultations.

4.16 Stakeholders were reluctant to promote the adoption of a “one-size-fits-all” approach to setting LoS thresholds. However, it seems that industry’s approach to this topic is still in its infancy – in part because of the different ages of sector institutions (e.g. the “recency” of the digital sector) and because of the lack of knowledge of the overlap between sectors (with the exception of Energy and Digital which may have more common infrastructure in the near future).

Good practice suggestions

4.17 Drawing on the evaluation discussion in Section 3, we consider that a "good practice" methodology should incorporate specific elements that work together to provide a better experience for the user while placing that experience in the appropriate context.

4.18 The guidelines below summarise more general good practice regarding methodologies. Our suggestion is that they are:

- **Proportionate to the scale of the potential costs/benefits**: that is, high impact LoS metrics should be developed using more thorough and comprehensive methodologies. This would make the overall set of LoS standards for a sector **more equitable**;
- **Customer or user focused**: it should measure something that really matters to customers and naturally incorporated into the LoS standard via the methodology used;
- **Use public consultation to ensure that interested parties (including operators, user groups and other relevant stakeholders) are given the opportunity to feed into the decision** as this can make the process behind the methodology more inclusive of all parties;
- **Consider the wider context**: by taking into account any relevant policy objectives, and other aspects that could be impacting services provided to users;
- **Aim to achieve continual improvement in outcomes**, with effective regulation substituting for competitive pressures in monopolistic markets, as this can help to drive improvement for the LoS standard;

4.19 Other good practice suggestions relate more specifically to the typologies, assuming that they can be adapted to keep them relevant for continuing to set LoS:

- **The use of other methodologies could enhance the main methodology,** for example, through validation of results. Benchmarking has often been used as an effective way to do this;
- **Take into account available data on relevant performance benchmarks, even if not immediately applicable** to the specific local context. There are instances where benchmarking across companies or countries is not used as the main methodology, but can still be useful for a peer review of the results from other methodologies – this can also help to drive service improvement for the LoS standard;
- **Quantify the cost implications of setting the LoS at a higher or lower level** and, if possible, quantify the benefits implications of setting the LoS at a higher or lower level as well. This can be combined with a CBA of different options. As a result of estimating the marginal cost and marginal benefit implications, complexity of the LoS methodology would increase but may in turn help stakeholders to make a more informed decision about the threshold;
- **Transparent documentation in a public domain document** – a published and shared methodology would more likely drive improvement;
- **A regular review of methodologies,** so they are adapted over time.

4.20 These suggestions provide guidelines on how to best implement the methodologies to set LoS standards. We recognise that they have limitations and are not always applicable to the letter in practice.

A Summary descriptions of selected LoS metrics

Energy methodologies

Introduction to the Energy Sector Regulatory Framework

A.1 The GB energy industry regulatory framework has undergone significant change since privatisation. The gas sector was restructured and privatised in 1986; the first parts of the electricity sector were privatised in 1990. The introduction of new industry structures with a combination of competitive and monopoly elements required the creation and introduction of a regulatory framework to protect consumers and prevent monopoly abuse. This framework has developed and evolved as the industry has matured and the issues it has faced have changed.

A.2 Under the current RIIO model, **R**evenue is set to deliver strong **I**ncentives, **I**nnovation and **O**utputs (i.e. Revenue = Incentives + Innovation + Outputs).

A.3 The RIIO model was applied in the gas distribution and gas and electricity transmission price control reviews in 2013, and in electricity distribution in 2015. Collectively, this first generation of RIIO price controls are termed RIIO-1.

A.4 This new framework sought to put consumers at the heart of the energy network companies' plans and encourage longer-term thinking, greater innovation and more efficient delivery. Key aspects of the new framework included:

- Stakeholders are provided with greater opportunity to influence Ofgem and network company decision-making;
- The focus is on outputs (including committed LoS targets) rather than inputs – at the start of the process, Ofgem will set the outputs that network companies are expected to deliver to achieve wider policy objectives;
- The price control and committed LoS targets will be set in advance (ex-ante);
- The price control will be set for eight years, with provision for a mid-period review of the outputs that network companies are required to deliver.

A.5 Following a period of consultation, Ofgem's RIIO-2 decision was published in July 2018. The RIIO-2 model will be applied to gas distribution, and gas and electricity transmission in 2021, and to electricity distribution in 2023.The key modifications to the existing framework which impact committed LoS are:

- There is greater consumer engagement compared with RIIO-1; and
- The price control period is reduced to five years (from eight years).

Loss of Load Expectation (LoLE)

Average number of hours per year in which supply is expected to be lower than demand under normal operation of the system.

Summary

A.6 The Loss of Load Expectation (LoLE) reliability standard for each year is set by using cost-benefit analysis, which compares the marginal cost of providing additional generating capacity with the value of lost load (VoLL). For domestic and SME customers, VoLL is estimated using stated preference choice experiments (CE), with econometric estimation and standard statistical techniques used to convert the results into £/MWh figures and confidence intervals. For I&C customers, VoLL estimates are obtained using a value-at-risk approach and econometric methods.

Background

A.7 Prior to the setting of a LoLE reliability standard for the GB electricity market, consultants were commissioned to estimate the VoLL. Technical consultants were also commissioned to provide cost assumptions for the estimation of the cost of new generating plant.

A.8 For VoLL, Ofgem and the Department of Energy and Climate Change (DECC) jointly commissioned consultants (London Economics) in 2013 to estimate VoLL for domestic, SME and I&C electricity consumers in Great Britain.

A.9 The research conducted by the consultants was based on a variety of methods, but the major work element involved estimation of VoLL using CE.

A.10 A stated preference CE was used to estimate the VoLL in terms of willingness-to-accept (WTA) payment for an outage and willingness-to-pay (WTP) to avoid an outage for domestic and SME electricity users. This approach allowed the consultants to examine the WTA and WTP of electricity outages of different lengths, seasons, days of the week and times of the day. Econometric estimation and standard statistical techniques were then used to convert the CE results into £/MWh VoLL figures and confidence intervals.

A.11 The study also included open-ended contingent valuation (CV) questions where respondents were asked to state their monetary value for an outage in WTA or WTP terms.

A.12 The consultants stated that CE was preferred to CV as it allowed outages to be examined on a multi-dimensional basis, reduced the possibility of strategic responses and allowed examination of preferences for attributes over a range of price/payment levels.

A.13 For I&C customers, a different method was employed, which involved using a value-at-risk approach and econometric methods to estimate VoLL.

A.14 The VoLL figure utilised in the reliability standard is a weighted average of VoLLs for domestic and SME customers at times of winter peak demand. The VoLL figure for I&C customers was excluded, as it was assumed they were able to participate in the capacity market through demand side response, or change their electricity use in response to price signals.

A.15 Separately, to estimate the cost of providing additional capacity generating, various cost assumptions on annual and short-run marginal costs of running a generating plant, construction, etc. were utilised from work conducted by technical consultants (Parsons Brinckerhoff).

A.16 The proposed reliability standard was set out in an annex to the Electricity Market Reform consultation and published in July 2013. DECC's decision, which considered stakeholders' comments, was issued in December 2013.

Customer Minutes Lost (CML)

Average number of minutes that a customer has their supply interrupted.

Summary

A.17 CML targets are set for each Distribution Network Operator and determined by benchmarking across DNOs and each DNO's historic performance. Operators can either accept or reject targets proposed by the regulator as part of the price control determination process. If rejected, operators are expected support their position with well-justified business plans. Regulator led with extensive input from operators. Operators and third parties can appeal regulator's decision. VoLL based on a combination of qualitative and quantitative Willingness To Pay (WTP), Willingness To Accept (WTA) and cost of interruptions research. VoLL used as an input to determine incentive structure for CML.

Background

A.18 Prior to the setting of the eight-year RIIO-ED1 price control in April 2015, which includes upfront CML targets for each distribution network operator (DNO), Ofgem commissioned independent research in May 2012 to undertake a desktop review and analysis of information on Value of Lost Load (VoLL), covering:

- Published estimates of *willingness to pay (WTP)*, measuring how much a customer would be willing to pay to avoid an interruption, or to avoid lengthier interruptions;
- Published estimates of *willingness to accept (WTA)*, measuring how much a customer would be willing to accept in exchange for enduring an additional interruption or longer interruptions; and
- Published estimates of *costs of an interruption*, measuring the costs a customer incurs due to an interruption.

A.19 The consultants (Reckon) reviewed numerous published studies, focusing on those that appeared most relevant.

A.20 The approach followed by the studies reviewed by the consultants were one of two broad types:

- An approach based on survey of customers about their WTP, WTA or about the costs they would incur due to changes in the reliability of their electricity supply; and
- An approach based on macroeconomic data, specifically the gross value added of sectors, and on sector-wide electricity consumption.

A.21 The consultants found that above two broad approaches were categorised by one study (SINTEF (2010) "Study on estimation of costs due to electricity interruptions and voltage disturbances", pp 61–72) into the following three methodologies:

- **Stated preference methods** – typically based on surveys where respondents are asked about their valuation of interruptions, which may be done directly or indirectly. Within this class of methods, it is possible to distinguish between:
  - *Contingent valuation methods* — respondents are asked directly about their WTP or WTA energy supply with a specific hypothetical reliability.

  - *Conjoint analysis* — respondents are asked to choose between alternative scenarios of energy reliability, with each different scenario having a particular price tag.
  - *Direct worth* — respondents are asked about the costs they estimate they would incur in particular scenario.
  - *Preparatory action method* — respondents are asked to select from within a list of actions, those that they would take for the purpose of mitigating the effect of a particular interruption.
- **Revealed preference methods** – makes use of information on how respondents have behaved in the past which may reveal their preferences with respect to energy supply reliability. This may involve analysing data, for example, on the expenses that customers have incurred in purchasing equipment such as back-up generators as a means of avoiding disruptions due to power outages.
- **Production function methods**. These methods rely on macroeconomic data, namely the gross value added of sectors, and on sector-wide annual electricity consumption to estimate VOLL.

A.22 To allow comparisons of estimates, the consultants converted the estimates from the different studies into a common unit. A range of estimates were then outlined for domestic and non-domestic customers. The estimates presented by the consultants were utilised by Ofgem when developing the incentive structure for CML.

A.23 The process that Ofgem followed in setting the CML targets, is outlined below.

A.24 Part of RIIO-ED1 price control (2015-23) includes an Interruption Incentive Scheme (known as IIS) which sets upfront targets for the duration (CML) of both planned and unplanned interruptions.

A.25 The setting of the CML targets are set for each DNO. These are set based on a combination of own average performance and benchmarking against the industry average or upper quartile performance.

A.26 Distribution companies are expected to develop well-justified business plans based on a "Strategy for the Review" consultation document issued by Ofgem. This document defines the outputs that the companies are expected to deliver, including proposed reliability and availability targets.

A.27 This stage of the process provides an opportunity for the network companies to either accept the targets or propose alternatives, supported by appropriate evidence, as part of their business plans.

A.28 Network companies' business plans are subject to an assessment before they are finalised. Ofgem then issues its final decision, which will include the upfront CML targets.

A.29 Operators and third parties can appeal the regulator's final decision (which British Gas Trading did for RIIO-ED1 price control).

Energy Not Supplied (ENS)

Volume of energy to customers that is lost as a result of faults or failures on the network.

Summary

A.30 ENS targets are set for each transmission company and determined by benchmarking each Transmission System Operator's (TSO's) historic performance. Operators can either accept or

reject targets proposed by the regulator as part of the price control determination process. If rejected, operators are expected support their position with well-justified business plans. Regulator led with extensive input from operators. Operators and third parties can appeal regulator's decision. VoLL is determined by Ofgem, based on previous estimates applied previously in GB and other jurisdictions (e.g. Ireland and Victoria (Australia)). VoLL used as an input to determine incentive structure for ENS.

Background

A.31 In setting VoLL to determine the incentive structure for ENS targets, Ofgem reviewed previous research on values previously applied in the GB (in 2010, 2000/01 (which was based on a 1977 Finnish study), 1996, 1995) as well as other jurisdictions (Ireland and Victoria (Australia)).

A.32 In terms of the process followed, Ofgem first publishes its "Strategy for the Review" consultation document on key elements of the RIIO-ET1 price control framework which includes the outputs the TNOs need to deliver (which will include amongst other things Ofgem's proposals for reliability and availability including the ENS targets, which is a primary output).

A.33 TNOs are expected to develop well-justified business plans based on the consultation document issued by Ofgem.

A.34 This stage of the process provides an opportunity for the network companies to either accept the targets or propose alternatives, supported by appropriate evidence, as part of their business plans.

A.35 Network companies' business plans are subject to an assessment before they are finalised. Ofgem then issues its final decision, which will include the upfront ENS targets.

A.36 Operators and third parties can appeal the regulator's final decision.

Loss of Supply

Minimum levels of network reliability performance for customers, covering number and duration of interruptions

Summary

A.37 Loss of Supply targets, covering number and duration of interruptions, are set for each gas distribution company and determined by benchmarking each DNO's historic performance. Operators can either accept or reject targets proposed by the regulator as part of the price control determination process. If rejected, operators are expected support their position with well-justified business plans. Regulator-led with extensive input from operators. Operators and third parties can appeal regulator's decision.

Background

A.38 The process that Ofgem followed in setting the Loss of Supply targets, is outlined below.

A.39 Part of RIIO-GD1 price control (2013-21) sets upfront loss of supply targets for each DNO, which are one of the primary outputs of the price control framework.

A.40 Distribution companies are expected to develop well-justified business plans based on a "Strategy for the Review" consultation document issued by Ofgem. This document defines the outputs that the companies are expected to deliver, including proposed loss of supply targets.

A.41 This stage of the process provides an opportunity for the network companies to either accept the targets or propose alternatives, supported by appropriate evidence, as part of their business plans.

A.42 Network companies' business plans are subject to an assessment before they are finalised. Ofgem then issues its final decision, which will include the upfront loss of supply targets.

A.43 Operators and third parties can appeal the regulator's final decision.

A.44 Ofgem undertook a mid-period review (MPR) in 2017, identifying issues in gas distribution (and transmission) that they wanted to look at further. As part of this work, Ofgem decided to update the Loss of Supply) targets, to ensure the targets for the remaining years of RIIO-GD1 remained challenging but realistic enough for companies to achieve. This involved stakeholder consultation to capture and address stakeholder views.

Guidelines of Good Practice

A.45 This is not an LoS metric like the other examples, but it was agreed with NIC that this should be included as it clearly outlines guidelines for good practice in terms of setting LoS thresholds. These theoretical insights were useful for this project.

Summary

A.46 In 2010, the Council for European Energy Regulators (CEER) issued Guidelines of Good Practice on Estimation of Costs due to Electricity Interruptions and Voltage Disturbances. The guidelines were intended to provide a set of recommendations for NRAs and other stakeholders on how to design and develop nationwide cost-estimation studies.

Background

A.47 The Guidelines identified two types for a cost-estimation study: (i) survey-based approach and (ii) case-based approach. Survey-based approaches typically involve the design of a questionnaire which is sent out to a large representative sample. Case-based approaches focus on a few single cases in order to identify consequences of interruptions or voltage disturbances for these typical cases.

A.48 The Guidelines include recommendations on:

- Definition of objectives;
- Choice of consultants;
- Specification of customer groups;
- Choice of cost-estimation method;
- Choice of normalisation factor and clarification of data needs;
- Check for available data;
- Choice of conduction method (means by which the survey/case analysis is
- performed);
- Design of questionnaires and scenarios;
- Sample selection;
- Test of questionnaires;
- Survey conduction: how to conduct the survey/case analysis;
- Selection of cases;
- Analysis of cases; and
- Cost analysis.

A.49 Regarding cost estimation methods, the following methods are identified:

- **Direct worth** – commonly used to estimate the monetary costs of electricity interruptions. Customers are asked to estimate the expenses which they incur due to a hypothetical or experienced interruption or voltage disturbance. Several scenarios are usually presented to the customer and the customer has to specify the economic costs according to predefined cost categories. The scenarios must be understandable, realistic and accepted by the respondent.
- **Contingent valuation** - the respondent is presented with a hypothetical or experienced scenario of an electricity interruption or voltage disturbance and asked for the willingness to pay to avoid it or willingness to accept compensation when it occurs. The scenarios must be understandable, realistic and accepted by the respondent.
- **Conjoint analysis** - instead of asking customers directly for willingness to pay to avoid or willingness to accept certain interruptions or voltage disturbances, respondents are asked to select the preferred option between pairs of hypothetical scenarios, or they may be asked to rank or rate a list of different hypothetical scenarios. Based on the choices, the costs are estimated indirectly through econometric models.
- **Preparatory action method** – customers are asked to choose from a list of hypothetical actions (e.g. the purchase of candles) which reduce the consequences of an electricity interruption or voltage disturbance. Each action is associated with a given cost.
- **Preventative cost method** – This method measures customers' expenditures on equipment which is already installed to prevent or counteract the consequences of interruptions or voltage disturbances. The value of such purchases can be seen as an estimate for the costs of an interruption or a voltage disturbance that they seek to avoid.
- **Direct worth in case study** – this where intensive analysis is undertaken of one or several "cases" in question. These "cases" are normally typical customers who can represent a large customer group or customers which have such complex consequences that the costs of interruptions and voltage disturbances have to be assessed on a case-by-case basis. These case studies can be based on both real experience and hypothetical scenarios.

Water methodologies

Introduction to the Water Sector

A.50 Ofwat, the water regulator for England and Wales, has adopted an output-based approach to regulating the sector. Under this approach, Performance Commitments[14] (PCs) are divided between:

- Common PCs, of which there are 14, where Ofwat requires all companies to monitor and report their performance against the metric. Ofwat sets commitment levels for all companies for some of these PCs; for the others, companies set their own commitment levels.
- Bespoke PCs, where only a subset of companies record their performance against the metric. Commitment levels are set by the individual companies, based on their customers' priorities.

[14] Defined by Ofwat as "the level of performance that companies commit to deliver for customers. They are the means to hold companies to account for their service delivery. Each performance commitment has an associated outcome delivery incentive (ODI)."

A.51 Outcome Delivery Incentives (ODIs), which are the financial or reputational (non-financial) incentives for companies to outperform and avoid underperformance against each of their performance commitments, are set for both common and bespoke PCs.

A.52 In general, Ofwat challenges companies to achieve the forecast upper quartile performance level for each year of the price control period. For supply interruptions, internal sewer flooding and pollution incidents, Ofwat states that it expects companies to propose performance commitment levels that are at least the forecast upper quartile performance level for each year. For performance commitments that have statutory obligations, companies are expected to set service levels in line with those statutory obligations unless they have evidence to show that customers would prefer a more stretching commitment level.

A.53 For PR19, Ofwat expects companies to improve the quality of data and processes related to the use of Cost-Benefit Analysis used to set PCs levels (i.e. both customer valuations and marginal cost data, as well as the use of sensitivity tests to assess the impact of different levels of customer valuations and marginal costs).

Supply/Demand Balance

Summary

A.54 The methodology used to determine the balance between supply and demand is established by UK Water Industry Research (UKWIR)/Environment Agency (EA). Supply must exceed demand plus target headroom; target headroom is established taking account of the range of uncertainty around each component of supply and demand. Individual companies determine the values of the parameters used in the assessment but will use sensitivity analyses and customer preferences (among other factors) to determine the robustness of their projections.

Background

A.55 In developing their Water Resource Management Plans (WRMP), water undertakers are expected to ensure that supply exceeds demand plus target headroom, and that this is achieved at least cost. Target headroom is defined as “the minimum buffer that water companies are required to maintain between supply and demand in order to account for current and future uncertainties in supply and demand”. This approach was embedded within the Economics of Balancing Supply and Demand (EBSD) framework adopted in 2002 to guide public water supply companies in England and Wales in conducting resource planning.

A.56 Although changes to planning priorities (with greater emphasis now on climate change, resilience, contestability, and consumer engagement) may have seen his approach evolve, the EBSD approach has been kept as a benchmark so that companies, regulators and customers know what the least cost plan could be. As a result, target headroom remains a key component of the supply: demand balance.

A.57 Target headroom is set by the individual companies, on a zone-by-zone basis, following the methodological guidelines established by UK Water Industry Research (UKWIR) in 2002 – these methodologies are embedded within the Environment Agency’s 2012 Water Resources Planning Guidance (WRPG). The approach seeks to combine the uncertainties around supply and demand to derive an overall probability of supply and demand being in balance.

A.58 However, this has now evolved into an “integrated risk modelling” approach, which is defined as “a method for combining both variability and uncertainty in a way that links risk to Levels of Service”.

A.59 In general, individual companies will assess each component of supply and demand to estimate the likely range of uncertainty in each case. The range of uncertainty follows the shape of a probability distribution from which such likelihoods are drawn. These distributions are co-sampled to create the combined (cumulative) probability distributions from which an appropriate target headroom value is determined.

A.60 Companies will need to ensure that their base assumptions are as well-founded as possible and will also carry out sensitivity tests on those assumptions and on the shape of input distributions to explore their robustness.

A.61 Companies will also take account of (among others):

- Customer requirement for reliable, continuous supply of water, usually derived from customer surveys undertaken for the WRMP and business plan;
- Consequences of failure to provide adequate supplies, including adverse or potentially hostile reaction from customers and the extra costs incurred;
- The period of time required to plan and implement the optimal supply-demand solution; and
- The financial and/or environmental costs of providing supply-demand solutions, which can affect customers' willingness (or not) to accept a higher risk on the future achievement of the target level of service.

Table A.1: Descriptions of the Options for a Company's Stated Risk Composition

	Risk Composition 1: 'Conventional' Plan (Based purely on historically observed droughts, with limited testing of more severe events)	Risk Composition 2: Resilience Tested Plan (Includes resilience testing of investment proposals using plausible alternative drought events)	Risk Composition 3: Fully Risk Based Plan (Uses quantified probabilities of drought types and severities not seen in the historic record)
Level of Service Statement	We expect to limit the average number of [demand restrictions] to around x in the next y years*.	We expect to limit the average number of [demand restrictions] to around x in the next y years*.	We are confident that, on average, we will only have to apply x [demand restrictions], in the next y years*. We would also expect to have to apply for temporary abstractions beyond normal environmental safeguards around x [times] during the same period.

Supply restrictions

Summary

A.62 This metric is not a target. It is up to companies to propose their own stretching performance commitment levels for this metric following engagement with their customers and stakeholders. This could have included cost-benefit analysis (CBA), which is the default approach where companies set the level of service where marginal cost equals marginal willingness to pay (the latter determined though stated preference WTP and other approaches). Companies' PR19 submissions suggest that this approach has not been followed and that additional modelling work is required before PC levels can be set.

Background

A.63 The risk of severe restrictions in a drought is a risk-based measure of resilience which was developed in collaboration with the industry for PR19 – it is a common performance commitment. It is not a target, although it is up to companies to propose their own stretching performance commitment levels for this metric following engagement with their customers and stakeholders.

A.64 Ofwat states that it aims to ensure that companies are reducing customer risk over the longer term as well as improving their understanding of their resilience challenges in these areas (e.g. by increasing model coverage) in the nearer term.

A.65 This performance commitment measures the percentage of the customer population at risk of experiencing severe restrictions (e.g. standpipes or rota cuts as part of Emergency Drought Orders) in a 1-in-200-year drought, on average, over 25 years. The population is considered to be 'at risk' if the supply-demand balance calculation in each water resource zone for the 1-in-200-year drought event results in a shortfall (deficit). This will occur when the theoretical deployable output minus outage allowance (available supply) is less than the dry year demand plus base year target headroom (demand plus uncertainty)

A.66 For PR19, companies were expected to use various methods to determine the performance commitment level, including cost-benefit analysis (CBA), comparative information, historic information, minimum improvement, maximum level attainable, and expert knowledge. Under the first, which is the default approach, companies needed to identify and understand their marginal costs (MC) and marginal benefits, in particular customers' marginal WTP, establishing level of service where marginal cost equalled marginal willingness to pay (the latter generally determined though stated preference WTP approaches although Ofwat was keen to encourage companies to use multiple sources of evidence on customer preferences in setting performance commitment levels – as a change in methodology for PR19).

A.67 However, a review of a sample of companies' PR19 submissions found no evidence of the use of CBA to determine performance commitment levels. It appears that additional modelling work is required before performance commitment levels can be determined.

The Compliance Risk Index (CRI)

CRI is a measure of water quality compliance, determined by risk modelling using weighted scores.

Summary

A.68 As a statutory obligation, Ofwat states that the performance commitment level should be set at zero. However, as it is a new measure introduced at PR19, Ofwat has permitted deadbands which allow for some fluctuations in performance, but which still provide a strong incentive to minimise compliance failures. A review of a sample of companies' submissions found that their proposed deadbands were based on the company's performance in the previous year or previous years, on delivery at upper quartile performance, or on average industry performance in the previous year or years.

Background

A.69 The Compliance Risk Index (CRI) is defined and calculated by the Drinking Water Inspectorate (DWI) and is used as a measure of water quality compliance across a company's asset base. Its calculation is aligned with the DWI's risk-based approach to the regulation of water quality.

The CRI is a statutory obligation[15]. Three CRI scores are calculated: for water supply zones, for supply points and treatment works, and for service reservoirs. The annual CRI for a company, for any given calendar year, is the sum of the individual CRI scores for every compliance failure reported during the year.

A.70 Ofwat requires full compliance with the CRI, although it has allowed for deadbands[16] to provide for some fluctuation in performance, whilst providing a strong incentive to minimise compliance failures. The same deadband has been set (at 2.0) for all companies for 2020-25, although Ofgem had previously stated that it was open to considering company-specific arguments and that it might allow exceptions if well justified.

A.71 The metric is made up of three components: a parameter score, with a focus on health-based impact; the DWI assessment of the failure/response; and the volume/population affected.

A.72 Companies' proposals for deadbands were based on various factors, including the company's performance in the previous year or previous years; delivery at upper quartile performance; and average industry performance in the previous year or years.

Risk of sewer flooding in a storm

Summary

A.73 This is a new, forward-looking measure of resilience which was introduced for PR19. As a result, cross-company comparative data and company-specific historic data is not available. Companies have not carried cost-benefit analyses to determine performance commitments, instead defining a level based on the most recent year performance which may or may not improve over time, i.e. benchmarking using previous experience or performance.

Background

A.74 This measure requires companies to determine the percentage of the population in their area that is at risk of being flooded in a 1-in-50-year storm event. The use of this metric has been justified on the basis that the potential for sewer flooding in a storm "is important to customers". It requires companies to use hydraulic models, where available, to identify that population. Given that the objective of the measure is to understand the resilience of systems to events beyond the norm, the 1-in-50-year storm event represents an event beyond conventional design (which normally considers the 1-in-30-year event) and thereby offers a better measure of resilience[17].

A.75 In developing this measure of resilience, Ofwat, in consultation with various stakeholders, has produced guidance[18] which enables all water and wastewater companies to report on the risk

[15] See: http://www.dwi.gov.uk/stakeholders/price-review-process/CRI_Def.pdf

[16] Deadbands are a specified range of performance levels where the Outcome Delivery Incentive (ODI) underperformance or outperformance payment is zero.

[17] Source: Developing and Trialling Wastewater Resilience Metrics, Final Report for Water UK, 7 November 2017, Atkins.

[18] https://www.ofwat.gov.uk/wp-content/uploads/2019/04/Reporting-guidance-Risk-of-sewer-flooding-in-a-storm_final_290319.pdf

of sewer flooding during an extreme wet weather event for a defined year with confidence and with a reasonable level of accuracy.

A.76 In setting out its approach to setting performance commitment levels, Ofwat states[19] that it is "ensuring that companies are reducing customer risk over the longer term as well as improving their understanding of their resilience challenges in these areas (e.g. by increasing model coverage) in the nearer term". The onus is on the companies to produce their analyses – in response to the companies PR19 submissions, Ofwat commented that the "quality of company responses varies greatly. Some companies provide the assumptions used and the intermediate steps requested, while others do not".

A.77 Although companies are expected to propose stretching performance commitment levels on this metric, Ofwat remained cautious about requiring companies to have financial ODIs related to this metric as it is at relatively early stages of development and so lack historic and comparative performance data.

A.78 From a review of a sample of their submission, given the lack of data, companies have, at a minimum, set performance commitments at current levels.

A.79 This metric was designed to assess existing and future resilience to an extreme wet weather event causing sewers to flood (in effect, to measure the resilience of sewerage undertakers in respect of their drainage systems). Ofwat, in consultation with various stakeholders, has produced guidance[20] which enables all water and wastewater companies to report on the risk of sewer flooding during an extreme wet weather event for a defined year with confidence and with a reasonable level of accuracy.

A.80 In setting out its approach to setting performance commitment levels, Ofwat states[21] that it is "ensuring that companies are reducing customer risk over the longer term as well as improving their understanding of their resilience challenges in these areas (e.g. by increasing model coverage) in the nearer term". The onus is on the companies to produce their analyses – in response to the companies PR19 submissions, Ofwat commented that the "quality of company responses varies greatly. Some companies provide the assumptions used and the intermediate steps requested, while others do not".

A.81 This measure requires companies to determine the percentage of the population in their area that is at risk of being flooded in a 1-in-50-year storm event. It requires that companies use hydraulic models, where available, to quantify the risk. The choice of the 1-in-50-year storm event as the basis for the analysis is not set out.

A.82 The use of this metric is justified on the basis that the potential for sewer flooding in a storm "is important to customers". As it was a new metric for PR19, Ofwat had not carried out comparative analysis across companies.

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[19] Page 16, https://www.ofwat.gov.uk/wp-content/uploads/2019/07/PR19-draft-determinations-Delivering-outcomes-for-customers-policy-appendix.pdf

[20] https://www.ofwat.gov.uk/wp-content/uploads/2019/04/Reporting-guidance-Risk-of-sewer-flooding-in-a-storm_final_290319.pdf

[21] Page 16, https://www.ofwat.gov.uk/wp-content/uploads/2019/07/PR19-draft-determinations-Delivering-outcomes-for-customers-policy-appendix.pdf

Transport methodologies

Introduction to the rail industry

A.83 The targets for the main rail infrastructure manager (i.e. Network Rail) are set by the Office of Rail and Road (ORR) every five years. The five-year cycle is referred to as a Control Period (CP) and is intended to align expenditure on rail infrastructure with delivery of rail capacity and performance. The targets for the franchised rail passenger operators are set by the franchising authority which includes the Department for Transport, Transport Scotland, Transport for Wales, and Transport for London. It is the targets for the infrastructure manager (not the operators) that are the focus of this section. There has been significant change in how these have been set in CP5 (2014 to 2019) and CP6 (2019 to 2024).

Rail punctuality

Percentage of trains that arrive at their terminating station on time compared to number of trains planned

Summary – Control Period 5, 2014 to 2019

A.84 As part of the previous periodic review, in respect of England & Wales the Secretary of State's HLOS in July 2012 set out targets for performance and reliability to be achieved by the end of Control Period 5 (CP5), which ran from April 2014 to March 2019.[22] The key metric was the Public Performance Measure (PPM), which is a measure of the proportion of schedule services that arrive at their planned destination within 5-minutes (or 10-minutes for a long-distance service). The overall national target of PPM for the end of CP5 was set at 92.5%. This target was set using a combination of the understanding of Network Rail's funding for CP6, and an assessment of the changes in infrastructure and train service. The target is not adjusted to account for the latest position in train service level or infrastructure provision. As such, the increase in train services across CP5 was not reflected in the targets set.

Summary – Control Period 6, 2019 to 2024

A.85 The first part of the process for CP6 was similar to CP5, in that the Department for Transport defined a High-Level Output Statement (HLOS) for the deliverables of Network Rail across the five-year period. However, there was a change in both the performance measure and the method for creating the benchmarks. The ORR defined a new regulatory metric "Consistent Route Measure - Passenger Performance (CRM-P)", along with non-regulatory measures such as a route level scorecard and PPM trajectory. delivered by train operators.

A.86 The ORR is responsible for formally Determining the performance benchmarks for each CP. In CP6, each of the Network Rail routes was tasked with developing their forecast on the level of CRM-P for their route, and to incorporate this into their Strategic Business Plans (SBP). The ORR used these levels as part (but by no means all) of the evidence for their Draft, and Final Determinations. The ORR completed a detailed assessment of the trajectories, and stakeholders (including the train operators) were consulted on the levels. It should be noted that there is a tension between operators and NR on the NR trajectories as the performance of NR has a significant impact on the ability of operators to deliver on their own performance targets.

[22] https://orr.gov.uk/__data/assets/pdf_file/0019/39313/pr18-final-determination-scorecards-and-requirements.pdf

Background

A.87 Public performance measure (PPM) combines figures for punctuality and reliability into a single performance measure expressed as a percentage. The Control Period 5 target was 92.5%. ORR specifies the performance measure to reflect the experience/impact on customers and to benchmark the performance of Network Rail in asset stewardship, operational control decisions and management of incidents to mitigate delays.

A.88 Network Rail populates a Performance System database (PSS) using input from the TRUST (Train Running System for TOPS) reporting system to record cancellations and the proportion of trains arriving to the minute at each timetabled station stop. This system covers more than 80% of stations. The nature of events is classified using Performance Event codes and reason for delays (Delay Attribution) is also recorded.

A.89 As part of ORR's 2018 periodic review of Network Rail (PR18), separate settlements were set for each of Network Rail's routes in England and Wales. The draft determination set out ORR's assessment of Network Rail's routes' Strategic Business Plans (SBPs) for CP6. Three performance issues were identified for the Anglia route: Anglia and its passenger operators were given a further opportunity to agree suitable targets for delivery across CP6, given that as of June 2018 they had been unable to agree. ORR also asked Anglia to review the modelling that it had used to calculate its CRM-P trajectory, as this had not been prepared on a consistent basis compared to other routes. In addition, ORR considered that CrossCountry should be represented on Anglia's scorecard (in addition to being on the FNPO's scorecard and the other six routes over which it operates). This reflected the degree of risk it faces as a franchised operator running timetabled services across the network. ORR therefore asked Anglia to agree a performance measure and trajectory with CrossCountry.

Motorway incidence clearance

Percentage of motorway incidents cleared within one hour

Summary

A.90 The Department for Transport set Government launched the first Road Investment Strategy (RIS) in 2015, which had a target for Incident Management to ensure good traffic flow. The requirement for Highways England (HE) is to maintain that at least 85% of all motorway lane impact closures between 0600 and 2200 are cleared within one hour. This was based on observations of the time highways officers spent out in the field when sent to manage incidents. In 2013 and 2014 the baseline was around 85% and this historic performance has been carried through to today.

Background

A.91 Highways England seeks to minimise the impact of traffic related delays. One of the outcomes set out in the RIS is a target for Incident Management, to ensure good traffic flow. The requirement is that in any one rolling year, HE is to maintain that at least 85% of all motorway lane impact closures between 0600 and 2200 are cleared within one hour.

A.92 In the operational metrics manual, there is an implication that 85% is a realistic target based on existing command and control data. It is not realistic to achieve 100% because of the nature of specific incidents, e.g. involving policy investigations, multiple vehicles and serious injury – these are often police-led and take over an hour.

A.93 Monitoring and benchmarking of the 85% target has shown that it is a realistic requirement.

Operational warning/response

Summary

A.94 There is a Rail Adapt Framework that contains two sections – development of an Adaptation Strategy and Implementation Plan – based on the experience of transport administrations such as the Swedish Transport Administration and the Finnish Transport Agency. The framework consists of risk appraisal, option generation, option analysis and different stages of review.

A.95 When identifying meteorological, climatic and other hazards, one may start with a review of historic experience to indicate the types of incidents that are of primary concern. However, potential future events are also explored by considering national meteorological or other services.

A.96 The Taiwan HSR has set thresholds for both wind and rain and has adopted an operational warning system based on weather forecasts that indicates whether meteorological hazards will affect operations.

A.97 For each level of poor weather condition (e.g. level 1 with rain under 35mm/h, level 2 over 35mm/h, level 3 over 45mm/h and level 4 over 50mm/h), the corresponding risk can be estimated and, in turn, this can be used to calculate an expected cost outcome. The expected cost outcome is the probability of an accident happening at a certain level multiplied by the estimated costs of that accident, or the costs of safety measures taken to prevent it.

A.98 The HSR is monitored closely for level 2, reduces its speed for level 3, and suspends some services for level 4, with a different LoS set for each weather condition level. These LoS standards are set to minimise the expected cost outcomes.

Background

A.99 Railways in many countries have developed operational warning systems that allow weather forecasters to indicate where and when meteorological hazards will affect operations. One example of this is in Taiwan High Speed Rail who set thresholds for both wind and rain which are used by their weather service provider.

A.100 If rainfall is forecast to exceed 160mm over 24 hours (or 35mm in 1 hour) then additional monitoring of critical locations is undertaken. At 180mm/24 hours (or 45 mm/hour) a reduction in operational speed is imposed and at 250 mm/24 hours (or 50 mm/hour) services are suspended. Similar actions occur at wind speeds of 20 m/s (45mph/70km/h), 25 m/s (56mph/90km/h) and 30 m/s (67mph/110km/h).

A.101 These conditions typically occur on up to 5 days per year due to cyclones but significantly reduce the derailment safety risk. Climate change will potentially change the number of events.

Pavement condition maintenance

Transportation Asset Management Plan (TAMP) to ensure that maximum percentage of pavement and bridge assets in poor condition is not exceeded.

Summary

A.102 Following the signing of The Moving Ahead for Progress in the 21st Century Act, MAP-21, the Federal Highway Administration (FHWA) was required to adopt a set of national pavement performance measures for evaluating the Interstate and National Highway systems. In January 2015, the FHWA issued a Notice of Proposed Rulemaking (NPRM) to establish performance measures to assess the condition of pavements on the NHS and Interstate System.

A.103 According to the NPRM, FHWA considered using existing methods such as Pavement Condition Index (PCI), remaining service life (RSL) and others but did not find anything suitable for their purposes. This led to FHWA proposing four pavement performance measures for: IHS good condition; IHS poor condition; NHS good condition; NHS poor condition. It appears that the thresholds were simply set by FHWA then later verified through studies to determine the "truth" of the data[23]. State-level Transport Asset Management Plans (TAMPs) are intended to meet FHWA requirements and are certified by the latter every four years.

Background

A.104 The Moving Ahead for Progress in the 21st Century Act, MAP-21, is a bill to govern US federal surface transport spending passed by Congress and signed by President Obama in 2012. In this Act, the FHWA was required to adopt a set of national pavement performance measures for evaluating the Interstate and National Highway System.

A.105 The Highway Performance Monitoring System (HPMS) is an internal data source that can be used to determine a performance measure for pavement condition. It shows extent, condition, performance, use and operating characteristics of the nation's highways.

A.106 For Interstate pavements, the maximum allowed percentage of pavement in poor condition is 5% of mileage. For National Highway System bridges, less than 10% can be in poor condition.

A.107 The Highway Performance Monitoring System is a national level highway information system that includes data on the extent, condition, performance, use and operating characteristics of federally sponsored road network. The database uses inputs from the data systems of local, regional, and state governments and is connected using a common geo-referencing system.

Freight rail delay

Delay minutes per 100 freight train-kms.

Summary

A.108 In Control Period 5, covering 1 April 2014 to 31 March 2019, freight delay minutes data changed from being a regulated target to a measure of whether Network Rail is likely to miss a regulated target. It remains based on the Network Rail caused delay minutes. Delay minutes are a useful diagnostic measure underpinning the punctuality of freight train services. In CP5 there are no regulatory targets for maximum levels of delays minutes[24].

Background

[23] https://www.fhwa.dot.gov/asset/pubs/hif17022.pdf

[24] Freight Rail Usage: Quality and Methodology Report, https://orr.gov.uk/__data/assets/pdf_file/0016/22903/freight-usage-quality-report.pdf

A.109 Delay minutes per 100 freight train-kms are seen as a useful metric by which to judge performance. Furthermore, delay minutes data receive a very high confidence grade (of A1 in both 2009/10 and 2010/11 when independently reviewed). For CP6 (April 2019 to March 2024), the policy with respect to benchmarks for both Network Rail and operators is that they should be set on the basis of expected performance. This is to ensure that money flows in the Schedule 8 regime are, on expectation, zero. I.e. the level of performance is set so that freight operators (FOCs) will neither pay nor receive Schedule 8 payments in relation to delay that they cause.

A.110 ORR determined that there would be no adjustment for FOC performance improvement when considering setting the delay metric requirement, as any historic performance improvement was coincidence and not funded by the government (where, in contrast, Network Rail are funded for and expected to deliver improvements), and including this trajectory for improvement might result in a perverse incentive for the FOC not to make any plans to improve their performance.

A.111 The measure is recalibrated every 5 years (Control Period) to recognise the impact of changes in traffic mix (the level of performance varies with different types of freight traffic).

Digital methodologies

Broadband USO

The Universal Service Obligation for broadband is a UK-wide measure to deliver broadband connections to the hardest to reach premises in the UK. Filling the gap left by UK Government's existing broadband roll-out programmes.

Summary

A.112 The Universal Service Obligation (USO) for broadband originated as a public announcement where government had a certain target in mind and consulted with the regulator Ofcom to determine how to set the LoS. The proposed headline 10Mbps download speed had been informed by Ofcom consumer research on the user experience at different access speeds, and statistical analysis of monthly data volumes by access speed. The final LoS was decided after consideration of the findings from a cost-effectiveness analysis on four potential outcomes, responses from consultations, and a cost-benefit analysis in the government's impact assessment.

Background

A.113 The Universal Service Obligation for broadband is a UK-wide measure to make 'decent' broadband access available to the hardest-to-reach premises in the UK.

A.114 Before 2003, there was an obligation on BT and KCOM that their phone lines should be capable of providing at least 2.4 kbps data rates. In 2003, this was effectively increased through Ofcom issuing guidelines specifying a benchmark minimum of 28.8 kbps, in order to support 'functional internet access'. As mass market broadband rolled out across the UK, it became apparent that consumers expected to have access to much higher minimum speeds, and the government introduced a 'universal service commitment' that download speeds of at least 2 Mbps would be available to all by 2012. Service levels continued to improve with the introduction of superfast broadband services, and in November 2015 the government announced that it would introduce a Universal Service Obligation for broadband, ensuring that

every premise in the UK would have the right to access at least 10 Mbps download speeds. This was subsequently included in the Conservative's 2017 manifesto.

A.115 The original source for the current headline 10 Mbps download speed for the broadband USO can be traced back to Ofcom's Communications Infrastructure Report 2013, which analysed consumers' monthly data usage by speed of connection and noted that *"Although average data consumption has increased, the profile of use vs. speed is very similar to last year. However, the threshold at which data consumption 'plateaus' has increased from around 8Mbit/s to around 10Mbit/s. consumers on connections of less than 10Mbit/s tend to use less data, suggesting that internet usage is constrained by lower speeds".*

A.116 Further research was undertaken in 2014 by consultants (Actual Experience) for Ofcom. This installed 'digital user' software at 540 volunteers' premises, which continually monitored various technical aspects of the users' internet experience and used proprietary algorithms to derive an automated 'voice of the customer' score. The consultants cross-checked these automated scores with results from a survey of participants, which achieved 145 responses. Actual Experience analysed the relationship between this 'voice of the customer' score and the broadband speeds on participants' lines, and concluded that "*The results show a clear correlation between access speed and consumers' experience up to around 8-10Mbps. Beyond this, there is only a marginal benefit to increased speed until 'superfast' connections of 40Mbps and above are reached*."

A.117 Ofcom drew on its analyses of monthly data usage by connection speed, and on the consumer research, to conclude in the 2015 Strategic Review of Digital Communications Market Review that "*The time has come to review public policy around the Universal Service Obligation for broadband*" and that "*There is evidence that today broadband of at least 10Mbit/s is required to support typical consumers' use*."

A.118 This finding informed the government's announcement in November 2015 that it would introduce a Universal Service Obligation for broadband, ensuring that every premise in the UK would have the right to access at least 10 Mbps download speeds. It was cited in the subsequent consultations in 2016 and 2017, which sought views on appropriateness of setting a broadband USO, and the proposed specification which would be set in secondary legislation.

A.119 The detailed specification for the LoS drew on the findings from these consultations, and from a technical cost effectiveness analysis undertaken by consultants (Analysys Mason) for Ofcom, which estimated the costs associated with four potential USO specification options, and estimated the numbers of premises for which the provision costs would exceed the proposed threshold.

A.120 The LoS for the USO was also informed by the government's Impact Assessment which assessed the economic costs and benefits of four potential options. Cost estimates were drawn from Analysys Mason's work for Ofcom, and the net economic GVA benefits were modelled by DCMS over a period to 2035, using a model originally developed for DCMS in 2013 by consultants (SQW) for the UK Broadband Impact Study.

A.121 The government's chosen specifications were believed to balance the importance of providing a service that meets households' typical needs with a proportionate approach that considers the costs to industry and the potential impacts on the good functioning of a competitive market.

A.122 DCMS moved ahead with their design and implementation of the regulatory USO, which is intended to be in place by 2020 – with operators KCOM (in Kingston-upon-Hull) and BT (elsewhere) designated as USO providers. This includes a minimum download speed of 10 Mbps, minimum upload speed of 1 Mbps, additional quality parameters, and a maximum cost threshold per premise. Government plans to keep the specification of the USO under review to ensure it keeps pace with consumers' evolving needs.

Mobile communications data service coverage/speed

Licensees shall provide and maintain an electronic communications network that is capable of providing, with 90% confidence, a mobile telecommunications service with a sustained downlink speed of not less than 2 Mbps when that network is lightly loaded, to 98% of the UK population.

Summary

A.123 Ofcom's mobile data coverage obligation of at least 2 Mbps, in one of the 4G spectrum licences, was designed to align with the government's universal broadband speed target at the time, i.e. it was influenced by a public announcement. Input from consultations and parliament was considered when setting the LoS, and appraisal techniques using cost-effectiveness analyses were also used.

Background

A.124 In March 2011 Ofcom consulted on the 800MHz and 2.6GHz bands. It was the largest ever single award in the UK of internationally harmonised mobile spectrum and was expected to deliver 4G mobile technologies such as LTE and WiMAX. The award was an important opportunity to ensure such services were made available in less urban areas as well as in more commercially attractive more densely populated areas.

A.125 At the time of Ofcom's consultations, the government had a 'universal service commitment' which aimed to make download speeds of at least 2 Mbps available throughout the UK by 2012. This may have informed Ofcom's proposed level of 2 Mbps for the minimum download speed in one of the 4G licences.

A.126 Ofcom first proposal was for once of the licences to require a sustained downlink speed of not less than 2Mbps with a 90% probability of indoor reception to an area within which at least 95% of the UK population lives. However, in their second consultation in 2012, they noted they had received 71 responses and many of these had argued for more extensive coverage of 98%. The House of Commons Culture, Media and Sport committee had also recommended increasing the coverage target from 95% to 98% in at least one of the licences. There was also support for a higher data rate of 5Mbps.

A.127 The LoS was also informed by case study research on mobile 'not-spots' undertaken by consultants (PA Consulting) for Ofcom, technical network coverage modelling undertaken by Ofcom, and coverage and detailed cost modelling for specific example areas by consultants (Real Wireless). It is not clear at this stage whether any quantification of monetised *benefits* was undertaken for this LoS.

A.128 More recently, Ofcom has used crowdsourced data from an Android smartphone app to shed further light on the mobile consumer experience and the speeds achieved for various applications. Analyses of this data were published in 2017 and 2018.

Smart metering service availability

Percentage of time that services do not have unscheduled downtime (Percentage availability of: Data Service, User Gateway, Service Management System, Self Service Interface)

Summary

A.129 Percentage availability was one of a set of service levels types included in Ofgem's Operational Performance Regime for the Data Communications Company (DCC) which provides the smart metering data communications infrastructure in GB. Specific minimum and target service levels have been negotiated with Communications Service Providers (CSPs), using **benchmarking of their previous experience or performance** and fed into the **regulator or operator estimation** process for determining the LoS.

Background

A.130 This was one of a set of service levels included in Ofgem's Operational Performance Regime (OPR) for DCC. A key performance incentive in DCC's licence is that its baseline margin is put at risk each regulatory year. The OPR sets out incentives to mimic competitive pressure and ensure that DCC efficiently manages costs while delivering an appropriate quality of service.

A.131 Ofgem consulted in 2016 and 2017 on the principles and then the more detailed types of service measures, within its consultations on the OPR for DCC. However, these did not set out specific target levels for the proposed service measures.

A.132 We understand that the specific minimum and target service levels percentages were negotiated between DECC and the Communications Service Providers (CSPs), and these were then inherited by DCC.

A.133 One specific service level is in the public domain, for *Percentage of time (in minutes) when the Self-Service Interface is available to be accessed by all Users during the Target Availability Period*, which has a target level of 99.5%, and a minimum level of 98%. For the other measures, the information on specific target and minimum levels has been redacted in the public domain versions of the relevant contracts. We assume that these were arrived at through DECC's negotiations with the CSPs, based on their **previous experience or performance**.

A.134 Industry feedback has been that, in practice, the current set of service levels are not necessarily the best measures of reliability; work is currently underway to explore whether a more customer-oriented set of service levels could/should be developed, encompassing measures related to service degradation.

Openreach's ethernet circuit provisions

Openreach's proportion of ethernet circuit provisions taking longer than an upper threshold time, in non-competitive areas of UK

Summary

A.135 Ofcom's review stemmed from a statutory process which requires them to conduct regular reviews of the business connectivity market.

Background

A.136 Ofcom has a statutory requirement to conduct regular reviews of the business connectivity market[25].

A.137 For Ofcom's 2016 Business Connectivity Market Review, the chosen LoS was informed by **consumer research** which included a quantitative study comprising 615 interviews via CATI (computer assisted telephone interviewing) with businesses with 10 or more employees that purchase business connectivity services (BCS)[26]. Market research was conducted by BDRC Continental to understand end-users' preferences with respect to products and supply conditions and understand how they may have changed since the last review.

A.138 The 2016 Business Connectivity Market Review found that openreach's performance in delivering ethernet circuits had significantly deteriorated in recent years.

A.139 As a result, Ofcom consulted on - and then implemented - a set of QoS remedies in areas of the UK where openreach had significant market power. The original target was set at less than 3% of ethernet orders taking more than 118 working days to deliver.

A.140 The 2019 Business Connectivity Review found that openreach's performance in delivering ethernet had improved substantially since the QoS remedies had been put in place. The 'tail' provision target was relaxed in that review to less than 3% of orders taking more than 138 working days (in year 1, or 135 working days in year 2), in the light of experience. This took into account **statistical analysis** of **operator previous performance** and arguments re the cost/efficiency implications of having tighter targets for this tail measure.

NZ Ultra-Fast Broadband coverage

New Zealand's target for fibre-to-the-premises coverage (Ultra-Fast Broadband)

A.141 While this metric does not measure a purely resilience aspect, it does fall under the infrastructure performance umbrella.

Summary

A.142 In the case of New Zealand's target for Ultra-Fast Broadband, this began with a **public announcement** or political commitment to provide a certain level of access. **Cost analyses** and **benefit analyses** were then used to estimate the magnitude of investment that would be required, and the potential economic benefits.

Background

A.143 In 2008 NZ's National Party promised 75% of New Zealand homes to have access to FTTP, citing potential economic benefits from the New Zealand Institute, although it is not clear how they estimated these. Therefore, the approach considered for this metric (at the time) was solely based on benefits. On election, the Ultra-Fast Broadband programme was set up to deliver this. Two leading industry analysts produced FTTP cost studies clearly setting out the

[25] **https://www.ofcom.org.uk/__data/assets/pdf_file/0026/57491/bcmr_2014_report-bdrc.pdf**

[26] **https://www.ofcom.org.uk/__data/assets/pdf_file/0026/57491/bcmr_2014_report-bdrc.pdf**

vision of a fibre future and the investment needed. The coverage aspiration has since been extended and is now 87% coverage by 2022.

A.144 It is unclear whether there was any specific analysis of the benefits of this LoS prior to original manifesto commitment. However, this policy appears to have been successful in boosting NZ's broadband speed rankings, and the approach taken has allowed for realistic coverage targets to be ratcheted up over time.

B Stakeholder interview details

Stakeholder interviews scheduled

B.1 Table B.1 shows the stakeholders interviewed by sector and the dates of the interviews.

Table B.1: Stakeholder interview list

Sector	Stakeholder organisation	Interview
Energy	BEIS	Cancelled
Energy	ENA	Wed 20/11/2019
Energy	Energy UK	Mon 25/11/2019
Energy	Ofgem	Fri 29/11/2019
Water	Severn Trent	Tues 05/11/2019
Water	Unified Utilities	Thu 07/11/2019
Transport	ORR	Wed 30/10/2019
Transport	Network Rail	Wed 6/11/2019
Transport	Highways England	Tue 12/11/2019
Digital	BT	Fri 08/11/2019
Digital	Ofcom	Mon 11/11/2019
Digital	DCC	Fri 22/11/2019

Source: Steer

C Stakeholder workshop details

Stakeholder workshop attendance

C1.1 Table C.1 presents the organisations that attended the workshop held on the morning of Thursday 28 November 2019 in the Steer London offices.

Table C.1: Stakeholder workshop (28/11/2019) attendance

Sector	Organisation	Stakeholder
Energy	ENA	Trade association
Water	Severn Trent	Operator
Water	Unified Utilities	Operator
Digital	DCC	Operator
Digital	Ofcom	Regulator
Digital	Openreach	Operator
Transport	Highways England	Infrastructure manager
Transport	Network Rail	Infrastructure manager
Transport	Rail Delivery Group	Trade association

Source: Steer

Stakeholder workshop agenda

C1.2 During the workshop, we delivered presentations and engaged stakeholder with activities listed in the following plan:

- 9:30-9:45 Welcome and introductions, NIC resilience study overview
- 9:45-10:15 LoS Methodology project overview and methodology examples
- 10:15-10:25 Activity 1: Key pros and cons of each methodology
- 10:25-10:35 Discuss early findings and list of criteria
- 10:35-10:45 Question to stakeholders on processes across the four infra sectors
- 10:45-11:00 Coffee break
- 10:45-11:15 Activity 2: Methodology evaluation by criteria
- 11:15-11:45 Comparison with our evaluation table
- 11:45-12:00 Final comments from stakeholders and conclusions.

C1.3 Both activities resulted in the validation and/or improvements of the draft work presented.

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