Office for Statistics Regulation

UK Statistics Authority

Assessment of compliance with the Code of Practice for Statistics

Statistics on air quality and emissions of air pollutants

(produced by the Department for Environment, Food and Rural Affairs)

Assessment Report 344

July 2019

Office for Statistics Regulation

We provide independent regulation of all official statistics produced in the UK. Statistics are an essential public asset. We aim to enhance public confidence in the trustworthiness, quality and value of statistics produced by government.

We do this by setting the standards they must meet in the Code of Practice for Statistics. We ensure that producers of government statistics uphold these standards by conducting assessments against the Code. Those which meet the standards are given National Statistics status, indicating that they meet the highest standards of trustworthiness, quality and value. We also report publicly on system-wide issues and on the way statistics are being used, celebrating when the standards are upheld and challenging publicly when they are not.

Contents

Executive Summary 4
Judgement on National Statistics Status 4
Key Findings 4
Public Value 4
Quality 5
Trustworthiness 5
Next Steps 5
Chapter 1: Public Value 7
Introduction 7
Findings 7
Table 1: Value – Findings and Requirements 11
Chapter 2: Quality 13
Introduction 13
Findings 13
Table 2: Quality – Findings and Requirements 19
Chapter 3: Trustworthiness 20
Introduction 20
Findings 20
Table 3: Trustworthiness – Findings and Requirements 22
Annex 1: About the Statistics 23
The Statistics 23
Data Sources and Methods – Additional Information 24
Uses and Users 26
Annex 2: The Assessment Process 28
Key documents 28
Annex 3: Next Steps 29
Responding to the assessment report: what the Office for Statistics Regulation and Defra should expect from each other 29
Annex 4: Glossary 31
Acronyms and abbreviations 31

Executive Summary

Judgement on National Statistics Status

ES.1 Users value Defra's air quality and emissions data and statistics and regard them as being of high quality and trustworthy. We identified a range of actions for the Department for Environment, Food and Rural Affairs (Defra) to further enhance the public value, quality and trustworthiness of the statistics, as described in chapters one to three of this report. We judge that these statistics can continue to be designated as National Statistics once Defra has met all six Requirements of this report.

Key Findings

Public Value

ES.2 Air quality is one of the most high-profile and important environmental issues. Air pollution has both short- and long-term effects on human health and impacts the environment. The air quality and emissions data and statistics are vital to supporting public understanding of the problem and informing public debate, and for the development and evaluation of policies that aim to reduce emissions of air pollutants and improve air quality.

ES.3 Both the air quality and emissions data and statistics have a wide range of users. Defra should enhance the value of the statistics by developing a better understanding the different types of users and their needs and initiating an ongoing dialogue with users to drive improvements. The statistics team might find it useful, as part of enhancing its engagement, to publish a user engagement plan.

ES.4 Although the air quality and emissions data and statistics are published separately, they form a package of related statistics. There are links between the ambient concentration of air pollutants and emissions of air pollutants, but the relationship is complex. To provide a coherent view of these connected topics and generate greater insight for users, Defra should integrate both sets of statistics as far as possible. It should explain the purpose of each set of statistics and how they differ, and should cross-reference them to provide a coherent narrative.

ES.5 Often, air quality and air pollution are a localised set of concerns. Many users highlighted the need for better access to more granular, disaggregated air quality data and to existing local air quality data. To increase transparency and public engagement with the air quality data, Defra should work quickly to develop and implement a portal bringing together local and national air quality data to maximising access to, and the value of, these data for a wide range of users. It should also consider how to incorporate these data when producing the air quality statistics to generate greater insights about trends in air quality.

ES.6 In general, the online UK Air Information Resource (UK-AIR) and the National Atmospheric Emissions Inventory (NAEI) website are easy to access and we received positive feedback from users on the websites, but users also identified areas for improvement. To ensure that the websites meet user needs, Defra should act on the feedback from the UK-AIR user needs project, and, in collaboration with the Department for Business, Energy and Industrial Strategy (BEIS), continue to review the NAEI website, to enhance their accessibility and navigability.

ES.7 The statistics bulletins (*Air quality statistics in the UK* and *Emissions of air pollutants in the UK*) present a good overview of the main trends, but Defra should make some improvements to enhance their clarity and insight. For instance, the emissions statistics bulletin comments on both short- and long-term trends in emissions, but it can be hard for users to interpret recent changes in emissions. To help users understand how recent policy interventions may have affected emissions, Defra should make short-term trends clearer in the commentary and the accompanying visualisations.

Quality

ES.8 Defra and Ricardo Energy & Environment (Ricardo) use the most appropriate data sources and follow internationally agreed and recognised methods to produce the best available estimates of emissions and ambient air quality. We are impressed by the close working relationship between Defra and Ricardo, and by their effective engagement with data providers and other contractors and stakeholders to ensure high data quality. In general, information about the emissions data sources and the air quality monitoring network is clear and helpful. To further help users Defra should explain how and why specific emissions data sources were selected and should update and expand information on the monitoring network.

ES.9 Defra and Ricardo help set standards and are ambitious about improving the quality of the emissions inventory. We welcome the extensive collaboration between Defra, Ricardo and topic and methods experts to compile the emissions inventory and drive improvements. Ricardo revises the emissions inventory every year, with the aim of improving its completeness and accuracy, and it is transparent about methods changes and revisions.

ES.10 The air quality statistics bulletin includes 95% confidence intervals for the mean estimate of the concentration of each pollutant, which helps users understand variation in air pollutant concentrations and uncertainty around the measurements. Given the complexity of the data sources and methods used to compile the emissions inventory, there is uncertainty around the emissions estimates. To aid user interpretation of the emissions statistics, it might be helpful if Defra presented a summary of the uncertainty analysis alongside the statistics and signposted this information in the datasets.

ES.11 Information about data sources and methods is not published alongside the statistics or is not signposted as clearly as it could be. For instance, the *Informative Inventory Report* (IIR), which provides a comprehensive overview of emissions data sources and methods is published separately, a month later. To help users understand the quality and methods of the emissions statistics, Defra should publish information on how the emissions inventory is compiled at the same time as the statistics, for example, via a summary methods and quality document. To support fuller user understanding of the production of the air quality statistics, Defra should enhance the information about methods it publishes alongside the statistics and on UK-AIR.

ES.12 The quality assurance and quality control (QAQC) processes for both sets of data and statistics are rigorous and well-established. They are well-documented and clearly explained, but accessibility to this information should be improved.

Trustworthiness

ES.13 The statistics are produced independently and released in an orderly manner; pre-release access arrangements for the emissions statistics are well documented and adhered to. There is no pre-release access for the air quality statistics as these are based on data that are already publicly available on the UK-AIR website.

ES.14 Defra will be recruiting a new statistician to the team, freeing up the lead statistician's time to focus on air quality data development. We welcome this additional resource and Defra's appetite to improve the air quality data and statistics. Defra should continue to commit enough resources to development, ensuring ambitions for air quality data are delivered.

ES.15 To enhance transparency about its approach to quality, the statistics team should explain how it is meeting the Defra Group's quality principles for the air quality and emissions statistics. Defra should also consider publishing a formal development plan for the statistics to keep users informed of changes and allow them monitor progress against the plan.

Next Steps

ES.16 We expect the Defra statistics team to report back to us by May 2020. We encourage the team to develop an action plan to meet the Requirements described in Tables 1, 2 and 3 of

this report. Aspects of some Requirements will take longer to implement, such as the user engagement work (Requirement 1) and the improvements to the UK-AIR website (Requirement 3c). For these, we expect Defra to send us a detailed update on progress towards meeting the Requirements by May 2020. Once Defra has shown us that it has enhanced the public value, quality and trustworthiness of the air quality and emissions statistics, having addressed the findings and Requirements, the Authority will decide whether to confirm the National Statistics designation, based on OSR's advice.

Chapter 1: Public Value

Introduction

1.1 Value means that the statistics and other numerical information are accessible, remain relevant and benefit society; helping the public to understand important issues and answer key questions.

1.2 Value is a product of the interface between the statistics or other numerical information and those who use them as a basis for forming judgements.

Findings

The statistics are high profile and have a wide range of users and uses, but Defra should engage more proactively with users

1.3 Air quality is one of the most high-profile and important environmental issues. According to the World Health Organisation, air pollution is a global public health emergency. In the UK alone, nitrogen dioxide and particulate matter, the two most harmful pollutants to human health, are estimated to cause the equivalent of between 28,000 and 36,000 premature deaths per year (based on the calculations of the UK's Committee on the Medical Effects of Air Pollutants). Air pollution not only has damaging effects on human health, it also impacts the environment, for example, through acidification, eutrophication and ozone depletion. Therefore, air quality and emissions data and statistics are vital to supporting public understanding of the problem and informing public debate, and for developing and evaluating policies that aim to reduce emissions of air pollutants and improve air quality. Both the air quality and emissions data and statistics have a wide range of uses (see Annex 1 for summary).

1.4 Defra carries out some user engagement for the air quality and emissions statistics. For example, it uses the Defra Statistics Twitter account to promote the latest statistics, and it is currently running a user needs project on the UK Air Information Resource (UK-AIR) website to look at the relevance and usefulness for both lay users and specialist users. While we welcome these activities, Defra should enhance the value of these statistics by engaging more directly or proactively with users across both sets of statistics.

1.5 The user community of these statistics is diverse. From our conversations with users, we identified several user types: data users who only use the websites (UK-AIR for air quality data and the National Atmospheric Emissions Inventory (NAEI) website for emissions data – see Annex 1 for summary); users who only read the statistics bulletins; and users who use both. To ensure the data and statistics remain relevant to a wide range of users, and to support different uses and potential uses, Defra should develop a better understanding of the different types of users and their needs. It should initiate an ongoing dialogue with users, tailoring its engagement to different types as users appropriate, and use it to drive improvements to the data and statistics. Effective user engagement will lead to data and statistics that better support understanding of, and inform decision-making on, air pollution in the UK. The statistics team might find it useful, as part of enhancing its engagement, to publish a user engagement plan. It should ensure that it is consistent with the Defra Group's user engagement policy.

Defra should improve coherence between the air quality and emissions data and statistics through integration, better explanation and clearer signposting

1.6 Although the air quality and emissions data and statistics are published separately (in the *Air quality statistics in the UK* and *Emissions of air pollutants in the UK* statistics bulletins respectively), they form a package of related statistics. There are links between the ambient concentration of air pollutants and emissions of air pollutants, but the relationship is

complex. As explained in the Air Quality Expert Group's (AQEG) report on Linking Emission Inventories and Ambient Measures, a change in emissions rarely leads to a proportionate change in the change the concentration in the atmosphere, because ambient measurements are the combination of emissions from a range of sources. At the same time, it can be difficult to measure or analyse ambient pollutant concentrations in a way that provides emissions estimates for a specific source sector required for emissions inventories.

1.7 Defra is aware of these links; for example, the air quality bulletin highlights the need to consider ambient air pollutant concentrations and emissions in conjunction. However, it does not help users understand this relationship or how the two sets of statistics form a package, and users that we spoke to found it frustrating that not all statistics are clearly linked to one another. To provide a coherent view of these connected topics and generate greater insight for users, Defra should integrate both sets of statistics as far as possible. It should explain the purpose of each set of statistics and how they differ. It should cross-reference the statistics to provide a coherent narrative. And, it should highlight other available estimates of emissions of air pollutants, for example, those produced by the Office for National Statistics (ONS) as part the environmental accounts, and explain how they differ from the Defra estimates. Drawing together this information will help users understand how the Defra statistics fit into the wider air pollution data and statistics landscape.

1.8 There are other reports and resources available on air quality. For example, the *Air Pollution in the UK* report presents measurement data from the air quality monitoring network as well as results from air quality modelling and a detailed assessment of compliance with the EU Air Quality Directive. Each devolved country has its own Air Quality website which contains information on devolved air quality policies and access to Scottish, Welsh and Northern Irish air quality data. And, there is a lot of good guidance in the public domain, such as the *Guide to Air Pollution Information Resources*. Together with UK-AIR and the air quality bulletin, they provide a comprehensive analytical picture of air quality in the UK. To improve coherence between these related resources, Defra should update and maintain the Guide to Air Pollution Information Resources and, where possible, clearly signpost users to these different sources of information. It would be helpful if Defra explained the differences between the air quality bulletin and *Air Pollution in the UK* report to help users understand the purpose and value of each report and to avoid confusion.

Defra should bring together local and national air quality data to maximise the value of the data and statistics

1.9 Often, air quality and air pollution are a localised set of concerns. Many users we spoke to highlighted the need for better access to more-granular, disaggregated air quality data and to existing local air quality data. For example, some users told us that greater availability of regional data would be useful for developing air quality policies. Local Authorities collect a lot of their own air quality data through the Local Air Quality Management (LAQM) system, particularly on nitrogen dioxide and particulate matter concentrations, and many users told us that it would help them if they had access to this level of data. Users also highlighted that London is well provisioned in terms of air quality data, but that accessing data from outside London, particularly from more rural local authorities, is more difficult.

1.10 Defra's Clean Air Strategy, published in January 2019, recognises that there is a user need for more joined-up air quality data across the UK. We welcome Defra's commitment in the strategy to improving air quality data and modelling. To increase transparency and help increase public engagement with air quality data, Defra should work quickly to develop and implement a portal that brings together local and national air quality data to maximise access to, and the value of, these data for a wide range of users. We encourage Defra to work closely and consult with users and stakeholders, including local authorities, when developing an improved air quality data resource (see 3.9 for resource committed to this work). As a first step, Defra could explain what data are available at the local, regional and national level and to map out the air quality data landscape. Defra should also consider how it can incorporate these local data when producing the air quality statistics to generate

greater insights about trends in air quality. Local air quality data may be more relevant for many users, but their quality is likely to be lower; therefore, there may be a trade-off between relevance and accuracy of the data. We encourage Defra to be ambitious about using local data to tell the story of air quality in the UK.

Defra should improve the accessibility of the statistics bulletins and promote them more widely

1.11 It is straightforward to access the air quality and emissions bulletins from the statistics landing pages and the Statistics at Defra homepage on gov.uk. But, only the most recent editions of the statistics bulletins and datasets are available. To give users access to previously published data and statistics and help them identify changes, Defra should add previous editions of the bulletins and datasets to gov.uk**.**

1.12 The emissions statistics bulletin is easy to find on the NAEI website and is well signposted. The description of the bulletin makes users aware that it does not include all air quality pollutants within the NAEI, which is helpful. However, it is difficult to find a link to or a description of the air quality bulletin on the UK-AIR website, and some users of UK-AIR told us they were not aware of the bulletin. The publication of the bulletins is highlighted in a news item on UK-AIR, but the news section is hidden, and rarely updated. To enhance the visibility and reach of the statistics bulletins, they should be promoted on their respective websites. Similarly, the bulletins should explain and cross-reference the UK-AIR and NAEI websites where possible to help users make the most of these rich resources.

Accessibility of the UK-AIR and NAEI websites is good but should continue to be reviewed

1.13 In general, the UK-AIR and NAEI websites are easy to access and we received positive feedback from users on the websites. UK-AIR provides data and resources for a wide range of users, including general users and expert users. It allows users to quickly access the Daily Air Quality Index (DAQI) regional data and to see the latest measured levels, in real-time, broken down by region, monitoring site and pollutant. Users highlighted recent improvements to the presentation of statistics and information on the UK-AIR website, including that the DAQI is now easier to understand.

1.14 However, users also identified areas for improvement. Some users told us that the UK-AIR website is hard to navigate; that it can be difficult to find the information they are looking for; that it can be difficult to access the data; and that downloading data can be complicated. One user described UK-AIR as “trying to be all things to all people”, which suggests that Defra has not optimised the website for different types of users. We welcome the user needs project that Defra is running on UK-AIR, which is gathering feedback on the website’s accessibility. Defra should act on this feedback to enhance the accessibility and navigability of UK-AIR to ensure that the website meets user needs.

1.15 The NAEI website is aimed more at the expert user who wants detailed data on emissions. Some users told us that they can easily access the information they need, but, again, they identified some areas for improvement. They mentioned that it can be difficult to find specific emissions data sets; that downloading data from the website is complicated; and that non-experts may find it difficult to understand and find information. We also think there is scope to modernise the website. We encourage Defra, in collaboration with the Department for Business, Energy and Industrial Strategy (BEIS), to continue to review the accessibility and navigability of the NAEI website and gather feedback from users on whether it is meeting their needs.

The statistics bulletins provide helpful background information and present a good overview of the main trends in air quality and emissions

1.16 The emissions bulletin is easy to follow and contains a clear and helpful background information section, explaining why emissions of pollutants are measured, the effects of air pollution on human health and the environment and the international framework that set controls on air pollution. The air quality bulletin has a clear structure and provides important background information on why air quality is measured, which allows all types of users to

understand the value of the statistics. Summaries at the start of each bulletin highlight the main messages.

1.17 Many users told us that they found the commentary in the bulletins helpful and that it provides a good overview of the main trends. For instance, one user commented that the differences between air pollutant concentrations in urban background and urban roadside locations were informative. The air quality bulletin provides a comprehensive picture of air quality by presenting both short- and long-term trends in the data and mean concentrations of each pollutant. In general, the visualisations support user understanding and interpretation of the air quality statistics.

1.18 We welcome the recent improvements to the statistics bulletins. For instance, the air quality bulletin now includes statistics on small particulate matter ($PM_{2.5}$), recognising $PM_{2.5}$ as a problematic pollutant and enhancing the statistics value through raising its awareness. The emissions bulletin includes more-detailed analysis and charts of the major emission sources, helping users understand the major drivers of emissions for each pollutant and how emissions from key sources have changed over time.

Defra should make several improvements to the bulletins to enhance the clarity and insight of the statistics

1.19 The order of the pollutant summaries in the emissions bulletin doesn't reflect their importance. Sulphur dioxide showed the biggest decrease in the latest bulletin, but emissions of this pollutant are already very low, and nitrogen oxides, particulate matter and ammonia are more relevant from a policy, health and environment perspective. It might be more informative and meaningful if the trends for these pollutants were presented first. Defra should continue to review the order of the pollutants on an ongoing basis.

1.20 The emissions bulletin comments on both short- and long-term trends in emissions, with a greater emphasis on long-term trends. However, it can be hard for users to interpret recent changes in emissions, particularly with the visualisations showing emissions back to 1970. One user thought it was slightly misleading to discuss improvements since 1970 and that Defra should focus more on recent factors and policies driving changes in emissions. To help users understand how recent policy interventions may have affected emissions, Defra should make short-term trends clearer in the commentary and the accompanying visualisations. This would also enhance transparency about the extent to which Defra is meeting current and future legally-binding emission ceilings. Adjustments made to the estimates should be explained clearly and prominently.

1.21 Defra could generate more insight for users by providing additional contextual information. For instance, when discussing nitrogen dioxide levels, a recent air quality bulletin refers to two locations contributing to the 'moderate' air pollution category. It provides some explanation for one of the areas (London), but not for the second area (in South Wales). Possible explanations and context would help users better understand differences in air pollutant concentrations. There also scope to improve the visualisations in the air quality bulletin – the choice of colour scheme makes some charts difficult to interpret.

1.22 We encourage the Defra statistics team to contact the Government Statistical Service's Good Practice Team, who will be able to provide advice on improving the commentary and visualisations to enhance the value of the statistics.

Interactive maps should be updated as soon as possible to meet user needs

1.23 The emissions interactive map (on the NAEI website) and ambient air quality interactive map (on the UK-AIR website) are informative and engaging, helping users understand how annual air pollutant emissions and annual mean ambient air pollutant concentrations vary across the UK. The users that we spoke to highlighted the value of these maps to their work. However, they also expressed frustration at the timeliness of the ambient air quality interactive map data; until recently, the most up-to-date data were two years old. One user submitted a request via the Environmental Information Regulations (EIR) to gain access to the latest data. There is therefore a clear user need for an up-to-date map. To enhance

transparency, Defra should improve its processes to ensure that it updates the map as soon the data become available.

Table 1: Value – Findings and Requirements

Findings	Examples	Requirement
The statistics have a wide range of users, but Defra's engagement with them is limited	• Defra does not engage with users directly or proactively	1 Defra should enhance the value of the air quality and emissions data and statistics by engaging more effectively with users. Defra should: a) develop a greater understanding of the different types of users and their needs b) initiate an ongoing dialogue with users, tailoring its engagement to different types of users as appropriate The statistics team might find it useful as part of enhancing its engagement to publish a user engagement plan.
The air quality and emissions data and statistics should be considered alongside each other and treated as a package of related statistics	• The statistics bulletins do not help users understand the relationship between air quality and emission of air pollutants • Users found it frustrating that not all statistics are clearly linked to one another • There are other reports and resources available on air quality • Users highlighted the need for better access to more granular air quality data and to existing local air quality data	2 To provide a coherent view of the air quality and emissions statistics, and generate greater insight for users, Defra should integrate the statistics as far as possible. It should: a) explain the purpose of each set of statistics and how they differ, and cross-reference the statistics to provide a coherent narrative b) highlight other available estimates of emissions of air pollutants, and explain how they differ from the Defra estimates c) regularly update and signpost users to existing air quality resources d) work quickly to develop and implement a portal that brings together local and national air quality data e) consider how it can incorporate local data when producing the air quality statistics
The accessibility of the statistics and data should be improved	• Previous versions of the bulletins and datasets are not available on the gov.uk landing page • Users identified a range of improvements to the UK-AIR and NAEI websites	3 To improve the accessibility of the data and statistics, Defra should: a) make previous bulletins available on gov.uk b) explain and reference the UK-AIR and NAEI websites in the bulletins, and promote the bulletins on their respective websites c) act on the UK-AIR user needs project feedback, and in collaboration with BEIS, continue to review the NAEI website, to enhance the accessibility and navigability of the websites

Findings	Examples	Requirement
Defra should make improvements to the bulletins to enhance the clarity and insight of the statistics	• The order of the pollutant summaries doesn't reflect their importance and relevance • It can be hard for users to understand recent changes in emissions	4 To enhance the clarity and insight of the statistics bulletins, Defra should: a) present the pollutants with the most policy importance and relevance first in the emissions bulletin b) improve commentary and visualisations to help users understand short-term trends in emissions and the extent to which Defra is meeting emissions ceilings c) where possible, add explanations and provide context to help users better understand differences in air pollutant concentrations

Chapter 2: Quality

Introduction

2.1 Quality means that the statistics and numerical information represent the best available estimate of what they aim to measure at a particular point in time and are not materially misleading.

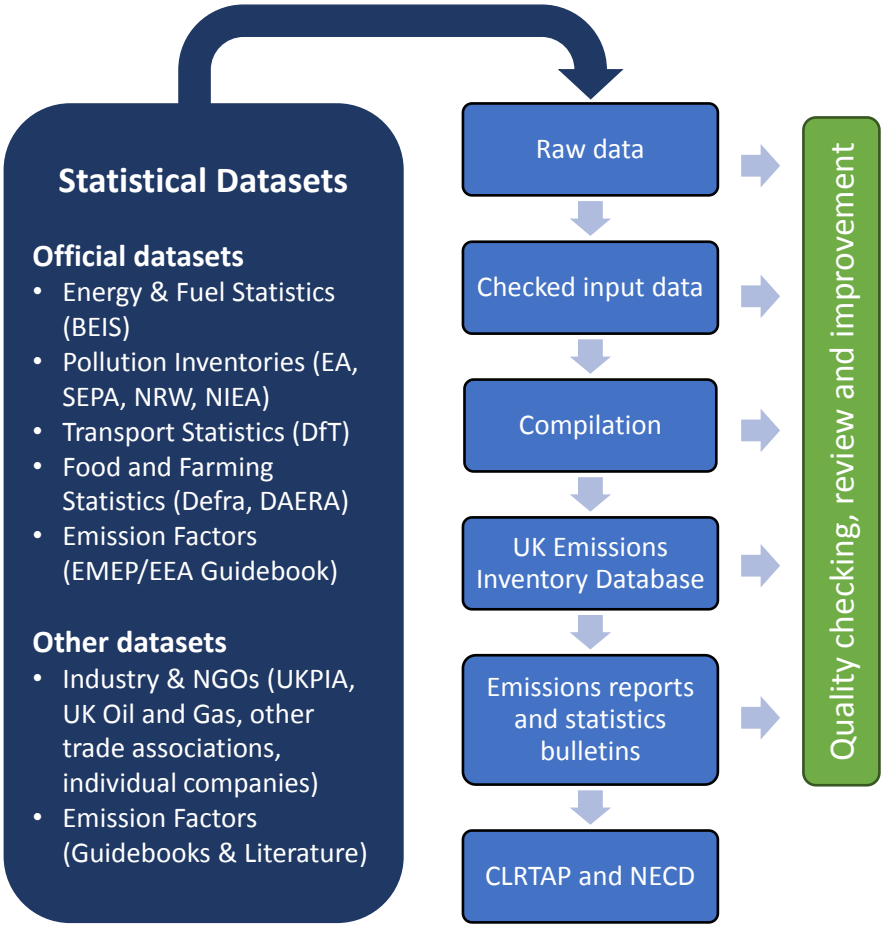
2.2 Quality is analytical in nature and is a product of the professional judgements made in the specification, collection, aggregation, processing, analysis, and dissemination of data.

Findings

Defra and Ricardo use the most appropriate data sources

2.3 Ricardo Energy & Environment (Ricardo), the lead contractor, uses many data sources to compile the UK air quality pollutant emissions inventory (the 'emissions inventory') (Figure 1). Two types of data are used: activity data (the extent to which a human activity takes place) and emission factors (a value that attempts to relate the quantity of a pollutant emitted with an activity level associated with the emission of that pollutant). Activity data come from UK official statistics and other national datasets, whereas emission factors come from literature sources or directly from process operators or trade associations (for more exact estimation).

Figure 1. Data sources and processes used to compile the emissions inventory

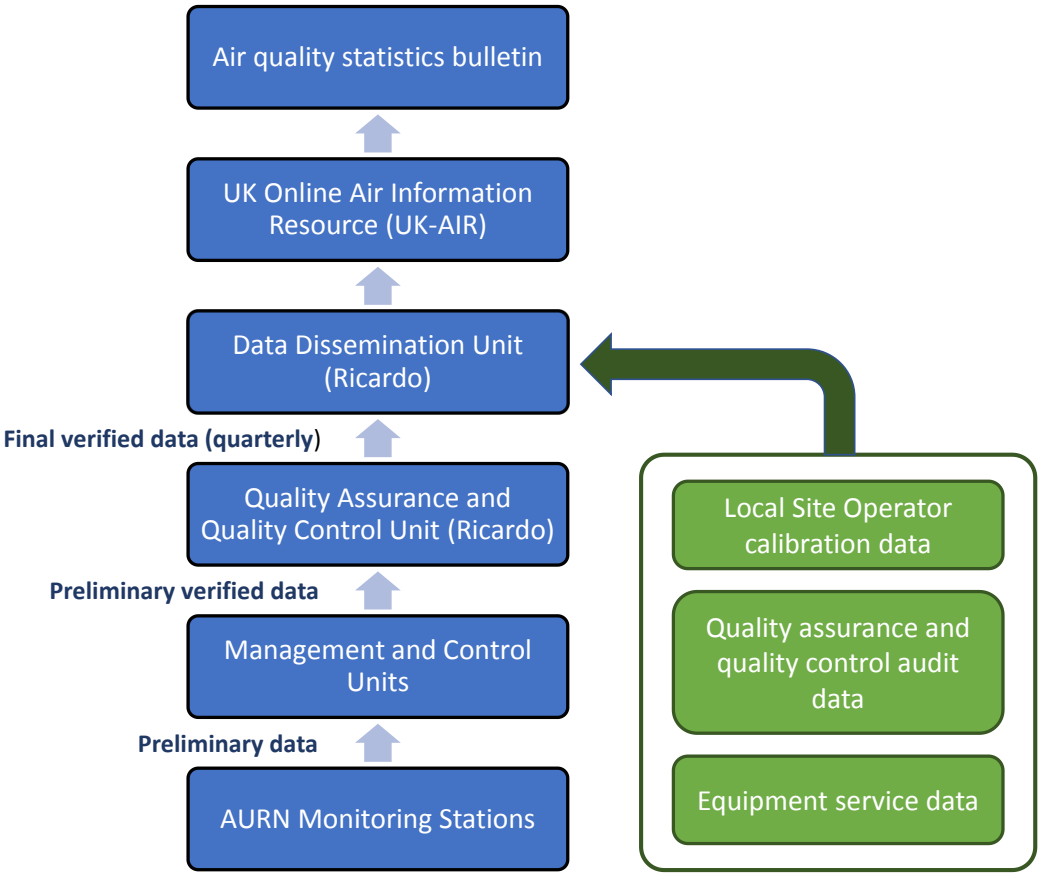


2.4 The two main sources of activity data are the energy statistics from the Digest of UK Energy Statistics (DUKES), produced by BEIS, and the industrial emissions data reported to the UK environmental regulatory agencies (Environment Agency, Scottish Environment Protection Agency, Natural Resources Wales, and the Northern Ireland Environment Agency). A range of other government, trade association and private company data are also used. Data provision is voluntary; there is currently no legal obligation for organisations to provide data specifically for the air quality emissions inventory (unlike for the greenhouse gas emissions inventory).

2.5 A detailed methodology report, the *Informative Inventory Report (IIR)*, which Defra is required to produce as part of the annual inventory submission, documents the data sources used to compile the emissions inventory. It provides a good account of the BEIS energy statistics and the industrial emissions data reported to the UK environmental regulatory agencies, but the report provides less information about how and why other emissions data sources are selected. To help users better understand how the emissions estimates are produced, Defra should explain how and why specific data sources are selected.

2.6 Data on ambient concentrations of air quality pollutants in the UK come from the Automatic Urban and Rural Network (AURN), the UK's largest automatic monitoring network. The AURN monitoring stations take hourly measurements of the concentration of the five key pollutants covered by the EU Ambient Air Quality Directive: oxides of nitrogen (NO_x), sulphur dioxide (SO_2), ozone (O_3), carbon monoxide (CO) and large and small particulate matter (PM_{10} and $PM_{2.5}$). The network currently has approximately 170 stations positioned across the UK but continues to expand. There are several site types (urban background, urban roadside, urban industrial and rural) and not all monitoring stations measure all pollutants; for instance, ozone is only measured at rural sites. The hourly measurements are uploaded directly to the UK-AIR website, but these provisional data go through a well-established process before they are published as official statistics (Figure 2 and Annex 1).

Figure 2. Flow of the ambient air quality data



2.7 The UK-AIR website contains good summary of the AURN, including a history of the network and an explanation of the different site types. The interactive map of the monitoring network is particularly helpful, giving users easy access to information about and data from all AURN monitoring stations. However, the descriptions miss out some key contextual information, such as why monitoring stations are positioned where they are and why not all monitoring stations measure all pollutants. To help users better understand the nature of the air quality data, it might be helpful if Defra updated and expanded the information on the monitoring network.

Defra and Ricardo follow internationally agreed and recognised methods to produce the best available estimates of emissions and ambient air quality

2.8 To compile the emissions inventory, Defra and Ricardo follow the European Monitoring and Evaluation Programme and the European Environment Agency's (EMEP/EEA) Air Pollutant Emissions Inventory Guidebook. The EMEP/EEA Guidebook is the most recognised set of emissions inventory estimation methods used in air pollution studies in Europe and the wider United Nations Economic Commission for Europe (UNECE) geographical area. It contains estimation methods and emission factors at various levels of granularity and is updated every three to four years to incorporate new information and relevant science. This ensures that emissions estimates are consistent and comparable across countries.

2.9 The IIR provides a comprehensive account of the methods used to calculate emissions of key pollutants and sectors. It explains why the methods are used and outlines the assumptions made, and the level of detail is proportionate to the complexity of the methods. The most common estimation approach is to combine activity data and emission factors to calculate an estimate of emissions of a given pollutant. For many sectors the UK methods are more complex (see Annex 1 for summary) and exceed what is specified in the EMEP/EEA Guidebook.

2.10 Compilation of the air quality pollutant emissions inventory and the greenhouse gas emissions inventory (led by Ricardo on behalf of BEIS) are strongly linked – they share many common data sources, methods, data management, and quality assurance and quality control procedures and reporting. This consistency between the two emission inventories ensures that the NAEI is coherent.

2.11 Defra and Ricardo follow the Standard Methods for monitoring air pollutants developed by the European Committee for Standardisation. These outline the minimum performance requirements for analysers, so that measurement methods comply with the data quality objectives of the EU Ambient Air Quality Directive. Different techniques are used to measure each air pollutant (see Annex 1). The Directive also specifies the siting and positioning of monitoring stations. As with the emissions inventory, this ensures that the air quality data are consistent and comparable across European countries. The UK-AIR website contains a clear summary of the EU Standard Methods and the monitoring methods used on the AURN, as well as links to supporting documentation.

Defra and Ricardo help set standards and are ambitious about improving the quality of the emissions inventory

2.12 Defra and Ricardo not only follow international standards, they also help set them. For instance, Defra and Ricardo are involved in updating the EMEP/EEA Guidebook and Defra provides input to the UNECE/EMEP Task Force on Emission Inventories and Projections (TFEIP), a technical forum and expert network. For the 2018 UK inventory submission, Ricardo won an award from the TFEIP for the most complete inventory.

2.13 We welcome the extensive collaboration between Defra, Ricardo and topic and methods experts to compile the emissions inventory and drive improvements. Ricardo regularly asks air quality and emissions experts from the emissions inventory, air quality modelling and research communities to conduct periodic reviews or validation of sections of the inventory. The UK also undertakes bilateral and external peer reviews as part of its annual inventory improvement programme. Bilateral reviews with other countries allow Defra and Ricardo to

learn from good practice of other countries, and to provide independent expertise to review estimates. In light of the UK's exit from the European Union, we expect Defra to keep engaged with international experts to drive development of the emissions inventory.

2.14 Defra and Ricardo also engage with expert opinion through the Air Quality Expert Group (AQEG), an Expert Committee to Defra which provides independent scientific advice on levels, sources and characteristics of air pollutants in the UK. AQEG regularly uses emissions inventory data and air quality data while assessing policy and science questions related to air quality, and it has published reports on a range of topics. Members of the Bureau Veritas team (for air quality) and Ricardo teams (for air quality and emissions) are represented on AQEG. They provide advice, for example, on the quality of the data and the restructuring of the monitoring station network, contribute to ongoing AQEG research, and in several cases, conduct related research with other AQEG members.

2.15 Ricardo revises the emissions inventory every year, with the aim of improving its completeness and accuracy. We welcome Defra and Ricardo's thorough and transparent approach to methodology changes and revisions. Updates are made in response to new research, new data sources, revisions to data sources and updated international guidance, and are backdated to ensure a consistent time series for emissions reporting; time series consistency is one of the most important data quality objectives for an emissions inventory, as enshrined in the EMEP/EEA guidance. The IIR provides a detailed account of these changes, explaining the scale and nature of each improvement or revision for each pollutant. The IIR also provides information on the planned methodological improvements for future inventories, giving users advance notice of upcoming changes. Significant recent improvements include the introduction of a new shipping emissions model.

2.16 Overall, the quality of the emissions activity data is high and meets international standards, but it varies by emission source and pollutant. For instance, industrial polluters and power stations provide the most certain data because there are regulatory procedures in place to capture emissions or activity data directly, or there are related official statistics available. In contrast, emissions of pollutants from diffuse sources, such as ammonia from farming, are more difficult to estimate. Defra and Ricardo put a lot of effort into improving data quality and filling in gaps in the emissions inventory through the annual inventory improvement programme and a range of other projects. For example, Defra told us it is working with equipment manufacturers to get better data on emissions from mobile machinery, and is collaborating with researchers to improve estimates of $PM_{2.5}$ emissions from wood burning, a major emission source for that pollutant.

2.17 The main risk to bias in the emissions inventory comes from emissions data which are not official statistics or National statistics; these are not subject to the same stringent quality assurance controls and there is a risk that the input data may be biased to suit the needs of the data provider. The Ricardo team either uses verified data or, wherever possible, conducts its own data verification checks to identify and minimise errors, for example, by: comparing datasets, for example, detailed plant-level activity data or emissions data (direct from operators) against regulatory reported totals through the Environment Agency or other regulators; using third-party verified data used in trading systems, such as the EU Emissions Trading System (EU ETS); and carrying out time series consistency and outlier checks. Ricardo told us it prioritises its limited resources, focusing on those sources and pollutants where errors will have the greatest impact on data quality.

Strong relationships between Defra, Ricardo and stakeholders ensure high data quality

2.18 We are impressed by the close working relationship between Defra and Ricardo, and by their effective engagement with data providers and other contractors and stakeholders (see Annex 1 for a summary of the roles and responsibilities). Defra meets regularly with Ricardo to discuss the emissions inventory and the air quality data, and data requirements and timetables are well-defined. Ricardo maintains good relationships with all data providers for the emissions inventory, encouraging them to undertake a range of commitments to data quality. Every year, Ricardo consults with industrial trade

organisations, government departments and other stakeholders to identify potential new data sources and areas for further improvement. Rothamsted, the contractor that compiles the agriculture emissions inventory, maintains constructive relationships with all organisations in the consortium. Bureau Veritas, which manages the AURN, works closely with Ricardo for both quality assurance and quality control (QAQC) and data dissemination purposes, as well as with a range of other organisations. These effective relationships ensure that the emissions inventory is robust and that the air quality monitoring network runs smoothly and delivers high quality data.

Defra and Ricardo are transparent about the limitations of the emissions data, but the limitations of the air quality data are not well-documented

2.19 The IIR contains a detailed assessment of the limitations of the main data source used to compile the emissions inventory: BEIS's energy statistics (from DUKES). It explains the steps that the BEIS team follows to ensure that the energy statistics are reliable and gives reasons why the activity data used to derive the emissions estimates for the inventory may not match the figures given in DUKES and other National Statistics. Information on the limitations of other data sources and of methods, and the steps that Ricardo took to reduce their impact, is also included. Ricardo carries out an assessment of the completeness of the emissions inventory. The summary, presented in the IIR, indicates where there are methodological or data gaps in pollutant inventories and the scale of missing data for some pollutants.

2.20 In contrast, the limitations of the air quality data are not explained. The monitoring stations do not capture data uninterrupted for the whole year, because analysers are regularly calibrated and serviced and may have defects; and, there is uncertainty around the measurements taken by analysers. Bureau Veritas, which manages the AURN, has processes in place to maximise data capture and minimise downtime, but these are not documented. Measurement uncertainties for individual analysers are published on UK-AIR, but this information is difficult to find. It is also unclear how representative measurements are for a given site and location and how comparable the data are between areas. To help users understand the limitations of the air quality data and reassure them that steps are taken to minimise their impact, Defra should publish a summary of the main limitations alongside the statistics.

Estimates of uncertainty are presented alongside the air quality statistics but not the emissions statistics

2.21 The air quality bulletin includes 95% confidence intervals for the mean estimate of the concentration of each pollutant, and these are communicated effectively via charts. Defra carries out statistical significance tests to compare mean pollutant concentrations between urban roadside, urban background and rural sites, and significant differences are commented on in the bulletin. This information helps users understand variation in air pollutant concentrations and uncertainty around the measurements.

2.22 Ricardo carries out a detailed assessment of uncertainty for the emissions inventory. It investigates the impact of uncertainty of individual parameters (such as emission factors and activity statistics) on the uncertainty in the total emissions of each pollutant and sector. The results are used to plan the annual programme of inventory improvement; those areas which are most uncertain are prioritised. The IIR presents 95% confidence intervals for each pollutant for the latest inventory estimates and the trend over time, helping users evaluate how uncertainty has changed over time. However, the emissions bulletin does not present information on uncertainty. It highlights that uncertainties vary between pollutants and emissions sources, but does not explain the extent of this variation, why uncertainty varies and how it has changed over time. To aid user interpretation of the emissions statistics, it might be helpful if Defra presented a summary of the uncertainty analysis alongside the statistics and signposted this information in the accompanying datasets.

Information about data sources and methods is not published alongside the statistics or is not signposted as clearly as it could be

2.23 The emissions bulletin includes no information about the data sources and methods used to compile the emissions inventory. The bulletin directs users to the NAEI website, but the website contains only general information about the inventory compilation process and focuses largely on the greenhouse gas emissions inventory. Although the IIR provides a comprehensive overview of data sources and methods, it is published separately, a month after the statistics. To help users understand how the emissions estimates are calculated, Defra should publish information on how the emissions inventory is compiled at the same time as the statistics, for example, via a summary methods and quality document. This should include a summary of the data sources (see 2.5), methods changes and improvements to the inventory (see 2.15), a discussion of the main strengths and limitations, and information on quality assurance (see 2.25). We encourage Defra to consider how it can communicate this information effectively to non-expert users, who are unlikely to read the IIR.

2.24 The air quality bulletin also contains limited information about air quality monitoring methods and directs users to UK-AIR website. To improve the accessibility of existing methods information, it would be helpful if Defra signposted the UK-AIR pages more clearly in the bulletin. To support fuller user understanding of the production of the air quality statistics, Defra should also enhance the information about methods it publishes alongside the statistics and on UK-AIR. For instance, the 2018 air quality bulletin contained a summary of recent methods changes, but this was not included in the latest bulletin and is not available on UK-AIR. Defra should provide a detailed description of methods changes that covers the reason for the change, why the new method was selected and the impact of the changes. Defra could also add a description of the technique used to measure each pollutant to help users better understand the air quality measurements.

The quality assurance processes for both sets of data and statistics are rigorous and well-established

2.25 The emissions inventory goes through a rigorous quality assurance and quality control (QAQC) process, dictated by international guidance. Ricardo has a dedicated QAQC manager for the inventory who coordinates the main QAQC activities across all stakeholders. Ricardo works with organisations that supply data to the inventory to encourage them to demonstrate their own level of QAQC that complies with the standards set out in the EMEP/EEA Guidebook. Ricardo's QAQC process itself goes through independent review by a contractor every year. The air quality data also go through a comprehensive QAQC process, and data are quality assured on an ongoing basis. Ricardo also has a dedicated QAQC manager for the air quality data. See Annex 1 for a summary of the main QAQC activities.

2.26 The QAQC arrangements are well-documented and are clearly explained. The IIR contains a detailed description of the QAQC system for the emissions inventory. The Air Quality Data Validation and Ratification Process document provides a short summary of the main activities for the air quality data. Defra also publishes a more detailed quality assurance report and the changes to the ratified data are documented on a log on UK-AIR. However, these documents are difficult to find on the UK-AIR and NAEI websites. In addition, neither statistics bulletin includes a summary of the quality assurance arrangements or a link to these documents. To improve accessibility to QAQC information, and assure users about the QAQC arrangements, Defra should add links to existing documents to the bulletins.

Table 2: Quality – Findings and Requirements

Findings	Examples	Requirement
Defra should publish additional information on the data sources and methods used, including on their limitations	• Information about data sources and methods is not published alongside the statistics or is not signposted as clearly as it could be • The description of the monitoring network on UK-AIR is missing some contextual information • Limitations of the air quality data are not documented • The emissions bulletin does not present information on uncertainty	5 To help users understand the quality and methods of the air quality and emissions and statistics, Defra should: a) publish information about the emissions inventory data sources, methods and quality assurance at the same time as the statistics, for example, through a summary methods and quality document b) provide additional information on the air quality monitoring network, including on the positioning of sites c) signpost relevant methods information and quality assurance documents in the statistics bulletins d) publish a summary of the main limitations alongside the air quality statistics and a summary of uncertainty alongside the emissions statistics

Chapter 3: Trustworthiness

Introduction

3.1 Trustworthiness means that the statistics and other numerical information are produced free from vested interest, based on the best professional judgement of statisticians and other analysts.

3.2 Trustworthiness is a product of the people, systems and processes within organisations that enable and support the production of statistics and other numerical information.

Findings

The statistics are produced independently

3.3 The statistics are presented impartially and objectively. The statistics bulletins do not include advocacy of policies, and Ministerial and policy statements are made separately from the statistics. The Defra statistics team maintains regular contact with communications and policy colleagues. For both sets of statistics, the team prepares a questions and answers document about the statistics for press colleagues. For the air quality statistics, the final bulletin is not shared outside the statistics team, and the team only produces lines to take once the bulletin has been published, even though there is no pre-release access (PRA) for these statistics (see 3.7).

3.4 Ricardo, the lead contractor, demonstrates its independence in several ways. One of the key quality objectives in the international inventory guidance is transparency, and the UK inventory data, methods and reports are reviewed at least annually to check for any risk of error or bias in the data (see 2.17). This helps ensure that Ricardo could not expect to manipulate or influence the reported data in response to pressure from any key stakeholder, including the UK Government. The emissions inventory comes under further regular scrutiny through other stakeholders, including air quality modellers (see 2.13), which further helps assure impartiality in data management and improvements. In some instances, there may be ways in which organisations can manipulate the data used in the emissions inventory, but Ricardo is aware of these risks and seeks to ensure that it minimises the use of data that are susceptible to such influences.

The Head of Profession is actively involved in decision making

3.5 The Defra Head of Profession for Statistics (HoP) has sole authority for the production and release of the statistics, and their roles and responsibilities are clearly set out in the Defra Group's statistical policy statements. The lead statistician has a monthly meeting with the HoP to discuss statistical issues and developments. The HoP provides advice on changes to the statistics, including changes to publication dates, and on quality assurance and managing stakeholder relationships.

3.6 Harmonisation of the air quality data and emissions inventories at the international level is coordinated through European Environment Agency (EEA) activities. Defra has a point of contact for EEA activities, who meets quarterly with the Defra network teams that feed into the EEA, including the air quality and emissions statistics team. The HoP is not involved in this network but has attended a recent meeting to understand how the network operates and the latest developments linked to EEA activities.

The statistics are released in an orderly manner

3.7 The Defra Group has published a statement of compliance with pre-release access which sets out its arrangements for PRA. The statistics team follows these principles when producing the emissions statistics; access is restricted to named individuals and Defra publishes the PRA list on its statistics homepage. The emissions inventory is only

submitted to the European Commission once the statistics have been published. Occasionally, legal policy colleagues are given pre-release access, for example, when Defra applies for an adjustment if it has exceeded an emissions ceiling. The statistics team reviews the PRA list every year and has taken steps to reduce the number of recipients. Ricardo (the lead contractor) also has processes in place to restrict access. There is no pre-release access for the air quality statistics as these are based on data which are already publicly available on the UK-AIR website.

Enough resources are allocated to data collection and statistics production

3.8 The resources required to produce the statistics form a small part of the total resource required to compile the emissions inventory and collect the air quality data. The cost of compiling the emissions inventory are substantial and include the cost of the contractor (Ricardo) and Defra staff. Similarly, the costs of running the air quality monitoring network are significant and a range of different organisations are involved. These costs relate to international reporting requirements (see Annex 1) and are therefore separate from the production of the statistics, but these commitments ensure that Defra will continue to collect the data and invest in improvements to data collection.

3.9 The statistics team will be recruiting a new statistician who will take over responsibility for producing the statistics bulletins and streamlining the production process. This will free up the lead statistician's time to focus on data development, including bringing together local authority air quality data and national-level data (see 1.10). We welcome this additional resource and Defra's ambition for improving the air quality data and statistics. Defra should continue to commit enough resources to the development of these data and statistics to maximise their value for users (see Value chapter).

Defra should be more transparent about its approach to quality and the development of the statistics

3.10 The Defra Group's Statistics Quality Statement sets out the key principles that underpin the delivery of statistical quality by the Defra Group. To enhance transparency about its approach to quality, the statistics team should explain how it is meeting these quality principles for the air quality and emissions statistics, for example, in the quality and methods documentation (see Quality chapter).

3.11 The statistics team maintains an informal log of potential changes to the statistics but has not published a work programme for these statistics. Given its ambitions for the air quality statistics and the UK-AIR website, Defra should consider publishing and regularly updating a formal development plan, to keep users informed of changes to the data and statistics and to allow them monitor progress.

Those involved in the collection of data and production of statistics are experienced and professional, and their roles and responsibilities are well-defined

3.12 The Defra statistics team's lead statistician is responsible for the production of the statistics, and the team's scientist is the project officer for the emissions inventory and provides support. The lead statistician has previously worked on other National Statistics. All the Ricardo, Rothamsted and Bureau Veritas staff that we spoke to have been involved in the collection and dissemination of air quality data or the compilation of the emissions inventory for many years and know each other well. They highlighted the close and effective working relationship between Defra and the contractors (see 2.18). The Ricardo air quality and emissions inventory teams interact frequently on numerous issues and as part of wider Ricardo air quality projects. Responsibility for operating individual monitoring sites is assigned to local site operators with relevant experience in the field. Operators are well-trained and briefed by Ricardo and follow the detailed instructions in Ricardo's local site operator manual. The IIR describes the arrangements and roles for the preparation of the emissions inventory, whereas the UK-AIR website provides a helpful high-level summary of how the air quality monitoring network is run (see Annex 1).

3.13 The greenhouse gas emissions inventory has a formal governance role in place via the National Inventory Steering Committee (NISC). This helps ensure that the same datasets are used for both the greenhouse gas and air quality pollutant emissions inventories. Defra and Ricardo told us they are considering introducing a similar committee for the air quality pollutant emissions inventory. We fully support the formation of such a steering committee as it would provide an additional layer of scrutiny and help set direction for the development of the inventory.

Defra and Ricardo have strong data governance arrangements in place

3.14 The statistics team has completed mandatory data security handling training. For both the emissions inventory and the air quality data, Ricardo staff have completed data security handling training and learn on-the-job as data handling is a core component of day-to-day activities. The IIR provides detailed information on Ricardo's data management processes for all stages of the compilation of the emissions inventory. Rothamsted has similar data governance arrangements in place for the agriculture emissions inventory. These arrangements are closely managed and regularly reviewed.

3.15 Much of the data and statistics used to compile the emissions inventory, including all official statistics, are publicly available. However, industrial production data from some small sectors are commercially sensitive, and Ricardo takes steps to protect the confidentiality of these data. It takes one of several approaches to achieve this: it reports just emissions data, not activity data; two or more sources are aggregated together and only the emissions total is reported to remove data sensitivity; or, it reports an approximated dataset, so that there is a degree of transparency but there is no release of confidential data. To reassure users about data confidentiality, it would be helpful if Ricardo published a summary of its approaches to aggregating data and statistical disclosure control.

Table 3: Trustworthiness – Findings and Requirements

Findings	Examples	Requirement
Defra should be more transparent about its statistical processes, including its approach to quality and its plans for development of the statistics	• Defra has not published a work programme for the air quality statistics	6 To enhance the trustworthiness of the statistics, Defra should: a) should explain how it is meeting the Defra Group's quality principles for the air quality and emissions statistics b) consider publishing a formal development plan for the data and statistics Ricardo should publish a summary of its approaches to aggregating data and disclosure control for sensitive emissions data.

Annex 1: About the Statistics

The Statistics

A1.1 Defra produces two sets of official statistics on air quality: statistics on ambient (atmospheric) concentrations of air pollutants and statistics on emissions of air pollutants. Data on ambient air quality are collected through a network of automatic monitoring stations whereas emissions of air pollutants are estimated using a range of emission data sources and complex methods (see Data Sources and Methods – Additional Information).

A1.2 The statistics are published in two separate bulletins: *Air Quality Statistics in the UK* (the 'air quality bulletin') and *Emissions of Air Pollutants in the UK* (the 'emissions bulletin'). The air quality bulletin presents short- and long-term trends in the annual mean concentration of a range of pollutants, from 1987 to the latest year. It also reports the average hours spent in moderate or higher pollution categories (of the Daily Air Quality Index) and variation in pollutant concentrations by hour of day, day of the week or month of the year. The air quality bulletin is published at the end of April, as soon as full year of ratified monitoring network data becomes available (see A1.16). The emissions bulletin presents short- and long-term trends in annual emissions of a range of air pollutants, from 1970 to the latest year, and an analysis of the major emission sources for each pollutant. The emissions bulletin is published in February, on the same day that the emissions inventory is submitted to the European Commission (see 3.7).

A1.3 Each set of statistics is supported by a website. The online UK Air Information Resource (UK-AIR) gives users access to current and historic ambient air quality data from the monitoring network; provides information on how air quality is monitored, the policy context and the effects of air pollution; and includes several interactive maps. The other main function of UK-AIR is to provide air pollution forecasts, to give people advance warning about air pollution episodes. The National Atmospheric Emissions Inventory (NAEI) website gives users access to detailed emissions datasets; provides information on the how the emissions inventory is compiled; and includes interactive maps. The NAEI website also provides data and information on greenhouse gas emissions, which are published by the Department for Business, Energy and Industrial Strategy (BEIS).

A1.4 This assessment considers the trustworthiness, quality and value of the statistics bulletins, datasets and the UK-AIR and NAEI websites. Defra publishes a range of other reports on air quality, including the *Air Pollution in the UK* report, and there are several other air quality resources available, such as the family of Air Quality websites for Scotland, Wales and Northern Ireland. Ricardo also produces air quality pollutant emissions inventories for each UK country, which are compiled by disaggregating the UK emissions totals. The results are presented in the *Air Pollutant Inventories for England, Scotland, Wales and Northern Ireland* report. These reports and resources are outside the scope of this assessment.

A1.5 Defra collects data on ambient air pollutant concentrations and produces estimates of emissions of air pollutants for a variety of reasons. It needs an evidence base to measure air quality and attempt to improve the health of the population and the environment through reducing emissions and concentrations of air pollutants. Defra is responsible for meeting the UK Government's international commitments to reporting and reducing emissions of air pollutants and monitoring air quality, so the air quality data and emissions inventory are vital for assessing compliance with legally-binding emissions ceilings (for emissions) and concentration limit values (for ambient air quality).

A1.6 Due to the transboundary nature of air pollution, action to manage and improve air quality in the UK has been driven by both international agreements and EU legislation. The EU Ambient Air Quality Directive (2008/50/EC) sets legally binding limits for concentrations in outdoor air of major air pollutants that impact public health (such as particulate matter and nitrogen dioxide). Defra coordinates assessment of air quality and air quality plans for the

UK as a whole and is responsible for meeting the air quality limit values in England. Responsibility for meeting air quality limit values in Scotland, Wales and Northern Ireland is devolved to the national administrations.

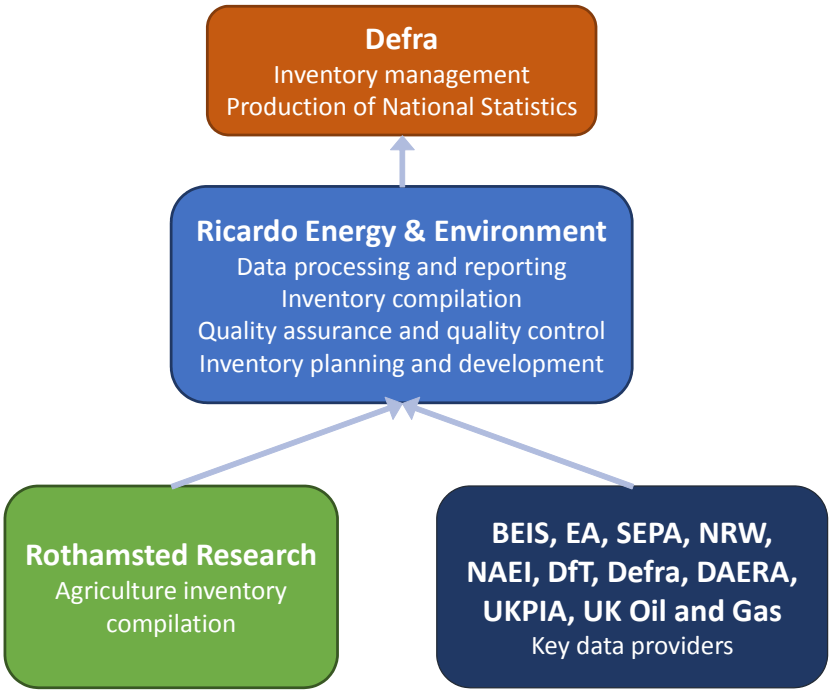
A1.7 The EU National Emissions Ceiling Directive (2016/2284/EU) (NECD) sets emissions ceilings and reduction commitments for the five key air pollutants (oxides of nitrogen, sulphur dioxide, non-methane volatile organic compounds, ammonia and, for 2020 and 2030, small particulate matter ($PM_{2.5}$)). The UK Government has also signed up to the UNECE Gothenburg Protocol which has the same emissions ceilings as the NECD post-2020 (and has similar existing ceilings). The NECD covers the compilation of the air quality pollutant emissions inventory and Defra has responsibility for national level planning and management of the inventory.

Data Sources and Methods – Additional Information

Emissions

A1.8 The air quality pollutant emissions inventory is compiled and maintained by a team led by the main contractor, Ricardo Energy & Environment (Ricardo), and is submitted to the European Commission by Ricardo on Defra's behalf (Figure 1). Rothamsted Research compiles the agriculture emissions inventory under a separate contract with Ricardo, which is then incorporated into the overall emissions inventory. Together with the greenhouse gas emissions inventory, which is compiled by a team led by Ricardo on BEIS's behalf, the two emissions inventories form the National Atmospheric Emissions Inventory (NAEI). BEIS manages the contract with Ricardo for the NAEI website, through which emissions inventory data and reports are published, but Defra has the authority (and contributes to the budget) on reporting and making changes to the air quality pollutant side.

Figure 3. Roles and responsibilities for the emissions statistics



A1.9 The two main data sources of activity data are BEIS's energy statistics, from the Digest of UK Energy Statistics (DUKES), and industrial emissions data reported to the UK environmental regulatory agencies. Other UK Government Departments that provide data include: Department for Transport, Ministry of Housing, Communities and Local Government, and the Office for National Statistics. Rothamsted Research compiles the

agriculture emissions inventory using mainly Defra and Devolved Administration agriculture statistics, and the Centre for Ecology and Hydrology (CEH) compiles ammonia emissions for sources in natural and waste sectors. Key trade associations and companies that provide data include Tata Steel, the UK Petroleum Industries Association and the Civil Aviation Authority.

A1.10 Where UK statistics and data are not available, activity data and emission factors may be estimated (modelled). The modelled activity data estimates are commonly derived from published data or the best available proxy information.

A1.11 Methods used to determine emissions include continuous monitoring of emissions from a source, short-term emission measurements that are extrapolated to a longer time period, and use of emission factors. The most common estimation approach is to combine activity data and emission factors to calculate an estimate of emissions of a given pollutant. The basic equation is: emissions = activity data x emission factors. For instance, in the energy sector, fuel consumption would be the activity data whereas kilogrammes of particulate matter emitted per unit of coal burned would be the emission factor.

A1.12 There are different tiers of methodological complexity: Tier 1 is the simple (most basic) method; Tier 2, the intermediate; and Tier 3, the most demanding in terms of complexity and data requirements. Tiers 2 and 3 are generally considered to be more accurate, for example, because they use country-specific information or facility-level data and/or employ more sophisticated models. Estimates of emissions from some sectors and subsectors are more accurate than from others; for instance, exhaust emissions from vehicles are calculated using tier 3 methods whereas emissions from domestic combustion are estimated using tier 1 methods.

A1.13 The main quality assurance and quality control (QAQC) activities for the emissions inventory are: quality control (raw data checks, calculation checks, output checks) to minimise the risk of errors within the available resources to deliver the inventory; quality assurance (e.g. peer reviews, bilateral reviews, expert reviews), whereby independent experts periodically review all or part of the inventory to identify potential areas for improvement; and verification, where alternate independent datasets are available to compare against inventory data and trends.

Air quality

A1.14 Data on ambient concentrations of air pollutants are collected through the Automatic Urban and Rural Network (AURN). The Environment Agency manages the UK's national monitoring sites on behalf of Defra and the Devolved Administrations. Bureau Veritas is responsible for the central operational management and coordination of the AURN, while the Environmental Research Group at King's College London manages the London Air Quality Network (LAQN) (Figure 4). Responsibility for operating individual monitoring sites sits with local site operators, such as local authority Environmental Health Officers, although not all monitoring stations are managed by local authorities. Quality assurance and quality control of the entire network is carried out by Ricardo. Defra has a separate contract with Ricardo for the dissemination of the air quality data via the UK-AIR website.

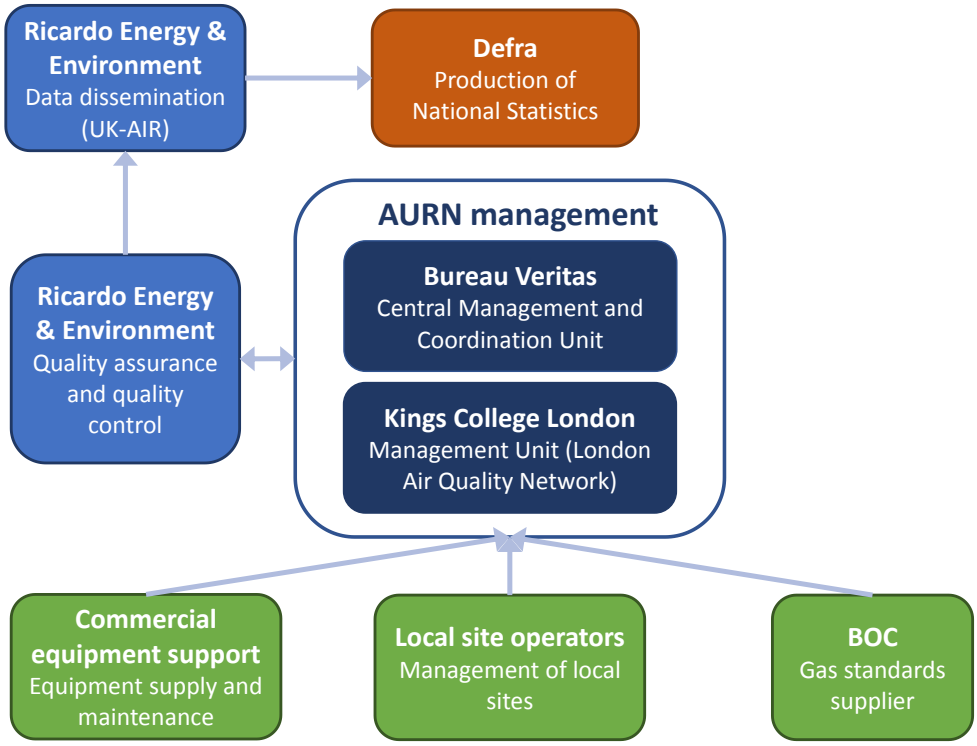
A1.15 Different techniques used are used to measure each pollutant: ultraviolet absorption (ozone), chemiluminescence (oxides of nitrogen), ultraviolet fluorescence (sulphur dioxide) and infrared absorption (carbon monoxide). For particulate matter, the AURN uses methods which are equivalent to the reference method, but which also allow continuous online monitoring (unlike the reference method). This is because it takes a long time to process and report the results from the reference method, which limits their use for rapid public dissemination through UK-AIR. Defra worked with the Environment Agency to develop a new and additional level of certification for measuring particulate matter through the Monitoring Certification Scheme (MCERTS).

A1.16 The provisional data uploaded directly to UK-AIR are independently checked by both the monitoring network managers (Bureau Veritas) and the European Environment Agency as

part of an ongoing QAQC process. Ricardo then validates the data, by cleaning up data and incorporating missing data, and ratifies it (on a quarterly basis) through a comprehensive check. It is these ratified data that are used to produce the air quality National Statistics.

A1.17 To produce the air quality statistics, data are extracted directly from UK-AIR and a minimum annual data capture requirement of 75% is automatically applied – only data from monitoring stations that have data for 75% (or greater) of the year are included. Ricardo also carries out six-monthly QAQC audits, which involve calibration of monitoring station instruments to ensure that they are responding accurately and consistently across the network. Occasionally, changes are made to ratified data, for example, when Ricardo receives new information.

Figure 4. Roles and responsibilities for the air quality statistics



Uses and Users

A1.18 The user community for these data and statistics is diverse. It includes: local government, Devolved Administrations, academics and researchers, industry bodies and trade associations, charities, campaign groups, and other official statistics producers.

A1.19 Users identified a wide range of uses of the air quality and emissions of air pollutant data and statistics, including:

- To prepare briefings and reports, for example, on the extent to which the UK is meeting international emissions ceilings limits and targets
- To assess the Government's performance against international limits and targets
- To assess the environmental impact of policies and sustainable management practices, for example, on farming
- To develop air quality policy and regulation
- To prepare the annual air quality status report for Defra (mandatory for local authorities)
- To address public inquiries and for planning applications
- For mapping, modelling or forecasting purposes

- For educational purposes, for example, by university students looking into updates to the emissions inventory
- To understand sector-level contributions and defend industry interests
- To update regional emissions inventories, for example, the London Atmospheric Emissions Inventory (LAEI)
- For quality assurance purposes, for example, by the Office for National Statistics (ONS) to check if trends in their emissions statistics are not dissimilar to those of Defra
- To build public understanding

Annex 2: The Assessment Process

A2.1 This Assessment was conducted from December 2018 to July 2019.

A2.2 This report was prepared by the Office for Statistics Regulation and approved by the Regulation Committee on behalf of the Board of the UK Statistics Authority, based on the advice of the Director General for Regulation.

A2.3 The regulatory team – Job de Roij and Michelle Caldwell – agreed the scope of and timetable for this assessment with representatives of Defra in December 2018. Documentary evidence for the assessment was provided by the Defra statistics team in December 2018. The regulatory team discussed and met with the statistics team in April 2019 to review compliance with the Code of Practice for Statistics, taking account of the evidence provided and research performed.

A2.4 Part of the assessment process involves consideration of the views of users. We approached some known and potential users of these statistics and received 26 responses. This gave us insights into the extent to which the statistics meet users' needs and users feel that the statistics' producers engage with them. We are aware that responses from users may not be representative of wider views, and we take account of this in the way that we prepare Assessment reports.

Key documents

A2.5 Evidence provided by Defra and Ricardo includes:

- *Air Quality Statistics in the UK* and *Emissions of Air Pollutants in the UK* statistics bulletins and datasets
- Methodology reports, including the *Informative Inventory Report* (IIR) for the emissions inventory
- Links to relevant international legislation and guidance, including the EU Ambient Air Quality Directive and the EMEP/EEA Guidebook
- Quality assurance and quality control documentation
- Informal log of development plans for the statistics
- User engagement policy implementation plan
- Team organisational chart
- Air pollutant emissions ceilings and air quality limit values
- Air Quality Pollutant Inventory improvement plan
- Defra Group's user engagement policy statement
- Defra Group's statement of compliance with pre-release access
- Defra Group's statement of revisions and corrections

Annex 3: Next Steps

Responding to the assessment report: what the Office for Statistics Regulation and Defra should expect from each other

A3.1 The publication of the Assessment report represents a key milestone in the assessment process, but should not be viewed as the end point. The next phase, to meet the Requirements set out in this report, is critical to delivering the value, quality and trustworthiness to achieve and maintain National Statistics status. The next steps are as follows:

- Immediately following the publication of the report, the Office for Statistics Regulation will arrange a meeting with the statistics team to talk through the detail of the Requirements and to ensure a common understanding
- The Head of Profession for Statistics (HoP) can follow up with the Assessment Programme Manager about the Director General for Regulation's letter that accompanies this Assessment Report. The letter: draws out the key findings; provides advice about where the statistics team is likely to need senior management support and direction and conveys any findings that have wider implications for the producer body and statistical system
- The HoP is encouraged to:
  i) develop an action plan to meet the Requirements to the timetable set out in paragraph ES.16 of this report
  ii) agree the action plan with their senior management, and confirm that it is appropriately resourced
  iii) share the action plan with the Office for Statistics Regulation, publish it alongside the statistics, and explain to users and suppliers how it will engage with them in delivering the plan
  iv) seek out peers and support services that can help in delivering the plan – for example, the Government Statistical Service's Good Practice Team
  v) agree with the regulatory team, how often, and in what form, the statistics team would like to engage about progress against the action plan – for example, some teams choose to meet with the regulatory team once a month
- The statistics team should provide full formal written evidence to the Office for Statistics Regulation by the deadline of May 2020 as set out in paragraph ES.16 of this report. There is no set format for reporting, except that Defra should demonstrate that it has addressed the findings given in Tables 1 to 3 and provide links to any published or internal documents as support
- The regulatory team will review the evidence within 10 working days and arrange to provide feedback to the statistics team. As part of this process, the regulatory team may talk again to users to establish how their experience of the statistics has changed. When the regulatory team is satisfied that the Requirements have been fully met, their conclusions will be quality assured by Office for Statistics Regulation's senior management and then presented to the Authority's Regulation Committee to confirm designation. The Director General will then write publicly to the lead official to confirm the decision

A3.2 Based on experience, the Office for Statistics Regulation strongly encourages statistics teams to:

- engage with the detailed thinking of the Assessment report, and revisit it regularly. The regulation team will be seeking evidence that the statisticians are demonstrating curiosity and are challenging their own thinking around delivering value, quality and trustworthiness. The Requirements in this report should not be viewed as a simple checklist
- view the responsibility for meeting the Requirements as falling to the organisation as a whole, not just the team that produces the statistics
- engage users early, not just to keep them updated; users can often offer valuable insight and expertise
- contact the regulatory team at any time if there are any questions or concerns

A3.3 Responsibility for complying with the Code of Practice does not end with the award of the National Statistics designation. It is the statistics producers' responsibility to maintain compliance and to improve the statistics on a continuous basis. The Office for Statistics Regulation encourages statistics producers to discuss promptly with the regulatory team any concerns about whether its statistics are meeting the appropriate standards. National Statistics status can be removed at any point when the highest standards are not maintained, and reinstated only when standards are restored.

Annex 4: Glossary

Acronyms and abbreviations

AQEG	Air Quality Expert Group
AURN	Automatic Urban and Rural Network
BEIS	Department for Business, Energy and Industrial Strategy
CEH	Centre for Ecology and Hydrology
CLRTAP	Convention on Long-Range Transboundary Air Pollution
CO	Carbon monoxide
DAERA	Department of Agriculture, Environment and Rural Affairs (Northern Ireland)
DAQI	Daily Air Quality Index
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DUKES	Digest of UK Energy Statistics
EA	Environment Agency
EEA	European Environment Agency
EIR	Environmental Information Regulations
EMEP	European Monitoring and Evaluation Programme
EU	European Union
EU ETS	European Union Emissions Trading System
IIR	Informative Inventory Report
LAQM	Local Air Quality Management
LAQN	London Air Quality Network
MCERTS	Monitoring Certification Scheme
NAEI	National Atmospheric Emissions Inventory
NECD	National Emissions Ceiling Directive
NIEA	Northern Ireland Environment Agency
NO_x	Oxides of nitrogen
NRW	National Resources Wales
O_3	Ozone
ONS	Office for National Statistics
PM	Particulate matter
PM_{10}	Particulate matter less than 10 micrometres
$PM_{2.5}$	Particulate matter less than 2.5 micrometres
QAQC	Quality assurance and quality control
SEPA	Scottish Environment Protection Agency
SO_2	Sulphur dioxide
TFEIP	Task Force on Emission Inventories and Projections
UK-AIR	UK Air Information Resource
UKPIA	UK Petroleum Industry Association
UNECE	United Nations Economic Commission for Europe