Chapter IX. Data quality and metadata

*This draft is based on the text adopted by the UN Statistical Commission for purposes of international recommendations for industrial and distributive trade statistics. Recommendations and encouragements are **in bold.** The Oslo Group members are invited to review the draft and to propose necessary amendments to reflect needs and priorities of energy statistics.*

A. Quality and its dimensions

9.1 *Quality*. Energy data made available to users are the end product of a complex process comprising many stages including collection of data from various sources, data processing, data formatting to meet user needs and, finally, data dissemination. Quality of data is assessed based on whether or not users are provided with information adequate for their intended use, that is to say, data quality is judged by data "fitness for use." For example, users must be able to verify that the conceptual framework and definitions that would satisfy their particular needs are the same as, or sufficiently close to, those employed in collecting and processing the data. Users have also to be able to assess the degree to which the accuracy of the data is consistent with their intended use or interpretation. All the measures that responsible agencies take to assure data quality constitute quality management. **Countries are encouraged** to develop their national energy data quality management programmes and make them available to users.

9.2 *Data quality assessment frameworks*. Most international organizations and countries have developed general definitions of data quality, outlining the various dimensions (aspects) of quality and quality measurement and integrated them into quality assessment frameworks.[1] Although the existing quality assessment frameworks differ to some extent in their approaches to quality and number, name and scope of quality dimensions (see figure VIII.1), they complement each other and provide comprehensive and flexible structures for the qualitative assessment of a broad range of statistics, including energy statistics. For example:

(a) The *IMF Data Quality Assessment Framework (DQAF)* takes a holistic view of data quality and includes governance of statistical systems, core statistical processes and statistical products. The Framework is organized as a cascading structure covering the prerequisites and five dimensions of quality: assurance of integrity, methodological soundness, accuracy and reliability, serviceability and accessibility;

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[1] See International Monetary Fund Data Quality Assessment Framework (http://dsbb.imf.org/Applications/web/dqrs/dqrsdqaf/); Eurostat, Working Group "Assessment of quality in statistics", "Definition of quality in statistics" (document Eurostat/A4/Quality/03/General/Definition), prepared for the sixth meeting (Luxembourg, 2 and 3 October 2003); Organization for Economic Cooperation and Development, Statistics Directorate, "Quality framework for OECD statistics" (Paris, June 2002); United Kingdom of Great Britain and Northern Ireland, Office for National Statistics, *Guidelines for Measuring Statistical Quality,* version 3.1 (London, 2007); *Statistics Canada's Quality Assurance Framework* (Ottawa, September 2002); Statistics Finland, *Quality Guidance for Official Statistics*, 2nd revised ed. (Helsinki, 2007), etc.

(b) The *European Statistical System (ESS)* focuses more on statistical outputs and defines the quality of statistics with reference to six criteria: relevance, accuracy, timeliness and punctuality, accessibility and clarity, comparability and coherence;

(c) The *OECD quality measurement framework* views quality as a multifaceted concept. As with the Eurostat approach, the quality characteristics depend on user perspectives, needs and priorities, which vary across groups of users. Quality is viewed in terms of seven dimensions: relevance, accuracy, credibility, timeliness, accessibility, interpretability and coherence.

9.3 The relationship between the International Monetary Fund Data Quality Assessment Framework, the Eurostat quality definition and the Organization for Economic Cooperation and Development quality measurement framework. The overall aim of the three quality assessment frameworks is to standardize and systematize statistical quality measurement and reporting across countries. They allow assessing of national practices in energy statistics in terms of internationally (or regionally) accepted approaches for data quality measurement. The quality assessment frameworks could be used in a number of contexts, including for (a) guiding countries' efforts towards strengthening their statistical systems by providing a self-assessment tool and a means of identifying areas for improvement; (b) technical assistance purposes; (c) reviews of particular statistical domains as performed by international organizations; and (d) assessment by other groups of data users.

9.4 *Dimensions of quality.* National agencies responsible for energy statistics can decide to implement one of the existing frameworks for quality assessment of any type of statistics, including energy statistics, either directly or by developing, on the basis of those frameworks, national quality assessment frameworks that fit best their country's practices and circumstances. The following dimensions of quality, which reflect a broad perspective and in consequence have been incorporated in most of the existing frameworks, should be taken into account in developing quality assessment frameworks for measuring and reporting the quality of statistics in general and energy statistics in particular: prerequisites of quality, relevance, credibility, accuracy, timeliness, methodological soundness, coherence and accessibility. They are described in greater detail directly below:

(a) *Prerequisites of quality.* Prerequisites of quality refer to all institutional and organizational conditions that have an impact on the quality of energy statistics. The elements within this dimension include the legal basis for compilation of data; adequacy of data-sharing and coordination among data-producing agencies; assurance of confidentiality; adequacy of human, financial, and technical resources for implementation of energy statistics programmes and implementation of measures to ensure their efficient use; and quality awareness;

(b) *Relevance.* The relevance of energy statistics reflects the degree to which they meet the real needs of users. Therefore, measuring relevance requires identification of user groups and their needs. The responsible agencies should balance the different needs of current and potential users with a view to producing a programme that goes as far as possible towards satisfying the most important needs of users for both coverage and content of energy data, given the resource constraint. The indicators of relevance are the requests of users, conducted users' satisfaction surveys and their results, and the identified gaps between key user interests and compiled energy statistics in terms of concepts, coverage and details;

(c) *Credibility.*[2] The credibility of energy statistics refers to the confidence that users place in those data based on the image of the responsible agencies producing the data. Confidence by users is built over time. One important aspect of credibility is trust in the objectivity of the data, which implies that the data are perceived to be produced professionally in accordance with appropriate statistical standards, and that policies and practices are transparent. For example, data should not be manipulated, nor should their release be timed in response to political pressure;

(b) *Accuracy.* The accuracy of energy statistics refers to the degree to which the data correctly estimate or describe the quantities or characteristics that they have been designed to measure. It has many facets and in practice there is no single aggregate for or overall measure of accuracy. In general, it is characterized in terms of errors in statistical estimates and is traditionally decomposed into bias (systematic error) and variance (random error) components, but it also encompasses the description of any processes undertaken by responsible agencies s to reduce measurement errors. In the case of sample surveys-based energy estimates, the accuracy can be measured using the following indicators: coverage, sampling errors, non-response errors, response errors, processing errors, and measuring and model errors. Revisions and revision studies of energy statistics undertaken at regular intervals are considered a gauge of reliability;

(c) *Timeliness*. The timeliness of energy statistics is a function of the amount of time between the end of the reference period to which the data pertain, and the date on which the data are released. The concept of timeliness applies equally to short-term and structural data, as the only difference is the time frame. Timeliness is closely tied to the existence of a publication schedule. A publication schedule may comprise a set of target release dates or may entail a commitment to release energy data within a prescribed time period following their receipt. This factor usually involves a trade-off with respect to accuracy. The timeliness of information also influences its relevance. Punctuality is another aspect of timeliness. It reflects the amount of time elapsing between the identified release date and the effective dissemination date of energy data;

(d) *Methodological soundness*. Methodological soundness is a dimension that encompasses the application of international standards, guidelines and good practices in the production of energy statistics. The adequacy of the definitions and concepts, target populations, variables and terminology underlying the data, and the information describing the limitations of the data, if any, largely determines the degree of adherence of a particular data set to international standards. The metadata provided along with energy statistics play a crucial role in assessing the methodological soundness of data. They inform the users on how close to the target variable (for example, any of the data items) are the input variables used for their estimation. When there is a significant difference, there should be an explanation of the extent to which this may cause a bias in the estimation of data items. Methodological soundness is closely related to the interpretability of data, which depends on all of the features of the information on energy data mentioned above and reflects the ease with which the user may understand and properly use and analyse the data;

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[2] This dimension is referred to as assurance of integrity in the IMF Data Quality Assessment Framework.

(e) *Coherence.* The coherence of energy statistics reflects the degree to which the data are logically connected and mutually consistent, that is to say, the degree to which they can be successfully brought together with other statistical information within a broad analytical framework and over time. The use of standard concepts, classifications and target populations promotes coherence, as does the use of a common methodology across surveys. Coherence, which does not necessarily imply full numerical consistency, has four important sub-dimensions:

(i) *Coherence within a data set.* This implies that the elementary data items are based on compatible concepts, definitions and classifications and can be meaningfully combined. For energy statistics, this sub-dimension governs the need for all data items to be compiled in conformity with the methodological basis of the recommendations presented in IRES;

(ii) *Coherence across data sets.* This implies that the data across different data sets are based on common concepts, definitions and classifications. The coherence between energy statistics and other statistics (e.g., economic, environmental) will be ensured if all data sets are based on common concepts, definitions, valuation principles, classifications, etc., and as long as any differences are explained and can be allowed for;

(iii) *Coherence over time.* This implies that the data are based on common concepts, definitions and methodology over time. This property will be established if, for example, an entire time series of energy data is compiled on the basis of the recommendations in IRES. If this is not the case, it is advisable that countries clearly note the divergences from the recommendations;

(iv) *Coherence across countries.* This implies that the data are based on common concepts, definitions and methodology across countries. Coherence of energy statistics across countries may be dependent upon the extent to which the recommendations in IRES have been adopted;

(f) *Accessibility.* The accessibility of energy statistics refers to the ease with which they can be obtained from the responsible agencies, including the ease with which the existence of information can be ascertained, as well as the suitability of the form or the media of dissemination through which the information can be accessed. Aspects of accessibility also include the availability of metadata and the existence of user support services. Accessibility requires development of an advance release calendar (see para.) so that the users will be informed well in advance on when and where the data will be available and how to access them.

9.5 These dimensions of quality are overlapping and interconnected and as such are involved in a complex relationship. Action taken to address or modify one aspect of quality will tend to affect other aspects. For example, there may be a trade-off between aiming for the most accurate estimation of the total annual energy production or energy consumption by all potential producers and consumers, and providing this information in a timely manner and when it is still of interest to users. **It is recommended that** if, while compiling a particular energy statistics data set, countries are not in a position to meet the accuracy and timeliness requirements simultaneously, they should produce a provisional estimate, which would be available soon after the end of the reference period but would be based on less comprehensive data content. This estimate would be supplemented at a later date with information based on more comprehensive data content but would be less timely than its provisional version. If there is no conflict between these two quality dimensions, there will of course be no need of produce such estimates.

9.6 The measurement of quality of any statistical data, including energy statistics data, is not a simple task. Problems arise from the difficulties involved in quantifying the levels of individual dimensions and in aggregating the levels of all dimensions. Under these circumstances, deriving a single quantitative measure of quality is not possible. In the absence of such a single measure, countries **are encouraged** to use a system of quality measures/indicators (see sect. B below) to develop their own quality assessment frameworks based on the above-mentioned approaches and dimensions and the specific circumstances of their economies and to regularly issue quality reports as part of their metadata. The quality framework offers responsible agencies s a practical approach to providing data that meet different users' needs, while the provision of quality information allows users to judge for themselves whether a data set meets their particular quality requirements. **It is recommended that** a quality review of energy statistics be undertaken every four to five years or more frequently if significant methodological changes or changes in the data sources occur.

B. Quality indicators and direct quality measures

9.7 *Quality measures.* Quality measures are defined as those items that directly measure a particular aspect of quality. For example, the time lag from the reference date to the release of particular energy statistics is a direct quality measure. However, in practice, many quality measures can be difficult or costly to calculate. Instead, quality indicators can be used in quality measurement. Quality measures and quality indicators can either supplement or act as substitutes for the desired quality measurement.

9.8 *Quality indicators*. Quality indicators are summarized quantitative data that provide evidence about the quality or standard of the data produced by national and international statistical and energy agencies. They are linked to the achievement of particular goals or objectives. Unlike ordinary raw statistics, quality indicators are generally conceptualized in terms of having some reference point and, so structured, can assist in making a range of different types of comparisons.

9.9 Quality indicators usually consist of information that is a by-product of the statistical process. They do not measure quality directly but can provide enough information for the assessment of a quality. For example, in respect of accuracy, it is almost impossible to measure non-response bias, as the characteristics of non-respondents can be difficult and costly to ascertain. In this instance, the response rate is often utilized as a proxy quality indicator to provide a measure of the possible extent of non-response bias.

9.10 It is not intended that all quality dimensions should be addressed for all data. Instead, countries **are encouraged** to select those quality measures/indicators that together provide an assessment of the overall strengths, limitations and appropriate uses of a given data set. Certain types of quality measures and indicators will be produced for each data item; for example, item response rate for total energy production would be calculated with each new estimate. Alternatively, some others would be produced once for all data items and would be rewritten only if there were changes. The latter case is exemplified in the description of survey approaches to data collection for the quality dimension "methodological soundness", which would be applicable to all energy statistics data items.

9.11 *Defining quality indicators.* When countries define the quality indicators for energy statistics, **it is recommended that** they ensure that the indicators satisfy the following criteria: (a) they cover part or all of the dimensions of quality as defined previously; (b) the methodology for their compilation is well established; and (c) the indicators are easy to interpret.

9.12 *Types of quality indicators*. Quality indicators can be classified according to their importance as follows:

(a) *Key indicators*, which ought to fulfil the criteria given in paragraph 9.11. Examples of key quality indicators are the coefficient of variation, measuring the accuracy of energy statistics obtained through sample surveys, and the time lag between the end of the reference period and the date of the first release of data, measuring the timeliness of energy statistics;

(b) *Supportive indicators*, which fulfil the criteria in paragraph 9.11 to the extent that they are considered important as indirect measures of the data quality. Such an indicator, for example, is the average size of revisions undertaken between the provisional and final estimates of a particular data set, which measures the accuracy of energy statistics;

(c) *Indicators for further analysis*, which are subject to further examination and discussion on the part of responsible agencies. After a careful analysis of the responsible agencies capabilities and available resources, for example, some countries may decide to conduct a user satisfaction survey and calculate a user satisfaction index for measuring the relevance of energy statistics.

9.13 **It is recommended** that careful attention be paid by countries to maintaining an appropriate balance between different dimensions of quality and the number of indicators. The objective of quality measurement is to have a limited set (minimum number) of indicators which can be used to measure and follow over time the quality of the energy data produced by the responsible agencies and to ensure that users are provided with a useful summary of overall quality, while not overburdening respondents with demands for unrealistic amounts of quality metadata.

9.14 *Minimum set of quality measures/indicators*. Table IX.1 below presents a limited set of key indicators[3] which countries **are encouraged** to use on a regular basis for measuring the quality of energy statistics. Their utilization is easy to implement and they provide users with a clear and up-to-date overview of the overall quality of energy statistics.

Table IX.1

Key indicators for measuring the quality of energy statistics

Quality dimension	*Quality measure/indicator*
Relevance	R_1. Identification of gaps between key user interests and compiled energy statistics in terms of concepts, coverage and detail R_2. Conducted users' satisfaction surveys
Accuracy	A_1. Sampling errors - Coefficient of variation A_2. Non-sampling errors - Unit response rate - Item response rate A_3. Quantity response rate (percentage of total sales reported) A_4. Number and average size of revisions of energy data
Timeliness	T_1. Time lag between the end of the reference period and the date of the first release (or the release of final results) of energy data
Methodological soundness	MS_1. Number and rates of divergences from the relevant international statistical standards in concepts and measurement procedures used in the collection/compilation of energy statistics
Coherence	CO_1. Comparison and joint use of related energy data from different sources
Accessibility	AC_1. Number and types of means used for dissemination of energy statistics AC_2. Energy statistics data sets made available, by mode of dissemination, as a percentage of total energy statistics data sets produced

C. Metadata on energy statistics

9.15 *Content of statistical data*. Generally, statistical data consist of the following:

(a) *Microdata*: data on the characteristics of units of a population, such as establishments and enterprises, collected by a census or a survey;

(b) *Macrodata:* data derived from microdata by grouping or aggregating them, such as total number of establishments or total value added;

(c) *Metadata*: data that describe the microdata, macrodata or other metadata.

[3] For more quality indicators, see the European Statistics Code of Practice, at: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=2273,1,2273_47140765&_dad=portal&_schema=PORTAL; the IMF Data Quality Assessment Framework website at: http://dsbb.imf.org/Applications/web/dqrs/dqrsdqaf/; and the United Kingdom of Great Britain and Northern Ireland Office for National Statistics, *Guidelines for Measuring Statistical Quality*, at: http://www.statistics.gov.uk/StatBase/Product.asp?vlnk=13578.

9.16 *Metadata*. The term metadata defines all information used to describe other data. A very short definition of metadata, then, is "data about data." Metadata descriptions go beyond the pure form and content of data to encompass administrative facts about data (who has created them and when), and how data were collected and processed before they were disseminated or stored in a database. In addition, metadata facilitate an efficient search for and location of data.

9.17 *Statistical metadata*. Statistical metadata describe or document microdata, macrodata or other metadata and facilitate sharing, querying and understanding of data. Statistical metadata also refer to any methodological descriptions on how data are collected and manipulated. For energy statistics, for example, metadata include the name of the data item, the unit from which the information has been collected, data sources, information about classifications used and series breaks, definitions and methodologies used in their compilation. Metadata are essential for the interpretation of statistical data. Without appropriate metadata, it would not be possible to fully understand energy statistics and conduct international comparisons.

9.18 *Metadata and quality.* There is a bidirectional relationship between metadata and quality. On the one hand, metadata describe the quality of statistics. On the other hand, metadata are themselves a quality component, which improves the availability and accessibility of statistical data.

9.19 *Users and uses of metadata.* There are many types of users and uses for any given set of data. The wide range of possible users and uses means that a broad spectrum of metadata requirements have to be addressed. In particular, the responsible agencies s as data suppliers must make sufficient metadata available to enable the least and the most sophisticated users to readily assess data and their quality. **It is recommended** that segmentation of users into groups and a layered approach to metadata presentation, in which each successive layer provides more detail, be accepted by countries. As a minimum segmentation, metadata at the following two levels **are recommended**:

(a) *Structural metadata* presented as an integral part of the data tables;

(b) *Reference metadata* providing details on the content and quality of data which may accompany the tables or be presented separately via the Internet or in occasional publications.

9.20 *Use of metadata to promote international comparability of data*. Metadata provide a mechanism for comparing national practices in the compilation of statistics. This may help and encourage countries to implement international standards and to adopt best practices in the compilation of statistics in particular areas. Better harmonization of approaches adopted by different countries will improve general quality and coverage of key statistical indicators.

9.21 *Purposes of energy statistics metadata*. The most fundamental purpose of metadata is to help the users of energy statistics to interpret, understand and analyse the data, even if they have not themselves participated in the process of the production of those data. In other words, energy statistics metadata should help users transform statistical data into information. Energy statistics metadata also help producers of statistics. The new knowledge gained from interpreting the data may also lead to enhancements both of production (through lowering the costs and improving the data quality) and of dissemination (through dissemination of comprehensive, timely, accessible and reliable data).

9.22 *Components of metadata*. For the purpose of disseminating comprehensive energy statistics, their corresponding metadata should encompass the following six main components: (a) data coverage, periodicity and timeliness; (b) access by the public; (c) integrity of disseminated data; (d) data quality; (e) summary methodology; and (f) dissemination formats. Each of these components may be characterized by a few monitorable elements which can be observed by the users of statistics.

9.23 Countries **are encouraged** to accord the development of metadata a high priority and to consider their dissemination an integral part of the dissemination of energy statistics. Moreover, **it is recommended that**, in consideration of the integrated approach to the compilation of economic statistics, a coherent system and a structured approach to metadata across all areas of economic statistics be developed and adopted, focusing on improving their quantity and coverage.

9.24 Various international organizations such as the International Monetary Fund (IMF), Statistical Office of the European Communities (Eurostat) and the Organization for Economic Cooperation and Development (OECD) have developed metadata standards and collected metadata for different areas of statistics. Further guidance on metadata for purposes related to energy statistics will be elaborated and presented in the future *Energy Statistics: Compilers Manual*. Statistical Data and Metadata Exchange (SDMX)[4] technical standards and content-oriented guidelines provide common formats and nomenclatures for exchange and sharing of statistical data and metadata using modern technology. The dissemination of national data and metadata using web technology and SDMX standards **is recommended** as a means to reduce the international reporting burden.

[4] For additional information on SDMX, see: http://www.sdmx.org/.