BAHAMAS BUREAU OF STANDARDS AND QUALITY

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Environmental management — Quantitative environmental information — Guidelines and examples

DBNS ISO 14033:2019

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BBSQ Foreword

This *draft* national standard is identical with the English version of the International Standard ISO 14033:2019 ***Environmental management – Quantitative environmental information – Guidelines and examples***. The national committee responsible for reviewing this standard is Technical Committee 14 *Environmental Management and Protection*. This *draft* standard contains requirements that are relevant for The Bahamas.

BBSQ Committee Representation

This ISO International Standard *will be* adopted as a national standard under the supervision of the National Technical Committee for Environmental Management and Protection (NTC 14) hosted by the Bahamas Bureau of Standards and Quality which at the time comprised the following members:

Member	**Representing**
Dr. Ancilleno Davis (**Chairperson**)	Bahamas National Trust
Mrs. Alphanique Swann-Newbold (**Vice Chairperson**)	N/A
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 207, *Environmental management*, Subcommittee SC 4, *Environmental performance evaluation*.

This first edition cancels and replaces ISO/TS 14033:2012, which has been technically revised.

The main changes compared with the previous edition are as follows:

- definitions have been added and principles have been modified;
- the framework has been elaborated and new examples of general application have been added;
- extended explanations of data sources and categories of data have been added;
- new topics in the ISO 14000 family of standards, such as financial applications, have been added;
- the relationship between quantitative environmental information and industrial digitalization has been added;
- the relationship between systems analytical environmental data and metrological aspects of acquiring data has been added;
- Annexes D and E have been added.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document provides guidelines and examples for the acquisition and provision of quantitative environmental information. It is also intended to support review and verification of quantitative information. This document supports the continual improvement of environmental management and the achievement of sustainable development. The purpose of this document is to help break down the complexity of environmental data handling, by applying systems analysis and metrology, into distinguishable practical steps, each with low complexity and a clear objective, to assist the process of gathering and processing quantitative environmental information. This document is intended for use by those who work with environmental quantitative information, including data acquisition, compilation, reporting and review.

Since this document addresses data measurement, data acquisition and compilation, it is also closely linked to areas of digitalization, such as digital twins, positioning of sensors, and acquisition, handling and interpretation of sensor data, as well as concepts related to “big data”, such as statistical analysis and statistical inference. This document provides guidelines on how to effectively and efficiently position sensors (or other data sources) for such analyses, as well as on how to transparently make references to such data sources, to help interpret and review big data statistical analyses.

The guiding framework adheres to the general principles of continual improvement and follows an iterative Plan-Do-Check-Act (PDCA) approach.

This document addresses data quality by providing guidelines and examples on how to acquire, compile and report data to reach the data quality requested by the application of quantitative environmental information. Data quality is an intended and implicit result from the guidelines provided by this document, but it is not specifically addressed throughout the text.

The guidelines range from planning, defining and acquiring quantitative data to performing mathematical processing. They can be used to review the work that results in environmental quantitative information for an application as part of a method or tool, such as life cycle assessment or environmental performance evaluations. The guidelines do not include specific methods or tools, but they address how to acquire and provide quantitative data for such applications. This document refers to data as individual entities rather than sets of values such as databases. The guidelines are developed with an understanding that many applications of quantitative environmental information are intended for different types of assessments within organizations. Quantitative environmental information therefore impacts the level of confidence for decision making, including technology development, investments and financial decisions. Any type of intended application and related assessment is dependent on first identifying the expectations linked to the results generated using the quantitative environmental information before establishing statistical and numerical design criteria to be used for data collection.

The guidelines are developed with the understanding that many applications of environmental information are intended for quantitative comparisons, such as levelling and benchmarking, controlling continual improvement (comparing with the previous year), quantitative identification of priority areas, numerical appraisal and comparison of risks, decisions about design, investment or procurement. This document supports quantitative comparisons by highlighting perspectives of the planning of the acquisition and provision that are particularly relevant to achieving comparable quantitative results.

This document provides guidelines for acquiring and providing a broad variety of quantitative environmental information and data. When an organization applies this document for various purposes within its environmental management system, or for specific tools, purposes or applications, maximum benefit is gained by following the principles described in Clause 5.

For adequate application of this document for the acquisition, compilation and reporting of quantitative environmental information, particular consideration should be given to identifying the skills needed by the practitioner.

Annex E provides explanatory information to prevent misinterpretation of the guidance presented in this document.

Environmental management — Quantitative environmental information — Guidelines and examples

1 Scope

This document gives guidelines for the systematic and methodical acquisition and review of quantitative environmental information and data about systems. It supports the application of standards and reports on environmental management.

This document gives guidelines for organizations on the general principles, policies, strategies and activities necessary to obtain quantitative environmental information for internal and/or external purposes. Such purposes can be, for example, to establish inventory routines and support decision making related to environmental policies and strategies, aimed in particular at comparing quantitative environmental information. The information is related to organizations, activities, facilities, technologies and products.

This document addresses issues related to defining, collecting, processing, interpreting and presenting quantitative environmental information. It provides guidelines on how to establish accuracy, verifiability and reliability for the intended use. It uses proven and well-established approaches for the preparation of information adapted to the specific needs of environmental management.

This document is applicable to all organizations, regardless of their size, type, location, structure, activities, products, level of development and whether or not they have an environmental management system in place.

NOTE 1 Quantitative information specifically addresses quantification of environmental performance in the form of environmental performance indicators in accordance with ISO 14031.

NOTE 2 Quantitative information also addresses quantification of risk for risk management purposes.

This document supplements the contents of other International Standards on environmental management.

NOTE 3 Annexes A and B provide illustrative and general examples of how to apply the guidelines and the framework. Annexes C and D provide sector-specific case studies on the application of the framework and case studies on selected documents from the ISO 14000 family, respectively. Annex E provides explanatory information to prevent misinterpretation of the guidance of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14050, *Environmental management — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14050 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at https://www.iso.org/obp
- IEC Electropedia: available at http://www.electropedia.org/

3.1 Types of information

3.1.1

basic data

data acquired from a data acquisition process

Note 1 to entry: Basic data consist of one or several values and units, depending on the nature of the item that the basic data represent. Some basic data can be dimensionless and have no units, e.g. an index or ratio.

3.1.2

activity data

quantitative measure of an activity that results in an environmental impact

3.1.3

quantitative data

numerical data item that includes its unit, or context for non-dimensional data

3.1.4

quantitative information

quantitative data (3.1.3) that has been processed or analysed to be meaningful for a specific purpose or objective

Note 1 to entry: Quantitative data can originate from *data sources* (3.2.2) that provide either *primary data* (3.1.5) or *secondary data* (3.1.6).

3.1.5

primary data

data obtained from known direct measurement or from implicitly or explicitly defined calculations based on data originating from such direct measurements

3.1.6

secondary data

data obtained in other ways than *primary data* (3.1.5)

3.1.7

metadata

data that provides information about other data

EXAMPLE The date when the data was originally measured, or a description of the *system* (3.2.4) that the data are intended to represent or information about how the data was obtained.

3.1.8

foreground data

data representing *property* (3.2.3) of a *foreground system* (3.2.6)

3.1.9

background data

data representing *property* (3.2.3) of the *system* (3.2.4) that lies outside the *foreground system* (3.2.6)

3.2 Managing information

3.2.1

metrology
science of measurement, embracing both experimental and theoretical determinations at any level of *uncertainty* (3.3.3) in any field of science and technology

Note 1 to entry: For details about metrology, refer to JCGM 200:2012.

Note 2 to entry: Metrology includes all theoretical and practical characteristics of measurement, whatever the measurement uncertainty and field of application.

3.2.2
data source
origin of data

Note 1 to entry: A data source might consist of *primary data* (3.1.5) or *secondary data* (3.1.6)

EXAMPLE Literature, databases, human resources, instruments.

3.2.3
property
aspect or quality of something that can be determined by measurement

[SOURCE: ISO/TS 15926-6:2013, 3.1.12, modified — The preferred term “physical quantity” and the Note 1 to entry have been removed.]

3.2.4
system
group or groups of independent and interrelated objects or processes

3.2.5
systems analysis
methodology for identifying and analysing properties of a *system* (3.2.4) by studying its internal constituents and their dependencies and relations

3.2.6
foreground system
subsystem of focus of a *systems analysis* (3.2.5)

3.3 Characteristics of information

3.3.1
data quality
characteristics of data that relate to their ability to satisfy stated requirements

Note 1 to entry: In this document, “stated requirements” refers to “requirements of the objective” and “ability to satisfy stated requirements” refers to “meeting the objective” according to Clause 6.

[SOURCE: ISO 14044:2006, 3.19, modified — Note 1 to entry has been added.]

3.3.2
transparency
open, comprehensive and understandable presentation of information

[SOURCE: ISO 14044:2006, 3.7]

3.3.3
uncertainty

variability due to random or systematic causes

Note 1 to entry: Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of, an event, its consequence, or likelihood.

4 Use of quantitative environmental information

4.1 General

Quantitative environmental information is used for environmental measurements, calculations, assessments, comparisons, reporting and communication about systems. This document supports any such use or application of quantitative environmental information throughout International Standards on environmental management. Examples are environmental performance indicators, environmental communication, environmental declarations, life cycle assessment, greenhouse gas emission reporting, climate change mitigation, climate change adaptation, carbon footprint, water footprint, eco-efficiency, reporting to authorities, sustainability reporting, social responsibility reporting, environmental technology verification (ETV) reporting, material flow cost accounting and monetary valuation.

The role that the application of environmental quantitative information has in relation to this document is shown in Figures 1, 2 and 3. The application sets requirements on different characteristics of the quantitative environmental information that in turn implies how the data and information is acquired and provided. The application also specifies the intended use and the requirements or expectations concerning credibility, accuracy and transparency. This document provides specific guidelines when the application implies a comparison between quantitative environmental information about different products, processes or systems.

4.2 Internal use of quantitative environmental information

This document gives guidelines for the acquisition and provision of quantitative environmental information for internal applications. Typical applications are as follows:

— monitoring of environmental performance indicators: acquisition and provision routines for repeated information handling tasks as required for documentation and for supporting the continual improvement of the environmental management system;

— environmental risk assessment: quantified environmental information about identified risk factors and possible impacts as intended or accidental;

— life cycle assessment studies of products and services (LCA): data acquisition procedures for the acquisition and provision of life cycle inventory (LCI) data for internal use;

— material flow cost accounting (MFCA): quantitative information on material and energy flows on the process level of an organization that are acquired and provided to improve the resource efficiency of production systems;

— business intelligence: quantitative methods and routines for the assessment of environmental performance and specified requirements for the general market;

— establishing mid- and long-term environmental goals connected or integrated with financial data;

— automatically optimizing production performance to minimize the risk for environmental impact from the production facility.

To establish consistency of data used in different applications and to maximize the usability of data, one common set of guidelines and routines for data acquisition and provision might be useful.

4.3 External use of quantitative environmental information

This document also gives guidelines for the acquisition and provision of quantitative environmental information for external applications, such as the following:

- greenhouse gas (GHG) trading scheme and GHG emission reporting;
- corporate environmental and sustainability reporting;
- governmental reporting;
- external communication, such as eco-labelling, environmental product declarations and other public life cycle assessments, by providing guidelines on how to specify requirements on transparency, accuracy and other characteristics that are important when communicating results of complex studies externally;
- environmental performance reporting, such as setting the quantitative specifications for the reporting of the eco-efficiency of products and services of a company;
- environmental technology verification (ETV) reporting based on new environmental technology verified in its claimed performance;
- communication with financial stakeholders, such as sustainability reports or financial databases;
- information that enables product users to manually or automatically optimize their product handling, use or waste treatment to minimize the risk for environmental impacts due to the product;
- information for suppliers of goods and services that enables them to manually or automatically optimize their supply to minimize the risk for environmental impacts during the supply.

External communication of quantitative environmental information sets requirements on consistency, reliability and transparency. Meeting these requirements is facilitated by common guidelines that support review, verifiability and credibility of the data. Information that is acquired and provided in compliance with a common guideline can be more easily interpreted and therefore also more easily used in several applications.

4.4 Using quantitative environmental information for comparisons

This document gives specific guidelines when the quantitative environmental information is intended for comparisons, such as:

- carbon dioxide emissions from different production plants;
- eco-efficiency of different products;
- life cycle impact assessment of different functional units;
- electricity consumption by different production units.

When acquiring and providing data intended for comparison, it is important to consider not only the application at hand, but also that any decisions are generalizable and repeatable when acquiring the same or similar data for the other system(s) for comparison.

One of the objectives of quantitative data might be to carry out comparative studies, such as:

a) a system at two or more different time intervals;

b) the effect of changes in systems, areas and product lines;

c) different organizational and operational boundaries internally or externally.

5 Principles for generating and providing quantitative environmental information

5.1 General

These principles are fundamental for ensuring that quantitative environmental information provides a true and fair account and is used as a guideline for decisions relating to this document.

5.2 Relevance

The selected data sources, system boundaries, measurement methods and assessment methods meet the requirements of the interested parties and/or the application.

NOTE These requirements can vary for different interested parties and different applications.

5.3 Credibility

The quantitative environmental information provided is truthful, accurate and not misleading to interested parties.

5.4 Consistency

Compatible, coherent and not self-contradictory quantitative environmental data and information are developed using recognized and reproducible methods and indicators, which respect related integrity constraints.

5.5 Comparability

The quantitative environmental information is generated, selected and provided in a consistent way, with consistent measurement units, thereby allowing for comparisons.

EXAMPLE Comparison of environmental performance of an organization over time; comparison of environmental performance of different organizations or of similar organizations in different countries.

5.6 Transparency

The processes, procedures, methods, data sources and assumptions for providing and generating quantitative information are made available to all relevant interested parties.

NOTE This is done to ensure a proper interpretation of the results and to give explicit reasons for any extrapolations, simplifications or modelling performed, taking into account confidentiality of information, if required. In addition, any volatility or uncertainty is disclosed.

5.7 Completeness

All significant quantitative environmental information for the intended use is reflected in such a way that no other relevant information needs to be added.

5.8 Validity

Systematic errors and associated uncertainties are minimized as far as practicable and tendencies towards a particular perspective or bias are eliminated.

5.9 Appropriateness

Quantitative environmental information is made relevant and fully understandable to interested parties, by using formats, language and media that meet their expectations and needs.

5.10 Materiality

The focus is kept where it really matters and where the application of the quantitative environmental information could influence the intended user's decisions and work efficiently with the acquisition and provision of quantitative environmental information.

NOTE The concept of materiality is used to identify information that, if omitted or misstated, would significantly misrepresent a compilation of quantitative environmental information to its intended application, thereby creating confusion or misunderstanding. Acceptable materiality is determined by the application.

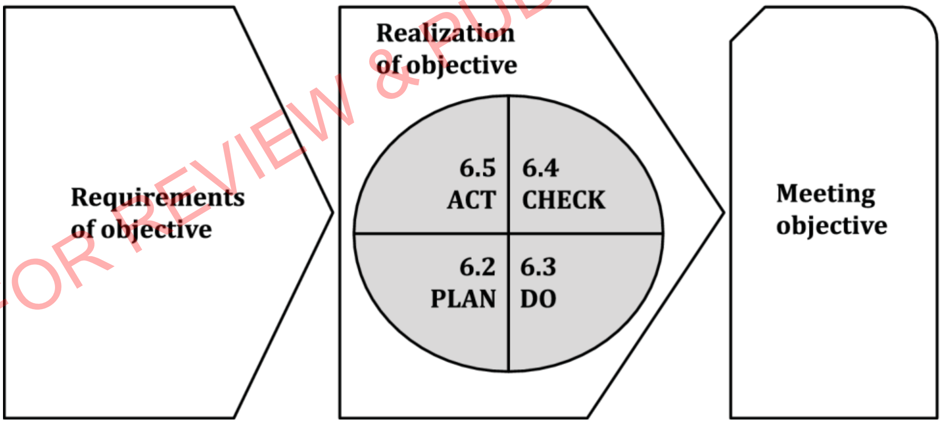
6 Guidelines

6.1 General

6.1.1 Plan-Do-Check-Act approach

The guidelines in this document are based on the continual improvement loop of Plan-Do-Check-Act (PDCA), as illustrated in Figure 2. The guidelines are organized into a consistent framework, described in this clause, and illustrated by Figures 1, 2 and 3.

To the extent necessary, all steps and outcomes of the PDCA should be sufficiently documented.

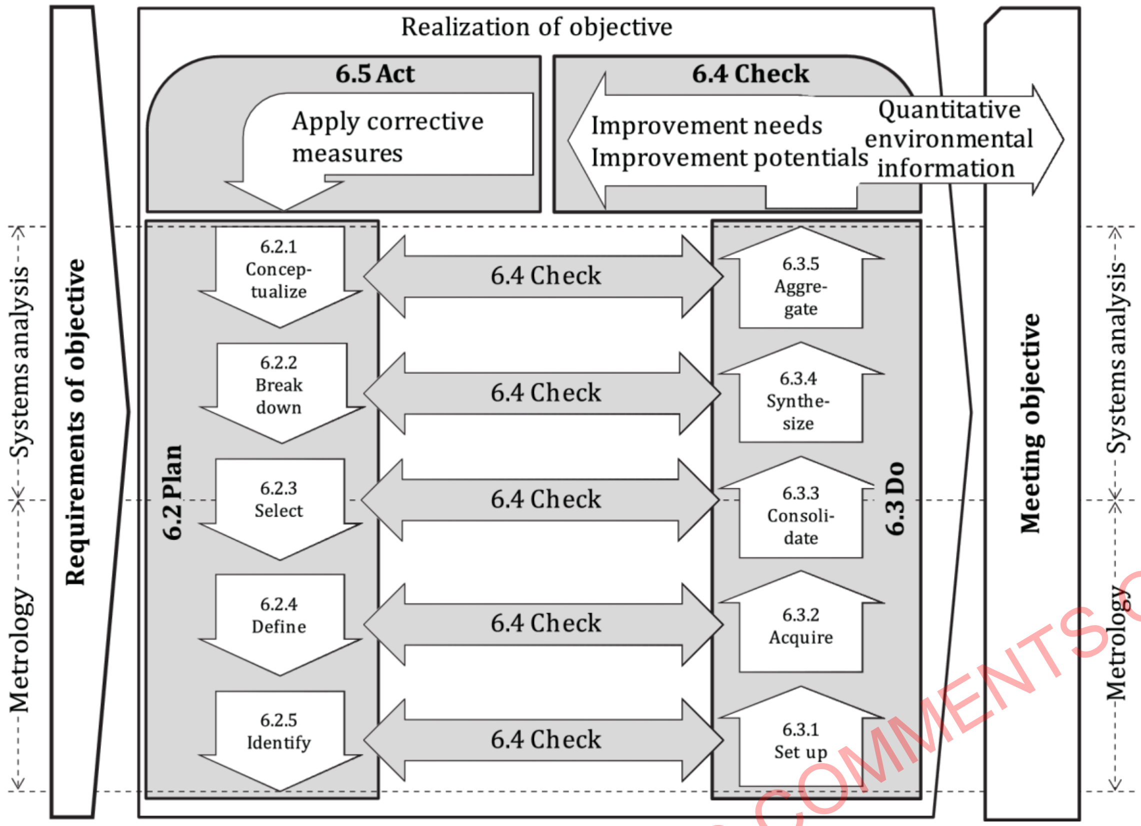


NOTE 1 The numbers in the figure refer to clauses and subclauses in this document.

NOTE 2 Due to the design of the framework (see Figure 2), the PDCA loop in Figure 1 is traversed counter-clockwise.

Figure 1 — The overall process model of the framework

The framework is based on a process model. The input to the process is the requirements of the objective, set by the actual application of the quantitative information. The requirements of the objective and judgement of whether the objective has been met is outside of the scope of this document but is set by the application. The application itself lies outside of the framework. The output from the process is the meeting objective. The focus of the framework is the process of the realization of objective. The PDCA work process starts with 6.2 "Plan". Figure 2 shows the realization of the objective in detail.



NOTE The numbers in the figure refer to clauses and subclauses in this document.

Figure 2 — Guidelines for acquiring and providing quantitative environmental information with PDCA

The emphasis of the guidelines lies in tasks which belong to Plan, Do and Check. Act is also part of the framework, but with lesser emphasis. In these steps, the quantitative environmental information is prepared and delivered according to the requirements of the objective. Each task of Plan corresponds to a task in Do. This covers the handling of specific issues down through the planning and data acquisition, up to the provision of the quantitative environmental information. Check is the evaluation of the actual correspondence between the tasks of Plan and Do, and of the overall meeting of the requirements of the objective.

The guidelines, as described in Figures 1 and 2, support a process view. The guidelines distinguish the three consecutive phases:

- requirements of the objective;
- realization of the objective;
- meeting the objective.

In Figure 2, the upper half of tasks are labelled as systems analysis (see 6.2.1 to 6.2.3 and 6.3.3 to 6.3.5), and the lower tasks are labelled as metrology (see 6.2.3 to 6.2.5 and 6.3.1 to 6.3.3). Tasks 6.2.3 and 6.3.3 belong to both those labels. This indicates that the acquisition of quantitative data rests on applicable sciences, standards and methods of metrology, and that the quantification of the system relies on the sciences, standards and methodologies of systems analysis. It also means that the selection of parameters (see 6.2.3) and the consolidation of parameters (see 6.3.3) is where this framework combines these two different fields to quantify environmental information.

The framework provides systematic approaches to check of quantitative environmental information. Check might be, for example, in the form of peer data quality check, peer review or third-party review. Two different forms of support for review and check are described in 6.4.2.1 and 6.4.2.2: consecutive check and check of resulting quantitative information.

The framework is intended to be used either or both iteratively and recursively, for different purposes and in different ways.

The iterative use of the PDCA loop is straightforward. At each iteration, it serves to gradually Plan and Do differently to more effectively and efficiently satisfy the requirements of the objective. It also serves to adapt Plan and Do to any changing requirements of the objectives, such as increased demands in data transparency, needs of additional parameters or other changing requirements.

Recursive use of the framework is schematically represented in Figure 3. If the data source results from the quantification of a transparent system model, the framework can be applied an arbitrary number of levels for practical reasons of work division or to satisfy the requirements of the objective.

Figure 3 shows a schematic representation of how the framework might be used recursively during break down or aggregation of a system to identify or set up data sources, in the figure exemplified as measurements, literature and expert data sources.

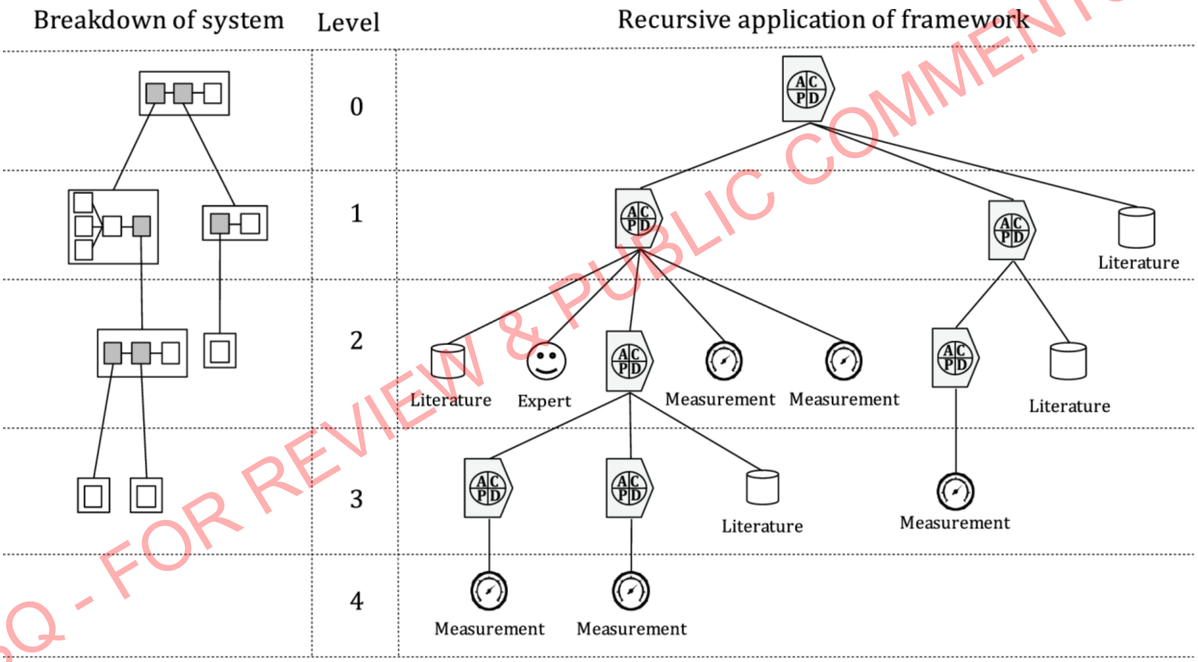


Figure 3 — Recursive use of the framework

The framework provides guidance from three viewpoints, as follows:

a) top down, as a detailed and stepwise guideline for specifying quantitative environmental information for one or several defined applications, i.e. Plan (see 6.2);

b) bottom up, as stepwise guidelines for how to compile basic data into quantitative environmental information intended for given applications, i.e. Do (see 6.3);

c) what and how to check, review and verify a specific compilation of quantitative environmental information, i.e. Check (see 6.4).

In 6.2 to 6.5, the guidelines are presented top down, starting with Plan. Supplementary illustrative examples and general examples on the application of the guidelines are given in Annexes A and B.

6.1.2 Data sources and categories of data

6.1.2.1 General

This document gives guidance on how to acquire data from data sources to compile requested quantitative environmental information. Sometimes the application sets requirements on the data sources to be used to compile the requested quantitative environmental information. For other applications, it is intended that the resulting quantitative environmental information will serve as data source for yet other applications. To provide useful guidance, it is therefore necessary to provide a clearer description and definition of some different data sources and categories of data mentioned in other standards in the ISO 14000 family. Examples are measurement method, foreground and background data, primary and secondary data sources and different specific data. This subclause describes different types of data sources and categories.

6.1.2.2 Primary and secondary data

6.1.2.2.1 General

This subclause gives guidelines on primary and secondary data.

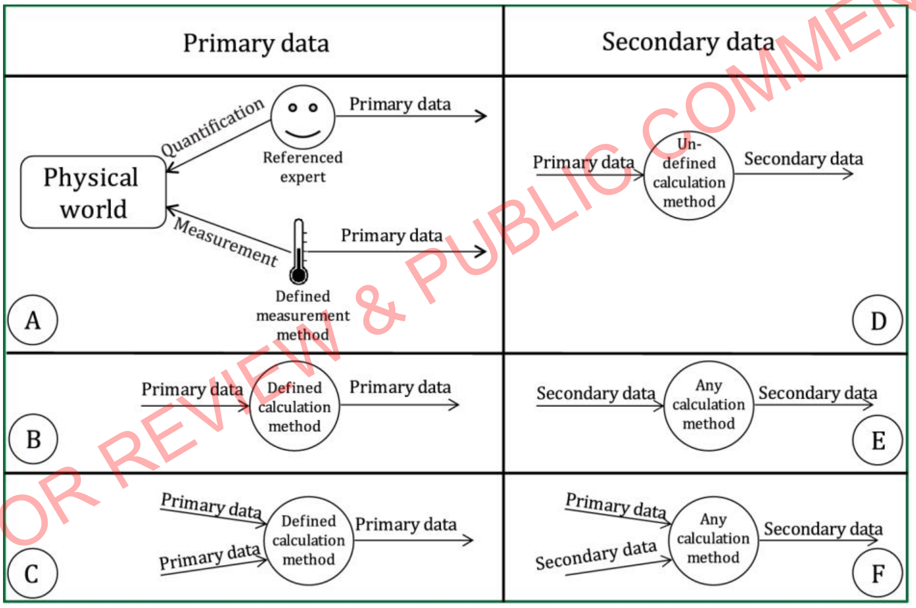


Figure 4 — Primary and secondary data sources

Letters A to F in the text below refers to the letters in Figure 4.

6.1.2.2.2 Primary data

A: The measurement method used to measure the primary data is implicitly or explicitly defined, and the observer is clearly referenced. See 6.1.2.3 for guidance on measurement methods.

EXAMPLE A primary data source can be, for example, the optical reading of gauges or diagrams, collecting electricity and raw material bills, or drawing data from analysis of laboratory experiments.

B and C: Application of any defined calculation method on one or several primary data results in primary data.

6.1.2.2.3 Secondary data

D: Application of any undefined calculation method on one or several primary data results in secondary data.

E: Modifying secondary data using any calculation method results in secondary data.

F: Application of any calculation method on any mix of primary and secondary data results in secondary data.

6.1.2.2.4 Calculation method

The calculation method is a strict mathematical operation. Any parameters or variables, such as emission factors needed to perform the calculation, are either primary data or secondary data.

A defined calculation method can be an algorithm or a mathematical function, without any secondary data factors or parameters.

An undefined calculation method can be any unknown algorithm or a mathematical function, or a known algorithm or mathematical function with secondary data factors or parameters.

6.1.2.2.5 Sources of data

For primary data, there are several key parameters depending on the data to acquire, such as the following:

- choice of methodology;
- location for the measurement;
- choice of entity to sample;
- sample frequency.

For secondary data, those which are sufficiently representative for the requirements of the objective should be chosen. For secondary data sources, there can be an assessment of the credibility of the data source, the relevance of the data and the sufficiency of the data for the purpose.

6.1.2.3 Measurement method

A measurement method is any means of acquiring data, from a defined measurement system such as a thermometer, copying a numerical value from a book or a database, or an estimated value provided by an expert.

Measurement methods might provide either primary or secondary data, depending on choice of measurement method.

6.1.2.4 Foreground and background data

Foreground data represents that part of the whole studied system over which the user of the information has control. It can, for example, include the operations of the organization that performs an evaluation of its life cycle environmental performance, while the background data in this case is data about the supply chain and the product life time. An illustration of foreground and background data is given in Figure 5.

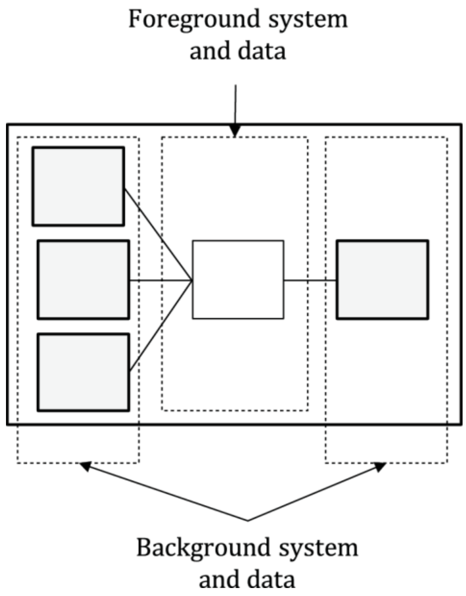


Figure 5 — Foreground and background data

Foreground and background data relate to how data are categorized in a specific systems analysis. They do not categorize a specific data source.

A foreground system is a subsystem of focus in a systems analysis, either aimed at studying the consequences from changes of the foreground system or at leading to decisions about changing the foreground system.

NOTE In some applications, it is required that foreground data are also primary data.

6.1.2.5 Specific and generic data

Specific data are data (primary or secondary) that represent a specific category, such as:

- site-specific, including production site, ecosystem, population, position of a vehicle, city and organization;
- technology-specific, relating to data specific to the measuring equipment or the system being studied;
- organization-specific, including any specific organization as described in ISO 14001;
- sector-specific, such as energy sector and transport sector;
- regionally specific, such as geopolitical regions and countries.

An illustration of specific and generic data is given in Figure 6.

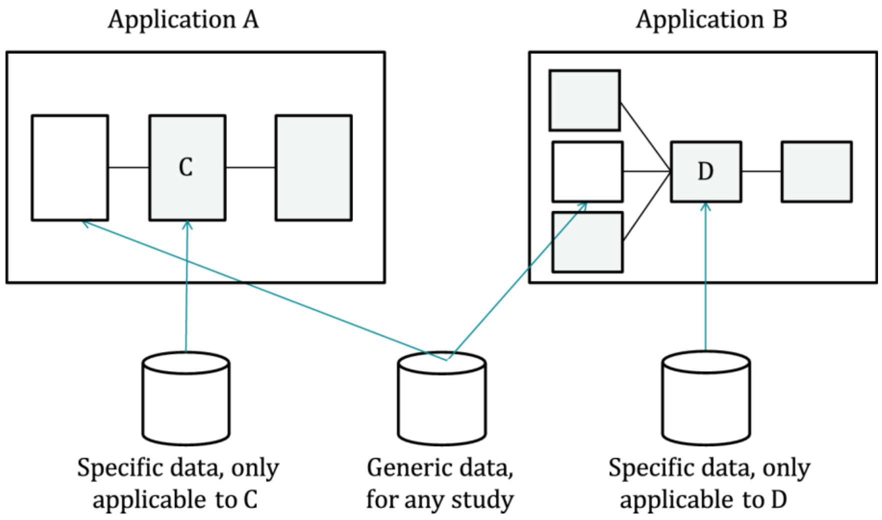


Figure 6 — Description of specific and generic data

Specific data has a considerably narrow applicability, whereas generic data has a considerably wide applicability. The choice of specific or generic data is determined by the requirements of the objective for which the information is acquired and compiled. Generic or specific does not imply data quality since data quality is determined by appropriateness.

6.1.2.6 Metadata

For quantitative information to be reviewable, transparent and interpretable, metadata should be supplied, with sufficient explanations about what the quantitative data represents, such as the measurement method, data gaps and scope of the system.

It is implicit throughout this document that sufficient metadata about each individual step through Plan, Do and Check is supplied together with any intermediately produced data as well as with the resulting quantitative information. This implies that sufficient metadata should be supplied while performing each step.

6.2 Plan

6.2.1 Conceptualize whole system

This step starts the realization of the objective. It identifies the scope of the system for which the quantitative information is to be collected. The aim of this step is to establish all the characteristics of the requirements of the objective that are relevant from a data acquisition and compilation point of view. All such characteristics are explicitly conceptualized and made understandable in terms of information and data requirements.

Conceptualizing the whole system involves understanding the basis for the collection of the quantitative environmental information. This includes the following:

- the objective of the information and intended use;
- the object on which information is to be provided;
- system boundaries;
- interested parties and target audience;
- requirements for the general quality of the information.

6.2.2 Break down system components

Breaking down into system components means dividing the object (described in 6.2.1) into manageable components. This can be done recursively to reach a level where data can be acquired (see Figure 3).

NOTE If the system identified in 6.2.1 is simple and easy to overview, this step can be omitted.

The breaking down into system components can be performed on the basis of different characteristics, for example:

- activities, functions and processes performed by the system;
- operational, technological, temporal, geographical or other features of the system;
- organizational, economic or responsibility structures and boundaries of the system;
- physical properties, for example, transformation, transportation and capability to build up stocks;
- species, eco-systems, media types and internal material transportation within, into and out from the system;
- other properties, such as indicators, aspects, inputs, outputs and stocks of the system.

When performing a system break down for a comparison application, it is essential that the individual system components are functionally comparable with the system components of any of the systems intended for comparisons.

6.2.3 Select parameters

Selection of parameters means identifying quantifiable entities of a system component that can be made to represent the quantified data. The parameters chosen are either the ones requested by the requirements of the objective or those needed to perform the calculations and aggregations necessary to quantify the requested data.

Different types of parameters can be chosen from system characteristics, for example:

- technical: activity data, production data, geographical data, energy data and emission data;
- ecological: biodiversity data, habitat data, nutrient data and biological data;
- socio-economic: demographic data, health data, development status data and economic data;
- other factors.

When selecting parameters for a comparison application, it is essential that the environmental significance of the individual parameters is comparable with the environmental significance of the parameters of any of the systems intended for comparisons.

6.2.4 Define basic data

Defining basic data means describing the data needed to quantify each parameter selected as described in 6.2.3. This includes the following:

- which basic data are needed to obtain the quantitative value for the parameter;
- how the basic data are transformed into quantitative value for the parameter;
- the scale of precision and statistical representativeness.

NOTE If the parameter can be directly measured or acquired from a data source, defining basic data is not needed; one can continue directly to identify the measuring method (see 6.2.5).

Basic data are defined to fulfil the quantity and quality requirements of the objectives of the intended information. This also includes the selection of the appropriate statistical or numerical guidelines for subsequent analysis and synthesis into useful data.

Basic data differ depending on which object, which property and which scale of precision is intended. When defining basic data for a comparison application, it is essential that any comparable basic data are defined in the same way for any of the systems intended for comparisons.

6.2.5 Identify measuring methods

Identifying measuring methods involves describing how to acquire the basic data with the required scale of precision and statistical representativeness, as described in 6.2.4 (see also 6.1.2.3).

From an industrial digitalization point of view, this step is where sensor systems are defined, positioned and chosen.

The measurement method depends on the object from which data are acquired, on the property data about which they are acquired, and on the required scale of precision of the basic data. The measurement method should be suitable regarding the definition of the basic data. Methods may be selected based on available standards, literature and/or expert advice.

When identifying measurement methods for a comparison application, it is essential that these measurement methods provide comparable results for the systems intended for comparisons.

Part of the definition of the measuring method is the data quality assurance associated with the metrological confirmation, which includes establishing baselines, calibration, validation of measuring system and verification of data collected.

6.3 Do

6.3.1 Set up measuring methods

Setting up a measuring method means to implement what has been planned in 6.2.5.

Sometimes the necessary measurement equipment and routines are already in place and only need to be identified. In some cases, adaptation of existing measuring systems might need to be carried out.

From an industrial digitalization point of view, this step is where sensors and sensor systems are connected.

The significance of any deviation of Plan should be estimated and, if needed, corrective values should be used or corrective routines established.

6.3.2 Acquire basic data

Basic data are acquired according to the measurement method as described in 6.2.5. Failures and disturbances of measurements affect the quality of the acquired data. Estimations of the magnitude of significance of these failures and disturbances should be expressed in terms of ranges or distributions of uncertainty of the acquired basic data.

From an industrial digitalization point of view, this step is where the sensor systems acquire data from the sensors and store it in databases.

6.3.3 Consolidate parameters

Parameters are consolidated according to Plan, as described in 6.2.3. If data processing differs from Plan, the deviation is explained together with an estimation, evaluation or analysis of its significance.

Significances are estimated iteratively, starting with a qualitative analysis that subsequently can lead to a thorough statistical analysis of uncertainty.

From an industrial digitalization point of view, this is where “big data” statistical analysis, data filtering and other data science methods and tools enter environmental information systems.

6.3.4 Synthesize system components

This is the step where the data analyses are formulated into quantitative statements about the subsystems of the total studied system.

NOTE In this document, the term “synthesize” refers to combining all sub-systems so that they together constitute the whole system according to the requirements of the objective.

System components are synthesized according to Plan, described in 6.2.2. To synthesize the system components, the parameters consolidated as described in 6.3.3 are related to the parameters of each system component, as described in 6.2.2.

The parameters selected according to 6.2.3 that have different origins might not have a defined relationship with each other. The synthesis aims at defining this relationship to coherently describe the resulting system component. The relationships between the parameters can be established on the basis of mechanistic or other physical or chemical relationships, synchronization of timelines, logic or other relevant causalities.

If there are deviations from Plan, such as a lack of data on system components, the significance is estimated and corresponding measures are taken. Examples of corresponding measures could be to accept the lack or to make a rough estimate, both associated with an uncertainty measure.

6.3.5 Aggregate whole system

This is where the data analyses are formulated into a quantitative statement of the total studied system. The whole system is aggregated according to the objectives, as described in 6.2.1. The system components are aggregated according to the appropriate aggregation type implied by the requirements of the objective.

If there are deviations from Plan, such as lacking data on system components, the significance is estimated and corresponding measures are taken. Examples of corresponding measures could be to accept the lack or to make a rough estimate, both associated with an uncertainty measure. Depending on the magnitude of the significance, corresponding measures might not be sufficient. Instead, Plan may be corrected according to factual elements.

6.4 Check

6.4.1 General views

Check implies reviewing the documentation and the data produced during the process of acquiring and providing quantitative environmental information. This is closely related to reviewing the information itself. When this is the case, the term "review" will be used interchangeably with Check.

The Check stage is largely based on the availability of documentation from the Plan and Do stages. It is also strongly recommended that each step of the Check stage is well-documented. It is especially important that any review comments are documented, and that they address the related documentation from the Plan and Do stages. Annexes A and B provide some examples of how documentation might be performed for the Check stage.

Reviews to ensure that Plan and Do follow the same approach and methodology for each of the different conditions that are to be compared can be done at each task, or can cover several tasks throughout the work process. Such a review covers the planning (see 6.2, Plan) and the data acquisition, processing and provision (see 6.3, Do), as well as the monitoring, comparison and evaluation (see 6.4, Check).

The review of the Plan stage may check whether the specifications are correct with regards to the application. The review of the data acquisition, processing and provision stages may check whether the specifications defined in planning have been followed, and whether the results are reported correctly.

If the review results in a conclusion that the acquisition and provision of the information is performed in line with the specifications, then the quantitative environmental information can be provided in accordance with the objective. Otherwise, new planning might be needed.

Any quality assurance observations, including plausibility checks, can assist in the review of the overall quantitative environmental information acquisition and provision process. The improvement needs and potentials to be identified and implemented are both improvements of the methods and processes, and of the data and information as a result from iterations.

Performing a Check of quantitative environmental information is systematic and consecutive. It can be done in different ways.

6.4.2 Applying the framework for Check or review

6.4.2.1 Consecutive Check

The framework provides a structure of distinct steps for planning and doing data acquisition and compilation, where previous steps set requirements for the next steps. For example, the requirements of the objective set requirements for conceptualizing the whole system, which in turn sets the system boundary and conditions for the break down into system components, etc. Consistency can be checked between each step to safeguard that there are no gaps or inconsistencies in Plan, from the requirements of the objective to defining the measurement method, and that there are no gaps or inconsistencies in doing the practical work, from setting up the measurement method to finally compiling the quantitative environmental information.

If a consecutive Check is applied throughout a quantification procedure, it will be possible to stop the work to perform corrective measures before spending resources on incorrect data and decisions.

Hence, following the framework while providing and compiling quantitative environmental information supports consecutive Check during the Plan and Do stages.

6.4.2.2 Check or review of resulting quantitative information

The framework provides support for a quantitative Check and review of quantitative environmental reports, regardless of whether the quantitative environmental information was provided using the framework or not.

Each step of the framework provides a viewpoint and a clear scope for a reviewer. At the highest level, a reviewer can focus on whether the scope of the information meets the requirements of the objective. At the next level, a reviewer can focus on the breaking down of the system components and whether the system components are complete and there is no overlap. At the lower level, a reviewer can check whether the parameters completely match the requirements, that they are correctly defined, that they are not overlapping, and that they are correctly calculated. At lower levels, a reviewer can check the choice of basic data, statistics, data sources and measurement methods.

In addition, the framework might be used as a measurement for how deep a review or data check goes; whether it, for example, identifies individual basic data sources or stops at synthesized system components. However, by applying the framework recursively, as described in Figure 3, the framework also provides a structured approach to transparently review system components down to basic data.

The review can be substantially facilitated if the framework has been applied throughout the Plan and Do stages during the compilation of the quantitative environmental information.

6.4.3 Process

The review process can be done by different experts, at different stages of the work. When this is the case, the expert who will do the final review should ensure that the overall review process is consistent and answers the overall purpose of the review.

This document provides support for how to organize such a review by providing the different work items of data acquisition, their connections and subjects for documentation.

The data and the calculation process to set the data should be reviewed.

Examples of the process stage under Check can be found in Annex A and generally for the Check stage in Annex B.

6.5 Act

Based on the results from Check, necessary actions are taken to continually improve the acquisition and provision process.

The Act stage is largely based on the availability of documentation from the Check stage. It is also strongly recommended that the Act stage is well-documented, since it might function as a work specification for future Plan and Do stages.

An automated and combined Check and Act stage can be formed to provide suggestions for new or better measured parameters and sensors, and can also provide suggestions or control the overall environmental performance of the system.

Annexes A and B provide some examples of how documentation might be performed for Act.

Annex A
(informative)

Illustrative examples of the framework

A.1 Examples of data sources

The following are examples of primary and secondary data sources (see 6.1.2).

An example of a choice of a primary data source is fuel consumption that can be derived from economic data for fuel-bills or from fuel flow measurements.

An example of a choice of secondary data source is fuel consumption that can be derived from literature providing data about technical estimations of fuel consumption at different effect levels for that type of technology.

A.2 Examples of realizing the objective

A.2.1 General

This subclause provides general illustrative examples for the different stages of the realization of the framework objectives presented in 6.2 and 6.3. The examples are grouped in Plan-Do pairs at the same vertical level, as presented in the framework in Figure 2. This means that examples in 6.2.1 and 6.3.5 constitute the first pair, those in 6.2.2 and 6.3.4 constitute the second pair, etc., with the last pair being 6.2.5 and 6.3.1. The text gives examples of what type of information activity is planned and done at each level.

A.2.2 Conceptualize and aggregate whole system

This subclause gives examples of characteristics to consider when conceptualizing the whole system to acquire and provide quantitative information about it, as well as examples of characteristics to consider when eventually aggregating the whole system to provide quantitative information about it (see 6.2.1 and 6.3.5).

(6.2.1) For a public sustainability report, the yearly energy consumption for all heat treatment units is compiled, from gate to gate. The yearly energy consumption can be given both in terms of total energy, in megajoules, and sources of energy purchased, e.g. natural gas, electricity. The energy consumption data in the sustainability report is also used to follow up on performance tracking. The yearly energy consumption can be calculated by aggregating all heat treatment units and reported as MTCo2 per kWh or MTCo2 per unit of product. The publication format requires an average to be calculated for the heat treatment unit.

(6.2.1) Country level environmental information can be gathered by sector or other divisions and aggregated at the top and compared to GDP, or other criteria, in country and to other countries and benchmarks set for prevention and reduction as well as reporting internationally.

(6.3.5) The yearly energy use for all heat treatment units is aggregated by aggregating the electricity and aggregating the natural gas, from which the yearly average energy use is derived. This yearly average is expressed both in terms of electricity consumption and natural gas consumption separately, and in terms of total energy use in megajoules.

Examples of the target audience of the information are as follows:

- authorities;

- customers;
- environmental coordinators;
- third-party reviewers;
- product designers;
- investors and asset management entities.

Examples of the intended use of the information are as follows:

- internal reporting or decisions;
- reporting to authorities;
- market claims;
- knowledge build-up;
- environmental, social and governance (ESG) investments.

Examples of the object about which to provide information are as follows:

- quantitative properties of a system or a process, such as a production unit or a product life cycle;
- quantitative properties of specific species in an eco-frame;
- amounts or flows of substance, such as inputs and outputs;
- quantitative properties of an organization;
- sectorial average process;
- multi-media models for impact assessment;
- functional units or values;
- costs;
- eco-efficiency;
- product or service;
- temporal, sectorial and geographically averaged data.

Examples of system boundaries are as follows:

- organizational unit;
- production site;
- production process;
- product life cycle;
- product life cycle, from cradle to gate;

- waste water pipe.

Examples of specific quantitative requirements are as follows:

- describe and quantify a system:
  - quantification and location of hot-spots and significant aspects;
  - quantification of the total CO_2 emission for an organization;
  - quantification of a sectorial average process, including the specification of its significant inputs and outputs;
  - quantification of the different weights to the individual process data from different production units when forming a new sectorial production average;
  - quantification of a life cycle cradle-to-gate inventory profile including the life cycle cradle-to-gate flow chart with site-specific data for all constituting processes;
- compare different systems:
  - provide quantitative comparative information about systems A and B;
  - quantify how much better or worse environmental performance process A has in comparison to process B;
  - provide quantitative information about how many species are found in a studied eco-frame during a specific period;
  - provide quantitative information about whether the number of species in the studied eco-frame has decreased or increased compared to a previous period, as well as quantitative information about how many species there were in the two different periods;
  - provide quantification of an emission, a flow, a status or of any other quality.

Examples of requests for the general quality of the information are as follows:

- credibility requirements;
- review requirements;
- documentation needs;
- numerical precision;
- whether new data needs to be collected from physical measurements or whether generic data might be used;
- metrological traceability;
- accuracy.

Examples of aggregations leading to a quantitative result are as follows:

- temporal average: data about a process from different time intervals is aggregated into an average over a more general time interval;

- product category average: material content of different but similar products is aggregated into an average material content for a common product category.

Examples of aggregations leading to a categorical result are as follows, based on quantitative comparisons the result is:

- a qualitative preference stating which system is better;
- priority ranking of different environmental aspects.

Examples of quantitative system model aggregations are as follows:

- combined aggregations, where sectorial and temporal averaged data, and life cycle inventories based on temporal, sectorial and geographically averaged data, are used to model a whole system;
- to aggregate a full eco-frame, it can be necessary to combine different models of different media, such as air, water and soil, into a combined multi-media model;
- to quantify the eco-efficiency of a product or service, a quantitative value of the functional value of the product or service is divided with a quantification of the environmental external cost of the same product or system.

Examples of a new system model (several interrelated systems are aggregated into a new system) are as follows:

- life cycle inventory: different processes are linked through their inputs and outputs into a larger aggregated process;
- environmental multi-media model: different partial eco-system media models are linked into a combined multi-media model;
- sectorial average: data from different processes are aggregated within the same sector into an average for processes within the sector; department, company, etc. are aggregated into an organizational model.

Comparison, by subtraction or ratio, such as:

- eco-system change: the status of an eco-system is compared at two different time intervals by subtraction;
- eco-efficiency: the values gained by a system are compared with the external costs caused by the same system.

A.2.3 Break down system components and synthesize system components

This subclause gives examples of characteristics to consider when breaking down the data acquisition into manageable smaller tasks, and when combining the acquired data items into system components to aggregate (see 6.2.2 and 6.3.4).

(6.2.2) Identifying each specific heat treatment unit and clarifying their respective system boundaries.

(6.3.4) Reporting of energy use per year for a heat treatment unit. The inflow of natural gas is measured through data in the invoices. The electricity consumption is measured by an electric meter installed at the heat treatment unit. These two different measured data are synthesized into a system component of one year of operation in terms of electricity consumption for that year and natural gas consumption for the same year.

Examples relating to breaking down system components are as follows:

- to produce a consistent model of inputs and outputs for a production unit, data for different raw material purchases, electricity bills, waste management bills and production data need to be combined with laboratory data about emission releases and sales figures;
- to produce a consistent carbon footprint of the product model from cradle to gate, the carbon dioxide emissions and carbon dioxide equivalents from each process throughout the whole supply chain are connected into one chain that together constitutes the resulting system.

A.2.4 Select parameters and consolidate parameters

This subclause gives examples of characteristics to consider when selecting parameters to acquire data about each system component, as well as how to consolidate the acquired data into quantified parameters of the systems components (see 6.2.3 and 6.3.3).

(6.2.3) From an analysis of the economic bookkeeping, it is concluded that the major energy purchases are electricity and natural gas for all heat treatment units. Therefore, a decision is made to acquire data for the two parameters: electricity and natural gas.

(6.3.3) It was intended to obtain the previous month's electricity consumption, but measurement during the previous month failed, so it is decided to use the previous year's measurement for the same month as data source. An estimate of the error is made based on changes in production volume and other influencing parameters, e.g. outside temperature. The significance of this error is considered relevant. Therefore, a corrective value of plus or minus a certain percentage is applied.

(6.3.3) Transform cubic metres into normalized cubic metres.

Basic data typically originate from different data sources. Some are acquired as quantitative figures and units, such as the amount of a specific emission or the amounts of all inputs and outputs of one production process, while others come in forms that need to be consolidated to be meaningful and relevant. Examples of the latter are electricity bills that need to be reformulated as inflows of electricity, raw measurement log files that need to be transformed into numerical data, and data that is formed from combining different literature sources and databases.

This explanation can be in the form of reference to standard methods or literature. The methodology used can include the combination of several measurement results, or the selection of only a portion of the data collected, to obtain the intended parameter. Examples of this are the use of averaged data and discarding data falling outside a specified range of values.

a) Examples of the selection of parameters are as follows:

   1) when identifying environmentally significant parameters for a category of products, such as including nuclear waste and CO_2 emissions in the inventory of an electric hydro power plant, to make the quantitative result comparable with other ways to produce electric power;

   2) only greenhouse gas emissions are relevant when the application concerns GHG or carbon footprinting, while a full set of emissions is relevant to conduct LCA or emissions reporting;

   3) the total amount of hazardous waste relevant for official reports compared to the total amount of only waste oil;

   4) the total amount of heavy metals used in equipment compared to the total amount of cadmium;

   5) the total amount of construction and demolition waste that exceeds aggregates.

b) Examples of consolidation are as follows:

1) several alternative quantitative estimates about the emission from a specific type of furnace: assign different probability or relevance weights to each estimate and produce one weighted average as quantitative data for the emission;

2) several alternative quantitative system models describing resource use, emissions, waste generation and production from a type of industrial process: assign different probability or relevance weights to each system model, and maybe also to input and output data, and produce a new system model based on a complex weighted average of the basic data;

3) several bird-count reports from a specific geographic area: assign different situation-, site- and time-related weights to each bird-count report, and produce a combined quantitative data based on a weighted average, taking into account duplication in the geographic area and different activity levels in daylight and at night time.

c) Examples of detailed characteristics to consider during consolidation are as follows:

   1) calculations based on activity data multiplied by emission or removal factors, i.e.

      i) the use of models,

      ii) facility-specific correlations, and

      iii) mass balance approach;

   2) measurement, either

      i) continuous, or

      ii) intermittent;

   3) a combination of measurement and calculation.

A.2.5 Define and acquire basic data

A.2.5.1 General

This subclause gives examples of characteristics to consider when defining and acquiring basic data, both single basic data and data consisting of several interrelated data such as data about production units (see 6.2.4 and 6.3.2).

(6.2.4) The basic data needed is electricity consumption data. Electricity consumption data from different time periods will be combined into a consumption value of the whole year. Due to high fluctuations in electricity consumption, the highest possible sampling frequency needs to be used.

(6.3.2) The sampling values of the instantaneous electricity consumption are stored in a log file. The overall electricity consumption is calculated by integrating the sampling values over the time period of one year.

Examples of different types of data are shown in Tables A.1 to A.5.

Table A.1 — Examples of acquiring single value data

Object	Physical property	Scale of precision
Waste water pipe of a production plant	Mass flow of waste water	Sampled daily by flow meter at site

Mass flow of waste water in a waste water pipe of a production plant	Biochemical oxygen demand (BOD)	Sampled daily at site, measured according to a standard model in a sample of waste water
Production plant	Number of products produced	Estimate from market size
Chemical process	Amount of oxygen consumed	Estimate from economic records
Production plant	Amount of specific material consumed	Estimate from material flow analysis
A specific product	Mass of a specific material	Parts per million of total weight
Transport to and from production site	Amount of emission to air of a specific substance	Average, based on generally acknowledged and credible estimate
A certain equipment	Amount of electric energy consumed	Based on marked effect and estimated use
A specific lake	Concentration of heavy metal in water	Based on measurements and reported as a representative yearly time series
General urban area	Mass per m^2 of dust fall	Based on distribution models A flat average within the 90th percentile
Section of railway in domestic area	LEQ of noise at a specific point of distance from the sound source	Based on actual measurements from typical trains passing
Drainage pipe from waste landfill	Throughput of liquid per second	To be measured at one minute each day between 11:59 and 12:00 every day and averaged into yearly throughput
Forest area	Number of woody stemmed plants greater than 2 m in height per unit area	Manually counted within ±10 cm using benchmark stick at randomly selected and statistically significant number of samples of size 100 m × 100 m areas within the forest area
Forest area	Number of ant species	Manually counted through field studies by insect specialist
Company car pool	Amount of fuel consumed in car pool	Estimated from registered fuel efficiency and distances run of each car in pool

Table A.2 — Examples of modular data

Object	Physical property	Scale of precision
A specific production site	All environmentally significant inputs and outputs	Precision of each input and output based on single measured values
A specific type of processes	All environmentally significant inputs and outputs	Precision based on single measured values at production sites and averaged to type process value

Table A.3 — Examples of technological data

Object	Physical property	Scale of precision
Activity data	Resource use, emissions, waste, spill and products	Site-specific measurement during specified time interval
Production data	Raw material and electricity consumption, spill, waste and production	Continuous measurement at site

Geographical data	Position, altitude and area	GPS and altimeter logging
Emission data	Concentration of pollutant	Precision of laboratory analytical method

Table A.4 — Examples of ecological data

Object	Physical property	Scale of precision
Biodiversity data	Species and number of individuals of each species	Species identification with reference to a standard sample and counts of species within a defined transect line and area of measurement
Habitat data	Number of inhabitants in habitat	Average for selected species
Nutrient data	Concentration of nitrate, nitrite, phosphate	Precision of laboratory analytical method
Biological data	Biochemical oxygen demand (BOD)	Sampled daily at site, measured according to a standard model in a sample of waste water

Table A.5 — Examples of socio-economic data

Object	Physical property	Scale of precision
Demographic data	Share of different demographic populations	Statistical sample interviews
Health data	Infant mortality rate	National statistics
Development status data	Share of adult population who can read and write	Estimations
Economic data	GDP growth	Trade statistics

Examples of deviations to Plan that might occur when acquiring basic data are as follows:

— automatic logging might fail, resulting in parts of time series being missing;

— measurement instruments might be prone to reading difficulties; hence, the value might be biased;

— time-stamps of economic records, such as delivery date, invoice or payment, might not be synchronized with physical time;

— it might be difficult to interpret representativeness of data from life cycle inventory databases, partly due to the complexity of the data and partly due to the quality of the documentation of the data;

— it might be difficult to interpret representativeness and accuracy of data produced by calculation models and software, partly due to the complexity and documentation of the calculation models and software code, and partly due to the accuracy level of the input parameters to the model or software;

— consulted experts might supply typical basic data and typical deviations, but such data might not reflect the actual situation;

— acquisition is not according to the specified precision or the statistical requirements.

A.2.5.2 Identify and set up measuring methods

The following examples relate to 6.2.5 and 6.3.1.

a) Environmental inventory of a manufacturing plant: To define the electric consumption for one unit of product, the quantitative data for electric consumption of one manufacturing machine is related to the number of units produced during the same time period that the consumption is measured. The same applies to all data about resources, emissions and waste figures. All quantitative data are related on basis of temporal synchronization and physical relationships.

b) Environmental inventory of an organizational unit: The principle for performing an environmental inventory of an organization differs from the environmental inventory of a manufacturing by the importance of economic and organizational causalities rather than physical causalities.

c) Process data for use in a life cycle assessment study: Normalize all input and output data to a unit of a product provided by the process. If all or some of the input and output data also relates to production of other products, allocate the input and output data according to defined allocation rule.

d) An eco-system: Describe how measurement data are used to describe load, concentration increase and environmental sensitivity of an eco-system.

e) Environmental life cycle performance per yearly production volume 2007.

f) Carbon footprint of products in business area 2008.

g) Environmental performance on selected impact categories from a specific product or function.

(6.2.5) Identifying the measuring points where the electric meters need to be installed at each heat treatment unit. The meters can be equipped with a logging function connected to a database for the log-file.

(6.3.1) A high frequency logging electricity meter is installed on a cable feeding only the production unit studied. The logging data are stored in a database, with electricity consumption logged every half second, each log value supplied with a data and a time stamp.

(6.3.1) A meter measuring a certain contaminant needed to be moved a certain distance downstream from its intended position. As a result, the probe measures a lower concentration than intended of the contaminant due to dilution. A correction value is introduced to transform measured concentration to actual concentration at the intended measurement point.

A.2.5.3 Check examples

A.2.5.3.1 General

This subclause gives examples related to 6.4 as well as to 6.4.1 and 6.4.3.

Example of a data acquisition review: How the extrapolation of a data has been done to yearly data, Check of the orders of magnitude.

Example of a data processing review: Check of the implementation of data in the processing tool, Check of the default values implemented in the tool and used for processing, Check of the way the processing tool is handling all the data, including which modelling is used.

Example of a correct reporting review: Check of consistency between the results of the calculations of the processing tool and the results in the report, including the metrics, values and units.

A.2.5.3.2 Process

Example of a review of the tools: Check of the default values implemented in the tool and used for processing, Check of the way the processing tool is handling all the data, including which modelling is used.

Example of an application of the tools: Which goal of an LCA study can be fulfilled with the tool, including eco-design or EPD making, which carbon footprint (organization or product) can be calculated with the tool.

Example of a review of each punctual use: Check of the data that have been gathered to be implemented in the tool, Check of the implementation of these data in the processing tool, Check of consistency between the results of the calculations of the processing tool and the results in the report, including metrics, values and units.

Annex B
(informative)

General simple examples

B.1 General

Quantitative environmental information can be communicated through several report types, which have divergent approaches when considering characteristics such as system boundaries, data sources, the intended use of quantitative environmental information or the gathering data and calculation process. To provide some examples, three main kinds of reports are considered: corporate reports, standardized reports and ad hoc reports.

Table B.1 shows the main features of each report type for the above-mentioned characteristics.

See Annex C for sector-specific examples.

Table B.1 — Main features of different report types

Report type	System boundaries	Continuity in time	Data sources	Intended use	Gathering data and calculation process
Corporate reports: — sustainability report — environmental report — environmental accounting	Whole reporting organization, at different levels: — local — regional — global	Continuous	Measurement systems Laboratory tests Delivery notes Invoices	Internal and external use	Statistical methods on measurement series Calculation Appliance of conversion factors
Standardized reports: — EPD — eco-labelling — LCA — MSDS	Product	Timeless	External database Supply chain	External use	Established methodology
Ad hoc reports:					

— flexible locations — temporary sites — others	Site and its environment Reporting organization, as an aggregation of sites	Not continuous Temporary	Measurement systems Estimates Expert testimony; literature data Monitoring	Internal and external use	Statistical methods on historical data series Data gap adjustments with average values Appliance of conversion factors

B.2 A simple example

B.2.1 Description

The intention of this simple example is to provide realistic concepts addressed at each stage during Plan, Do, Check and Act to meet the requirements of an objective for environmental information.

B.2.2 Requirements of the objective

The production management of a processing industry will start compiling a report about the energy use for the total production plant, within its physical gates, including internal transports. The report is intended for the continuous increase of energy efficiency, counted per number of units shipped and per economic value produced within the gates of the production plant. The report should make it possible to distinguish different units, such as the production departments, the production steps where most energy is provided to or drawn from the processes or the treated material. Since all information is intended to be used for production analysis and improvement decisions, it is important that all data are acquired by repeatable methods from within the production plant, and that they are not modelled from any literature sources.

NOTE 1 This first report is based on a yearly average as of the previous year's January to December.

NOTE 2 Calculating the number of units shipped and the economic value produced is not within the scope of this reporting system.

B.2.3 Plan

Plan is based on a generic objective requesting energy use of a production system.

Table B.2 provides a simple example of Plan.

Table B.2 — A simple example of Plan

Decisions when planning system quantification	Simple example of Plan
6.2.1, Conceptualize whole system	Acquire or draw a total map of the production plant within the gates.

6.2.2, Break down system components	Based on the total map of the production plant, decide on a suitable division of the production plant into several interlinked subsystems. Document it using, for example, a map and explanatory text. Some production units might be used for several different subsystems, such as an air compressor or a high voltage electric feeder transformer. Decide and document how to allocate its total energy use onto the different subsystems. Allocations are usually expressed as mathematical relationships. Document those relationships clearly. For each interlinked subsystem, consider whether it is easier to apply Plan to divide it further (see Figure 3). Use the same overall requirements of the objective, except that they should only be applicable to the smaller subsystem.
6.2.3, Select parameters	With aid of the system break down, document which types of energy parameters to report to meet the requirements of the objective. — Electric power used, in kWh. — Net district heat, in kWh: — used district heat, in kWh; — produced district heat, in kWh.
	— Available heat energy lost by unattended cooling. — Amount of diesel used by the fork lifters, in kWh.
6.2.4, Define basic data	For each parameter, document how basic data should be acquired to calculate the parameter. — Electric power used, in kWh: — acquire basic data from the effect meters; if necessary, complement measurements at specific equipment. — Net district heat, in kWh: — used district heat, in kWh: — acquire basic data from the energy meters; — produced district heat, in kWh: — acquire basic data from the energy meters. — Available heat energy lost by unattended cooling: — calculate from mass, heat capacity and the difference between the start and end temperatures. — Amount of diesel used by the fork lifters, in kWh: — from previous years, acquire volume metering data for the in-site diesel tank, make estimations of the remaining amounts in the fork lifts or in the tank.
6.2.5, Identify measuring methods	For each basic data, address where it should be acquired. — Electric power used, in kWh:

	— document the exact location of the electric meters; — document where and when any complementary measurements should be made. — Net district heat, in kWh: — used district heat, in kWh: — document the exact location of the energy meter(s); — produced district heat, in kWh: — document the exact location of the energy meter(s). — Available heat energy lost by unattended cooling: — document where to acquire data about material mass and heat capacity for the material; — document how to acquire data about start and end temperatures. — Amount of diesel used by the fork lifters, in kWh: — document where to get the data for the volume meter for the in-site diesel tank; also, provide a document about how to estimate the remaining amounts of diesel in the tank and in the fork lifters.

B.2.4 Do

The Do phase is directly related to Plan. If everything is made exactly and unambiguously according to Plan, no notes or explanations are needed.

Table B.3 provides a simple example of Do.

Table B.3 — A simple example of Do

Activities when quantifying system	Simple example of Do
6.3.1, Set up measuring methods	For each parameter, define how data should be acquired. — Electric power used, in kWh: — document if there were any deviations or additional significant details in relation to Plan, such as if new meters had to be installed, or if some were measuring supply to unplanned equipment or subsystems; — document where and when all complementary measurements are made. — Net district heat, in kWh: — used district heat, in kWh: — document if there were any deviations or additional significant details in relation to Plan; — produced district heat, in kWh: — document if there were any deviations or additional significant details in relation to Plan; — Available heat energy lost by unattended cooling: — for heat capacity and start and end temperatures, document if there were any deviations or additional significant details in relation to Plan. — Amount of diesel used by the fork lifters, in kWh: — document where to get the data for the volume meter for the in-site diesel tank; also, provide a document about how to estimate the remaining amounts of diesel in the tank and in the fork lifters. Since this is year one, be as specific as possible, so that next year it will be easier.
6.3.2, Acquire basic data	Data are acquired from the above-mentioned measuring methods. Clearly to document significant characteristics, such as data gaps, the removal of outliers or the basis or reasons for estimations.
6.3.3, Consolidate parameters	Document how basic data are consolidated into parameter data. — Electric power used, in kWh: — document in detail the following: — from meter values, sum a yearly total; — allocate total sum onto different equipment and subsystems; — summarize all electricity use per subsystem. — Net district heat, in kWh:

	— used district heat, in kWh: — from meter values, sum a yearly total; — allocate total sum onto different equipment and subsystems; — summarize all district heat use per subsystem; — produced district heat, in kWh: — from meter values, sum a yearly total; — allocate total sum onto different equipment and subsystems; — summarize all district heat use per subsystem; — subtract total district heat generation from total district heat use. — Available heat energy lost by unattended cooling:
	— calculate total amount of cooled mass based on the number of units and weight per unit; — calculate the total amount of heat from relevant cooling models, applying relevant heat capacity data, temperature difference and mass; — summarize the total amount of cooling energy lost from each cooling subsystem; avoid double counting any heat energy provided to district heat net. — Amount of diesel used by the fork lifters, in kWh: — summarize all diesel purchases made during the year; correct for the original remainder in the on-site diesel tank before the 1st January first purchase and what was left in the tank at 31st July; if estimations are necessary, document those; estimate that fork lifters have same amount left in their tanks; — recalculate the volume of diesel into kWh.
6.3.4, Synthesize system components	Summarize for each subsystem the total electricity use, the net district heat use and the available heat lost due to unattended cooling, as well as the amount of diesel used by fork lifters. Make sure that energy use is either measured directly to each subsystem, or apply the allocations decided during the break down of system components (see 6.2.2).
6.3.5, Aggregate whole system	For the total production plant, summarize the total electricity use, the net district heat use and the available heat lost due to unattended cooling, as well as the amount of diesel used by fork lifters.

B.2.5 Check

Check of this simple example means to thoroughly compare the following items.

- Does the compilation of the energy data meet the requirements of the objective?
- Is the total production plant included with the scope?
- Are all relevant subsystems included, and are all overlaps and double counting avoided?

- Are all relevant parameters included and are they correctly calculated from basic data?
- Are all relevant basic data acceptable from the viewpoint of the requirements of the objective?
- Are the data sources well-chosen, identifiable and repeatable, in line with the requirements of the objective?

B.2.6 Act

Act of this simple example means to thoroughly go through the results from Check to consider whether new plans are needed for the next year reporting.

Annex C
(informative)

Sector-specific case studies

C.1 Data sources example for quantitative environmental information in the construction sector

The following examples show a way to collect and process quantitative environmental information in the construction sector in two different contexts: a single work site (in Table C.1) and a whole company (in Table C.2). These examples could follow the same pattern and encounter common issues, but to provide a more complete picture for this case, two examples in different contexts with different issues are provided.

Table C.1 — Single work site

Activities	Example actions
PLAN	
6.2.1, Conceptualize whole system	In this example, the work site is the system for which environmental data is collected.
6.2.2, Break down system components	The main components of the selected system are identified. They will be analysed later. They can be as detailed as needed. — Atmosphere: — dust emissions; — fuel gas emissions; — volatile organic compounds (VOCs) and chlorofluorocarbon (CFCs) emissions; — night light. — Noise and vibrations: — noise; — vibrations. — Effluent discharges. — Occupation of rivers or sea beds and water abstraction. — Occupation, pollution or loss of soils. — **Use of natural resources** (further explored in step 6.2.3): — water consumption;

	— fuel consumption; — electric energy consumption; — concrete consumption; — asphalt agglomerate consumption;
	— steel consumption; — earth consumption; — vegetal soil consumption; — dangerous substances storage and handling. — **Waste generation** (further explored in step 6.2.3): — generation of hazardous waste; — generation of non-hazardous waste; — generation of inert waste; — generation of municipal waste. — Radiation emissions: — land planning and urban environment planning. For this example, the system components marked above in bold are used.
6.2.3, Select parameters	For the two system components selected from those mentioned above, several parameters can be identified. — Use of natural resources: — re-use of aggregates from other work sites; — use of recoverable elements in site processes, e.g. removable walls in aggregates crushing installations; — **re-use of waste and residual waters from processes** (P1, further explored in step 6.2.4); — re-use of removed topsoil; — usage of elements recovered from other projects, e.g. portable water treatment plants, containers. — Waste generation:

	— reduction of aggregates taken to the tip compared with the forecasted volume in the project; — classifications/separation of waste from building and demolition for individual handling; — changes in the design or in the building system with regard to the use of materials that generate dangerous waste (e.g. asbestos, de-coffering liquids, additives, resins, varnishes, paints) or that generate waste of less or no danger; — reduction of packaging waste through practices such as requesting materials with packaging that is returnable to the supplier, re-use of polluted packaging and receiving elements in bulk that are normally provided in packages; — **management of waste from excavation** (P2, further explored in step 6.2.4); — valuation of rubble. For this example, the parameters selected for each system component are marked above in bold. These parameters quantify preventive environmental measures implemented on site.
6.2.4, Define basic data	To calculate the selected parameters, some data has to be defined, for example, as follows. — P1: Re-use of waste and residual waters from processes: — cubic metres displayed on flow meters (the amount of residual waters that pass through the pipe), expressed in units of volume. — P2: Management of waste from excavation: — waste in the work site, expressed in tonnes and cubic metres (units of volume, cubic metres or units of mass), for each possible destination, e.g. reuse on site or on other work sites, recovery, landfill.
6.2.5, Identify measuring methods	After clarifying the needed information to collect, the methods to obtain this data are identified. — P1: Re-use of waste and residual waters from processes: — the method to obtain the basic data for this parameter is the displayed data of the flow meters distributed in different locations of the work site; — the type of flow meter installed is taken into account, considering two types: cumulative flow meter (displays the total amount of water) and instantaneous flow meter (displays the amount of water at each moment). — P2: Management of waste from excavation: — to measure the amount of waste from excavation, in cubic metres or tonnes, different methods can be applied, such as:

	— delivery notes and invoices from carriers or waste managers, or the number of trucks transporting the waste and the freight capacity; this method gives cubic metres or tonnes; — estimations and measurements of the waste volumes by technical experts on site (topographer, surveyor or engineer, etc.); this method gives cubic metres.
DO	
6.3.1, Set up measuring methods	— P1: Re-use of waste and residual waters from processes: — install, calibrate and verify flow meters. — P2: Management of waste from excavation: — person to count the trucks, ask for delivery notes or make estimations once a week.
6.3.2, Acquire basic data	— P1: Re-use of waste and residual waters from processes: — auto-read flow meters every 5 min (instantaneous flow meter) or daily, weekly, monthly (cumulative flow meter). — P2: Management of waste from excavation: — read delivery notes, invoices and expert's reports.
6.3.3, Consolidate parameters	— P1: Re-use of waste and residual waters from processes: — calculate the percentage of residual waters that are reused from the process. — P2: Management of waste from excavation: — calculate the percentage of waste from excavation that is transferred to the different destinations.
6.3.4, Synthesize system components	The synthesis of the results can be made, for example, by assigning two coefficients to each parameter (importance and degree of implementation). The coefficients can be assigned based on experts' suggestions, bibliography, work site experiences, etc. The product of these coefficients gives a score. The total addition of the products of the two numbers in each parameter is the total score for the work site. The coefficients 1, 2 or 3 can, for example, be assigned to the importance and degree of implementation. — P1: Characterized by the importance and degree of implementation depending on the percentage of residual waters reused from the process (> 15 %, > 30 % or > 60 %);

Identification	**Importance**	**Goal (degree of adoption)**		
		1	**2**	**3**
Re-use of waste and residual waters from processes	2	> 15 %	> 30 %	> 60 %

- P2: Characterized by the importance and degree of implementation depending on the percentage of waste from excavation that is used on another site or for restoration of a degraded area (> 1 %, > 30 % or > 50 %).

Identification	Importance	Goal (degree of adoption)		
		1	2	3
Management of waste from excavation	2	> 1 %	> 30 %	> 50 %

Depending on the degree of adoption, which is calculated based on the acquired basic data, the product of the coefficients can be calculated. This provides a result for the system component.

6.3.5, Aggregate whole system	**Effluent discharges**: Percentages, importance, degree of implementation and the result of the product between the importance and the degree of implementation. **Waste generation:** Percentages, importance, degree of implementation and the result of the product between the importance and the degree of implementation.

CHECK

Data accuracy should be ensured by a system of site support visits, internal and external audits and by the quality checks to which the data are subjected, first at the site and subsequently at the various stages of data integration.

The technical review of the inventory of environmental data is carried out at the following levels:

- on site: checking lists, measurements, inspections and follow-ups;
- regional offices: reviews made in the site support visits;
- technical services: internal audits;
- external verifier to the organization: external audits.

If environmental data are gathered at site level, the reviews performed by staff of the company regional offices, technical services and verifiers can be considered external to the site, whereas if the data are processed at corporate level, only the review involving verifiers is external to the organization.

ACT

The results of the different checks and reviews are fed back to the data suppliers on site, aiming to correct and improve the quality of the data and methods used in acquiring and providing the environmental information.

Table C.2 — Whole company

Activities	Example actions
PLAN	
6.2.1, Conceptualize whole system	In this example, the whole company is chosen as the system to be considered.
6.2.2, Break down system components	The main system components are identified so that the activity of the whole company can be classified and later analysed. Different types of construction works could be considered: — dams; — bridges; — **roads** (further explored in step 6.2.3); — railways; — pipelines; — sewerage systems. Each of these construction works could consider different environmental issues, such as atmosphere, noise and vibration, use of natural resources, occupation, pollution or loss of soils and generation of waste. For this example, "roads" is chosen, specifically “noise and vibration” and “occupation, pollution or loss of soils in the construction stage of a road”.
6.2.3, Select parameters	Now that the system component "roads" has been selected for this example, the following parameters can be considered. — Noise and vibration: — **use of devices to reduce noise and vibration in installations or machinery on the site, with silencers, anti-noise barriers, shock absorbers, etc.,** (P3, further explored in step 6.2.4); — rubber lining in hoppers, mills, sieves, containers and buckets; — consideration of environment conditions in the work programme; — reduction of the effects of blasting; — improvement over the levels required by law for controlled sound levels; — use of modern machinery. — Occupation, pollution or loss of soils: — restoration of the areas affected by site installations; — limitation of the areas of access; — **limitation of occupied areas** (P4, further explored in step 6.2.4); — prevention of accidental tipping.

	A list of parameters based on environmental good practices can be defined for the system components. These parameters quantify preventive environmental measures implemented on site. The parameters selected for each system component are P3 and P4 (marked above in bold). These parameters can be evaluated on the basis of two coefficients: the importance of the good practice and its degree of implementation. The product of these coefficients yields a score that can be considered a value of the site's environmental performance. The data needed to obtain the final indexes might be, at first, mostly estimates falling within a reasonable range, provided by technical staff in charge of the acquisition of environmental data or by experts' opinion. During the site life, these estimates are permanently verified, checked and adjusted.
6.2.4, Define basic data	To calculate the selected parameters for all the roads of the company, some data from each work site has to be defined. These data could be as follows. — P3: Use of devices to reduce noise and vibration in installations or machinery on the site, with silencers, anti-noise barriers, shock absorbers, etc.: — number of installations (shock absorbers, anti-noise barriers, etc.); — number of machines with silencers or other devices installed; — number of days when work site is active during the night. — P4: Limitation of occupied areas: — written or graphical documentation of the areas occupied for different uses at the different work sites, aggregated by concepts such as machinery, personnel offices and stocks; — signals and physical delimitations installed.
6.2.5, Identify measuring methods	— P3: Use of devices to reduce noise and vibration in installations or machinery on the site, with silencers, anti-noise barriers, shock absorbers, etc. In the work site, there should be a report with the information about the equipment used and whether it has special devices installed to reduce the noise and the vibrations (silencers, shock absorbers, etc.). In addition to this, it should be known what equipment is working at all times. With this information, the work site manager or experts can fill out the surveys. — P4: Limitation of occupied areas. The design of the work site, maps, signals, physical barriers installed, etc. should be known. With this information, the work site manager or experts can fill out the surveys. There should be written or graphical documentation about areas that could be occupied by machinery and/or personnel, the existence of physical delimitations or signposting in the occupied areas, and information about whether the occupied areas are limited strictly to the area occupied by the work site. The quantity of measures adopted to avoid or prevent the unnecessary occupation of soils can also be considered. With this information, the work site manager or experts can fill out the surveys.
DO	
	— P3: Use of devices to reduce noise and vibration in installations or machinery on the site, with silencers, anti-noise barriers, shock absorbers, etc.;

6.3.1, Set up measuring methods	— programme the surveys software; — check the computers and the server for receiving the surveys. — P4: Limitation of occupied areas: — programme the surveys software; — check the computers and the server for receiving the surveys.
6.3.2, Acquire basic data	— P3: Use of devices to reduce noise and vibration in installations or machinery on the site, with silencers, anti-noise barriers, shock absorbers, etc.: — fill out the survey every four months. — P4: Limitation of occupied areas: — fill out the survey every four months.
6.3.3, Consolidate parameters	— P3: Use of devices to reduce noise and vibration in installations or machinery on the site, with silencers, anti-noise barriers, shock absorbers, etc.: — calculate the percentage of equipment with devices installed to reduce noise and vibrations; — calculate the number of days on which the work site has been active during the night. — P4: Limitation of occupied areas.
	— gather information about occupied areas, signalization and the physical delimitation of the areas.
6.3.4, Synthesize system components	The aggregation of the results of each work site into a global result for the whole company can be made, for example, by assigning two coefficients to each parameter (importance and degree of implementation). The coefficients can be assigned based on experts' suggestions, bibliography, work site experiences, etc. The product of these coefficients gives a score. The average of the product of these two numbers in each work site is the total score. The coefficients 1, 2 or 3 can, for example, be assigned to importance and degree of implementation. — P3: Characterized by the importance and the degree of implementation, depending on the percentage of critical equipment with anti-noise and anti-vibrations devices installed and the equipment used during the night.

Identification	Importance	Goal (degree of adoption)		
		1	2	3
Use of devices to reduce noise and vibration in installations or machinery on the site, with silencers, anti-noise barriers, shock absorbers, etc.	3	Presence of these devices in some equipment that is considered critical	As before, in 50 % of the equipment considered critical and in 50 % of that used at night	As before, in 100 % of both critical equipment and that used at night

<table>
<tr><td></td><td>— P4: Characterized by the importance and the degree of implementation, depending on the delimited area (physical or not) and signposting.
<table>
<tr><th rowspan="2">Identification</th><th rowspan="2">Importance</th><th colspan="3">Goal (degree of adoption)</th></tr>
<tr><th>1</th><th>2</th><th>3</th></tr>
<tr><td>Limitation of occupied areas</td><td>1</td><td>There is written/graphical documentation of the areas that can be occupied by machinery and personnel</td><td>In addition, there is physical delimitation or signposting of these areas</td><td>In addition, these areas are limited to the area occupied by the site</td></tr>
</table>
Depending on the degree of adoption, which is calculated based on the acquired basic data, the product of the coefficients can be calculated. This provides a result for the system component.</td></tr>
<tr><td>6.3.5, Aggregate whole system</td><td>Noise and vibration: Percentage of equipment with anti-noise and anti-vibration devices installed, number of days with activity during the night, importance, degree of implementation and the result of the product between the importance and the degree of implementation.
Occupation, pollution or loss of soils: Information of the limited areas, its limitation and signalization, importance, degree of implementation and the result of the product between the importance and the degree of implementation.</td></tr>
<tr><th colspan="2">CHECK</th></tr>
<tr><td colspan="2">Information regarding Check is not available for this example.</td></tr>
<tr><th colspan="2">ACT</th></tr>
<tr><td colspan="2">Information regarding Act is not available for this example.</td></tr>
</table>

C.2 Limited/simplified example of environmental accounting system implementation

The example in Table C.3 shows a simplified example of environmental accounting system implementation at a heating and power company, using software-based data gathering and accounting tools. The numbers, including factors used, are not real values.

Table C.3 — Simplified example of environmental accounting system implementation

Activities	Example actions
PLAN	
	Objective:

6.2.1, Conceptualize whole system	— accounting of climate and energy characteristics for energy production company in Hafslund, Norway. Target: — find air emissions per produced energy (mass/energy). System boundary: — energy production, business area only; — yearly from 2008 onwards; — quarterly from 2010. Intended use: — continual monitoring of performance; — internal and external reporting.
6.2.2, Break down system components	Organization: — level 1: Hafslund Group; — level 2: business area; — level 3: company; — level 4: site. Activities: — heat production; — cooling production; — pellet production; — combined heat and power production.
	Hydro power production: — sources; — bio oil, biomass (wood chips), pellets; — electricity; — heating oil, LNG, propane; — municipal waste, commercial waste.
6.2.3, Select parameters	Activity/input: — total fuel(s) used (in tonnes of crude oil equivalent); — total fuel(s) from renewable sources (in megawatt-hours). Climate gases:

	— CO_2e (equivalents). Other air pollutants: — NO_x (in tonnes); — dust (in kilogrammes); — SO_x (in tonnes). Production parameters: — total produced energy (in megawatt-hours). Other parameters: — total efficiency (# 0–1).
6.2.4, Define basic data	Parameter inputs: — fuel oil (in litres); — bio oil (in litres); — electricity (in megawatt-hours); — commercial waste (in tonnes); — biomass (in kilogrammes); — used energy from seawater/sewage (in megawatt-hours). Factors: — energy contents (in kilowatt-hours per litre); — renewable shares (#); — CO_2 emission factors (in tonnes per unit); — NO_2 emission factors (in tonnes per unit); — dust emission factor (in kilogrammes per unit); — SO_2 emission factor (in kilogrammes per unit). Constants: — densities (in kilogrammes per litre).
	Parameter inputs:

<table>
<tr><td>6.2.5, Identify measuring methods</td><td>— production databases;
— oil flow (in meters);
— biomass weighing (in meters);
— energy from heat pump (in meters);
— energy management system;
— electricity bills.

Factors:
— from reliable public sources (documented for each factor in portal accounting system);
— energy contents from regular laboratory analyses and/or vendor specification.</td></tr>
<tr><td colspan="2">DO</td></tr>
<tr><td>6.3.1, Set up measuring methods</td><td>All measuring equipment already set up.</td></tr>
<tr><td>6.3.2, Acquire basic data</td><td>Parameter raw data acquired from production system outputs for whole year, for example:
<table>
<tr><th>Site</th><th>Heat
MWh</th><th>Wood chips
t</th><th>Electricity
MWh</th><th>Oil
l</th></tr>
<tr><td>Site 1</td><td>6 004</td><td>2 052</td><td>8 957</td><td>506 587</td></tr>
<tr><td>Site 2</td><td>0</td><td>0</td><td>7 906</td><td>68 581</td></tr>
</table>
Data input into software solution (distributed input from each site):
Input data gathered for whole year:
— combusted wood chips: 2 052 t;
— energy content: 3,50 MWh/t;
— total heat production: 6 004 MWh.

Factor read from factor library:
— CO_2 factor word chips: 13 kg/MWh;
— NO_x factor wood chips: 0,5 kg/MWh.</td></tr>
<tr><td>6.3.3, Consolidate parameters</td><td>Consolidation of parameters by models in environmental accounting software:
Energy consumed (chips):
— combusted wood chips (in tonnes) × energy content wood chips (in megawatt-hours per tonne) = combusted wood chips (energy) (in megawatt-hours).

Renewable amount consumed:</td></tr>
</table>

<table>
<tr><td></td><td>
— combusted wood chips (energy) (in megawatt-hours) × renewable share - wood chips [#] = renewable flow - combusted wood chips (in megawatt-hours).

Produced renewable energy (chips):
— total heat production (in megawatt-hours) × renewable share - wood chips [#] = heat production from renewable sources (in megawatt-hours).

CO_2 emissions from heat production (wood chips):
— combusted wood chips (energy) (in megawatt-hours) × CO_2 factor chips (in kilogrammes per megawatt-hour)/1 000 = CO_2 (in tonnes).
</td></tr>
<tr><td></td><td>
NO_x emissions from heat production (wood chips):
— combusted wood chips (energy) (in megawatt-hours) × NO_x factor chips/pellets (in kilogrammes per megawatt-hour)/1 000 = NO_x (in tonnes).
</td></tr>
<tr><td>6.3.4, Synthesize system components</td><td>
Data tagged to organization [levels 1, 2, X, activity, scope (GHG), recipient and source of emission]:
<table>
<tr><th>Level 3</th><th>Measuring point</th><th>Parameter</th><th>Scope</th><th>Value</th></tr>
<tr><td>Haraldrud</td><td>Wood chip boiler</td><td>CO_2</td><td>1</td><td>6 121 t</td></tr>
<tr><td>Haraldrud</td><td>Electric boiler</td><td>CO_2</td><td>2</td><td>6 858 t</td></tr>
<tr><td>Haraldrud</td><td>Waste boiler</td><td>CO_2</td><td>1</td><td>17 166 t</td></tr>
</table>
</td></tr>
<tr><td>6.3.5, Aggregate whole system</td><td>
Examples of the aggregated use of data:
— total sum of CO_2 for Hafslund;
— compare total CO_2 per company;
— compare CO_2 year by year.
</td></tr>
<tr><th colspan="2">CHECK</th></tr>
<tr><td colspan="2">Information regarding Check is not available for this example.</td></tr>
<tr><th colspan="2">ACT</th></tr>
<tr><td colspan="2">Information regarding Act is not available for this example.</td></tr>
</table>

C.3 Data sources example for quantitative environmental information when performing a life cycle analysis

The example in Table C.4 shows a way to collect and process quantitative environmental information within the construction sector, with the scope and viewpoint of the construction company.

Table C.4 — Data sources for quantitative environmental information when performing a life cycle analysis

Activities	Example actions
PLAN	

6.2.1, Conceptualize whole system	A life cycle inventory with verifiable electricity mix as background data.
6.2.2, Break down system components	Identify where the different production and transports steps occur to identify which electricity mixes to use and how to calculate the electricity mixes.
6.2.3, Select parameters	Decide on types of electricity production to include in the different mixes and which data categories to include.
6.2.4, Define basic data	Define precision and credibility requirements.
6.2.5, Identify measuring methods	Identify and select databases and literature from which to acquire data about electricity production and grid mixes.
DO	
6.3.1, Set up measuring methods	Acquire data about electricity production and electricity mixes from the selected databases.
6.3.2, Acquire basic data	Assess fulfilment of precision and credibility requirements of all data.
6.3.3, Consolidate parameters	Compile data into specific electricity production and electricity mix. Combine data from different sources where necessary.
6.3.4, Synthesize system components	Include the electricity mix unit processes into the life cycle inventory data collection.
6.3.5, Aggregate whole system	Perform the normalization and the aggregation of the product system and establish its life cycle inventory profile.

C.4 Data sources example for quantitative environmental information in the oil industry — On-shore oil exploration and production (E&P)

The following examples show a way to collect and process quantitative environmental information in the oil industry in the exploration and production (E&P) sector, particularly on-shore operations in two different contexts: a single oilfield, including oil wells, oil gathering station facility and a water injection system for secondary recovery (see Table C.5) and an E&P business unit at an oil company (see Table C.6).

Table C.5 — On-shore typical oilfield operation

Activities	Example actions
PLAN	
6.2.1, Conceptualize whole system	Considering the whole system, the typical on-shore oilfield operation for which environmental data are going to be collected in this example includes oil wells, oil gathering station facility and a water injection system for secondary recovery.
6.2.2, Break down system components	At this step, the concepts of the selected system are identified. These are the main components and will be analysed later. They can be as detailed as needed. Atmosphere: — flaring gas emissions; — fugitive emissions; — fuel gas emissions; — H2S emissions.

	Effluent discharges. Occupation, pollution or loss of soils. **Use of natural resources** (further explored in step 6.2.3): — water consumption; — earth consumption. Waste generation: — generation of hazardous waste; — generation of non-hazardous waste; — generation of municipal waste; **Energy use** (further explored in step 6.2.3): — natural gas consumption; — electric energy consumption.

6.2.3, Select parameters	The next step is to identify examples of two different system components, marked above in bold, and select parameters for them.
	— Use of natural resources (water): for this system component, several parameters could be selected, such as:
	  — **re-use of produced water generated, which is separated from the treatment process used for secondary recovery, avoiding the rising intensity of the possible use of fresh water as a supplement** (P5, further explored in step 6.2.4);
	  — adoption, where possible, of a dump-flooding mechanism to avoid using fresh water as a supplement and simultaneously reduce the need of energy use for pressuring reservoir in secondary recovery.
	— Energy use: for this system component, several parameters could be selected, such as:
	  — **use of solar energy (renewable) to heat oil during storage and for production well driving instrumentation** (P6, further explored in step 6.2.4);
	  — improvement of the energy efficiency factor of the oil gathering and treatment system;
	  — promotion of cogeneration, where possible.
	In this example, P5 and P6 have been selected, marked above in bold, and a list of parameters related to them and based on environmental good practices can be defined. These parameters quantify preventive environmental measures implemented on site.

6.2.4, Define basic data	In order to calculate the parameters selected, the data to be managed are as follows. — Use of natural resources (water): re-use of produced water generated (in cubic metres), which is separated from the treatment process in the secondary recovery, avoiding the rising intensity of possible use of fresh water as make up (P5). — Energy use:

	use of solar energy (renewable) to heat oil during storage and for production well driving instrumentation (P6).
6.2.5, Identify measuring methods	After clarifying what information needs to be collected, the sources and methods to obtain this data are identified. — P5: Re-use of produced water generated (in cubic metres), which is separated from the treatment process in the secondary recovery: — the method to obtain the basic data for this parameter is displayed in flow meter in the input (oil gathering station) and output (water injection for secondary recovery system) and/or estimation using basic sediments and water (BSW) rate where relevant; — records of flow meters installed in the water injection facilities system, taking into account the type of flow meter installed; considering two types, cumulative flow meters (displays total amount of water) and instantaneous flow meters (displays the amount of water in each instant). — P6: Use of solar energy (renewable) to heat oil during storage and for production well driving instrumentation: — in order to measure the energy supplied, an energy meter is used and estimation is made by experts: — a meter to measure electric energy purchased from energy companies; — software and a meter for natural gas used in the process of oil water separation, and a thermo-chemical treater/heater.
DO	
6.3.1, Set up measuring methods	— P5: Re-use of produced water generated (in cubic metres), which is separated from the treatment process in the secondary recovery: — install, calibrate and verify flow meters. — P6: Use of solar energy (renewable) to heat oil during storage and for production well driving instrumentation: — select software and a meter calibration procedure for natural gas consumption and electric energy consumed.
6.3.2, Acquire basic data	— P5: Re-use of produced water generated (in cubic metres), which is separated from the treatment process in the secondary recovery: — auto-read flow meters every 30 min (instantaneous flow meter) or daily, weekly, monthly (cumulative flow meter). — P6: Use of solar energy (renewable) to heat oil during storage and for production well driving instrumentation: — auto-read energy meters for 30 min (instantaneous) and daily/monthly (cumulative measurement).
6.3.3, Consolidate parameters	— P5: Re-use of produced water generated (in cubic metres), which is separated from the treatment process in the secondary recovery:

<table>
<tr>
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<td>
calculate the percentage of produced water reused for secondary recovery in the process.
P6: Use of solar energy (renewable) to heat oil during storage and for production well driving instrumentation:
calculate the percentage of energy used in an on-shore oilfield operation.
</td>
</tr>
<tr>
<td>6.3.4, Synthesize system components</td>
<td>
<p>The synthesis of the results can be made, for example, by assigning two coefficients to each parameter (importance and degree of implementation). The coefficients can be assigned based on experts' suggestions, bibliography, work site experiences, etc. The product of these coefficients gives the score. The total addition of the products of the two numbers in each parameter is the total score for the work site.</p>
<p>The coefficients 1, 2 or 3 can, for example, be assigned to the importance and degree of implementation.</p>
P5: Characterized by the importance and the degree of implementation, depending on the percentage of produced water generated from the process that is reused in a secondary recovery facility system (> 70 %, > 85 % or > 95 %).
<table>
<tr><th rowspan="2">Identification</th><th rowspan="2">Importance</th><th colspan="3">Goal (degree of adoption)</th></tr>
<tr><th>1</th><th>2</th><th>3</th></tr>
<tr><td>Re-use of produced water generated (cubic metres), which is separated from the treatment process in the secondary recovery one and avoiding the rising intensity of possible use of fresh water as a supplement (P5)</td><td>3</td><td>> 70 %</td><td>> 85 %</td><td>> 95 %</td></tr>
</table>
P6: Characterized by the importance and the degree of implementation, depending on the percentage of electric energy and natural gas replaced for solar energy (> 1 %, > 2 % or > 3 %).
<table>
<tr><th rowspan="2">Identification</th><th rowspan="2">Importance</th><th colspan="3">Goal (degree of adoption)</th></tr>
<tr><th>1</th><th>2</th><th>3</th></tr>
<tr><td>Use of solar energy (renewable) to heat oil during storage and for production well driving instrumentation (P6)</td><td>2</td><td>As much as 1 % on total energy used in oilfield</td><td>More than 1 % and less than 2 %</td><td>More than 2 %</td></tr>
</table>
<p>The next step is to calculate the product of the coefficients.</p>
</td>
</tr>
<tr>
<td>6.3.5, Aggregate whole system</td>
<td>
<p>Natural resources (water): Percentages, importance, degree of implementation and the result of the product between the importance and the degree of implementation.</p>
<p>Generation of waste: Percentages, importance, degree of implementation and the result of the product between the importance and the degree of implementation.</p>
</td>
</tr>
</table>

CHECK
Data accuracy can be ensured by a system of site support visits, internal audits and by the quality checks to which the data are subjected, first at the site and subsequently at the various stages of data integration. The technical review of the inventory of environmental data is carried out at the following levels: — on site: checking lists, measurements, inspections and follow-ups; — E&P business unit offices: review made in the support site visits; — technical services: internal audits; — external verifier to the organization: external audits. If environmental data are gathered at site level, the reviews performed by staff of the E&P business unit offices, technical services and verifiers can be considered external to the site, whereas if the data are processed at corporate level, only the review involving verifiers is external to the organization.
ACT
The results of the different checks and reviews are fed back to the data suppliers on site, aiming to correct and improve the quality of the data and methods used in acquiring and providing the environmental information.

Table C.6 — On-shore E&P business unit

Activities	Example actions
PLAN	
6.2.1, Conceptualize whole system	At this step, an on-shore E&P business unit is selected as the system to be considered.
6.2.2, Break down system components	The main system components are identified so that the activity of a typical on-shore E&P business unit can be classified and later analysed. The following operations/processes can be considered: — exploration; — drilling operations; — oil production; — gas processing and LNG storage; — oil and natural gas transfer to a refinery or customers. For each of the above, different environmental components can be taken into account, such as atmosphere, use of natural resources, energy use, occupation, pollution or loss of soils, generation of waste, etc. In this example, two are selected: drill cutting waste generation and atmosphere (contribution to climate change).
6.2.3, Select parameters	For the two system components selected from those mentioned above, several parameters can be identified. — Drill cutting waste generation:

	— **use, as much as possible, of drilling fluid water in order to make possible the re-use of waste as a raw material in the construction sector, for road pavements, etc.** (P7, further explored in step 6.2.4); — storage of drill cutting waste in a rubber lined soil base; — research on ways to diversify its re-use. — Atmosphere (contribution to climate change): — forestation of areas where the activities take place; — **reduction of the flaring of production-associated gas** (P7, further explored in step 6.2.4). In this example, P7 and P8 have been selected, marked above in bold, and a list of parameters related with them and based on environmental good practices can be defined. These parameters quantify preventive environmental measures implemented on site. The parameters can be evaluated on the basis of two coefficients: the importance of good practice and its degree of implementation. The product of these coefficients yields a score that can be considered a value of the site's environmental performance. The data needed to obtain the final indexes might be, at first, mostly estimates falling within a reasonable range, provided by technical staff in charge of the acquisition of environmental data or by experts' opinion. During the site life, these estimates are permanently verified, checked and adjusted.
6.2.4, Define basic data	In order to calculate the parameters selected for drilling operations for the on-shore E&P business unit, the data to be managed comes from each well-drilled site according to drilling rig records. — Drill cutting waste generation, i.e. tonnes of drilling waste for each possible destiny: landfill, recycling on site, etc.: — use, as much as possible, of drilling fluid water in order to make possible the re-use of waste as a raw material in the construction sector, for road pavements, etc. (P7); — number of wells where it is possible to use drilling fluid water, describing the depth and other characteristics that drive the choice and waste volume. — Atmosphere (contribution to climate change), i.e. the rate of associated gas that is not flared in the oilfield production processes, as a percentage: — reduction of the flaring of production-associated gas (P8). For each process/facility where gas flaring can occur, it is necessary to analyse the occurrence records of flaring throughout a defined period.
6.2.5, Identify measuring methods	— P7: Use, as much as possible, of drilling fluid water in order to make possible the re-use of waste as a raw material in the construction sector, for road pavements, etc.: — in the work site (drilling rig), a report with the information about the drilling fluid can be used, including depth of the drilled well, records of transportation and destiny/use; — surveys filled out by the work site manager or by experts (measurements or estimations) can be used.
	— P8: Reduction of the flaring of production-associated gas:

	— the main points where flaring of excessive gas takes place should be known; — make changes in procedure and technology to avoid unnecessary flaring and at the same time improve safety conditions; — experts in processes and automation can make surveys aided by employees working on each site (for procedures); — surveys filled out by the work site manager or by experts (measurements or estimations) can be used.
DO	
6.3.1, Set up measuring methods	— P7: Use, as much as possible, of drilling fluid water in order to make possible the re-use of waste as a raw material in the construction sector, for road pavements, etc.: — programme the surveys software; — check the computers and the server for receiving the surveys.
	— P8: Reduction of the flaring of production-associated gas: — programme the surveys software; — check the computers and the server for receiving the surveys.
6.3.2, Acquire basic data	— P7: Use, as much as possible, of drilling fluid water in order to make possible the re-use of waste as a raw material in the construction sector, for road pavements, etc.: — fill out the survey every three months. — P8: Reduction of the flaring of production-associated gas: — fill out the survey every month.
6.3.3, Consolidate parameters	— P7: Use, as much as possible, of drilling fluid water in order to make possible the re-use of waste as a raw material in the construction sector, for road pavements, etc.: — calculate the total of drilling cut waste generated in the whole process of drilling operations and calculate the number of delivery for each use/destiny. — P8: Reduction of the flaring of production-associated gas: — gather information about areas/facilities where associated production gas flaring occurs and the relevant amount.
CHECK	
Information regarding Check is not available for this example.	
ACT	
Information regarding Act is not available for this example.	

Annex D

(informative)

Case studies from the ISO 14000 family of standards

D.1 Example of a metal company producing copper plated wire

In this example, the metal company produces copper plated wire and has a certified ISO 14001:2015 environmental management system

Activities	Example actions
PLAN	
6.2.1, Conceptualize whole system	The intended purpose is to collect quantitative information for top management's yearly audit of the company's environmental performance of the significant environmental aspects and their indicators. Objectives: — collect and report on GHGs from operations with reporting accuracy according to scope 1 and scope 2 emissions (GHG reporting scheme nomenclature): scope 1 direct emissions with a > 95 % accuracy, scope 2 reported with no certainty of measurement (uncertainty for scope 2 emission factors acceptable to be unknown); — energy consumption by the sites' operations and facility: accuracy > 90 % desired; — collect and report data for water use and consumption: accuracy to be > 97 %; — collect and report on total steel wire purchased, consumed and sold, including scrap for recycling: accuracy to be 99 %; — collect and report on total chemical usage (copper sulfate): > 99 % accuracy. See ISO 14001:2015, 4.1 and 4.2, 4.3, 4.4, 5.1, 5.3, 6.1.1, 6.1.2 and 6.1.3, 6.2.1, 6.2.2, 7.4.3.
6.2.2, Break down system components	System boundaries/scope of the site (see ISO 14001:2015, 4.3): — one site, 420 employees (medium-sized organization); — total area of plant: 30 000 m^2, all operations; — exclude product design; — customer-based automotive industry, wire for rubber tires. Environmental aspects of all business processes (see ISO 14001:2015, 5.1 c), 6.1.1 to 6.1.3): — sales: new chemical, sales volumes and total shipped; — purchasing: purchase new chemicals, total all chemical use and inventory levels to sales volumes, purchase electricity from power grid; — manufacturing aspects: scope 1 emissions and scope 2 from energy consumption, copper sulfate and chemical consumption:
	— receiving: wire and chemicals; — wire draw: energy consumption, steel throughput and scrap; — copper plating, annealing furnace, air emissions from CH_4 consumption and N_2O emissions, water usage; — water treatment, copper waste recovery, water consumption and waste. VOCs from aerator; — landfill waste, cardboard, plastic, pallets and solid waste from waste water treatment;

	— test (inspection): scrap wire; — management/business planning: — financial planning and resource allocation; — environmental policy/goals: pollution reduction; — facilities: air conditioning, heating, maintenance, air compressor, plug load: energy consumption scope 2 emissions from energy.
6.2.3, Select parameters	(See ISO 14001:2015, 6.1.1 to 6.1.3.) — N_2O/kg, kg/annual: annealing furnace exhaust from combustion of CH_4. — Energy consumption, MJ/year. — Raw material consumption (including X % secondary/recycled material): — iron resources, tonne/annual; — copper (for plating and waste water), tonne/annual; — chemical (for manufacturing and waste water), kg/annual; — cardboard/paper, kg or tonne /annual. — Manufacturing and facility water consumption, m^3/annual. — Landfill waste, tonne/annual copper solids, recycling: — battery, per unit; — cardboard (packaging), tonne/annual; — plastic (packaging), tonne/annual; — machine oil, L/annual. — Water, m^3/annual. — GHG emissions: — CO_2/kg, MT CO_2 annual, energy consumption, emission factors.
6.2.4, Define basic data	(See ISO 14001:2015, 6.1.2, 6.2.1, 7.1, 7.2, 7.3, 8.1, 9.1 and 9.3.) — Energy consumption: use of primary data (meters) and secondary data (estimates from motors, pumps, plug load), and comparison to monthly utility bills and annual consumption. — Collection of landfill waste from the copper plating line and waste water treatment facility, and solids going to landfill. — Collection of landfill waste from cardboard and plastic packaging.
6.2.5,	— GHG emissions (see ISO 14064-1):

Identify measuring methods	— CO_2/kg (secondary), energy consumption (primary) conversion using emission factor (source: IEA – *uncertainty unknown*); — N_2O/kg (primary), stack flow meter (uncertainty 1 % calibration), stack temperature/thermocouple (uncertainty 0,5 % calibration), gas flow meter (uncertainty 2 % calibration): total uncertainty 3,5 %. — Energy consumption (see ISO 50001, ISO 50006 and ISO 50015): — manufacturing meter at copper plating (primary data) (uncertainty 1,5 %); — facilities: utility bills/meter (uncertainty 0,5 %) (primary data); — purchased amount of fuels (primary data), comparison of utility bills and a comparison between utility bills and measurement from fuel consumption meters; — purchased amount of electricity (utility bill compared to internal meter); — baseline for each process; — meter 1 plating line, includes all pumps, motors and waste water treatment; — meter 2 draw machine; — meter 3 for N_2O annealing furnace plating line: natural gas; — facilities (electricity, A/C, heat and plug load) energy efficiency X %. — Raw material consumption steel wire (weight/tonne/purchase orders, subtract scrap/recycle per month using weight scale 0,7 % uncertainty): — iron: total purchase to total shipped subtract scrap; — copper (for plating and waste water) total purchased minus total consumed minus landfill waste/sludge from waste water uncertainty add VOC evaporation from waste water treatment; — chemical (for manufacturing and waste water) acids, copper sulfate, buffer solutions: total purchased minus total consumed, unaccounted for VOC evaporation; — cardboard/paper, total tonne per annual. — Manufacturing and facility water consumption (see ISO 14046): — copper plating line: meter 4 input and meter 5 output to wastewater, total consumption compared to output (% evaporation); — waste water output meter 6 compared to input meter 5 from plating line X % evaporated; — percentage compared total water consumption subtracted from utility bill (city sewage and city water treatment). — Landfill waste: weight per tonne/annual, utility bill and scale on site. — Recycling:

	— battery, per unit annual count; — machine oil, L/annual by supplier invoices; — water, see above.
DO	
6.3.1, Set up measuring methods	Scope 1: all measurement equipment already installed according to Plan. Scope 2: CO_2 emissions are based on data provided by suppliers and by referenced databases.
6.3.2, Acquire basic data	Data are acquired according to Plan.
6.3.3, Consolidate parameters	(See ISO 14001:2015, 6.2.1, 9.1 and 9.3 and ISO 14064-1, ISO 14067 and ISO 14046.) — Energy data has been collected and trended into total consumption and applied to product output, i.e. 150 kWh per tonne of steel wire with a 90 % confidence level. — CO_2 data from energy consumption has an unknown measurement certainty because IEA emission factors are theoretical, data has significant uncertainty value as reported. — Water consumption data has been aggregated at total annual consumption and reported as 99 % accuracy. — Natural gas consumption is accurate at 99 % from meter and utility bills. — N_2O from combustion of CH_4 annealing furnace is aggregated per annual and is 94 % accurate using conversion factor, gas flow meter accuracy and heat thermal meter accuracy, due to all three data points (2 m and utility bills) and furnace efficiency rating, only a 94 % confidence level is achieved. All recyclables (cardboard, plastic) are 99 % accuracy per annual by count and ton weight scale.
6.3.4, Synthesize system components	(See ISO 14001:2015, 8.1 and 9.1.) The energy data measurement plan is as follows. — Meter 1 on plating line is a continuous data collection meter. Monthly, every 30 days on a Saturday at 10:00 am, data are taken for total energy consumption for the month for plating line motors, pumps, wire winder, electric conductivity plates, blower fan and waste water pumps both water and agitation (primary data). — Meter 2 on wire draw machines, as above: every 30 days on a Saturday at 10:00 am, 160 machines on one buss (primary data). — Meter 3 on a stack flow for N_2O, a utility bill for natural gas consumption is used, total consumption per 30 days to be compared to stack meter for N_2O, the efficiency is determined by total consumption of CH_4, utility bills and a stack meter (primary data). — Meter 4 on cut and twist machines, as above: every 30 days at 10:00 am, data are taken for total energy consumption for the month (primary data).

	— Use of ISO 50001, 98 % confidence level, data has been metered along with utility bills as primary data, the revenue meter is compared for accuracy with a calibrated meter to ensure the utility bills were accurate, no issues are found. — Each identified process (plating line, draw machines, cut and twist machines and furnace) have an energy baseline. Regression analysis is used to determine the normalized baselines with the variables for each process i.e. heating and cooling degree days (HDD/CDD). The local meteorological organization (NOAA) is used to retrieve weather data for the city plant location. These data are secondary data. However, a coefficient is calculated and used to normalize each baseline.
	— Each baseline is then used in a second order polynomial equation to normalize all baseline to a single company baseline. Other variables used to determine the aggregated normalized baseline include production outputs for monthly time period, hours of operation, and size of wire produced each month (average). — Monthly KPIs are set for each defined process in the unit of measure of "kWh per ton" of product produced. Each month, the data collection at the meters requires the operator to calculate the difference between the last data point and the most recent; this shows the monthly energy consumption. The data log (manual) is reviewed by the energy team each quarter during the management review. Actions for improvement with documented plans are produced, resources allocated and improvements to energy performance are made. The water consumption plan is as follows. — Meter 5 is used to measure water input to the plating line from the on-site water well. Total consumption is taken every 30 days. — Meter 6 output water consumption from plating line to waste water treatment is taken every 30 days. Meter 4 and meter 5 total consumption is compared to account for evaporation and waste. — Meter 7 output meter from waste-water treatment to city treatment plant is taken. Meter 5 and 6 total consumption difference is compared to account for evaporation and waste. The landfill waste plan is as follows. — A weight scale is used every 30 days. The total weight of plastic and cardboard to the landfill is segregated. Supplier weight invoice and weight scale readings is compared (primary data). — For water consumption use, see ISO 14046, the total consumption from the on-site flow meters is measured. The emissions to air plan is as follows. — Emissions/GHG, scope 1: Gas flow meter and stack meter data are gathered for six months. Conversion factor (secondary data) is used: CH_4 combustion to N_2O and furnace efficiency rating compared to total CH_4 consumed, and gas meter at furnace and utility bills (primary data). — Emissions/GHG, scope 2: Total energy consumption meters and utility bills (primary data) multiplied by IEA emission factor. The measurement certainty is unknown. LCA per ISO 14044 and CFP per ISO 14067 is conducted. All secondary data with no certainty of measurement are publicly reported.
6.3.5, Aggregate whole system	Set up the energy and aspect measurement and verification plan:

	— install meter 1: copper plating line, measures all motors and pumps including waste water treatment (plating system): — install meter 2: wire draw machines; — install meter 3: annealing furnace stack in plating line to measure N_2O from CH_4 combustion; — use utility bills from revenue meter for facilities energy consumption; — install meter 4 water input to plating line copper bath solution (the organization has own water well and no utility bills); — install meter 5 output meter from plating line copper solution to waste water treatment plant; — install meter 6 waste water treatment plant to city water minus evaporation. Use the current weight scale for cardboard and plastic landfill from packaging materials.
CHECK	
— Real-time measurement and monitoring of energy data from meters, reported annual consumption of energy at a 95 % certainty level due to primary data meters and accuracy of the meters, i.e. calibration, resolution, linearity and bias. — Annual CO_2 data using emission factors secondary data. No certainty can be reported as emission factors are “theoretical”. — The data collection and certainty level as planned is not at a desirable level. The variables and temperature coefficient are used improperly. This was not known at the Plan stage and additional meters, data monitoring and analysis will be conducted to achieve a higher certainty level. — Additional quick meters will be used for further gathering of primary data for toque, speed and temperature.	
ACT	
— After a formal review by the leadership team, the accuracy and precision of the data taken, analysed, aggregated and reported has a less than desirable certainty values regarding the CO_2 and CFP, this data will no longer be reported publicly. — It was found that the data taken for the energy consumption had uncertainty at the aggregated level (company baseline). After analysis, it was found that the coefficient used for each baseline normalization models (HHD/CCD) was used inappropriately. Further calculations will be conducted by applying the coefficient of outside temperature (seasonal) used at the aggregated normalized baseline only. This will aid further accuracy of the total energy consumption by the company.	

— It was noticed that, after a comparison of the aggregated baseline and the utility bill for electricity of a six-month period, the estimate of consumption was 28 % difference. Secondary data are used to understand the line loss within the company. Motors, pumps and furnace efficiencies were no longer valid as stated from the maintenance manuals and data plates of the pumps and motors.

— Additional data will be taken to meter (quick connect) each pump, motor and furnace stack temperature and efficiency along with RPM and torque values to understand the actual energy consumption and efficiency of each. This will aid in determining our energy loss due to line loss and inefficiencies as well as the degradation curve. It is estimated that the new metered data (primary) taken will provide an additional 15 % accuracy of the total consumption data aggregated and publicly reported.

— Executive management decided that they will no longer waste resources calculating and reporting CFP and CO_2 from energy, as they do not see any business value for these resources.

D.2 Example of a plastic products eco-profile in the scope of ISO 14025 and ISO 14044

Activities	Example actions
	PLAN

6.2.1, Conceptualize whole system	Collect information for the production of plastic products eco-profiles, including quantitative environmental information, in accordance with the “PlasticsEurope Eco-profile and EPD programme” requirements, in the scope of ISO 14025 and ISO 14044.
	Objectives:
	— compile average industry data, which could be used for internal company benchmarking allowing individual process improvement:
	  — leading to elimination of poor sections of processes;
	  — improvements by addition of waste treatment sections.
	— include sufficient data, which could be used by customers for product development against environmental criteria to:
	  — allow evaluation of the plastics contribution relative to the overall product;
	  — enable collaboration with recovery procedures to reduce collective impacts;
	  — draw attention to poor environmental links in user chains, which can lead to subsequent improvement.
	— target generic data, which could be used to optimize the management of plastics waste:
	  — facilitates choosing among options such as mechanical recycling, reuse as a petrochemical raw material and use as a substitute fuel;
	  — provides sufficient data to investigate alternative solutions for regulatory compliance, e.g. with the EU Packaging and Packaging Waste Directive.

6.2.2, Break down system components	The following processes should be included in the cradle-to-gate LCI system boundaries: — extraction of non-renewable resources (e.g. operation of oil platforms and pipelines); — growing and harvesting of renewable resources (e.g. agricultural planting); — beneficiation or refining, transfer and storage of extracted or harvested resources into feedstock for production; — recycling of waste or secondary materials for use in production; — refining of non-renewable or renewable resources into energyware; — production processes; — all relevant transportation processes (transport of materials, fuels and products at all stages); — management of relevant waste streams or pollution generated by processes within the system boundaries. Further processes might need to be included if relevant to the goal of the production process: — if a process is aimed at polymer resin production, then it is included as a whole; — if a process includes production of polymer resins as a by-product, all activities that are connected to resin production should be included and the system boundaries should allow for an appropriate allocation.
6.2.3, Select parameters	For raw materials, as follows. — Raw materials inputs should be reported as all materials that are extracted from the earth. Fuels and water consumption, however, are reported elsewhere. — Note that sulphuric acid is manufactured from both elemental sulfur and from sulfur dioxide recovered from oil refining and metallurgical processes. If feasible, these different sources of sulfur should be entered separately in the raw materials table as either elemental or bonded sulfur. — Further, the entries for air, nitrogen and oxygen refer to compressed air, liquid or gaseous nitrogen and liquid or gaseous oxygen, respectively, that are taken into the processes for use as process materials or services. Air or oxygen, as a resource, used in fuel burning is not recorded. For water consumption, as follows. — Almost all industrial processes use water either as cooling water or process water. In the calculation of eco-profiles, cooling water should be specifically identified. — Further, irrigation water should be recorded separately, e.g. in case of agricultural pre-chains. All other water should be treated as process water.
	For air emission data, as follows.

	— Air emission data should be reported as cumulative totals arising when all operations are traced back to the extraction of raw materials from the earth. Note that the recorded emissions refer to those remaining after any on-site treatment and do not necessarily reflect the output of the production sequence to the on-site air treatment facility. — As a general rule, the air emission data in LCI should be adequate to calculate relevant impact categories in LCIA. This requirement is fulfilled when using the default list. — Note that emissions reported by sites and facilities in compliance with EU regulations relate to single site emissions. Eco-profile results usually refer to data aggregated from a number of sites often in different geographical locations. Great care is therefore needed in any interpretation of LCI data since the reported, aggregated emissions do not refer to a point source. — Where they are known, fugitive emissions should be recorded separately. Such emissions refer to losses from the system other than reaction losses. They will therefore include storage tank losses, losses in the delivery systems and leakage from pipe flanges and valves. — Air emissions should be grouped into categories. In case the product system includes renewable materials or biomass as fuel, special care needs to be dedicated to handling "negative emissions", i.e. CO_2 uptake during the agricultural or forestry pre-chain. For wastewater emission data, as follows. — Wastewater emission data should be reported as cumulative totals arising when all operations are traced back to the extraction of raw materials from the earth. — Note that the recorded emissions refer to those remaining after any on-site treatment: and do not necessarily reflect the output of the production sequence to the on-site wastewater treatment facility. — It is important to recognize that some parameters will inevitably involve an element of double counting. In particular, both BOD and COD, which are the result of a specific monitoring test, will give rise to this because of the presence of some emissions, which are separately identified elsewhere. These parameters can, however, be used for plausibility checks and are therefore retained in spite of the double counting. — As a general rule, the wastewater emission data in LCI should be adequate to calculate relevant impact categories in LCIA. This requirement is fulfilled when using the default list. — Note that emissions reported by sites and facilities in compliance with EU regulations relate to single site emissions. Eco-profile results usually refer to data aggregated from a number of sites often in different geographical locations. Great care is therefore needed in any interpretation of LCI data since the reported, aggregated emissions do not refer to a point source. — Water emissions should be grouped into categories as described earlier.
	For solid waste, as follows.

	— Waste management operations should be within the system boundaries. Such operations can include landfill (inert waste, municipal waste), underground storage (hazardous waste, nuclear waste), waste incineration, waste water treatment, carbon capture and storage, etc. These are technical processes and thus should be part of the product system. Hence, in terminated data sets, wastes should not be treated as elementary flows. Any flows of waste for treatment must have been traced to the applicable waste treatment facilities and modelled accordingly. Only final deposits released into the environment should be recorded in the LCI tables. — In addition, however, to facilitate interpretation by producers, the waste arising on the selected foreground process level (usually the polymerisation step) should be reported as well — Wherever feasible, an attempt should be made to report single species for elementary flows. Substance groups, such as “metals (unspecified)”, should be avoided where possible.

6.2.4, Define basic data	For cut-off rules, as follows.
	— The LCI data collection for eco-profiles should aim for completeness, a closed mass and energy balance, and avoid cut-offs altogether. Where quantitative data are available, they should be included.
	— However, no undue effort should be spent on developing data of negligible significance concerning environmental effects. Where elementary flows are unknown or no quantitative data are available, the following minimum criteria should guide eco-profile data collection:
	  — include all material inputs that have a cumulative total of at least 98 % of the total mass inputs to the unit process;
	  — include all material inputs that have a cumulative total of at least 98 % of total energy inputs to the unit process;
	  — include any material, no matter how small its mass or energy contribution, that has significant effects in its extraction, manufacture, use or disposal, is highly toxic, or is classified as hazardous waste (environmental significance).
	— Cut-offs might become necessary in cases where no data are available, where elementary flows are very small (below quantification limit), or where the level of effort required to close data gaps and to achieve an acceptable result becomes prohibitive.
	— Flows that are cut off, estimated or substituted should be recorded in qualitative and quantitative terms, and the omission should be examined and justified, if applicable, by a sensitivity analysis considering:
	  — mass: percentage of total input or output mass flows;
	  — energy: percentage of total input or output energy flows;
	  — cost: percentage of market value;
	  — environmental significance: percentage contribution to relevant impact indicators.

	For individual data collection, as follows. The following requirements for data quality should guide the data collection:

6.2.5, Identify measuring methods	— direct measured data should be preferred over inferred or estimated data;
	— locally appropriate data should be preferred over data from remote sources;
	— data for identical processes should be preferred over data from analogous processes;
	— recent data should be preferred over older data;
	— as a last resort, estimated data should be used until the mass and energy balance for the process is complete.
	Secondary or background data concerns processes either outside the operational control of the respective producer, or for which primary data are not available at a feasible effort. Such generic data sets can be derived from publicly available or commercial LCI databases.
	Eco-profile and EPD preparation: eco-profile and EPDs should use average data representative of the respective foreground process (usually a polymer resin production), both in terms of technology and market share.
	The primary data should be derived from site specific information for processes under operational control. Secondary data might be derived from generic data sets for background processes, or to close data gaps.
	In the course of the data collection and research, the type of data (by source) should be noted as follows:
	— primary data:
	    — measured (e.g. accounting or analytical data);
	    — calculated (e.g. using stoichiometric relations or emission factors);
	    — estimated (e.g. expert judgment);
	— secondary data (e.g. literature, third-party database).

DO	
6.3.1, Set up measuring methods	LCI data sets should report numerical values where these are above detection or quantification limits. If, however, entries are below detection or quantification limits, no numerical value can be given (not even zero nor any arbitrary estimate between zero and the quantification limit). Note that the detection limit can vary depending on the substance; hence, it should be recorded during data collection. For the purposes of eco-profile reports, such entries should be reported as "not quantifiable", with a footnote explaining that items are below detection or quantification limit. These cases should then be handled by applying cut-off rules.
6.3.2, Acquire basic data	In preparation of the LCI data collection, the eco-profile project team (EPT) will hold a meeting including a knowledge-building session to raise awareness about the procedures and success factors of the exercise. The LCA practitioner will usually employ an Excel1)-based questionnaire, which is distributed to the participating member companies. To this aim, a generic questionnaire template could be developed, which should contain default substance flow names as per the International Reference Life Cycle Data System (ILCD) handbook[31], accommodate data entry in varying units (drop-down to select unit), offer automatic conversion to metric standard units (e.g. tonnes to kg), and ensure a base-level plausibility by restricting numerical entries to reasonable ranges. Generic data sets can be derived from publicly available or commercial LCI databases.

	[1] Excel is the trademark of a product supplied by Microsoft. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.
6.3.3, Consolidate parameters	When modelling and calculating average eco-profiles from the collected individual LCI data sets, vertical averages should be calculated. Vertical averaging involves combining a sequence of unit process inventories (UPI), or sometimes aggregated processes, which are linked by a reference flows, e.g. precursors or intermediates. Vertical aggregation also means that data are first calculated separately for each production chain, and only then an average is calculated, weighted by the production tonnage of each chain. The sub-system boundaries for the production chains to be vertically averaged should be set in such way as to avoid allocation as far as possible. They should take into account a sufficient number of representative site-specific production routes. The data sets obtained by vertical averaging are deemed to be the most appropriate representation of industrial reality, reflecting the high level of integration within production sites and industrial networks. For reasons of confidentiality and to avoid revealing commercially sensitive information, averages should be calculated from at least three (3) distinct individual data sets.

6.3.4, Synthesize system components	It should be carefully noted that eco-profile projects comprise the calculation of the life cycle impact assessment (LCIA) as a mandatory step so as to prepare a default set of impact categories as environmental key performance indicators.
	These can be reported in either of the following ways:
	— as an optional annex of the eco-profile report;
	— as optional environmental product declarations (EPDs).
	The rules for calculation and presentation in both formats are identical except where otherwise noted.
	The results of the LCIA are reported in EPDs in a minimum set of mandatory inventory and impact category parameters. For the selection of impact categories, the primary reference is the CML Guide to LCA (2002)[32]. Additionally, reference is made to the ILCD handbook[31] to capture the emerging best practices.
	Inventory level — Input parameters: Primary energy resources.
	— The use of primary energy resources should be reported and differentiated into renewable and non-renewable resources: primary energy demand (cumulative energy demand, CED or gross energy requirements, GER4), measured as upper heating value (UHV) in MJ, differentiated into:
	    — non-renewable primary energy resources, measured as upper heating value (UHV) in MJ;
	    — renewable primary energy resources, measured as harvested energy in MJ.
	    — Since it is common practice to use the lower heating value (LHV) in many LCA studies, these indicators should also be reported as lower heating values where applicable.
	    — In addition, the embodied energy, quantified as gross calorific value of polymer, should be reported to indicate the energy recovery potential.
	Inventory level — Input parameters: Water.
	— The use of water should be given as follows (if possible, specifying the source, e.g. groundwater):

  - process water in litres;
  - cooling water in litres.
  - If other water uses (e.g. irrigation in agricultural pre-chains) are found to be relevant, these should be commented upon.

Inventory level — Input parameters: Natural resources.

- The depletion of material and energy resources and the use of water should be given as follows:
  - abiotic depletion potential (ADP) elements: all mineral resources, excluding fuels, measured as kg antimony (Sb) equivalents;
  - ADP fossil fuels: all abiotic fuels, measured as MJ (LHV).

Inventory level — Input parameters: Key air emissions.

- As a minimum, the following air emission data should be reported, in kg:
  - total carbon dioxide (CO_2);
  - total carbon monoxide (CO);
  - total methane (CH_4);
  - total sulfur dioxide (SO_2);
  - total nitrous oxides (NO_x).

Inventory level — Output parameters: Waste.

- Waste should be reported as follows:
  - at the system boundary (after treatment): final deposits (life cycle inventory output item);
  - at the key foreground process level (before treatment): waste generation (arising from the selected foreground process, i.e. usually the polymerisation).

Inventory level — Output parameters: Impact categories.

- The following set of environmental impact categories should be included in the EPD:
  - global warming potential (GWP): greenhouse gas contributions in kg carbon dioxide (CO_2) equivalents (time horizon of 100 years);
  - acidification potential (AP): acidifying contributions in g sulfur dioxide (SO_2) equivalents;
  - eutrophication potential (EP)6: nutrifying contributions (aquatic and terrestrial eutrophication) in g phosphate (PO43–) equivalents;

	— ozone depletion potential (ODP): ozone depleting contributions in g CFC-11 equivalents; — photochemical ozone creation potential (POCP): summer smog contributions in g ethene (ethylene) equivalents; — dust and particulate matter in g.
6.3.5, Aggregate whole system	So-called metadata, i.e. a description of the LCI data set and the underlying methodology, should be prepared including: — general information about the data owner, data set developer, programme owner and programme manager; — number of plants participating in the LCI data collection; — representativeness or coverage in terms of production volume or tonnage (i.e. percentage of total production represented by the sampled plants); — year of data collection; — year of reference; — expected temporal validity; — noteworthy cut-offs; — an overall evaluation of data quality; — the chosen allocation method.
	The eco-profile report should comprise: — a standardized executive summary, which is identical with the EPD; — a project-specific detailed report with supplementary data and analyses; — comments on changes compared with the previous version of the eco-profile as far as applicable; — where necessary, any specific references; — a glossary of terms. The EPD should comprise: — metadata; — a description of the product and the production process; — (optional) comments and recommendations on the use phase and end-of-life management of sample applications deemed illustrative or representative; — the declaration of environmental performance, i.e. the key performance indicators, mandatory parameters as rounded figures for ease of reading; — mandatory and optional additional information.

	Where the EPD is used separately, the reference to the full eco-profile report is included, and a glossary of terms is recommended.

CHECK

A basic data and parameters check comprises the following.

Data quality should be assessed considering the following requirements:

- technological, temporal, and geographical coverage (with regard to goal and scope);
- relevance, representativeness and consistency (with regard to goal and scope);
- completeness (e.g. by noting omitted or substituted flows);
- precision and accuracy (e.g. by providing a confidence range);
- data sources, reliability and uncertainty (e.g. ranging from verified measurement to non-qualified estimate).

To assess accuracy, specifically where estimates or substitutes are used, a sensitivity analysis should be conducted as follows: each data item is doubled and halved, then a check is made of whether the final impact assessment for the product system being modelled varies by less than 5 %, in which case, the approximate values can be used. Where the variation is greater than 5 %, further investigation of this parameter should be undertaken.

The LCA practitioner should address each of the requirements in the eco-profile report.

These data quality criteria should then be checked and confirmed in the external review of the eco-profile report and data set. Based on the outcome, the reviewer can assign data quality indicators (DQI) to the data set.

Below are descriptions on how the subclauses of ISO 14040 and ISO 14044 relate to data quality requirements of an eco-profile report.

- For technological coverage requirements relating to a specific technology or technology mix for which data was collected, see ISO 14040:2006, 3.1.5, and ISO 14044:2006, 3.1.5.
- For time-related coverage requirements relating to the age of data and the minimum length of time over which data was collected, and, additionally, the expected temporal validity of the data set, see ISO 14040:2006, 3.1.6, and ISO 14044:2006, 3.1.6.
- For geographical coverage requirements, the geographical area from which data for unit processes were collected, see ISO 14040:2006, 3.1.7, and ISO 14044:2006, 3.1.7.
- For relevance and representativeness requirements relating to the qualitative assessment of the degree to which the data set reflects the true population of interest (i.e. geographical coverage, temporal and technology coverage).
- For consistency requirements relating to the qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis.
- For reproducibility requirements relating to the qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study.
- For precision and accuracy requirements relating to the measure of variability of the data values for each data expressed (e.g. variance).

- For completeness requirements relating to the percentage of flows measured or estimated.
- For data sources requirements relating to documentation of the data origins, see ISO 14040:2006, 3.3.1, and ISO 14044:2006, 3.3.1.
- For reliability and uncertainty requirements relating to the uncertainty of the information (e.g. data, models and assumptions).

A consolidation results internal check comprises the following.

First, before submitting the preliminary eco-profile report and calculations to the EPT, the LCA practitioner and data set developer should conduct an internal review. This can be included in ongoing quality assurance procedures. In particular, the LCA practitioner should conduct plausibility checks as per ISO 14040 and ISO 14044, e.g. checks on units and dimensions, completeness, consistency, and sensitivity analysis. For further details about such checks, reference is made to the ILCD handbook[31].

Second, after submitting the preliminary eco-profile report and calculations to the EPT, the results of the calculations (i.e. the respective industry averages) will be discussed in the EPT for further cross-checking. These measures are meant to eliminate errors of the primary data and data collection procedures.

Third, the LCA practitioner should compare the final results with the previous version of the eco-profile, if available, and comment on any significant changes. Interpretations and explanations should be included in the eco-profile report. This will be part of a benchmarking approach and will also provide invaluable feedback to the member companies. The LCA practitioner should mention any known reason for significant changes between updates to facilitate plausibility checks and interpretation.

The overall external check comprises the following.

All procedures, methods and assumptions should conform to the requirements in ISO 14040 and ISO 14044. In particular, the eco-profile reports (LCI data collection and calculations) should be prepared in an auditable way.

Before approval of the eco-profile or EPD reports, the programme manager should conduct an external review. In particular, the external reviewer should check and confirm whether the data quality requirements are met and, optionally, assign data quality indicators accordingly.

ACT

As far as update of data are concerned after years, identify the origin of potential changes:

- variation in the number of plants;
- important technology changes.

If some potential changes causes are identified, adapt the model and proceed to the workflow.

If no potential changes are identified, two options are possible:

- 2A: update background data only;
- 2B: in addition to 2A, update partially foreground data based on relevance analysis (only update input/output relevant to the results).

Always check the production volume.

Often, energy and main raw material amounts should be considered.

Annex E
(informative)

Clarification of concepts

In addition to the terms and definitions given in Clause 3, clarification of selected concepts is provided below to prevent misunderstanding.

— The words "appropriate" and "applicable" are not interchangeable. "Appropriate" means suitable (for, to) and implies some degree of freedom, while "applicable" means relevant or possible to apply and implies that if it can be done, it should be done.

— The word "consider" means it is necessary to think about the topic but it can be excluded. Whereas "take into account" also means it is necessary to think about the topic but it should not be excluded.

— "Continual" indicates duration that occurs over a period of time, but with intervals of interruption (unlike "continuous" which indicates duration without interruption). "Continual" is therefore the appropriate word to use when referring to improvement.

— In this document, the word "effect" is used to describe the result of a change to the organization or to one or more of its activities. The phrase "environmental impact" refers specifically to the result of a change to the environment.

— "Recursive" or "recursively" means the model or process is repeated, in its whole, in one or more sub-levels to conduct the realization of objective, as described in Clause 6 (see, for example, Figure 3), while "iterative" or "iteratively" means going step-wise back and forth between the levels to improve or fine-tune the realization of the objective.

— In this document, the expression "life cycle of a product" is used to imply the environmental impacts over the life cycle and to avoid confusion with "product life cycle", which in marketing and economics often refers to the sales profile during the economic life length of a product.

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