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Technical energy systems — Basic concepts

Systèmes d'énergie technique — Concepts fondamentaux

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 13600 was prepared by Technical Committee ISO/TC 203, *Technical energy systems.*

Annex A forms an integral part of this International Standard.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central
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Introduction

The International Standards of the 13600 series are intended to be used as tools to define, describe, analyse and compare technical energy systems at micro and macro levels. The use of these tools provides an objective basis for discussion on energy options in the technical, economic, environmental and social context and thus helps consensus-building and decision-making.

Technical energy systems – Basic concepts

1 Scope

This International Standard gives the basic concepts needed to define and describe technical energy systems. It introduces the concept technosphere and its division into two sectors. The economic purpose of one of these is to supply the other with energy in the technical-economic sense, i.e. energyware, to be distinguished from energy in the physical sense. The items included in that concept are given in a closed list. The standard prescribes the input-output model and the consolidation principle applied to technical energy systems. The outputs from the model are the intended product or service, the releases from the technosphere to nature, the use of natural resources and the associated exploitative impacts.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1 ancillary input:
Additives, packaging materials, energywares and supplies needed to produce and deliver the output product or service.

2.2 by-product:
Output of a technical energy system that is neither the intended product of that system nor release.

2.3 commodity:
Product or service that is available on a market.

2.4 energy:
Quantity that obeys the laws of thermodynamics.

NOTE Energy, like all quantities in physics, is an abstract concept.

2.5 energy carrier:
Substance or phenomenon that can be used to produce mechanical work or heat or to operate chemical or physical processes.

2.6 energyware:
Tradable commodity used mainly to produce mechanical work or heat, or to operate chemical or physical processes, and listed in annex A.

NOTE Energywares form a proper subset of energy carriers. The set of energy carriers is open.

2.7 energyware consumption system:
Technical energy system consuming energyware and in many cases also other energy carriers and producing products and services.

2.8 energyware demand sector:
Portion of the technosphere whose purpose is to produce the desired services from energyware and natural resources.

2.9 energyware production system:
Technical energy system which transforms natural resources into energyware.

2.10 energyware reclaim system:
Technical energy system which transforms reclaimable resources into energyware.

2.11 energyware storage system:
Technical energy system which can receive and store energyware to be released later in the same form.

2.12 energyware supply sector:
Portion of the technosphere whose purpose is to produce energyware, transform and transport it for consumption.

2.13 energyware transformation system:
Technical energy system which transforms one or more kinds of energyware into one or more other kinds of energyware.

2.14 energyware transportation system:
Technical energy system which transports energyware from one place to another.

2.15 environmental load:
Depletion of natural resources, releases and exploitative impacts.

2.16 exploitative impact:
Change in nature, other than depletion, appearing as a side effect when natural resources are brought into the technosphere.

2.17 main input material:
Raw materials, intermediary goods and components which together, often after transformation, make up the output product.

2.18 natural resource:
Substance or phenomenon appearing in nature which can be used as input to the technosphere.

2.19 product:
Intended tangible (material) output from a technical energy system

2.20 physical effect:
Mechanical vibration and shock, acoustic, electromagnetic and thermal phenomena, ionizing and non-ionizing radiation.

2.21 reclaimable resource:
Materials, not appearing in nature which can be recovered or recycled and used as an input to a technical energy system, but would otherwise be disposed of as release

2.22 release:
Substances, whether useful or harmful, which leave the technosphere, but can be brought back to the technosphere only by the same methods, if at all, as for bringing in natural resources, and physical effects.

2.23 service:
Intended intangible (non-material) output from a technical energy system or the benefit of using a product.

2.24 technical energy system:
Combination of equipment and plant interacting with each other to produce, consume or, in many cases transform, store, transport or handle energyware.

2.25 technosphere:
All technical energy systems and products produced by them, to the extent that they have not been discarded as release.

3 Conceptual model

The technosphere is surrounded by and interacts with nature, which includes the astrosphere, biosphere, atmosphere, hydrosphere and geosphere (see figure 1). These other spheres also interact with each other. Humankind is considered to be part of the biosphere.

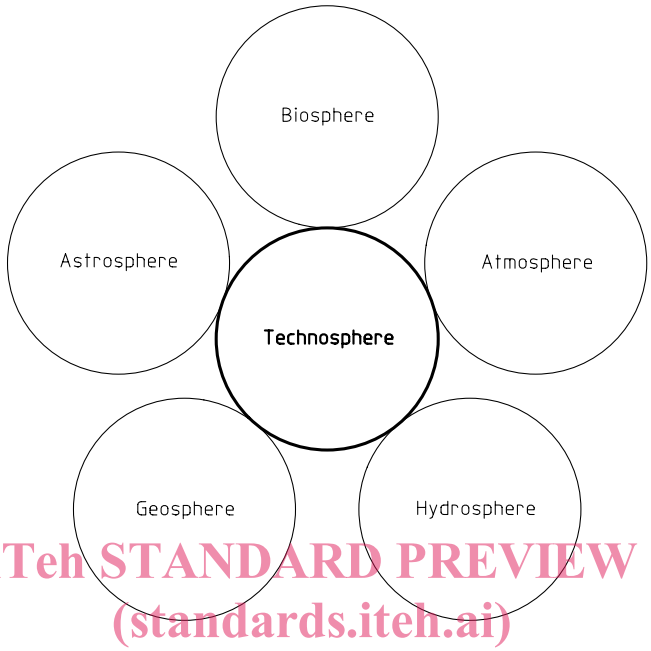

Figure 1 — Technosphere and nature

Natural resources, in the form of substances, are brought into the technosphere by operations such as mining, quarrying, excavation, collection, harvesting or intake of air and water. They serve as inputs to technical energy systems, i.e. combinations of equipment and plant, whose main outputs are products and services, but which also produce by-products and release. Natural resources in the form of other energy carriers such as solar radiation, ocean thermal differences, geothermal energy, wind and heat are also used for direct transformation into mechanical energy, heat or electricity.

Products, which are the output of a technical energy system, are either used as inputs to other technical energy systems or are used to provide services. At the end of their useful life, they are either recycled inside the technosphere or brought back to nature as release. The inputs to the technosphere thus are natural resources and the outputs are services (to humankind), releases and exploitative impacts (see figure 2).

The operations which bring natural resources into the technosphere affect nature in two ways: depletion and exploitative impacts. Nature is moreover affected by the technosphere through the services provided to humankind and through releases (see figure 3).

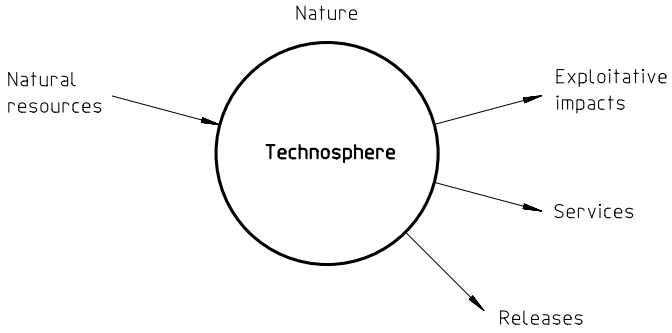

Figure 2 — Technosphere and nature

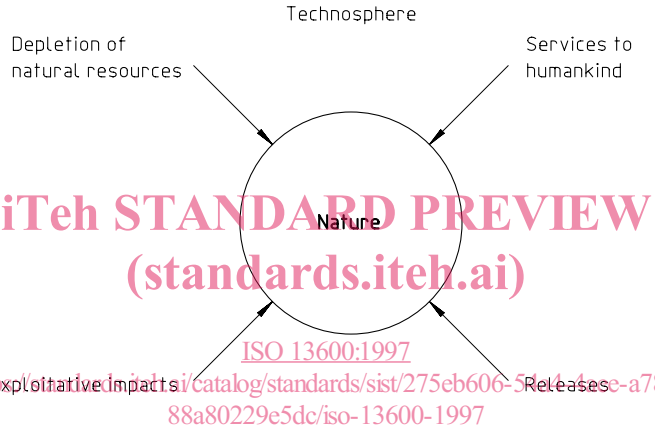

Figure 3 — Effect of the technosphere on nature

The technosphere can be subdivided in many ways. Only two, rather conventional ones, are considered in this International Standard: according to economic activity, and according to geographical boundaries.

According to economic activity, the technosphere is subdivided in two sectors (see figure 4):

— the energyware supply sector, comprising the oil, coal, gas, commercial heat and electricity industries and those industries that put on the market various fuels based on solar radiation, biomass and reclaimable resources, and

— the energyware demand sector, comprising mining, manufacturing, biological, residential, commercial and institutional subsectors. The only break with established practice is the splitting up of the transport and construction subsectors and the introduction of a transport infrastructure and a waste handling and processing subsector. In this sector different energy carriers are used in decentralized applications.

These two sectors are further divided in subsectors.

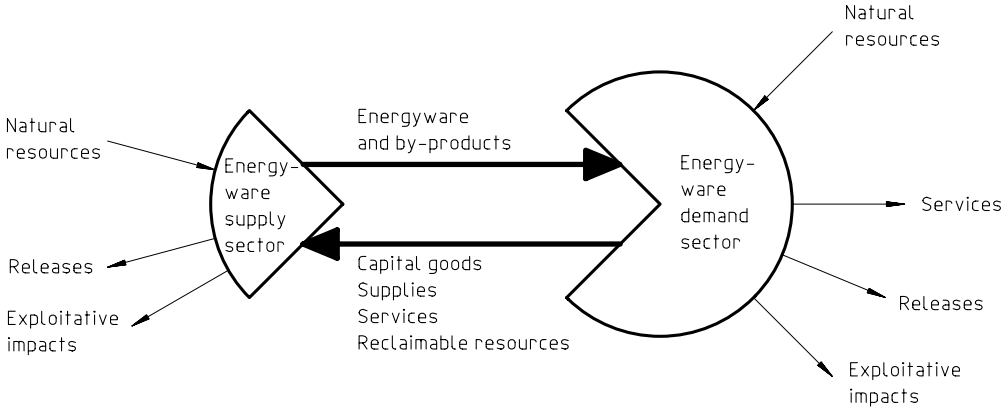

Figure 4 — The two sectors of the technosphere

To enable a uniform approach to the description of technical energy systems, a formalised input-output model shall be used. Any element of a system can be represented by a box. The inputs and outputs of such a box shall be grouped each under three main headings as shown in figure 5.

A system is described by a flowchart consisting of several boxes, as appropriate, interconnected by arrows indicating flow direction.

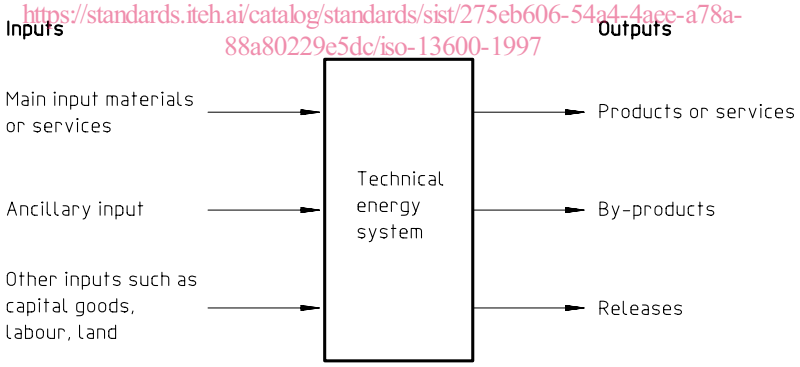

Figure 5 — Elementary input-output model

Both the amount and composition of inputs and outputs may vary during the lifetime of a system. For small, simple systems, it is useful to consider three phases: investment, normal operation and decommissioning. Scrapped equipment is to be regarded as a by-product. Depending on the goal and scope of the study, it may be necessary to consider the three phases separately or to combine them by time-average (periodizing). For large and complex systems, the three phases overlap in a more or less continuous manner.

5 Consolidation principle

A box can represent part of a machine, a machine, a group of machines, a whole user sector, a country, or a group of countries. Large boxes may hence be made up of smaller boxes.