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Energy management and energy savings — Guidance for net zero energy in operations using an ISO 50001 energy management system

Management de l'énergie et économies d'énergie — Recommandations pour zéro énergie nette dans le cadre des opérations utilisant un système de management de l'énergie ISO 50001

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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).

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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 301, *Energy management and energy savings*.

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.

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Introduction

0.1 General

This document shows how an organization that manages its energy performance can use that process to achieve net zero energy (NZE). It explains what is meant by NZE and how an energy management system (EnMS) in accordance with ISO 50001:2018 can be implemented to achieve, maintain and improve NZE. It also considers the integration of renewable energy and issues around planning for NZE in new and retrofitted facilities which is beyond the scope of ISO 50001. In addition, it is designed to complement organizational action to achieve net zero carbon (NZC).

This document introduces several new concepts to the determination of whether a facility meets the criteria it recommends for showing that it meets NZE or NZC goals. Many jurisdictions use the two terms interchangeably, and others promote one goal over the other as discrete choices. This document attempts to reconcile these definitions. It distinguishes between several different scopes and boundaries for these different net zero goals and their targets, which are increasingly effective at reducing energy and greenhouse gas (GHG) emissions, and correspondingly more difficult to achieve. It suggests that an EnMS be structured to allow continual improvement from lower targets to higher ones.

A number of countries around the world have pledged to achieve a net zero goal, and many more have committed to significant energy savings and carbon reductions in their societies.[17] Meeting these commitments over the coming decades requires accelerated improvements in energy management.

Many organizations are undertaking specific actions to reduce their carbon emissions by better management of energy, including targeting NZE. These actions may include:

— measuring, managing and minimizing energy use to achieve NZE through operations;

— designing and constructing new buildings or other facilities to meet a target of NZE;

— retrofitting existing buildings to improve their performance toward or beyond NZE;

— integration of renewable energy, e.g. photovoltaics (PVs), solar water heating, geothermal energy, on-site wind turbines;

— coordinating robust energy management with other sustainability initiatives, to achieve or surpass NZC.

This document shows how an EnMS can include objectives such as specified levels of NZE and NZC. The EnMS conforms to ISO 50001:2018. This document recommends establishing specific, quantifiable targets for energy consumption that can serve as a pathway to NZE. Use of this document should enable closer harmonization of claims of NZE within and between organizations, and across regions and nations.

By following the standardized approach provided, the organization can take advantage of common resources (e.g. software) to produce reliable and documentable processes and results, and of the basic structure this document provides in developing its own management system.

This document provides flexibility for organizations to determine their own scope, boundaries and calculation methodology for calculating net energy consumption, and for setting a pathway towards NZE. It does not discuss how to measure non-energy-related GHG impacts; for these, see ISO 14064-2:2019 and ISO 14067:2018.

This document recognizes that energy targets and calculation methods are chosen by the organization to be specific to its situation and can be determined outside the organization (e.g. by governments or consequent upon a GHG-calculation methodology). For situations when the measurement and calculations are developed by the organization itself, this document includes a high-level set of recommendations based on global best practice.

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0.2 NZE goals are being increasingly adopted

NZE is a key indicator for an organization wishing to demonstrate leadership in energy management and sustainable development. It is applicable for buildings, industries and other sectors. It may also be measured at the organizational, district or city level. The buildings sector has been the first to accept NZE concepts widely, but there are also NZE industrial facilities. To achieve NZE goals, buildings can use mandatory NZE codes. Meeting challenging targets requires industry to consider residual energy use.[14]

The global market for NZE buildings and industries is exhibiting rapid compound annual growth, spurred on in part by legislation or pledges at the local, national or supranational level (see, for example, EU Directive 2018/844[13]).

However, if these ambitious targets are to be met, a wide range of users including, but not limited to, energy service providers, building occupants, industrial managers, energy efficiency experts and government agencies require a common understanding of NZE and the use of standardized processes (such as those provided by this document) for targeting, measuring and maintaining it.

NOTE "Net zero building" is abbreviated as either "NZE building" or "NZC building".

This document aims to meet these needs and uses the EnMS goal of continual improvement, as required by ISO 50001, to harmonize definitions and claims in the context of improving from one target to the next over time. It also allows facilities that find it impractical to reach NZE in the short term to show how close they come to achieving it, and to demonstrate how they choose to approach NZE over time.

0.3 Importance of an energy management system to achieve NZE

In a typical building's life cycle, the operation and maintenance (O&M) phase (as shown in Figure 1) is more than 80 % of the total life-cycle energy consumption of that building and plant.[15] Thus, good energy management is critical to the life-cycle energy consumption of a building. As energy management improves as recommended by this document, it is likely that net energy consumption during operation declines dramatically, while energy consumption in other parts of the life cycle stays constant or declines by a smaller percentage. Thus, the non-operational energy impacts over the life cycle become relatively more important. That is one reason why that this document addresses these effects along with operational energy consumption, particularly when the energy targets are intended to be met in future years when energy performance is improved, and renewable energy production is increased.

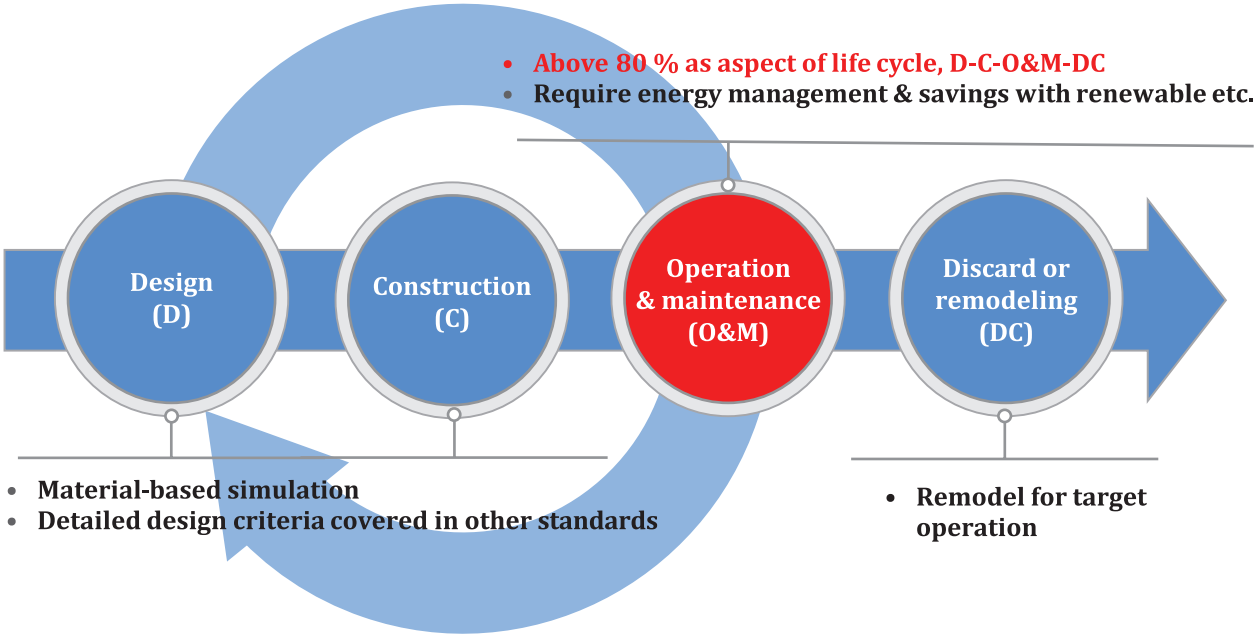

Figure 1 — Total life cycle energy use of an organization

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0.4 Contents of this document

Clause 4 provides a high-level introduction to the goals and processes of meeting different defined NZE targets, which are linked to each other by the process of continual improvement as part of an EnMS. It discusses how renewable energy should be treated in NZE demonstrations. It looks at how to select the most appropriate energy performance indicators (EnPIs) within an EnMS that can then be used to monitor progress towards achieving, maintaining and reaching higher levels of NZE (including NZC) over future years. The clause also considers how to develop a data collection plan, and ways of accounting for year-to-year variability, especially where renewable energy generation varies with weather conditions. The explanations of the rationales for the recommendation for NZE are provided in Annex B.

The additional NZE targets, which go beyond many existing definitions of NZE, are variants on the principle of NZC. In this document, “carbon” is used in a variety of terms (e.g. carbon footprint, carbon neutral) as carbon dioxide (CO_2) to represent GHG emissions and CO_2 equivalent, which is a unit of measurement for global warming effect. This document develops these recommendations on the effective O&M with renewable energy and how it is integrated into an EnMS. It highlights demand response as a way of matching energy consumption with available renewable energy in Clauses 5 and 6.

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Energy management and energy savings — Guidance for net zero energy in operations using an ISO 50001 energy management system

1 Scope

This document gives guidance on the use of an energy management system (EnMS) in accordance with ISO 50001:2018 to achieve net zero energy (NZE), and supports the achievement of net zero carbon (NZC) and other sustainability goals. It describes how to establish an enhanced EnMS designed to achieve:

a) improvement of operational and maintenance practices based on NZE principles;

b) integration of renewable energy into operations and maintenance;

c) planning for facilities, systems, equipment or processes to implement NZE and NZC.

This document does not apply to technologies, design or construction. The technical specification of passive, active or renewable energy for NZE or NZC is also not included because of different regional conditions by countries.

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 50001:2018, *Energy management systems — Requirements with guidance for use*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 50001:2018 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Terms related to net zero

3.1.1
net zero
state in which a quantity of a commodity with one attribute is balanced by the same quantity of the commodity with a different attribute

Note 1 to entry: The commodity can be physical (e.g. water), a waste, a by-product (e.g. greenhouse gas emissions) or a form of energy.

Note 2 to entry: Net zero can be applied within specified *net zero energy target boundaries* (3.1.7) over a defined period of time.

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3.1.2
net zero energy
NZE
state in which a quantity of energy consumption is balanced by the same quantity of *clean renewable energy* (3.2.2) generated

Note 1 to entry: The energy consumed can be in the form of a fuel such as gas, oil or coal, or a medium such as electricity, steam or heat.

Note 2 to entry: NZE can be applied within specified *NZE target boundaries* (3.1.7) over a defined period of time.

3.1.3
net zero carbon
NZC
state in which a quantity of greenhouse gas (GHG) emissions is balanced by the same quantity of GHG removals

Note 1 to entry: Where *GHGs* (3.2.8) take the form of different gases (such as CO_2, CH_4, N_2O, F-gases or SF_6) they can be converted to a common unit such as tonnes of CO_2e using their global warming potential.

Note 2 to entry: NZC can be applied within boundaries specified by the organization over a defined period of time.

Note 3 to entry: The GHG removals can be achieved by *clean renewable energy* (3.2.2) generation.

Note 4 to entry: This document uses the term "net zero carbon" to mean net zero GHG emissions, following common practice among net zero energy practitioners. The difference between CO_2 and GHGs can be small or negligible for buildings but can be significant for industrial facilities.

3.1.4
energy independence rate
EIR
rate of energy generation compared with energy consumption within the same *net zero energy target boundaries* (3.1.7)

Note 1 to entry: It is expressed as a percentage.

3.1.5
zero energy performance indicator
zEnPI
indicator which trends to or is equal to zero for *net zero energy (NZE)* (3.1.2) or *net zero carbon* (3.1.3)

Note 1 to entry: zEnPI can be a ratio or rate between *renewable energy* (3.2.1) and *delivered energy* (3.2.4) within specified *NZE target boundaries* (3.1.7) over a defined period of time.

Note 2 to entry: zEnPI can be *normalized* (3.2.9) energy use (e.g. renewable energy consumption per unit of output).

Note 3 to entry: zEnPIs do not replace the energy performance indicators for the energy management system and can be used in defining the zEnPI, e.g. zEnPI is normalized energy consumption (kWh) minus renewable energy produced (kWh).

3.1.6
NZE target
net zero energy target
quantifiable objective of *net zero energy (NZE)* (3.1.2)

Note 1 to entry: The quantifiable objective of NZE is the zero energy performance indicator (zEnPI) value, which is = 0 based on the definition of *zEnPI* (3.1.5).

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3.1.7
NZE target boundaries
net zero energy target boundaries
physical or organizational limits within which an *NZE target* (3.1.6) is assessed

EXAMPLE A process, a group of processes, a site, multiple sites under the control of an organization, an entire organization.

Note 1 to entry: The organization defines its NZE target boundaries.

3.2 Terms related to net zero energy operation

3.2.1
renewable energy
energy not depleted by extraction as it is replenished at a rate equal to or faster than it is extracted

Note 1 to entry: Renewable energy excludes recovered or wasted energy.

Note 2 to entry: Organic fraction of municipal waste can be considered as a renewable energy.

Note 3 to entry: Whether the energy stored in a technical system is renewable or not depends upon the nature of the original energy.

Note 4 to entry: Criteria to categorize an energy source as renewable can differ amongst jurisdictions, based on local environmental or other reasons.

[SOURCE: ISO 50007:2017, 3.38, modified — "naturally" deleted before "replenished" and "equal to or" added before "faster" in the definition.]

3.2.2
clean renewable energy
renewable energy (3.2.1) whose direct or indirect emissions of *greenhouse gas (GHG)* (3.2.8), other gases with adverse impacts on human health, water pollutants, or other toxic releases, and whose impacts on ecosystems are substantially lower than those of fossil fuels

Note 1 to entry: Geothermal energy that releases high levels of SO_2 gases to the atmosphere does not qualify under this definition.

Note 2 to entry: Wood pellet or solid wood combustion does not qualify if the GHG emissions associated with producing the wood-derived fuels are not substantially lower than those from gas-fired generation.

[SOURCE: ISO 50007:2017, 3.38, modified — "fossil fuels" replaced "conventional alternatives such as gas-fired generation" in the definition. "wood-derived fuels are not substantially lower than those from gas-fired generation" replaced "wood are similar to those of coal on the basis of a megajoule of fuel" in Note 2 to entry.]

3.2.3
off-site energy
energy (such as electricity and heat) necessary for the organization and originating from outside the organization's boundary

Note 1 to entry: Off-site energy is one of the energy production and supply methods to achieve *net zero energy* (3.1.2).

Note 2 to entry: On-site energy generation is a method of supplying and producing energy within the boundary of the site.

Note 3 to entry: The electricity generated is delivered to the grid first.

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3.2.4
delivered energy
energy arriving at the boundaries of an organization

[SOURCE: ISO 50047:2016, 3.3, modified — Note 1 to entry deleted.]

3.2.5
primary energy
energy that has not been subjected to any conversion or transformation process

Note 1 to entry: Primary energy can be either a non-renewable or a *renewable energy* (3.2.1), or a combination of both.

[SOURCE: ISO 50047:2016, 3.17]

3.2.6
embodied energy
energy consumed in the processes associated with the production, transportation, installation and assembly of materials, products and services through their lifecycle

[SOURCE: ISO 6707-3:2017, 3.7.6, modified — "total of all the" deleted before "energy" and "transportation, installation and assembly of materials, products and services through their lifecycle" replaced "of materials and products" in the definition.]

3.2.7
demand response
ability of an organization consuming energy to respond to a trigger by lowering or raising their power consumption temporarily

Note 1 to entry: The trigger may be from a utility system operator, load-serving entity, regional transmission organization/independent system operator or other entity.

Note 2 to entry: The trigger may be a reliability trigger or a price trigger.

Note 3 to entry: Demand response is a temporary change in energy consumption, sometimes with a decrease in service level (e.g. less comfortable climate, non-optimal lighting).

3.2.8
greenhouse gas
GHG
gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds

Note 1 to entry: For a list of GHGs, see the latest Intergovernmental Panel on Climate Change Assessment Report.

Note 2 to entry: Water vapour and ozone are anthropogenic as well as natural GHGs, but are not included as recognized GHGs due to difficulties, in most cases, in isolating the human-induced component of global warming attributable to their presence in the atmosphere.

[SOURCE: ISO 14064-1:2018, 3.1.1]

3.2.9
normalize
modify data to account for changes to enable comparison of energy performance under equivalent conditions

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