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Energy management systems — Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI) — General principles and guidance

Systèmes de management de l'énergie — Mesurage de la performance énergétique à l'aide des performances énergétiques de référence (PER) et d'indicateurs de performance énergétique (IPÉ) — Principes généraux et lignes directrices

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Foreword

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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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is Technical Committee ISO/TC 242, *Energy management*.

Introduction

This International Standard provides organizations with practical guidance on how to meet the requirements of ISO 50001 related to the establishment, use and maintenance of energy performance indicators (EnPIs) and energy baselines (EnBs) in measuring energy performance and energy performance changes. EnPIs and EnBs are two key interrelated elements of ISO 50001 that enable the measurement, and therefore management of energy performance in an organization. Energy performance is a broad concept which is related to energy consumption, energy use and energy efficiency.

In order to effectively manage the energy performance of their facilities, systems, processes and equipment, organizations need to know how energy is used and how much is consumed over time. An EnPI is a value or measure that quantifies results related to energy efficiency, use and consumption in facilities, systems, processes and equipment. Organizations use EnPIs as a measure of their energy performance.

The EnB is a reference that characterizes and quantifies an organization's energy performance during a specified time period. The EnB enables an organization to assess changes in energy performance between selected periods. The EnB is also used for calculation of energy savings, as a reference before and after implementation of energy performance improvement actions.

Organizations define targets for energy performance as part of the energy planning process in their energy management systems (EnMS). The organization needs to consider the specific energy performance targets while identifying and designing EnPIs and EnBs. The relationship between energy performance, EnPIs, EnBs and energy targets is illustrated in Figure 1.

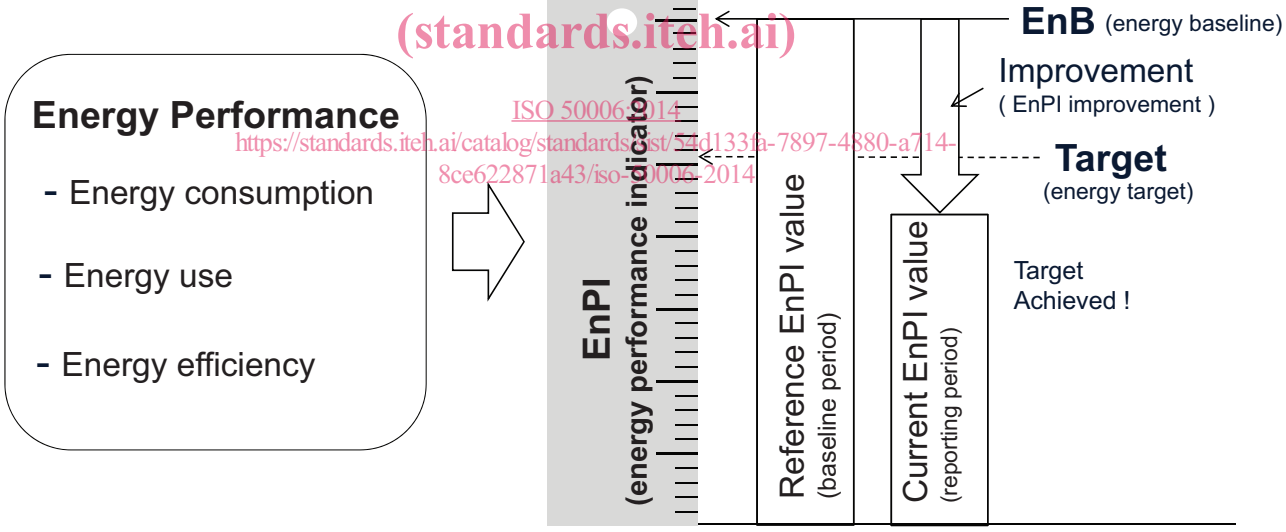

Figure 1 — Relationship between energy performance, EnPIs, EnBs and energy targets

This International Standard includes practical help boxes designed to provide the user with ideas, examples and strategies for measuring energy performance using EnPIs and EnBs.

The concepts and methods in this International Standard can also be used by organizations that do not have an existing EnMS. For example, EnPIs and EnBs can also be used at the facility, system, process or equipment level, or for the evaluation of individual energy performance improvement actions.

Ongoing commitment and engagement by top management is essential to the effective implementation, maintenance and improvement of the EnMS in order to achieve the benefits in energy performance improvement. Top management demonstrates its commitment through leadership actions and active involvement in the EnMS, ensuring ongoing allocation of resources including people to implement and sustain the EnMS over time.

Energy management systems — Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI) — General principles and guidance

1 Scope

This International Standard provides guidance to organizations on how to establish, use and maintain energy performance indicators (EnPIs) and energy baselines (EnBs) as part of the process of measuring energy performance.

The guidance in this International Standard is applicable to any organization, regardless of its size, type, location or level of maturity in the field of energy management.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 50001:2011, *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 and the following apply.

3.1
adjustment
process of modifying the energy baseline in order to enable energy performance comparison under equivalent conditions between the reporting period and the baseline period

Note 1 to entry: ISO 50001 requires adjustments to the EnB when EnPIs no longer reflect organizational energy use and consumption, or when there have been major changes to the process, operational patterns, or energy systems, or according to a predetermined method.

Note 2 to entry: Typically adjustments are made to account for changes in static factors.

Note 3 to entry: Predetermined methods typically reset the EnB at defined intervals.

3.2
baseline period
defined period of time used to compare energy performance with the reporting period

3.3
boundaries
physical or site limits and/or organizational limits as defined by the organization

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

[SOURCE: ISO 50001:2011, 3.1]

3.4
energy
electricity, fuels, steam, heat, compressed air, and other like media

Note 1 to entry: For the purposes of this International Standard, energy refers to the various forms of energy, including renewable, which can be purchased, stored, treated, used in equipment or in a process, or recovered.

Note 2 to entry: Energy can be defined as the capacity of a system to produce external activity or perform work.

[SOURCE: ISO 50001:2011, 3.5]

3.5
energy baseline
EnB
quantitative reference(s) providing a basis for comparison of energy performance

Note 1 to entry: An energy baseline reflects a specified period of time.

Note 2 to entry: An energy baseline can be normalized using variables which affect energy use and/or consumption, e.g. production level, degree days (outdoor temperature), etc.

Note 3 to entry: The energy baseline is also used for calculation of energy savings, as a reference before and after implementation of energy performance improvement actions.

[SOURCE: ISO 50001:2011, 3.6, modified — Abbreviated term has been added.]

3.6
energy consumption
quantity of energy applied

Note 1 to entry: Energy consumption can be represented in volume and mass flow or weight units (fuel) or converted into units that are multiples of joules or watt-hours (e.g. GJ, kWh).

Note 2 to entry: Energy consumption is typically measured using permanent or temporary meters. The values can be measured directly or can be calculated over a specific period of time.

[SOURCE: ISO 50001:2011, 3.7, modified —Notes 1 and 2 to entry have been added.]

3.7
energy efficiency
ratio or other quantitative relationship between an output of performance, service, goods or energy, and an input of energy

EXAMPLE Conversion efficiency; energy required/energy used; output/input; theoretical energy used to operate/energy used to operate.

Note 1 to entry: Both input and output need to be clearly specified in quantity and quality, and be measurable.

[SOURCE: ISO 50001:2011, 3.8]

3.8
energy performance
measurable results related to energy efficiency, energy use and energy consumption

Note 1 to entry: In the context of energy management systems, results can be measured against the organization's energy policy, objectives, targets and other energy performance requirements.

Note 2 to entry: Energy performance is one component of the performance of the energy management system.

[SOURCE: ISO 50001:2011, 3.12]

3.9
energy performance indicator
EnPI
quantitative value or measure of energy performance, as defined by the organization

Note 1 to entry: EnPIs could be expressed as a simple metric, ratio or a more complex model.

[SOURCE: ISO 50001:2011, 3.13]

3.10
energy target
detailed and quantifiable energy performance requirement, applicable to the organization or parts thereof, that arises from the energy objectives and that needs to be set and met in order to achieve this objective

[SOURCE: ISO 50001:2011, 3.17]

3.11
energy use
manner or kind of application of energy

EXAMPLE Ventilation; lighting; heating; cooling; transportation; processes; production lines.

[SOURCE: ISO 50001:2011, 3.18]

3.12
facility

single installation, set of installation or production processes (stationary or mobile), which can be defined within a single geographical boundary, organization unit or production process

[SOURCE: ISO 14064-3:2006, 2.22]

3.13
normalization
process of routinely modifying energy data in order to account for changes in relevant variables to compare energy performance under equivalent conditions

Note 1 to entry: EnPIs and corresponding EnBs can be normalized.

3.14
relevant variable
quantifiable factor that impacts energy performance and routinely changes

EXAMPLE Production parameters (production, volume, production rate); weather conditions (outdoor temperature, degree days); operating hours; operating parameters (operational temperature, light level).

3.15
reporting period
defined period of time selected for calculation and reporting of energy performance

EXAMPLE The period for which an organization wants to assess changes in EnPIs relative to the EnB period.

3.16
significant energy use
SEU
energy use accounting for substantial energy consumption and/or offering considerable potential for energy performance improvement

Note 1 to entry: Significance criteria are determined by the organization.

[SOURCE: ISO 50001:2011, 3.27, modified — Abbreviated term has been added.]

3.17
static factor
identified factor that impacts energy performance and does not routinely change

EXAMPLE 1 Facility size; design of installed equipment; the number of weekly production shifts; the number or type of occupants (e.g. office workers); range of products.

EXAMPLE 2 A change of a static factor could be a change in a manufacturing process raw material, from aluminium to plastic.

[SOURCE: ISO 50015:2014, 3.22, modified — Examples have been modified.]

4 Measurement of energy performance

4.1 General overview

4.1.1 General

In order to effectively measure and quantify its energy performance, an organization establishes EnPIs and EnBs. EnPIs are used to quantify the energy performance of the whole organization or its various parts. EnBs are quantitative references used to compare EnPI values over time and to quantify changes in energy performance.

Energy performance results can be expressed in units of consumption (e.g. GJ, kWh), specific energy consumption (SEC) (e.g. kWh/unit), peak power (e.g. kW), percent change in efficiency or dimensionless ratios, etc. The general relationship between energy performance, EnPIs, EnBs and energy targets is illustrated in Figure 1 in the introduction.

Energy performance can be affected by a number of relevant variables and static factors. These can be linked to changing business conditions such as market demand, sales and profitability.

An overview of the process to develop, use and update EnPIs and EnBs is illustrated in Figure 2 and described in detail in 4.2 to 4.6. This process helps the organization to continually improve the measurement of its energy performance.

4.1.2 Energy consumption

Quantifying energy consumption is essential for measuring energy performance and energy performance improvements.

When multiple forms of energy are used, it is useful to convert all forms to a common unit of measure of energy. Care should be taken to perform the conversion in a manner that appropriately represents total energy consumed including losses in the energy conversion process.

4.1.3 Energy use

Identifying energy uses such as energy systems (e.g. compressed air, steam, chilled water, etc.), processes and equipment helps to categorize energy consumption and to focus energy performance on uses that are important to an organization.

4.1.4 Energy efficiency

Energy efficiency is a frequently used metric for measuring energy performance and may be used as an EnPI.

Energy efficiency can be expressed in a number of ways, such as energy output/energy input (conversion efficiency); energy required/energy consumed (where energy required may be derived from a theoretical

model or some other relationship); production output/energy input (for example the tons of production per unit energy consumed).

NOTE Energy input/production output is sometimes used as an EnPI and is referred to as energy intensity.

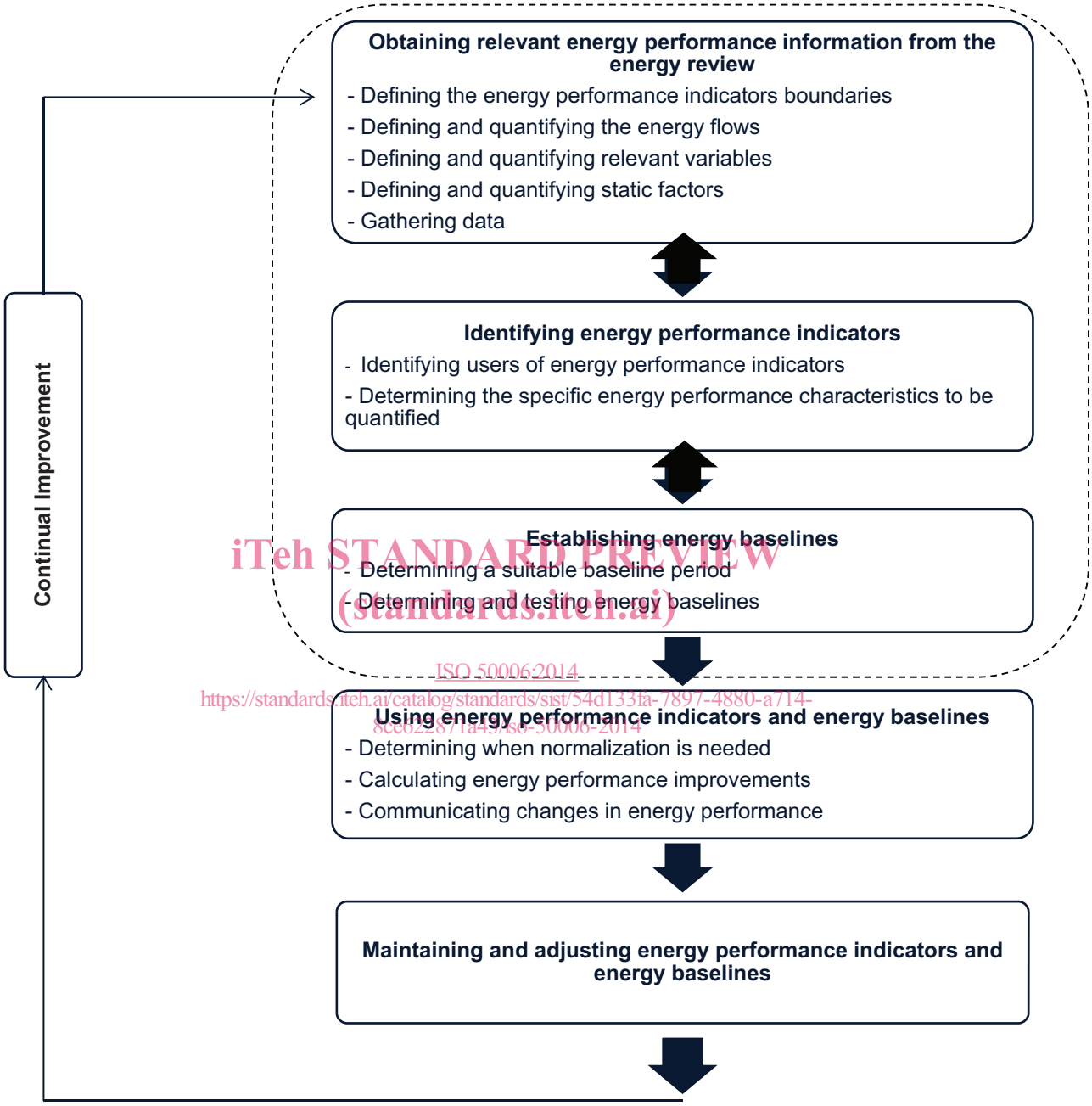

Figure 2 — Overview of energy performance measurement

4.1.5 Energy performance indicators (EnPIs)

EnPIs should provide relevant energy performance information to enable various users within an organization to understand its energy performance and take actions to improve it.

The EnPIs can be applied at facility, system, process or equipment levels to provide various levels of focus.

An organization should set an energy target and an energy baseline for each EnPI.

4.1.6 Energy baselines (EnBs)

An organization should compare energy performance changes between the baseline period and the reporting period. The EnB is simply used to determine the EnPI values for the baseline period. The type of information needed to establish an energy baseline is determined by the specific purpose of the EnPI.

4.1.7 Quantifying energy performance

Energy performance changes can be calculated using EnPIs and EnBs for facilities, systems, processes or equipment.

Comparing energy performance between the baseline period and the reporting period involves calculating the difference in the value of the EnPI between the two periods. Figure 3 illustrates the simple case where direct measurement of energy consumption is used as the EnPI and energy performance is compared between the baseline period and the reporting period.

In cases where the organization has determined that relevant variables such as weather, production, building operating hours etc. affect energy performance, the organization should normalize the EnPI and its corresponding EnB to compare energy performance under equivalent conditions.

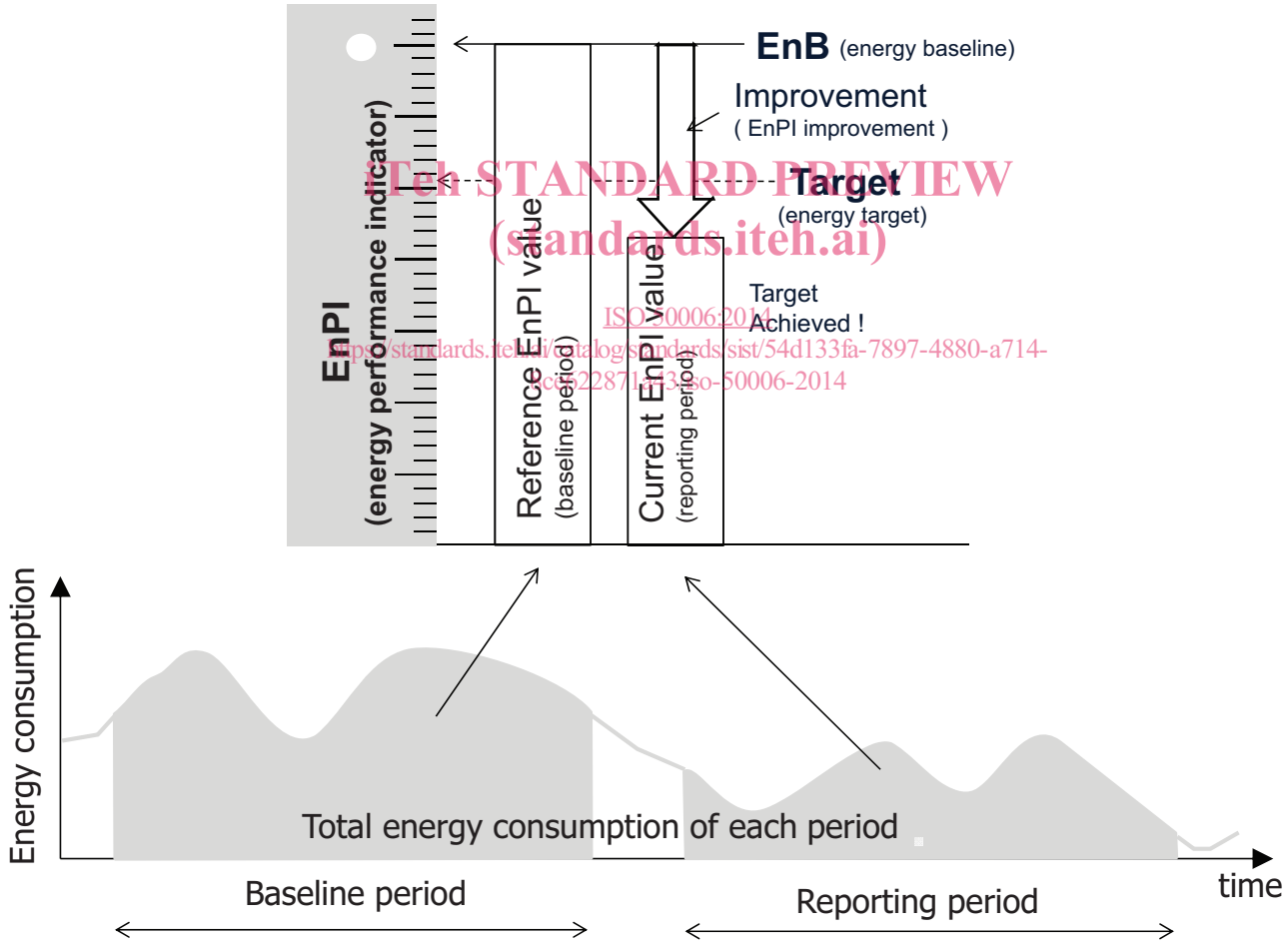

Figure 3 — Concept of baseline period and reporting period for an EnPI

4.2 Obtaining relevant energy performance information from the energy review

4.2.1 General

The energy review provides useful energy performance information for developing EnPIs and EnBs. Annex A illustrates the relationship between the energy review and information needed to identify EnPIs and establish EnBs. The establishment of appropriate EnPIs and corresponding EnBs requires access to available organizational energy data, analysis of the data, and processing of energy information.

4.2.2 Defining the energy performance indicator boundaries

The EnMS scope and boundary comprise the area or the activities within which an organization manages energy performance.

To measure energy performance, suitable measurement boundaries for each EnPI should be defined. These are termed EnPI boundaries and they may overlap.

NOTE The users of EnPI and their needs are identified first (see 4.3.2), and then the corresponding EnPI boundary is defined.

When defining an EnPI boundary, consideration should be given to:

— organizational responsibilities in relation with energy management;

— the ease of isolating the EnPI boundary by measuring energy and relevant variables;

— the EnMS boundary;

— the significant energy use (SEU) or group of SEUs the organization designates as a priority to control and improve;

— specific equipment, processes and sub-processes that the organization wishes to isolate and manage.

The three primary EnPI boundary levels are individual, system and organizational as described in Table 1.

Table 1 — The three EnPI boundary levels

EnPI boundary levels	Description and examples
Individual facility/equipment/process	The EnPI boundary can be defined around the physical perimeter of one facility/equipment/process the organization wants to control and improve Example: The steam production equipment
System	The EnPI boundary can be defined around the physical perimeter of a group of facilities/processes/equipment interacting with each other that the organization wants to control and improve Example: The steam production and the steam use equipment, such as a dryer
Organizational	The EnPI boundary can be defined around the physical perimeter of facilities/processes/equipment also taking into account the responsibility in energy management of individuals, teams, groups or business units designated by the organization Example: Steam purchased for a factory/factories, or department of the organization

Supplemental information on EnPI boundaries in the production process can be found in Annex B.

4.2.3 Defining and quantifying energy flows

Once an EnPI boundary is defined, the organization should identify energy flowing across the boundary. The organization can use a diagram like the one in Figure 4 to determine the energy information required to establish EnPIs. These fence diagrams or energy maps visually show flow of energy within and across the EnPI boundary. They can also include additional information, such as metering points and product flow which are important for energy analysis and establishment of EnPIs.