



**Standardisation landscape for the energy management
and environmental viability of data centres**

7th Edition 2020

Foreword

This Report was prepared by the CEN/CLC/ETSI Joint Coordination Group Green Data Centres.

CONTENTS

Foreword	2
1 Scope.....	9
2 Void	9
3 Definitions and abbreviations	9
3.1 Definitions.....	9
3.2 Abbreviations	11
4 Context.....	12
4.1 Data centres.....	12
4.2 Design standardisation	14
4.3 Operational standardisation	14
4.4 Key Performance Indicators (KPIs)	14
4.5 Taxonomy	14
5 Designing for improvement of energy management	15
5.1 General.....	15
5.2 Infrastructure requirements	15
5.2.1 Construction.....	15
5.2.2 Power distribution	15
5.2.3 Environmental control.....	16
5.2.4 Telecommunications cabling	16
5.2.5 Building automation.....	16
5.2.6 Measurement/monitoring/metering	17
5.3 Infrastructure recommendations (best practice).....	17
5.3.1 General.....	17
5.3.2 Location.....	17
5.3.3 Construction.....	18
5.3.4 Power distribution	18
5.3.5 Environmental control.....	18
5.3.6 Telecommunications cabling	18
5.3.7 Building automation.....	19
5.3.8 Measurement/monitoring/metering	19
5.3.9 Key Performance Indicators	19
5.4 ITE requirements	19
5.4.1 Computing.....	19
5.4.2 Storage.....	19
5.4.3 Networking.....	20
5.4.4 Measurement/monitoring/metering	20
5.4.5 Key Performance Indicators	20
5.5 ITE recommendations (best practice)	20
5.5.1 Computing.....	20
5.5.2 Storage.....	21
5.5.3 Networking.....	21
5.5.4 Measurement/monitoring/metering	21
5.5.5 Key Performance Indicators	21
6 Designing for environmental viability.....	22
6.1 General.....	22

- 6.2 Infrastructure requirements 22
 - 6.2.1 Construction 22
 - 6.2.2 Power distribution 22
 - 6.2.3 Environmental control..... 23
 - 6.2.4 Telecommunications cabling 23
 - 6.2.5 Building automation..... 23
 - 6.2.6 Measurement/monitoring/metering 23
 - 6.2.7 Key Performance Indicators 23
- 6.3 Infrastructure recommendations (best practice) 24
 - 6.3.1 Location 24
 - 6.3.2 Construction 24
 - 6.3.3 Power distribution 24
 - 6.3.4 Environmental control..... 24
 - 6.3.5 Telecommunications cabling 24
 - 6.3.6 Building automation..... 24
 - 6.3.7 Measurement/monitoring/metering 25
 - 6.3.8 Key Performance Indicators 25
- 6.4 ITE and software requirements 25
 - 6.4.1 Computing..... 25
 - 6.4.2 Storage 25
 - 6.4.3 Networking 26
 - 6.4.4 Measurement/monitoring/metering 26
- 6.5 ITE and software recommendations (best practice) 26
 - 6.5.1 Computing..... 26
 - 6.5.2 Storage 26
 - 6.5.3 Networking 27
 - 6.5.4 Measurement/monitoring/metering 27
 - 6.5.5 Key Performance Indicators 27
- 7 Operating procedures..... 28
 - 7.1 General..... 28
 - 7.2 Infrastructure requirements 28
 - 7.2.1 Power distribution 28
 - 7.2.2 Environmental control..... 28
 - 7.2.3 Measurement/monitoring/metering 29
 - 7.3 Infrastructure recommendations (best practice) 29
 - 7.3.1 Power distribution 29
 - 7.3.2 Environmental control..... 29
 - 7.3.3 Measurement/monitoring/metering 30
 - 7.4 ITE requirements 30
 - 7.4.1 Computing..... 30
 - 7.4.2 Storage 30
 - 7.4.3 Networking 30
 - 7.4.4 Measurement/monitoring/metering 31
 - 7.5 ITE and software recommendations (best practice) 31
 - 7.5.1 Computing..... 31
 - 7.5.2 Storage 31
 - 7.5.3 Networking 31

7.5.4	Measurement/monitoring/metering	32
8	Operational Key Performance Indicators	33
8.1	Energy management	33
8.1.1	General.....	33
8.1.2	Objective KPIs.....	33
8.1.3	Global KPIs	35
8.2	Environmental viability.....	35
8.2.1	Objective KPIs.....	35
8.2.2	Maturity.....	35
Annex A	Product standards: Construction (e.g. lighting products)	36
A.1	General.....	36
A.2	Products	36
A.2.1	Containment.....	36
Annex B	Product standards: Power distribution (e.g. transformers, UPS, LVDC)	37
B.1	General.....	37
B.2	Products	37
B.2.1	Transformers.....	37
B.2.2	Switching equipment	37
B.2.3	Distribution panels	38
B.2.4	Uninterruptible power supplies	38
B.2.5	Connecting hardware	38
B.2.6	Measurement equipment.....	38
Annex C	Product standards: Environmental control.....	39
C.1	General.....	39
Annex D	Product standards: ITE	40
D.1	General.....	40
Annex E	Key Performance Indicators for energy management.....	41
E.1	Technical KPIs.....	41
E.2	Objective KPIs.....	41
E.3	Global KPIs	42
E.4	Summary	42
Annex F	Bibliography.....	43
F.1	List of referenced standards from main body.....	43
F.1.1	CENELEC	43
F.1.2	ETSI.....	44
F.1.3	IEC.....	44
F.1.4	ISO/IEC	44
F.1.5	ITU.....	45
F.2	List of referenced activities/documents from main body.....	46
F.3	List of referenced standards from Annexes	46
F.3.1	CENELEC	46
F.3.2	IEC.....	46
F.4	List of potentially useful standards.....	47
F.5	List of bookmarked standards.....	47
F.5.1	CENELEC	47
F.5.2	ISO.....	48

F.5.3 ISO/IEC 48

List of Figures

Figure 1 – Schematic of ESO standardisation for data centre energy management..... 8
Figure 2 - Schematic of ESO standardisation for data centre environmental viability..... 8
Figure 3 – Schematic of basic data centre functional elements..... 12
Figure 4 – Standardization landscape for data centre energy management and
environmental viability 13
Figure E.1 - The relationship of energy-related Technical, Objective and Global KPIs..... 42

Introduction

It is widely recognised that demand for data will increase and that this demand is founded upon data centres of all sizes and serving a variety of business objectives i.e. whether they serve subscribers' demands for broadband delivery or employees demands within enterprises. It is also recognised that this increasing demand for data will, unless pressure is applied to improve energy efficiency, result in an unsupportable demand for power. This is already the situation in certain areas of our large cities.

For the purposes of this report, an improvement in energy management comprises four separate elements:

- a reduction of the total energy consumption of a data centre;
- an increase of task efficiency (i.e. doing more work for a given energy input);
- the use, or increased use, of locally provided energy generated from renewable sources;
- the re-use of any waste heat from the data centre.

In addition, it is clear that in the longer term there are other environmental viability issues to consider including the use of natural resources such as water to provide cooling to the data centre and the impact of the data centre on greenhouse gas (GHG) emissions, air pollution and other hazardous by-products.

NOTE: The term "environmental viability" is used recognising that well established treatments of "sustainability" feature three separate viability objectives (environmental, economic and social). For the purposes of this report, only operational aspects of environmental viability are considered. A wider approach to environmental viability takes other factors into account including the use of raw materials and avoidance of hazardous substances in the construction or de-commissioning of the data centre spaces or the equipment within it- these factors are not considered in this report.

It is therefore imperative to underpin these wider objectives for energy management and environmental viability, which can be met by encouragement (voluntary engagement) or by regulation, by providing a foundation of standards which represent the "tools" to support the application of these "levers".

This document sets out the required standardisation landscape and details both actions that are underway, and those that require initiation, within European Standardization Organizations (ESOs) in relation to energy management (shown schematically in Figure 1) and environmental viability (as in Figure 2).

Activities in Layer A are described in the main body of this document. Activities in Layer B are described in the informative Annexes

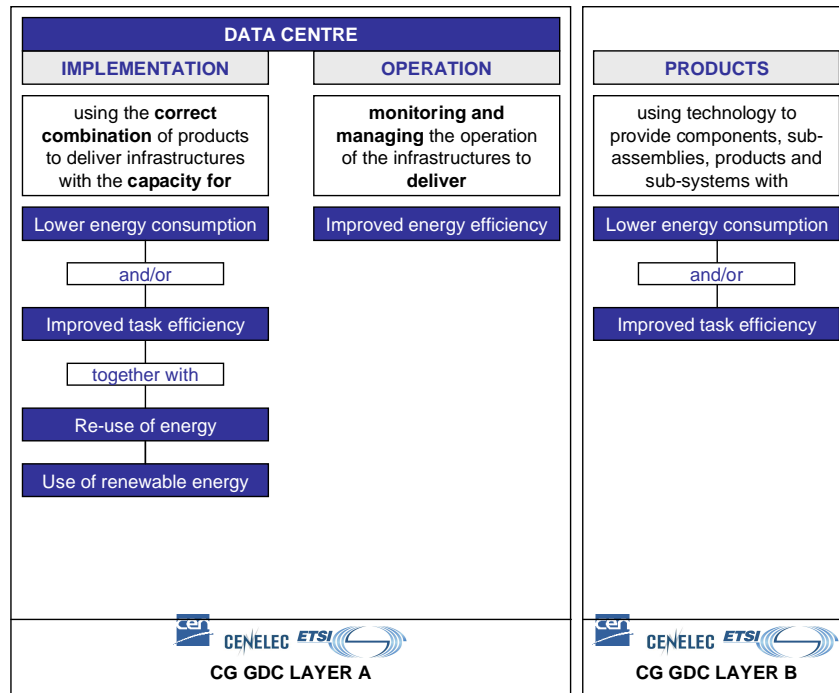


Figure 1 – Schematic of ESO standardisation for data centre energy management

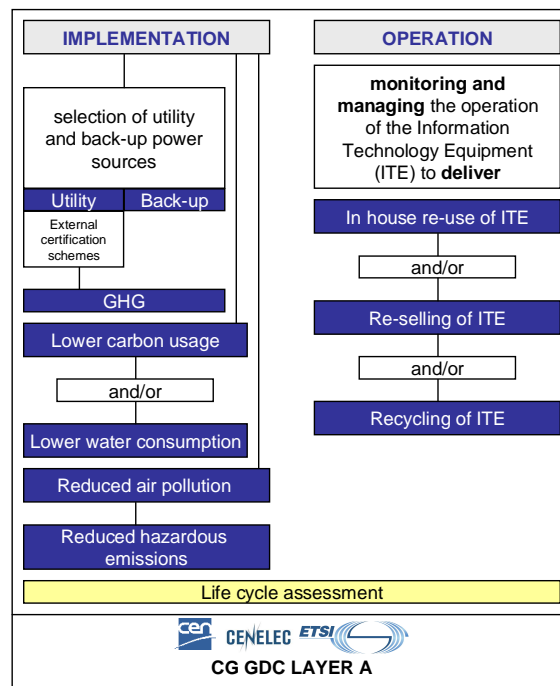


Figure 2 - Schematic of ESO standardisation for data centre environmental viability

1 Scope

This report:

- provides a mapping of European and international standards and other relevant documents applicable to the construction, implementation and operation of data centres and the equipment and systems contained within them;
- identifies potential areas of duplication and areas requiring development;
- acts as a “live” record of evolving standardisation activity and provides a foundation for other “snapshot” documents produced by CEN/CENELEC/ETSI Coordination Group on Green Data Centres.

2 Void

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this report the following definitions apply.

3.1.1

data centre

structure, or group of structures, dedicated to the centralized accommodation, interconnection and operation of information technology and network telecommunications equipment providing data storage, processing and transport services together with all the facilities and infrastructures for power distribution and environmental control together with the necessary levels of resilience and security required to provide the desired service availability

Note 1 to entry: A structure can consist of multiple buildings and/or spaces with specific functions to support the primary function.

Note 2 to entry: the boundaries of the structure or space considered the data centre which includes the information and communication technology equipment and supporting environmental controls can be defined within a larger structure or building.

[SOURCE: EN 50600-1:2019, 3.1.9, ISO/IEC 30134-1, 3.1.1]

co-hosting data centre

data centre in which multiple customers are provided with access to network(s), servers and storage equipment on which they operate their own services/applications

Note 1 to entry: Both the information technology equipment and the support infrastructure of the building are provided as a service by the data centre operator.

[SOURCE: EN 50174-2:2018, 3.1.2 and EN 50600-1:2019, 3.1.5]

co-location data centre

data centre in which multiple customers locate their own network(s), servers and storage equipment

Note 1 to entry: The support infrastructure of the building (such as power distribution and environmental control) is provided as a service by the data centre operator.

[SOURCE: EN 50174-2:2018, 3.1.3 and EN 50600-1:2019, 3.1.6]

enterprise data centre

data centre that is operated by an enterprise which has the sole purpose of the delivery and management of services to its employees and customers

[SOURCE: EN 50174-2:2018, 3.1.8 and EN 50600-1:2019, 3.1.14]

hosting data centre

a data centre within which ownership of the facility and the information technology equipment is common but the software systems are dictated by others

3.1.2 energy consumption

total consumption of energy by an operational infrastructure

[SOURCE: ETSI EN 305 200-1 V1.1.1:2018]

3.1.3 energy management

combination of reduced energy consumption and increased task efficiency, re-use of energy and use of renewable energy

[SOURCE: ETSI EN 305 200-1 V1.1.1:2018, CLC/TR 50600-99-1:2020, 3.1.12 – modified: replaced “task” by “energy”]

3.1.4 energy re-use

transfer or conversion of energy (typically in the form of heat) produced by the operational infrastructure to do other work

[SOURCE: ETSI EN 305 200-1 V1.1.1:2018]

3.1.5 environmental control system

facilities and infrastructures necessary to maintain the equipment of a data centre within its required environmental performance range

3.1.6 Information Technology Equipment (ITE)

equipment providing data storage, processing and transport services together with the network telecommunications equipment dedicated to providing direct connection to core and/or access networks.

[SOURCE: EN 50600-2-2:2019, 3.1.3]

3.1.7 IT load

electrical consumption of all the information technology equipment measured at its input terminals including all on-board integrated power supplies and cooling fans

[SOURCE: EN 50600-2-2:2019, 3.1.14]

3.1.8 Key Performance Indicator (KPI)

global KPI

a KPI of an operational infrastructure which presents information from a number of separate objective KPIs

objective KPI

a KPI assessing one of the objectives of energy management or environmental viability of an operational infrastructure which may be subsequently used to define a global KPI

technical KPI

a KPI assessing the energy management or environmental viability of a component, sub-assembly, product or sub-system under a specified set of conditions

3.1.9

operational infrastructure

the combination of information technology equipment (ITE) together with the power supply and environmental control systems necessary to ensure provision of service

[SOURCE: ETSI EN 305 200-1 V1.1.1:2018 modified]

3.1.10

power supply and distribution system

facilities and infrastructures necessary to provide power to the equipment of a data centre to meet desired operational objectives

3.1.11

renewable energy

a) energy produced from dedicated generation systems using resources that are naturally replenished

[SOURCE: ETSI EN 305 200-1 V1.1.1:2018]

b) energy obtained from a renewable energy source

Note 1 to entry: Criteria to categorize an energy as renewable can differ amongst jurisdictions, based on local environmental or other reasons.

[SOURCE: EN 50600-4-3:2016, 3.1.1, EN ISO/IEC 13273-2:2016, 3.1.6]

3.1.12

task efficiency

measure of the work done (as a result of design and/or operational procedures) for a given amount of energy consumed

[SOURCE: ETSI EN 305 200-1 V1.1.1:2018]

3.2 Abbreviations

For the purposes of this report the following abbreviations.

CEN	European Committee for Standardization
CENELEC, CLC	European Committee for Electrotechnical Standardization
ESO	European Standardization Organizations (CEN, CENELEC and ETSI)
ETSI	European Telecommunications Standards Institute
EU CoC BP	EU Code of Conduct for Data Centre Energy Efficiency Best Practices
GHG	Green House Gas
IEC	International Electrotechnical Commission
ITE	Information Technology Equipment
ISO	International Standardization Organization
KPI	Key Performance Indicator
TC	Technical Committee

4 Context

4.1 Data centres

Data centres contain a mixture of equipment providing data storage, processing and transport within the data centre and other equipment connecting the data centre to the “outside world”. This information technology equipment (ITE) has, in most cases, to be supported by power distribution, environmental control and building automation systems (such as lighting and access control). A schematic showing the relationship of these functional elements is shown in Figure 3.

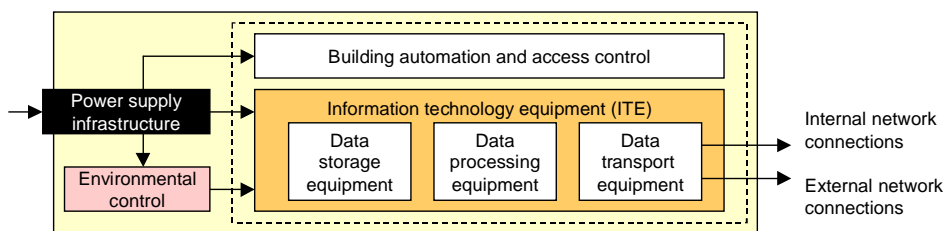


Figure 3 – Schematic of basic data centre functional elements

However, data centres come in all shapes and sizes ranging from one or more cabinets in an existing building to dedicated, “stand alone”, structures which may comprise multiple buildings. As a result the need for power supply infrastructures, environmental control systems and building automation and access control systems varies greatly as does the implementation (reliability and resilience) of those systems.

For the purposes of this report, an improvement in energy management comprises four separate elements:

- a) a reduction of the total energy consumption of a data centre;
- b) an increase of task efficiency (i.e. doing more work for a given energy input);
- c) the use, or increased use, of locally provided energy generated from renewable sources;
- d) the re-use of any waste heat from the data centre.

In addition it is clear that in the longer term there are other environmental viability issues to consider including the use of natural resources such as water to provide cooling to the data centre and the impact of the data centre on greenhouse gas (GHG) emissions, air pollution and other hazardous by-products.

NOTE: The term “environmental viability” is used recognising that well established treatments of “sustainability” feature three separate viability objectives (environmental, economic and social). For the purposes of this report, only operational aspects of environmental viability are considered. A wider approach to environmental viability takes other factors into account including the use of raw materials and avoidance of hazardous substances in the construction or de-commissioning of the data centre spaces or the equipment within it- these factors are not considered in this report.

The most basic data centres will have limited “dedicated” content with respect to such facilities and infrastructures and these will generally have a “design” availability defined by that of the building in which they are housed. However, dedicated, “stand alone”, data centres would be expected to feature facilities and infrastructures meeting specified “design” availability criteria.

The purpose of the data centres and the business models served by them can also vary dramatically. The business models are generally differentiated by the nature of separate ownership of the facility, the information technology equipment and the software systems operated on that equipment.

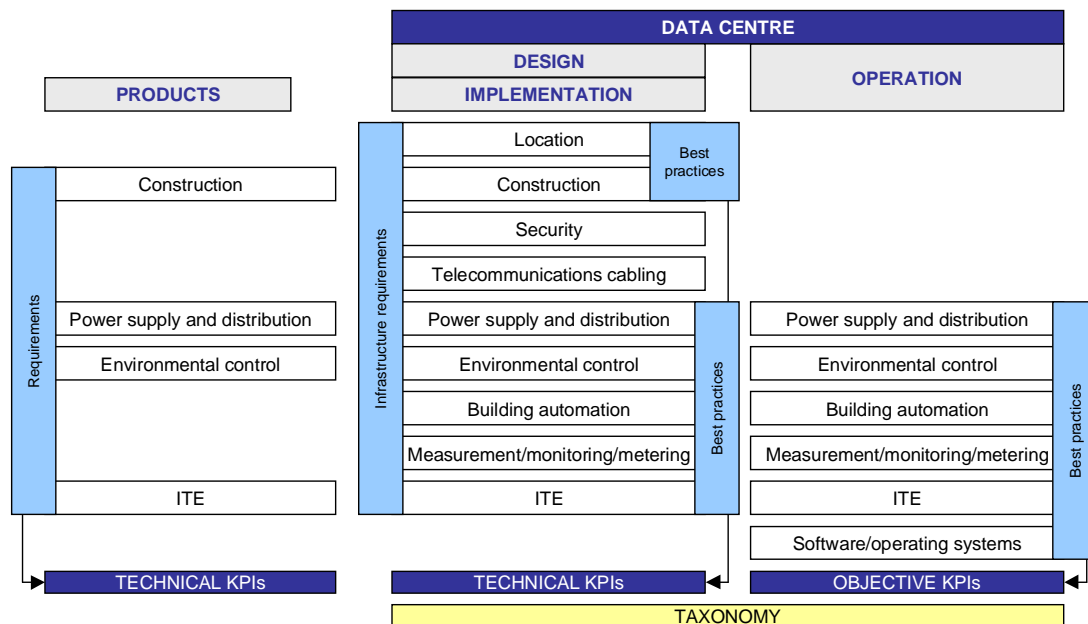
These models are commonly described as:

- 1) enterprise: where ownership of the facility, the information technology equipment and the software systems is common: i.e. the “operator” as defined in the European Code of Conduct for Data Centre Energy Efficiency Best Practices (EU CoC BP);
- 2) co-location: where ownership of the facility is separate from that of the information technology equipment, the software systems and their immediate accommodation (“colo” as defined in EU CoC BP);
- 3) hosting: where ownership of the facility and the information technology equipment is common but the software systems are dictated by others (“MSP” as defined in EU CoC BP).

The type of organisations operating the different types of data centre model is not restricted e.g. network operators may operate all three types.

The ability of owners of the data centre facilities and infrastructures to influence the energy performance and environmental viability of their data centres varies substantially across the three models. The same is true of actual availability of the service from the data centre which ultimately relies on the type and configuration of the ITE - independent of the “design availability” of the facility and infrastructures. Nevertheless, facilities and infrastructures with higher levels of “design availability” will tend to exhibit lower levels of task efficiency.

Independent of the detailed definition of a data centre the standardisation landscape has the form shown in Figure 4. It is important to differentiate between standards that support data centre design and those that can be used to improve their operation.



NOTE: For the purposes of this document “location” and “construction” relate to the building or structure containing the data centre and its facilities. Regenerative architecture (e.g. vegetated roof, storm water management practices) and land use is addressed if considered to have significant impact.

Figure 4 – Standardization landscape for data centre energy management and environmental viability

4.2 Design standardisation

In design terms it is realistic to develop European standards (or technical reports) that:

- a) define energy performance and environmental viability requirements for products (see the informative Annexes of this report) and infrastructures (clauses 5 and 6);
- b) define requirements and recommendations (best practices) which dictate how those products, and others, are used within the implementation of data centre facilities and infrastructures to improve energy management and environmental viability;
- c) specify the various infrastructures of monitoring/metering/measurement devices of defined accuracy necessary to calculate/present the operational Key Performance Indicators (KPIs) of 4.3.

4.3 Operational standardisation

In operational terms it is realistic to develop European standards (or technical reports) that:

- a) describe best practices, or perhaps sets of best practices, that indicate how management of an existing, operational, data centre may be applied to improve its energy performance and environmental viability;

NOTE: It is important to consider “design” best practices as separate from operational best practices since the latter have to be applicable to legacy data centres within which the design best practices have not been followed. This separation will greatly enhance the value of both documents.

- b) define a range of KPIs for energy management and environmental viability that may be applied to an operational data centre;
- c) specify the various infrastructures of monitoring/metering/measurement devices of defined accuracy necessary to calculate/present the KPIs of b).

4.4 Key Performance Indicators (KPIs)

Standards are being developed to specify how KPIs are measured, monitored and applied. Annex E provides greater detail in the differentiation of technical, objective and global KPIs for energy and other resource management.

It is highlighted that it is not the intention to characterise an operational data centre by a single global KPI – different global KPIs may combine different combinations of objective KPIs with the intention of focussing on specific resource efficiency objectives.

It is also important to:

- consider operational KPIs (objective or global) as trend indicators and not comparators between different data centres;
- ensure that the use of global KPIs does not serve to hide the trends demonstrated by the underpinning objective KPIs.

4.5 Taxonomy

Taxonomy is a useful exercise and is included as potential standardisation work. However, there are dangers of trying to define terms with a single meaning that may have to be used differently in the various types of standards to be produced. There are multiple examples of this in other technologies. Despite the apparent universality of taxonomy it is actually of little importance since individual standards should contain the required definitions - at least in the initial stages.

5 Designing for improvement of energy management

5.1 General

The standards/initiatives within ESOs, international standards bodies and other fora relating to the energy management aspects of the design (and implementation) of data centres are detailed in this clause. The tables of this clause show which ESO activity is complete, underway or required.

5.2 references requirements and recommendations for data centre facilities and infrastructures.

5.3 references best practices for the selection of components and subsystems for use within data centre facilities and infrastructures in order that overall objectives for improved energy management are attainable.

5.4 references requirements and recommendations for data centre ITE.

5.5 references best practices for the selection of ITE in order that overall objectives for improved energy management are attainable.

5.2 Infrastructure requirements

5.2.1 Construction

CEN	CLC	ETSI
	EN 50600-2-1	EN 305 174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TS 22237-2	
Industry fora		EU initiatives
BREEAM LEED		

5.2.2 Power distribution

CEN	CLC	ETSI
	EN 50174-1 EN 50174-2 EN 50600-2-2	EN 305 174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC 14763-2 ISO/IEC TS 22237-3 ISO/IEC 22237-3 (in development)	
Industry fora		EU initiatives

5.2.3 Environmental control

CEN	CLC	ETSI
	EN 50600-2-3	EN 305 174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TS 22237-4 ISO/IEC 22237-4 (in development)	
Industry fora		EU initiatives

5.2.4 Telecommunications cabling

CEN	CLC	ETSI
	EN 50600-2-4 EN 50173-2 EN 50173-5 EN 50173-6 EN 50174-1 EN 50174-2	EN 305 174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TS 22237-5 ISO/IEC 11801-2 ISO/IEC 11801-5 ISO/IEC 11801-6 ISO/IEC 14763-2	
Industry fora		EU initiatives

5.2.5 Building automation

CEN	CLC	ETSI
	EN 50173-6	EN 305 174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC 11801-6	
Industry fora		EU initiatives

5.2.6 Measurement/monitoring/metering

CEN	CLC	ETSI
	EN 50600-2-2 EN 50600-2-3 EN 50600-2-5 EN 50600-3-1	EN 305 174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TS 22237-3 ISO/IEC TS 22237-4 ISO/IEC TS 22237-6 ISO/IEC TS 22237-7 ISO/IEC 22237-3 (in development) ISO/IEC 22237-4 (in development)	
Industry fora		EU initiatives

5.3 Infrastructure recommendations (best practice)

5.3.1 General

The additive use of the most task efficient components and subsystems does not automatically produce the most overall task efficient solution and it has to be recognised that there may be conflict within any race to produce standardised solutions. Against this background, best practices are the most pragmatic mechanism to encourage application of the most effective solutions. By definition, best practices are recommendations which are most appropriate for publication as Technical Reports.

5.3.2 Location

CEN	CLC	ETSI
	CLC/TR 50600-99-1 CLC/TS 50600-2-10 (in development)	ETSI TS 105 174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133 (in development) ISO/IEC TS 22237-30 (in development)	L.1300
Industry fora		EU initiatives

5.3.3 Construction

CEN	CLC	ETSI
	CLC/TR 50600-99-1 CLC/TS 50600-2-10 (in development)	ETSI TS 105 174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133 (in development) ISO/IEC TS 22237-30 (in development)	L.1300
Industry fora		EU initiatives

5.3.4 Power distribution

CEN	CLC	ETSI
	CLC/TR 50174-99-1 CLC/TR 50600-99-1	ETSI TS 105 174-2 ETSI TR 102 532
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133 (in development)	L.1300
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

5.3.5 Environmental control

CEN	CLC	ETSI
	CLC/TR 50600-99-1	ETSI TS 105 174-2 ETSI TR 102 489 EN 300 019 series
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133 (in development)	L.1300
Industry fora		EU initiatives
ASHRAE		EU CoC BP V.11.1.0

5.3.6 Telecommunications cabling

CEN	CLC	ETSI
		ETSI TS 105 174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133 (in development)	L.1300
Industry fora		EU initiatives

5.3.7 Building automation

CEN	CLC	ETSI
	CLC/TR 50600-99-1	ETSI TS 105 174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133 (in development)	L.1300
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

5.3.8 Measurement/monitoring/metering

CEN	CLC	ETSI
	CLC/TR 50600-99-1	ETSI TS 105 174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133 (in development)	L.1300
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

5.3.9 Key Performance Indicators

CEN	CLC	ETSI
	CLC/TR 50600-99-1	ETSI TS 105 174-2
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

5.4 ITE requirements

5.4.1 Computing

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

5.4.2 Storage

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

5.4.3 Networking

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

5.4.4 Measurement/monitoring/metering

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

5.4.5 Key Performance Indicators

CEN	CLC	ETSI
		EN 303 470
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC 30134-4 ISO/IEC 21836 (in development)	
Industry fora		EU initiatives

5.5 ITE recommendations (best practice)

5.5.1 Computing

CEN	CLC	ETSI
	CLC/TR 50600-99-1	ETSI TS 105 174-2
ISO	IEC or ISO/IEC	ITU-T
		L.1300
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

5.5.2 Storage

CEN	CLC	ETSI
	CLC/TR 50600-99-1	ETSI TS 105174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC 24091	L.1300
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

5.5.3 Networking

CEN	CLC	ETSI
	CLC/TR 50600-99-1	ETSI TS 105 174-2
ISO	IEC or ISO/IEC	ITU-T
		L.1300
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

5.5.4 Measurement/monitoring/metering

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

5.5.5 Key Performance Indicators

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6 Designing for environmental viability

6.1 General

The standards/initiatives within ESO, international standards bodies and other fora relating to the environmental viability aspects (beyond those of energy management) of the design (and implementation) of data centres are detailed in this clause. The tables of this clause show which ESO activity is complete, underway or required.

6.2 references requirements and recommendations for data centre facilities and infrastructures.

6.3 references best practices for the selection of components and subsystems for use within data centre facilities and infrastructures in order that overall objectives for environmental viability are attainable.

6.4 references requirements and recommendations for data centre ITE together with the associated software.

6.5 references best practices for the selection of ITE in order that overall objectives for environmental viability are attainable.

6.2 Infrastructure requirements

6.2.1 Construction

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives
BREEAM		
LEED		

6.2.2 Power distribution

CEN	CLC	ETSI
		EN 305 174-2
ISO	IEC or ISO/IEC	ITU-T
	IEC 60364-8-1	
Industry fora		EU initiatives

6.2.3 Environmental control

CEN	CLC	ETSI
		EN 305 174-2
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.2.4 Telecommunications cabling

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC 14763-5 (in preparation)	
Industry fora		EU initiatives

6.2.5 Building automation

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.2.6 Measurement/monitoring/metering

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.2.7 Key Performance Indicators

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.3 Infrastructure recommendations (best practice)

6.3.1 Location

CEN	CLC	ETSI
	CLC/TR 50600-99-2	
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.3.2 Construction

CEN	CLC	ETSI
	CLC/TR 50600-99-2	
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.3.3 Power distribution

CEN	CLC	ETSI
	CLC/TR 50600-99-2	
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.3.4 Environmental control

CEN	CLC	ETSI
	CLC/TR 50600-99-2	
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.3.5 Telecommunications cabling

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.3.6 Building automation

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.3.7 Measurement/monitoring/metering

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.3.8 Key Performance Indicators

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.4 ITE and software requirements

6.4.1 Computing

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.4.2 Storage

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.4.3 Networking

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.4.4 Measurement/monitoring/metering

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.5 ITE and software recommendations (best practice)

6.5.1 Computing

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.5.2 Storage

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.5.3 Networking

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.5.4 Measurement/monitoring/metering

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

6.5.5 Key Performance Indicators

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

7 Operating procedures

7.1 General

The standards/initiatives within ESO, international standards bodies and other fora relating to the energy management and environmental viability aspects of the operation of data centres are detailed in this clause. The tables of this clause show which ESO activity is complete, underway or required.

7.2 and 7.3 reference requirements and best practices respectively for the operation of data centre facilities and infrastructures in order that overall objectives for improved energy management and environmental viability are attainable.

7.4 and 7.5 reference requirements and best practices respectively for the selection of ITE in order that overall objectives for improved energy management and environmental viability are attainable

7.2 Infrastructure requirements

7.2.1 Power distribution

CEN	CLC	ETSI
		EN 305 174-2
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

7.2.2 Environmental control

CEN	CLC	ETSI
		EN 305 174-2
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

7.2.3 Measurement/monitoring/metering

CEN	CLC	ETSI
	EN 50600-2-2 EN 50600-2-3 EN 50600-2-5 EN 50600-3-1	
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TS 22237-3 ISO/IEC TS 22237-4 ISO/IEC TS 22237-6 ISO/IEC TS 22237-7 ISO/IEC 22237-3 (in development) ISO/IEC 22237-4 (in development)	
Industry fora		EU initiatives

7.3 Infrastructure recommendations (best practice)

7.3.1 Power distribution

CEN	CLC	ETSI
	CLC/TR 50600-99-1 CLC/TR 50174-99-1	ETSI TS 105 174-2 ETSI TR 102 530
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133	L.1300
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

7.3.2 Environmental control

CEN	CLC	ETSI
	CLC/TR 50600-99-1	ETSI TS 105 174-2 ETSI TR 102 530 EN 300 019
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133	L.1300
Industry fora		EU initiatives
ASHRAE		EU CoC BP V.11.1.0

7.3.3 Measurement/monitoring/metering

CEN	CLC	ETSI
	EN 50600-2-2 EN 50600-2-3 EN 50600-3-1 CLC/TR 50600-99-1	ETSI TR 102 530
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TS 22237-3 ISO/IEC TS 22237-4 ISO/IEC TS 22237-7 ISO/IEC TR 30133 ISO/IEC 22237-3 (in development) ISO/IEC 22237-4 (in development)	L.1300
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

7.4 ITE requirements

7.4.1 Computing

CEN	CLC	ETSI
		EN 305 174-8
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

7.4.2 Storage

CEN	CLC	ETSI
		EN 305 174-8
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

7.4.3 Networking

CEN	CLC	ETSI
		EN 305 174-8
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

7.4.4 Measurement/monitoring/metering

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

7.5 ITE and software recommendations (best practice)

7.5.1 Computing

CEN	CLC	ETSI
	CLC/TR 50600-99-1	ETSI TS 105 174-2 ETSI TS 105 174-8 (in development) ETSI TR 102 530
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133	L.1300
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

7.5.2 Storage

CEN	CLC	ETSI
	CLC/TR 50600-99-1	ETSI TS 105 174-2 ETSI TS 105 174-8 (in development)
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133	L.1300
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

7.5.3 Networking

CEN	CLC	ETSI
	CLC/TR 50600-99-1	TS 105 174-2 ETSI TS 105 174-8 (in development)
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133	L.1300
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

7.5.4 Measurement/monitoring/metering

CEN	CLC	ETSI
	CLC/TR 50600-99-1	ETSI TS 105 174-2
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 30133	L.1300
Industry fora		EU initiatives
		EU CoC BP V.11.1.0

8 Operational Key Performance Indicators

8.1 Energy management

8.1.1 General

The dramatic differences of data centre scale, levels of intended availability and operational business model make it difficult to produce effective comparisons of energy consumption or task efficiency between data centres. For example, business drivers such as service level agreements and data security may require resilient design features which tend to negatively influence both energy consumption and energy efficiency. Similarly, the early operational stages of an evolving data centre may exhibit low energy consumption while demonstrating relatively poor energy efficiency by some measures.

Even to determine trends within a given data centre requires careful consideration. However, it is equally clear that operational practices which improve energy performance without engendering risks to availability should be encouraged and that operational KPIs are necessary to support the formulation of targets, trends or comparisons.

For the purposes of this report, operational energy management comprises four separate elements:

- energy consumption;
- task efficiency – a number of different indicators are under consideration and the most appropriate solution may depend upon the business model of, processes undertaken within, the data centre;
- the re-use of any waste heat - however, any approach on this topic has to be addressed with caution - one needs to consider how the reusable heat is obtained (e.g. is it preconditioned to a higher temperature) and where would the heat have come from otherwise;
- the use of locally provided energy generated from renewable sources.

Objective KPIs (see 4.4) are required for each element.

Global KPIs (see 4.4) which combine the objective KPIs in a meaningful and fair manner (see Annex E) are subject to standardisation.

8.1.2 Objective KPIs

8.1.2.1 Energy consumption

CEN	CLC	ETSI
		ETSI EN 305 200-2-1 ETSI EN 305 200-3-1
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC TR 21897 (in development) ISO/IEC TR 23050	
Industry fora		EU initiatives

8.1.2.2 Task efficiency

8.1.2.2.1 IT

CEN	CLC	ETSI
	EN 50600-4-2	
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC 30134-2 ISO/IEC 30134-5	L.1302
Industry fora		EU initiatives

8.1.2.2.2 Facilities and infrastructure

CEN	CLC	ETSI
	EN 50600-4-2 EN 50600-4-7	
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC 30134-2 ISO/IEC 30134-7 (in development)	
Industry fora		EU initiatives

8.1.2.3 Re-use of energy

CEN	CLC	ETSI
	EN 50600-4-6	
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC 30134-6 (in development)	
Industry fora		EU initiatives

8.1.2.4 Use of renewable energy

CEN	CLC	ETSI
	EN 50600-4-3	
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC 30134-3	
Industry fora		EU initiatives

8.1.3 Global KPIs

CEN	CLC	ETSI
		ETSI EN 305 200-2-1 ETSI EN 305 200-3-1 TS 105 200-3-1
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

8.2 Environmental viability

8.2.1 Objective KPIs

Objective KPIs (see 4.4) are applicable to aspects of environmental viability. These KPIs include the use of other resources such as carbon and water usage but the relevance of a specific KPI will depend upon the availability of the resource in question.

CEN	CLC	ETSI
	EN 50600-4-8 (in development) EN 50600-4-9 (in development)	ETSI TR 105 178
ISO	IEC or ISO/IEC	ITU-T
	ISO/IEC 30134-8 (in development) ISO/IEC 30134-9 (in development)	
Industry fora		EU initiatives

8.2.2 Maturity

Work is underway to develop a maturity model in relation to environmental sustainability based upon both energy management and environmental viability practice implemented by the data centre owner and/or user.

CEN	CLC	ETSI
	CLC/TS 50600-5-1 (In development)	
ISO	IEC or ISO/IEC	ITU-T
Industry fora		EU initiatives

Annex A

Product standards: Construction (e.g. lighting products)

A.1 General

This Annex provides information regarding the standards/initiatives within ESO, international standards bodies and other fora relating to the energy management and environmental viability aspects of the sub-systems of data centre construction.

A.2 Products

A.2.1 Containment

CEN	CLC	ETSI
	EN IEC 62996-1 EN IEC 62966-2	
ISO	IEC or ISO/IEC	ITU-T
	IEC 62966-1 IEC 62966-2	
Industry fora		EU initiatives

Annex B

Product standards: Power distribution (e.g. transformers, UPS, LVDC)

B.1 General

This Annex provides information regarding the standards/initiatives within ESO, international standards bodies and other fora relating to the energy management and environmental viability aspects of the sub-systems of power distribution.

This Annex addresses the following components:

- uninterruptible power supplies (UPS), transformers, switch gear, back-up generators including tanks, power distribution units (PDUs), batteries and connecting hardware.

This Annex addresses the following components if considered to have significant impact:

- power cables, renewable energy generator if part of the data centre (solar panels, wind turbine, geothermal...), other miscellaneous component loads, such as data centre lighting.

B.2 Products

B.2.1 Transformers

B.2.2 Switching equipment

CEN	CLC	ETSI
	EN 62040-1 EN 62040-2 EN 62040-3 EN 62040-4 EN 60947-3 EN 60947-6-1 EN 61439-1 EN 61439-2	
ISO	IEC or ISO/IEC	ITU-T
	IEC 62040-1 IEC 62040-2 IEC 62040-3 IEC 62040-4 IEC 60947-3 IEC 60947-6-1 IEC 61439-1 IEC 61439-2	
Industry fora		EU initiatives

B.2.3 Distribution panels

CEN	CLC	ETSI
	EN 61439-1 EN 61439-2	
ISO	IEC or ISO/IEC	ITU-T
	IEC 61439-1 IEC 61439-2	
Industry fora		EU initiatives

B.2.4 Uninterruptible power supplies

CEN	CLC	ETSI
	EN 88528-11 EN 62040-1 EN 62040-2 EN 62040-3 EN 62040-4	
ISO	IEC or ISO/IEC	ITU-T
	IEC 88528-11 IEC 62040-1 IEC 62040-2 IEC 62040-3 IEC 62040-4	
Industry fora		EU initiatives

B.2.5 Connecting hardware

CEN	CLC	ETSI
ISO	IEC or ISO/IEC	ITU-T
	IEC TS 62735-1 IEC TS 62735-2	
Industry fora		EU initiatives

B.2.6 Measurement equipment

CEN	CLC	ETSI
	EN 60044-1	
ISO	IEC or ISO/IEC	ITU-T
	IEC 60044-1	
Industry fora		EU initiatives

Annex C

Product standards: Environmental control

C.1 General

This Annex will provide information regarding the standards/initiatives within ESO, international standards bodies and other fora relating to the energy management and environmental viability aspects of the sub-systems of environmental control systems

This Annex addresses the following components:

- chillers, computer room air conditioning units (CRACs), direct expansion air handler (DX) units, pumps, cooling towers.

This Annex will address the following components if considered to have significant impact:

- heat exchange systems (e.g. equipment for using natural or industrial heat exchange), reservoir storage for collecting rain water

Annex D

Product standards: ITE

D.1 General

This Annex will provide information regarding the standards/initiatives within ESO, international standards bodies and other fora relating to the energy management and environmental viability aspects of ITE.

This Annex addresses the following components:

- ITE servers, switches, routers etc;
- storage devices etc.

This Annex will address the following components if considered to have significant impact:

- keyboard, video and mouse (KVM) systems, monitors, workstations/laptops, printers, network cables.

Annex E

Key Performance Indicators for energy management

E.1 Technical KPIs

Individual components or sub-assemblies can be designed to have improved task efficiency i.e. less energy is consumed for a given output or task. Such components or sub-assemblies may be inherently more efficient in the way in which they use energy under specific operating conditions but are essentially unable to manage that consumption. An example of such a product would be a power supply unit which may be more efficient under higher load conditions.

More complex products may contain hardware and/or software which automatically reduce energy consumption under specific operating conditions by putting certain functions into "idle" states if not required. This is distinctly different than that of a single task component or sub-assembly detailed above.

Technical KPIs can be applied to both of the above by assessing energy consumption for a number of specific operating conditions and also across a combination of such operating conditions. Assuming those operating conditions reflect the probable operating environment for the component, sub-assembly or product, a customer may make valued judgements in relation to the appropriateness of the Technical KPI.

For example, two products that have equal "combined" Technical KPIs, may be more efficient under very specific conditions. For example, a design of power supply that is more task efficient under high load conditions may be inappropriate for users who plan to predominantly operate under low load conditions (and vice versa).

A higher level of task efficiency management is also possible where groups of products are managed to reduce energy consumption by either allocating loads in such a way that the group is operating at maximum task efficiency and/or by putting individual products within the group into an "idle" mode. Examples of such managed solutions are seen in data centre software plug-ins (such as those developed under the Fit4Green and GAMES projects funded by the European Commission) and in documents developed by ETSI TC EE. Once again, the value of such approaches can be validated by the establishment of Technical KPIs which can be applied to both of the above by assessing energy consumption of a defined group of products for a number of specific operating conditions and also across a combination of such operating conditions.

Figure E.1 provides a schematic in relation to energy-related KPIs. The left-hand side of that schematic relates to the Technical KPIs of the design and engineering phase for components, sub-assemblies, products and systems.

E.2 Objective KPIs

The Objective KPIs relate to specific elements of energy management described in E.1 for operational infrastructures under the control of their operators as follows:

- energy consumption: the total consumption of energy by an operational infrastructure;
- task efficiency: a measure of the work done (as a result of design and/or operational procedures) for a given amount of energy consumed;
- energy re-use: transfer or conversion of energy (typically in the form of heat) produced by the operational infrastructure to do other work;
- renewable energy: energy produced from dedicated generation systems using resources that are naturally replenished.

The procurement of products and systems based upon their Technical KPIs for energy consumption and/or task efficiency underpins the relevant Objective KPIs. However, Objective KPIs define requirements for the measurement of operational infrastructures i.e. taking into account the real operating conditions over a defined period of time.

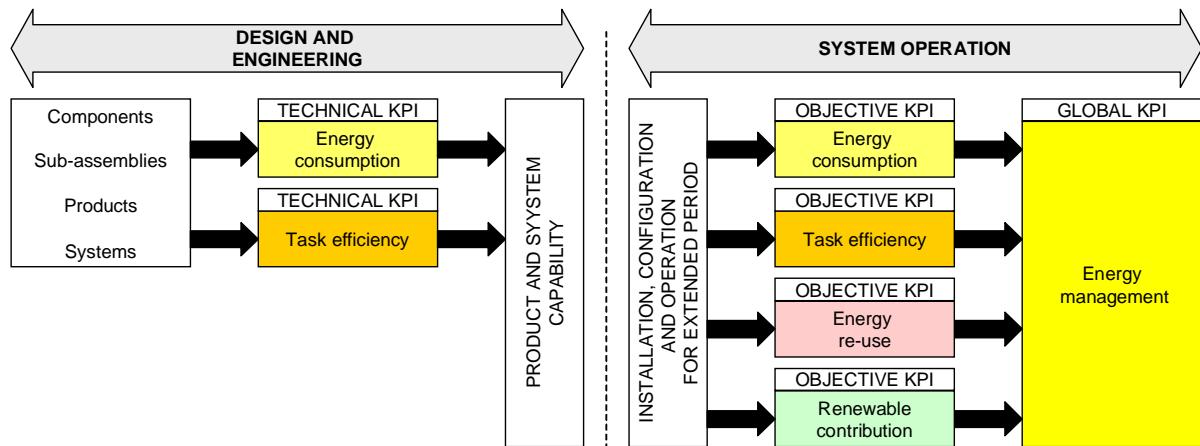


Figure E.1 - The relationship of energy-related Technical, Objective and Global KPIs

The performance of products and systems, of proven Technical KPIs performance, may exhibit different energy consumption and task efficiency characteristics when subjected to actual operating conditions which lie outside those of the Technical KPIs applied to those products and systems at the design and engineering stages and, equally importantly, when subjected to user configuration and controls which may undermine the sophisticated systems available.

The right-hand side of the schematic in Figure E.1 relates to the Objective KPIs of complete infrastructures in the operational phase.

E.3 Global KPIs

The Objective KPIs, of which task efficiency is only one, may be combined using a formula appropriate to the specific operational infrastructure to produce one or more Global operational KPIs which reflects the overall performance of the operational infrastructures against wider energy management targets which may be self-imposed by the operators or externally applied by legislators.

Global KPIs provide a different view of a users' commitment to strategic energy management practices than the Objective KPIs. For example, a user is not supporting overall energy goals by achieving class-leading provision of local renewable energy if their overall energy consumption is based upon equipment with very poor task efficiency. Global KPIs may be useful but their use should not serve to hide the trends demonstrated by the underpinning Objective KPIs.

E.4 Summary

Operational Global and Objective KPIs are fundamentally different to the Technical KPIs applied to products and systems at the design and engineering stages. The former are used to monitor and drive user behaviour whereas the latter are substantial indications of potential operational performance.

It is therefore important to support, but differentiate, the role of the Technical KPIs from the Objective and Global operational KPIs.

Annex F

Bibliography

F.1 List of referenced standards from main body

F.1.1 CENELEC

CLC/TR 50174-99-1, *Information technology - Cabling installation - Part 99-1 Remote powering*

CLC/TR 50600-99-1, *Information technology - Data centre facilities and infrastructures – Part 99-1: Recommended practices for resource management*

CLC/TR 50600-99-2, *Information technology - Data centre facilities and infrastructures – Part 99-2: Recommended practices for environmental viability*

CLC/TS 50600-2-10, *Information technology - Data centre facilities and infrastructures – Part 2-10: Earthquake risk and impact analysis*

CLC/TS 50600-5-1, *Information technology - Data centre facilities and infrastructures – Part 5-1: Data Centre Maturity Model*

EN 50173-2, *Information technology - Generic cabling systems – Part 2: Office spaces*

EN 50173-5, *Information technology - Generic cabling systems – Part 5: Data centre spaces*

EN 50173-6, *Information technology - Generic cabling systems – Part 6: Distributed building services*

EN 50174-1, *Information technology - Cabling installation– Part 1: Installation specification and quality assurance*

EN 50174-2, *Information technology - Cabling installation– Part 2: Planning and installation practice inside buildings*

EN 50600-1, *Information technology - Data centre facilities and infrastructures – Part 1: General concepts*

EN 50600-2-1, *Information technology - Data centre facilities and infrastructures – Part 2-1: Building construction*

EN 50600-2-2, *Information technology - Data centre facilities and infrastructures – Part 2-2: Power supply and distribution*

EN 50600-2-3, *Information technology - Data centre facilities and infrastructures – Part 2-3: Environmental control*

EN 50600-2-4, *Information technology - Data centre facilities and infrastructures – Part 2-4: Telecommunications cabling infrastructure*

EN 50600-2-5, *Information technology - Data centre facilities and infrastructures – Part 2-5: Physical security*

EN 50600-3-1, *Information technology - Data centre facilities and infrastructures – Part 3-1: Management and operational information*

EN 50600-4-2, *Information technology - Data centre facilities and infrastructures - Part 4-2: Key Performance Indicators - Power Usage Effectiveness (PUE)*

EN 50600-4-3, *Information technology - Data centre facilities and infrastructures - Part 4-3: Key Performance Indicators - Renewable Energy Factor (REF)*

EN 50600-4-6, *Information technology - Data centre facilities and infrastructures - Part 4-6: Key Performance Indicators - Energy Re-use Factor (ERF)*

EN 50600-4-7, *Information technology - Data centre facilities and infrastructures - Part 4-7: Cooling Effectiveness Ratio (CER)*

EN 50600-4-8, *Information technology - Data centre facilities and infrastructures - Part 4-8: Carbon Usage Effectiveness (CUE)*

EN 50600-4-9, *Information technology - Data centre facilities and infrastructures - Part 4-9: Water Usage Effectiveness (WUE)*

EN IEC 62996-1, *Mechanical structures for electrical and electronic equipment – Aisle containment for IT cabinets – Part 1: Dimensions and mechanical requirements*

EN IEC 62996-2, *Mechanical structures for electrical and electronic equipment – Aisle containment for IT cabinets – Part 2: Details of air flow, air separation and air cooling requirements*

F.1.2 ETSI

ETSI EN 300 019 series, *Environmental conditions and environmental tests for telecommunications equipment*

EN 303 470, *Measurement Process for Energy Efficiency KPI for Servers*

EN 305 174-2, *Broadband Deployment and Lifecycle Resource Management; Part 2: ICT Sites*

ETSI EN 305 174-8, *Broadband Deployment and Lifecycle Resource Management; Part 8: Management of end of life of ICT equipment (ICT waste/end of life)*

ETSI EN 305 200-2-1, *Energy management; Operational infrastructures; Global KPIs; Part 2: Specific requirements Sub-part 1: ICT sites*

ETSI EN 305 200-3-1, *Energy management; Operational infrastructures; Global KPIs; Part 3: ICT sites Sub-part 1: DCEM*

ETSI TR 102 489, *Environmental Engineering (EE); European telecommunications standard for equipment practice; Thermal management guidance for equipment and its deployment*

ETSI TR 102 530, *Environmental Engineering (EE); The reduction of energy consumption in telecommunications equipment and related infrastructure*

ETSI TR 102 532, *Environmental Engineering (EE); The use of alternative energy solutions in telecommunication installations*

ETSI TS 105 174-2, *Broadband Deployment and Lifecycle Resource Management; Part 2: ICT sites: Implementation of energy and lifecycle management practises*

ETSI TS 105 174-8, *Broadband Deployment and Lifecycle Resource Management; Part 8: ICT sites: Implementation of WEEE practices for ICT equipment during maintenance and at end-of-life*

ETSI TR 105 178, *Access, Terminals, Transmission and Multiplexing (ATTM); Comparison of sustainability parameters between internal and external, including "cloud-based", ICT hosting solutions*

ETSI TS 105 200-3-1, *Energy management; Operational infrastructures; Implementation of Global KPIs; Part 3: ICT sites Sub-part 1: DCEM*

F.1.3 IEC

IEC 60364-8-1: *Low voltage electrical installation - Energy efficiency*

F.1.4 ISO/IEC

ISO/IEC 11801-2, *Information technology - Generic cabling for customer premises – Part 2: Office premises*

ISO/IEC 11801-5, *Information technology - Generic cabling for customer premises – Part 5: Data centres*

ISO/IEC 11801-6, *Information technology - Generic cabling for customer premises - Part 6: Distributed building services*

ISO/IEC 14763-2, *Information technology - Implementation and operation of customer premises cabling - Part 2: Planning and installation*

ISO/IEC 21836, *Information technology - Data Centres - Server Energy Effectiveness Metric*

ISO/IEC 22237-3, *Information technology - Data centre facilities and infrastructures – Part 3: Power supply and distribution*

ISO/IEC 22237-4, *Information technology - Data centre facilities and infrastructures – Part 4: Environmental control*

ISO/IEC 24091, *Information technology - Power efficiency measurement specification for data center storage*

ISO/IEC 30134-2, *Information Technology - Data Centres - Key Performance Indicators – Part 2: Power Usage Effectiveness (PUE)*

ISO/IEC 30134-3, *Information Technology - Data Centres - Key Performance Indicators – Part 3: Renewable Energy Factor (REF)*

ISO/IEC 30134-4, *Information Technology - Data Centres - Key Performance Indicators – Part 4: IT Equipment Energy Efficiency for Servers*

ISO/IEC 30134-5, *Information Technology - Data Centres - Key Performance Indicators – Part 5: IT Equipment Energy Utilisation for Servers*

ISO/IEC 30134-6, *Information Technology - Data Centres - Key Performance Indicators – Part 6: Energy Reuse Factor (ERF)*

ISO/IEC 30134-7, *Information Technology - Data Centres - Key Performance Indicators – Part 7: Cooling Efficiency Ratio (CER)*

ISO/IEC 30134-8, *Information Technology - Data Centres - Key Performance Indicators – Part 8: Carbon Usage Effectiveness (CUE)*

ISO/IEC 30134-9, *Information Technology - Data Centres - Key Performance Indicators – Part 9: Water Usage Effectiveness (WUE)*

ISO/IEC TR 21897, *Data centres energy efficiency - Methods and tools to assess and express energy production, storage and consumption of data centres in reference to primary energy*

ISO/IEC TR 23050, *Information technology - Data Centres - Excess Electrical Energy*

ISO/IEC TR 30133, *Information technology - Data centres - Guidelines for resource efficient data centres*

ISO/IEC TS 22237-2, *Information technology - Data centre facilities and infrastructures – Part 2: Building construction*

ISO/IEC TS 22237-3, *Information technology - Data centre facilities and infrastructures – Part 3: Power distribution*

ISO/IEC TS 22237-4, *Information technology - Data centre facilities and infrastructures – Part 4: Environmental control*

ISO/IEC TS 22237-5, *Information technology - Data centre facilities and infrastructures – Part 5: Telecommunications cabling infrastructure*

ISO/IEC TS 22237-6, *Information technology - Data centre facilities and infrastructures – Part 6: Physical security*

ISO/IEC TS 22237-7, *Information technology - Data centre facilities and infrastructures – Part 7: Management and operational information*

ISO/IEC TS 22237-30, *Information technology - Data centre facilities and infrastructures – Part 30: Earthquake risk and impact analysis*

F.1.5 ITU

ITU-T L.1300¹, *Best practices for green data centers*

ITU-T L.1302, *Assessment of energy efficiency on infrastructure in data centres and telecom centres*

F.2 List of referenced activities/documents from main body

ASHRAE (American Society of Heating, Refrigeration and Air-conditioning Engineers): *Thermal Guidelines (for data processing environments)*

BREEAM (Building Research Establishment Environmental Assessment Method)

European Union: *Code of Conduct for Data Centres Best Practices V.10.*

LEED (Leadership in Energy & Environmental Design)

F.3 List of referenced standards from Annexes

F.3.1 CENELEC

EN 60044-1, *Instrument transformers - Part 1: Current transformers*

EN 60947-3, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

EN 60947-6-1, *Low-voltage switchgear and controlgear. Multiple function equipment. Transfer switching equipment*

EN 61439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

EN 61439-2, *Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies*

EN 62040-1, *Uninterruptible power systems (UPS) - Part 1: General and safety requirements for UPS*

EN 62040-2, *Uninterruptible power systems (UPS) - Part 2: Electromagnetic compatibility (EMC) requirements*

EN 62040-3, *Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements*

EN 62040-4, *Uninterruptible power systems (UPS) - Part 4: Environmental aspects - requirements and reporting*

EN 88528-11, *Reciprocating internal combustion engine driven alternating current generating sets - Part 11: Rotary uninterruptible power systems - Performance requirements and test methods*

EN IEC 62966-1, *Mechanical structures for electrical and electronic equipment – Aisle containment for IT cabinets - Part 1: Dimensions and mechanical requirements*

EN IEC 62966-2, *Mechanical structures for electrical and electronic equipment – Aisle containment for IT cabinets - Part 2: Qualification of air flow, air separation and air conditioning requirements*

F.3.2 IEC

IEC 60044-1, *Instrument transformers - Part 1: Current transformers*

¹ Last revised in 2014 with the majority, many without change, of the EU CoC Best Practices for ITE selection (these have been superseded by the 2020 editions of both CLC/TR 50600-99-1 and the EU CoC Best Practices). Furthermore, L.1300 includes a small number of practices introduced by the members of ITU-T including the use of environmental ranges of ETSI EN 300 019 series standards.

IEC 60947-3, *Low-voltage switchgear and controlgear. Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 60947-6-1, *Low-voltage switchgear and controlgear. Multiple function equipment. Transfer switching equipment*

IEC 61439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61439-2, *Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies*

IEC 62040-1, *Uninterruptible power systems (UPS) - Part 1: General and safety requirements for UPS*

IEC 62040-2, *Uninterruptible power systems (UPS) - Part 2: Electromagnetic compatibility (EMC) requirements*

IEC 62040-3, *Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements*

IEC 62040-4, *Uninterruptible power systems (UPS) - Part 4: Environmental aspects - requirements and reporting*

IEC 62966-1, *Mechanical structures for electrical and electronic equipment – Aisle containment for IT cabinets - Part 1: Dimensions and mechanical requirements*

IEC 62966-2, *Mechanical structures for electrical and electronic equipment – Aisle containment for IT cabinets - Part 2: Qualification of air flow, air separation and air conditioning requirements*

IEC TS 62735-1, *Direct current (DC) plugs and socket-outlets for information and communication technology (ICT) equipment installed in data centres and telecom central offices - Part 1: Plug and socket-outlet system for 2,6 kW*

IEC TS 62735-2, *Direct current (DC) plugs and socket-outlets for information and communication technology (ICT) equipment installed in data centres and telecom central offices - Part 2: Plug and socket-outlet system for 5,2 kW*

F.4 List of potentially useful standards

EN ISO 13790, *Energy performance of buildings. Calculation of energy use for space heating and cooling*

EN ISO 14001, *Environmental management systems. Requirements with guidance for use*

EN ISO 14040, *Environmental management. Life cycle assessment. Principles and framework*

EN ISO 14064 series, *Greenhouse gases*

EN ISO 50001, *Energy management systems. Requirements with guidance for use*

IEC TR 62726, *GHG Emissions*

F.5 List of other related standardization documents

F.5.1 CENELEC

EN 50600-4-1, *Information technology - Data centre facilities and infrastructures - Part 4-1: Key Performance Indicators - Overview and general requirements*

EN 62474, *Material declaration for products of and for the electrotechnical industry*

EN ISO 9000, *Quality management systems - Fundamentals and vocabulary*

CLC/TR 50600-99-3, *Information technology - Data centre facilities and infrastructures - Part 99-3: Guidance to the application of EN 50600 series*

F.5.2 CEN

EN ISO/IEC 13273-2:2016, *Energy efficiency and renewable energy sources - Common international terminology - Part 2: Renewable energy sources (ISO/IEC 13273-2:2015)*

F.5.3 ISO

ISO 15392, *Sustainability in building construction - General principles*

ISO 26000, *Guidance on social responsibility*

ISO 21929-1, *Sustainability in building construction - Sustainability indicators. Framework for the development of indicators and a core set of indicators for buildings*

ISO 31000, *Risk management - Principles and guidelines*

F.5.4 ISO/IEC

ISO/IEC 22237-1: *Information technology - Data centre facilities and infrastructures – Part 1: General concepts*

ISO/IEC 30134-1, *Information Technology - Data Centres - Key Performance Indicators – Part 1: Overview and general requirements*

ISO/IEC TS 22237-1, *Information technology - Data centre facilities and infrastructures – Part 1: General concepts*